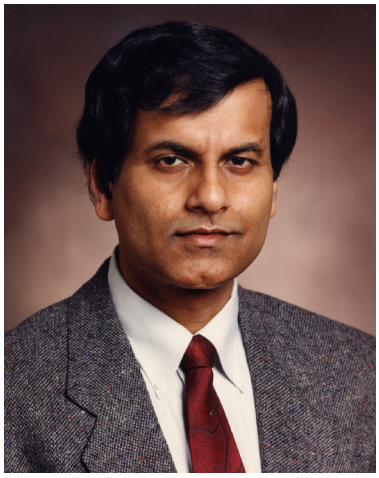
Dynamic Systems and Control Division Newsletter

Editor: Manish Paliwal *Spring 2005*



Clarence W. de Silva, Chair, DSCD

Chairperson's corner

Since its inception in 1943, the Dynamic Systems and Control Division (DSCD) has come a long way. My formal association with our Division started in 1978 by attending the Executive Committee Meeting, as a new assistant professor. Our mentors at the time were such giants like Dave Wormley, Art Murphy, Herb Richardson, and Mike Rabins, whom we rarely see now at these meetings, and other greats like Hank Paynter who have, sadly, left us forever. Over the years the Division has changed and matured in many respects, and remained somewhat static in a few other respects. In a changing world, our parent society, ASME, itself is undergoing significant changes. I am proud to state, however, that with regard to service to our members, leadership in the advancement of engineering and technologies, and prudent financial management, we have consistently outperformed our parent society.

DSCD's growth and the technical leadership are evident, for example, from the expansion of our technical panels such as Micro-elecromechanical Systems (MEMS) and Fluid Power Systems into subdivisions and divisions, and from the profile and impact of such journals as IEEE/ASME Transactions on MEMS, which had their origins within our Division. Our Division will continue to serve you through: our journals (ASME Dynamic Systems, Measurement and Control; IEEE/ASME Trans. Mechatronics) and conferences (ASME IMECE-the Congress; American Control Conference-ACC); supporting our prospective and budding members (e.g., providing travel support for students to attend our conferences); organizing conference sessions, symposia, and workshops; co-sponsoring international conferences (e.g., Japan-USA Flexible Automation; IEEE/ASME Intelligent Mechatronics or AIM; AVEC); supporting and facilitating research funding (e.g., providing a forum for NSF); recognizing the achievements and contributions of our members (e.g., through honors and awards); our presence in the American Automatic Control Council (AACC) and the operating board of the Systems and Design Group (S&DG); and so on.

More needs to be done. From what I gathered by attending the ASME Technical Executives Meeting (TEC); Continuity & Change General Assembly of the 2004 IMECE; and the Council on Engineering (COE) meeting where the organizational changes of ASME were presented and where the fiscal issues of ASME were discussed, it has become necessary to further expand our horizons. In particular, we must be involved in activities at the international domain and also establish closer collaborations with other organizations such as IEEE Control Systems Society (CSS) and International Federation of Automatic Control (IFAC), which have similar interests to our own. The recent tsunami tragedy in Asia is a "signal" to us in this direction. While the technologies that come under the purview of our Division can directly help those who have been affected, international activities, preferably in partnership with other technical organizations, can make a significant professional impact and also bring us closer as an open-minded global engineering community. To this end, the Executive Committee (see a listing elsewhere in the Newsletter) is committed to assisting and supporting the talented and enthusiastic volunteers within various technical panels and committees of the Division. The upcoming strategic plan of the Division will reflect our efforts and intentions in this direction.

As a start, we are in the process of assessing the performance of our technical panels, and elevating the deserving panels to technical committees. We will look into forming an Institute within the ASME, perhaps jointly with one or more other divisions. Collaboration with other organizations like IEEE CSS and IFAC can be broadened at the Institute level. Other changes that you will notice in the near future will include the following: Award functions that are more open and friendly to our members; providing a higher profile for our society-level award-the Oldenburger Medal; formation of a technical panel on Industrial Process Control with a view to establishing desirable partnerships with IEEE CSS and industry; and division-sponsored distinguished lectures.

I conclude by inviting those of you who have not yet been involved in the activities of the Division to please visit our web site (http://www.asme.org/divisions/dscd/), be familiar with what we are doing, and then volunteer for these activities and/or with new ideas and initiatives. Just send an e-mail with your coordinates and interests to someone on the executive committee or any other committee of DSCD. Everyone (industry, academia, government, young, young-at-hart, students, etc.) is invited. If you are already active in the Division, Thank You!

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Changes and Opportunities in Dynamic Systems and Controls at NSF

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The Civil and Mechanical Systems Division at NSF has been re-organized into three clusters: Engineered Materials and Mechanics, Infrastructure Systems and Hazard Mitigation, and Intelligent Civil and Mechanical Systems. This reorganization, which was conducted under the leadership of Division Director Galip Ulsoy, is aimed at providing an improved framework for responding to increasing proposal submissions in emerging areas such as nanomechanics, biomechanics, smart structures and mechatronics. The Intelligent Civil and Mechanical Systems cluster includes and expands the former Dynamic System Modeling Sensing and Control Program. This cluster is comprised by four programs, which are described below.

Control Systems Program

This program supports research leading to advances and novel developments in control systems strategies and technologies with broad applicability to civil and mechanical systems. Control of dynamical systems at all scales (nano to micro to macro), with or without humans in the loop, is considered in this program.

Dynamical Systems Program

This program supports fundamental advances in the understanding, design and operation of dynamic systems, including acoustics, vibrational response, and kinematic relationships; modeling, simulation, and design of nonlinear time-varying and distributed systems.

Information Technology and Infrastructure Systems

This program supports research seeking to create knowledge for the intelligent renewal of civil infrastructure systems, such as transportation, water supply, sanitation, power generation, and the built environment. It also supports research leading to engineering knowledge for the intelligent design, construction, maintenance, operation and decommissioning of the built environment.

Sensor Technologies for Civil and Mechanical Systems

This program supports research on acquiring and using information, through advanced sensors and sensor systems, about civil and mechanical systems to improve their safety, reliability, cost, and performance. This includes research that extends the knowledge base for development of advanced sensors in terms of sensing material and system characterization, and real-time monitoring that intelligently use the sensed information.

Each program has a responsible director. The director's biographies are included. There is intellectual overlap among the four programs; for this reason, the program directors work closely together to identify the most appropriate review panel (or panels) for any given proposal. The windows for submission to these program elements are February 1 to March 1 and September 1 to October 1.

The Civil and Mechanical Systems Division will participate in a new solicitation – Dynamic Data Driven Application Systems (DDDAS). DDDAS is a paradigm whereby simulation models and measurements become a symbiotic feedback control system. It entails the ability to dynamically incorporate additional data into executing simulations, and in reverse, the ability of the simulations to dynamically steer the measurement process. Such capabilities promise more accurate analysis and prediction, more precise controls, and more reliable outcomes. For large-scale complex interconnected systems, the DDDAS paradigm would enable estimation and prediction in the presence of uncertainty and limited computational resources. Manufacturing process controls; resource management; weather, natural hazards, and climate prediction; traffic management; prognosis in systems of systems; geo-exploration, social and behavioral modeling; cognitive measurement and bio-sensing are examples of areas likely to benefit from DDDAS.

It is expected that the dynamic systems and control (DSC) community of the ASME will partner with computer science colleagues to participate in this new initiative. The DSC community has the domain expertise to contribute the simulation models underlying the DDDAS paradigm. This community has also 40 years of experience with optimal estimation and prediction algorithms. It is expected that this experience will guide fundamental advance in DDDAS. Perhaps, pioneer papers will appear in the ASME Journal of Dynamic Systems, Measurement, and Control in complete analogy with Kalman's seminal paper: "A New Approach to Linear Filtering and Prediction Problems," Transaction of the ASME—Journal of Basic Engineering, pp. 35-45 (March 1960).

Dr. Jesús M. de la Garza is the Director of the Information Technology and Infrastructure Systems Program in the Civil and Mechanical Systems Division in the Engineering Directorate at the National Science Foundation. Dr. de la Garza also holds the Vecellio Endowed Professorship at Virginia Tech. Dr. de la Garza received his PhD from the University of Illinois in 1988. ASCE has specially recognized Dr. de la Garza's two journal papers by conferring the Thomas Fitch Rowland Price and the Best Paper Award in the Technical Council on Computer Practices. The Financial Management Association has also specially recognized a third journal paper.

Dr. Shih-Chi Liu is the Director of the Sensor Technologies for Civil and Mechanical Systems Program in the Civil and Mechanical Systems Division in the Engineering Directorate at the National Science Foundation. He is also an Honorary Professor of Tonji University (Shanghai), Institute of Engineering Mechanics (Harbin), Harbin Institute of Technology, and Nanjing University of Aeronautics and Astronautics. His industrial experience includes eight years (1967-1975) at Bell Laboratories (Whippany, New Jersey) in the general areas of structural/earthquake engineering, soil-structure interaction, seismic risk analysis, optimal design, random vibration, ground motion studies, and probabilistic/statistical methods in engineering applications. Recent research is focused in structural control, civil infrastructures, smart structures, and structural health monitoring technologies. Dr. Liu has received numerous awards, including AIJ Cultural Award, Architectural Institute of Japan in July 2003, and the China Seismological Bureau (CSB) Award for special contribution to US-China Cooperative Research in Earthquake Engineering in April 2003.

Dr. Eduardo Misawa is the Director of the Dynamical Systems Program in the Civil and Mechanical Systems Division in the Engineer

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Sensor Networks, Automation, and Integrated System Health Management (ISHM)

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Sensors make possible implementation of automatic systems with feedback control. But classically, design of control systems assumes that sensors provide data with an acceptable degree of accuracy. Classic automatic control loops rely on sensors to operate within design requirements while not suffering anomalies. This is perhaps acceptable for relatively low complexity, low criticality systems, where consequences of sensor anomalies on the performance of the system may be tolerated. The increasing complexity and level of automation of current and future systems, and the requirements on safety, availability, and cost of ownership (life-cycle costs), are driving up the numbers of sensors, and making requirements for sensor reliability, and availability tighter.

Industry and technology developers have embraced the paradigm of sensor networks as a way to simplify complexity (significant decrease in number of wires) and increase the availability of sensor data to multiple processing elements (e.g. controllers connected to the network as nodes). To further improve the benefits of sensor networks, standard protocols have been defined so that sensors from any manufacturer can be plugged in the network (Fieldbus, and others). One drawback of these protocols was their speed. The throughput was usually less than 10 data updates per second, or even less for more complex systems.

Driven by the telecommunications community, vast improvements in networking technologies have been achieved in the past decade. Specifically, speed and reliability have increased dramatically. Fortunately, these technologies are almost directly applicable to sensor networks, or even networks of any type of elements that makeup a system-of-systems (controllers, processing computers, etc). Furthermore, thanks to a vision and push that I believe is attributable to Dr. Kan Lee form NIST, the IEEE 1451.X standard was defined for smart sensors (TEDS - Transducer Electronic Data Sheet). This standard establishes a foundation for development of "intelligent" networked sensors.

The combination of faster network protocols and "Smart" sensor standards make now possible the maturation of technologies to implement effective networks of intelligent sensors, or for that matter, of intelligent elements. Implementation of such networks may take different forms. In the case of intelligent sensors, "intelligence" can reside physically on (or near) the sensing element itself. In this case we have a physical intelligent sensor (PIS). However, intelligence in the form of a virtual intelligent sensor (VIS) can also reside on a processor (computer) attached remotely to the network. This later option is suitable to retrofit existing systems that use classical sensors. There are two areas where technology needs to be matured to define Systems-of-Systems (SoS) as hierarchical networks of intelligent elements: (1) define what intelligence must go in the sensors (or other elements), and (2) develop an effective integration framework that focuses on management of data, information, and knowledge (DIaK) and not just data. This later area includes developing appropriate software tools to manage DIaK. Furthermore, managing DIaK implies (a) storage, (b) sharing, (c) maintenance, and (d) evolution.

Intelligence that resides in a sensor must be defined according to the functional capability needed at the sensor. This capability is levied by higher level capability requirements from the SoS. For instance, NASA's Exploration Systems Mission Directorate (ESMD - www.exploration.nasa.gov) is currently focused on development of technologies for products that will enable fulfilling President Bush's New Vision for Exploration. The Exploration Systems Research and Technology (ESR&T) Program has defined specific capabilities needed, one of them being Integrated System Health Management (ISHM). ISHM is about knowing at all times the condition of every element of the SoS. It is about embedding knowledge and information so that the system can apply human-inspired strategies to monitor, capture anomalies, diagnose sources of anomalies, and prognose future status of the SoS. It is also about providing the user with an integrated situational awareness of the SoS, and of every element in the context of its function within the SoS. As per the ISHM requirement, it is very appropriate to embed intelligence in every element of a SoS to achieve the capability using a distributed intelligence approach that also embodies other needed attributes such as modularity, flexibility, and life-cycle cost affordability.

Going back to defining intelligence that should reside in an intelligent sensor, in the context of ISHM, the requirement calls for sensors to provide data, qualification of the condition of the data (e.g. error estimate, useful or not), and the health of the sensor. This package of DIaK must be provided to the process (measurand) with which the sensor is associated (e.g. a pressure sensor measuring a pressurization process in a tank). In turn, the process should provide back to the sensor, information that may be used to update the sensor health. DIaK within each intelligent sensor should be sufficient to use its own historical data, information about the sensor, knowledge of the physical phenomena (empirical, analytical, etc.) governing the operation of the sensor, and perhaps very basic information about the process that the sensor is serving (e.g. an estimate of the time-constant of the parameter being measured). In addition, measurements about the operating environment of the sensor (e.g. temperature, humidity) should also be used as they can help determine the sensor health.

Integrated System Health Management (ISHM) is a NASA Stennis Space Center (SSC) core competency. An ISHM core prototype system under development utilizes the centers rocket engine test facilities as testbeds representing a SoS. These SoS are defined as a network of integrated intelligent elements (e.g. sensors, processes, etc.). This project is funded by the Human and Robotic Technology (H&RT) Office (ESMD), and was awarded as a result of the intramural competition in 2004. The project is part of a larger combined project "ISHM Testbed and Prototypes" with NASA Johnson Space Center, that includes the International Space Station (ISS) as a test bed to mature/develop ISHM technologies (the author is the PI of this project). The combined project targets a methodic insertion of ISHM capability into ground support facilities, then into space-based facilities, and finally as key enablers for Moon and Mars missions.

NASA's Exploration Mission has been launched, providing great opportunities

for academia, industry, and other private/public entities to contribute in this endeavor. In the very short term, there will be various announcements of opportunity for research and development at www.exploration.nasa.gov . SSC is interested in collaboration and partnering related to the topic of this article, as well as other topics.

Changes and Opportunities.... (*contd. from page 2*)

-ing Directorate at the National Science Foundation (start date May 16, 2005). He is also a Professor of Mechanical and Aerospace Engineering with Oklahoma State University. He joined the faculty in 1990 after been Assistant Professor of Mechanical Engineering with the University of Sao Paulo, and senior scientist and department chairman of the Systems and Control Department at the Technological Research Institute in Brazil. Dr. Misawa received his Ph.D. degree from the Massachusetts Institute of Technology (1988) and his B.Sc. (1979) and M.Sc.(1983) degrees from the University of Sao Paulo, Brazil. All degrees are in Mechanical Engineering, with focus in Dynamic Systems and Controls. He was also a site director of the NSF I/UCRC Measurement and Control Engineering Center, at Oklahoma State University. His research and teaching activities are focused on Dynamic Systems, Measurement and Control. His group has contributed in the field of theory and application of Lyapunov-based robust estimation and control techniques, in particular in control theory and application in motion control, medical de-vices and nanotechnology.

Dr. Mario A. Rotea is the Director of the Control Systems Program in the Civil and Mechanical Systems Division in the Engineering Directorate at the National Science Foundation. He is the point-of-contact from the NSF Engineering Directorate to the DDDAS initiative. Dr. Rotea is also a Professor of Aeronautics and Astronautics with Purdue University. He received his PhD degree in Control Science and Dynami-cal Systems from the University of Minnesota, Minneapolis, in 1990. Dr. Rotea received his MSEE degree in Electrical Engineering in 1998 from the University of Minnesota and his EE diploma in 1983 from the National University of Rosario, Argentina. His research and teaching activities are focused on control en-gineering and optimization. His group has contributed theory and practical algorithms for performance analysis, state and parameter estimation, and control of systems with inexact and uncertain models. From 1997 to 1998, Dr. Rotea was also a Senior Research Engineer with the United Technologies Research Cen-ter (East Harford, CT) where he was member of a team responsible for identifying and demonstrating the benefits of active control and optimization in a diverse set of applications and products. Dr. Rotea is a past recipient of the National Science Foundation Young Investigator Award for his research on Multiobjective Synthesis of Robust Feedback Systems.

Workshop Announcement

ACC 2005

(http://www.ee.washington.edu/conf/acc2005)

In cooperation with IFAC

American Control Conference

2005 June 8 -10, Portland, Oregon USA

The American Automatic Control Council (AACC) will hold its annual ACC in cooperation with IFAC at the Hilton Portland in Portland, Oregon. This conference will bring together people working in the fields of control, automation, and related areas from AIAA, AIChE, AIST, ASCE, IEEE, ASME, ISA and SCS. Topics include, but are not limited to: robotics, manufacturing, guidance and control, power systems, process control, identification and estimation, signal processing, modeling and advanced simulation, model validation, fault detection, multivariable control, adaptive control, robust control, intelligent control, expert systems, neural networks, industrial applications of advanced control, control engineering education and computer-aided design. Join us for the following workshops to be held at the 2005 ACC. More details can be found on the conference web site or by contacting the Workshop Chair, Karlene Hoo, Karlene.Hoo@coe. ttu.edu. The advance registration period is February 5 - May 2. Rates vary for 1-day and 2-day workshops. Discounts are given for students and retirees. See the conference web site for details.

Suhada Jaisurya, General Chair

ASME International Mechanical Engineering Congress and Exposition (IMECE 2005)

The 2005 Congress will be held at the Walt Disney World Swan & Dolphin Hotels, Florida.

Walt Disney World Swan and Dolphin Hotel
1500 Epcot Resorts Boulevard
Lake Buena Vista, Florida 32830

November 5-11, 2005 Orlando Florida
http://www.asmeconferences.org/congress05/

IMECE 2004: DSCD Awards Dinner

The recipient of the 2004 Leadership Award of the Division, Wayne Book, is receiving his award from the Division Chair, Clarence de Silva.

Rufus Oldenburger Medal recipient at the 2004 ASME Congress, Professor Sir Alistair MacFarlane (center) is being congratulated by Masayoshi Tomizuka (left) at the Awards Dinner of the Division. The Division Chair, Clarence de Silva is on the right.

The 2004 Outstanding Investigator Award of the Division went to Galip Ulsoy (right). The Division Chair, Clarence de Silva, is seen inviting the awardee to address the audience at the Awards Dinner. The Chair of the Honors Committee, Harry Asada, is standing in the background.

The Best Student Paper Award of the Division in 2004 went to Katherine Kuchenbecker of Stanford University. Catherine is being congratulated by the Division Chair, Clarence de Silva. The Past Chair Giorgio Rizzoni (right), Executive Committee Member Eduardo Misawa (center), and the Secretary Huei Peng (left) are also in the picture, seated in the background.

To our readers...

The need for "Continuity and Change" has been stressed at various ASME platforms in the past year. The DSCD Chair has also called for "expanding the horizons" in his message. This issue of the DSCD Newsletter further promotes the theme and includes two invited articles addressing the changes and opportunities for DSCD members. Dr. Rotea, Program Director at NSF (Civil & Mechanical Systems), has given his perspective of the opportunities in DSC at NSF. Dr. Figueroa in his article has highlighted the on-going work on "Integrated System Health Management (ISHM)" at NASA Stennis Space Center, and the present and future opportunities for collaborative research.

Each upcoming issue of the Newsletter will have a theme and articles will be invited from academia and industry addressing key issues, technologies, and applications. From the next issue, we will introduce a new column, "Student's corner", in which the articles, comments, and reports on activities from the student community will be included. I look forward for your comments, based on which the Newsletter will be improved to make it a discussion forum for contemporary issues benefiting the community in general.

It is a great medium to reflect the Division's perspective, and we are working hard to extend its reach and impact.

Sincerely,
Manish Paliwal, Editor

Call for Award Nominations

ASME DSC Division Level Awards

The DSCD Honors Committee is soliciting nominations for two DSCD awards for 2005:

Education Award: For either excellent sustained contributions or for an outstanding major, singular contribution to education in areas of interest to the DSCD.

Outstanding Young Investigator Award: For investigator under 40 years of age at the time of the 2005 IMECE who has demonstrated outstanding research contributions, either basic or applied, in fields of interest to the DSCD.

Requirements and guidelines for nominations can be found at: http://www.asme.org/divisions/dscd/awards/index.html

Award recipients will receive cash awards and be recognized at the DSCD Awards Dinner at the 2005 IMECE. All nominations and supporting information must be submitted in electronic form (PDF) to Glenn Masada at masada@mail.utexas.edu **by August 31, 2005.**

AACC Awards

The American Automatic Control Council seeks nominations for several yearly awards.

Richard E. Bellman Control Heritage Award (career contributions)
Control Engineering Practice Award (advancement of control practice)
Donald P. Eckman Award (young (<35 years old) engineer)
John R. Ragazzini Award (education)
O. Hugo Schuck Best Paper Award (ACC paper)

Description of awards and requirements: http://www.a2c2.org/awards/index.php
Nomination process: http://www.a2c2.org/awards/bellman/nomination.php
Deadline: December 1 of the year prior to the award year.

Glenn Masada, Chair, DSCD Honors Committee

The *Dynamic Systems and Control Division Newsletter* is published twice annually (Spring & Fall). News items, call for papers, conferences, as well as other items of interest are welcome from all DSCD Members. Please submit your items for publication by e-mail.

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The DSCD

The DSCD Executive Committee establishes policy and manages the affairs of the Division. It meets twice a year at the IMECE and at the ACC. For 2004–2005 it is comprised of the following people:

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A full listing of the all the DSCD office bearers, Technical Panel Chairs, and their coordinates can be found at the DSCD web site at:
http://www.asme.org/divisions/dscd/