Newsletter of the IEEE Robotics & Automation Society

# ROBOTICS AND AUTOMATION



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## In This Issue



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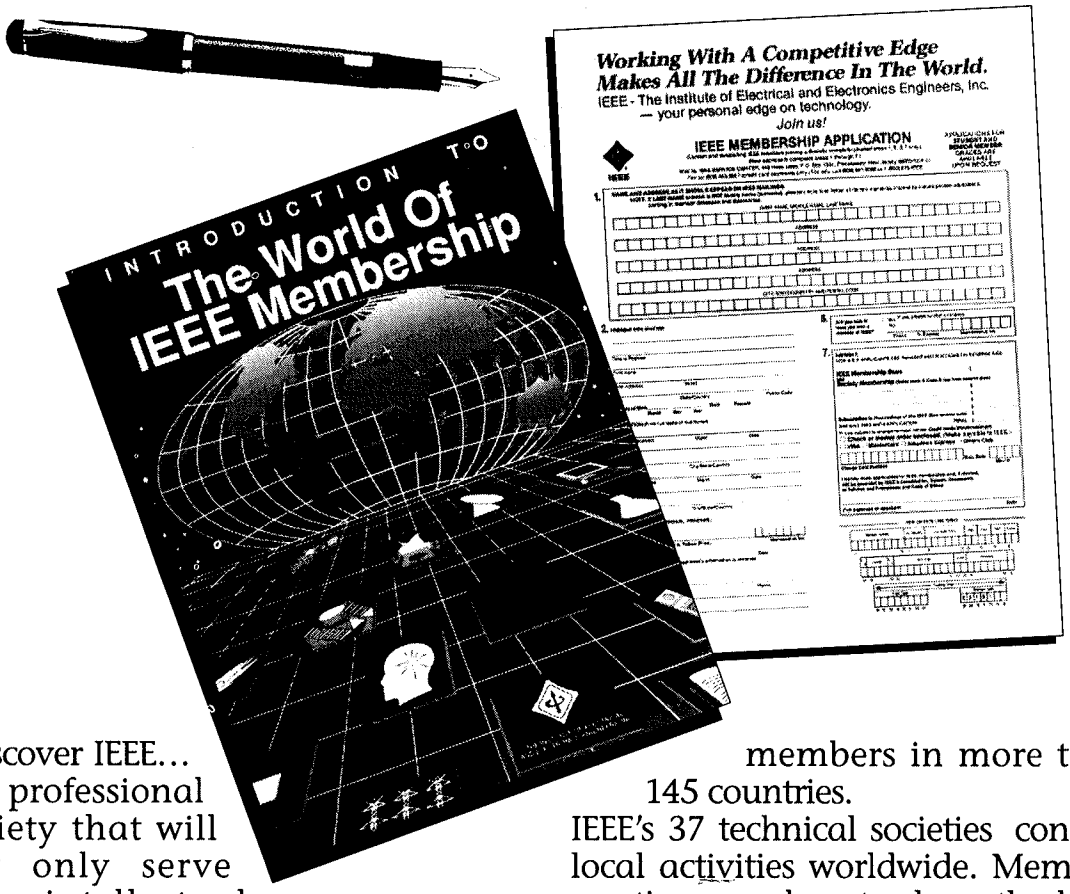


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# President's Message

*Tzyh-Jong Tarn*
*Washington University*

First, I am pleased to announce that the AdCom members elected for three-year terms are: Professor Wayne J. Book, School of Mechanical Engineering, Georgia Institute of Technology; Dr. Thurston L. Brooks, ST Systems Corporation, Lanhan, Maryland; Professor Toshio Fukuda, Department of Mechanical Engineering, Nagoya University, Japan; Professor C.S. George Lee, School of Electrical Engineering, Purdue University; Professor Peter B. Luh, Department of Electrical and Systems Engineering, University of Connecticut; and Dr. Russell H. Taylor, IBM T.J. Watson Research Center, Yorktown Heights, New York.

The 1992 IEEE International Conference on Robotics and Automation was the best conference ever. That statement is the consensus of those who attended this meeting in the Acropolis Convention Center of Nice, France. Professor Giuseppe Menga, the General Chairman, and Professor Georges Giralt, the Program Chairman and the various R&A'92 committees did a superb job in organizing this conference. The R&A'92 was truly an international conference. It had nearly 800 people in attendance from 32 countries.

At the AdCom meeting held on Monday, May 11 in Nice, four amendments to the constitution were passed. The details can be found inside this newsletter. As you know, the term of office for the President and other officers is presently one year. One of the amendments specifies that the term of office will be two years. Also, at the AdCom meeting, Richard Klafter was elected to be the President elect. Professor Klafter will serve as the President of our Society for two years in 1994 and 1995.

We congratulate and applaud the Robotics and Automation Society members elected to Fellow grade as of January 1, 1992. They are: Antti J. Koivo, Purdue University; Takeo Kanade, Carnegie Mellon University; Professor Aristides A.G. Requicha, University of Southern California; Raymond A. Jarvis, Monash University; and Ruzena Bajcsy, University of Pennsylvania. Congratulations also to the members of the Robotics and Automation Society whose evaluations for Fellow status were submitted by other IEEE societies.

The Robotics and Automation Society has the opportunity to look forward and respond to the current rapidly changing world events. With the superpowers searching for peaceful coexistence, I foresee for our Society a stronger future emphasizing commercial application of robotics, especially the service robots. I recently read an article entitled "Robotics Comes Back to the Reality" from the New York Times' Business Day, April 29, 1992. In the article, the author pointed out that it is one thing to weld a fender, quite another to serve a burger. I believe that the R&A Society has the ability and obligation to make a major contribution in the advancement of robotics.

One of the activities of our society that I would like to stress is service to the members of the society, for it is the fundamental reason for the existence and growth of the Society. For the Society to grow, the support of many members is necessary. We need volunteers. We especially need your ideas and your participation. Please let me know of your preference or get in touch with the Vice President within your area of interest or the Editor of the Transactions.

# From the Editor's Desk

*Michael B. Leahy*
*Air Force Logistics Command*
*Robotics and Automation Center of Excellence (RACE)*

It finally stopped raining in Texas and the heat and summer sun have returned. I can look *forward* to daytime highs in the 90's everyday until late September. One can not underestimate the value of central air conditioning. It will be interesting to see if my summer electric bills surpass my winter heating bills from the old days in Ohio. One thing is for sure: one could hardly improve on the weather we had in Nice. I hope I speak for most of the conference attendees in saying that Nice was an outstanding location. The world is really becoming a global village when one can sit at an outdoor cafe with a friend from Italy and enjoy French food while Bruce Springsteen plays in English in the background. The Acropolis was a great location for the conference sessions, and the local arrangements people deserve a round of applause. The increased European participation also made the conference particularly rewarding for me. A note of thanks to all members who took the time to provide feedback on the Newsletter.

If you were able to travel to Nice, what did you think of the conference? If you want to share those thoughts we will be willing to print them. Comments ranging from complaints about why the proceedings volumes did not correspond to the daily schedule to more substantiative issues about the value of accepted papers to the applications engineer would be appropriate. This is your conference, help us continue to improve our service to the general membership. If you don't want to publicly comment, I am sure that Dr. Wayne Book, general chairman of the 1993 conference, would appreciate hearing from the membership on how the conference could be improved. You will find additional information about the '93 conference in Dr. Book's article.

The Monday of conference week is traditionally the time for the semi-annual Adcom meeting. This was Dr. T.J. Tarn's first Adcom as our society president. TJ will fill that role for the next two years.

One of the Adcom activities was to elect his successor, Dr. Richard Klafter from Temple University. Dr. Klafter has served as our vice president for finance for as long as anyone cares to remember.

Keeping the society books straight is an arduous task made all the more difficult by the IEEE accounting system. But if you have a nose for finance and are looking for a challenge, your society has a job for you. If finance is not your forte, the society still has numerous ways to utilize your talents. The Technical Committees of the society are always looking for new members. Dr. George Lee, the vice president for technical activities, provides a report on technical committee activities and names and addresses of committee chairs.

Technical chairs, take note: keep the other members of the society apprised of your committees activities by contributing meeting notes to the newsletter.

We are working toward a "year in review" section in the winter issue that would include articles overviewing the main research events in each of the technical committee areas. More information on that concept will be distributed to the TC chairs later this summer.

In the previous issue I began to champion the development of regional testbeds. The crux of my statement was that a large portion of research effort is misdirected away from the real issue and put toward maintaining or developing the system necessary to experimentally demonstrate the results. Testbeds would minimize the hardware constraints and facilitate realistic trade-off analysis of rival algorithms. Your comments were generally supportive of the concept. The next step in the evolution of this idea could be a panel session at our '93 conference.

In response to the April issue Mr. Harry Roman reminded me that under his direction Public Service Electric & Gas Company in New Jersey has developed an Applied Robotics Technology (ART) Facility. The overall mission of the ART Facility is: *To provide an industry focus for influencing the development of utility- specific robotic systems, and to serve as a nationally recognized robotic training and demonstration center.*

The ART facility is one approach to the testbed concept. Another approach is being taken by the Advanced Robotics Research Institute (ARRI) in Arlington TX.

ARRI is championing the development of a consortium of academic and industrial concerns who share a common set of problems in surface finishing. Surface finishing can produce repetitive motion injuries in human operators. ARRI is trying to focus research on the key problems inherent across the breadth of surface finishing applications. A surface finishing testbed is under development to provide a central facility for evaluating the applicability of new technologies to this problem. More details about the ART facility and the

**See *Editors Desk:* P. 20**

# We've Come a Long Way!
# A Brief History of the IEEE Robotics and Automation Society

*Rosalyn Snyder*

Nothing is ever simple. For instance is ICRA93 in Atlanta going to be the 10th conference or the 9th?

The 1984 International IEEE Conference on Robotics in Atlanta was sponsored by the IEEE Computer Society Technical Committee on Robotics. The move was already afoot to form the IEEE Council on Robotics and Automation, and many members of the Robotics TC were active in the effort to form the new council.

After much hard work and heavy politicking, the formation of the council was approved in June 1984 with Prof. George Saridis as President. The new Council sponsored a quarterly journal, edited by Prof. George Bekey of the University of Southern California. The International Conference on Robotics and Automation sponsored by the RA Council, was held in St. Louis in March 1985 with the late Prof. K.S. Fu as general chair and Prof. Thomas Lozano Perez as Program Chair.

By 1987 it became evident that Robotics and Automation was not just a passing fad, and the wheels began rolling to form a new society of the IEEE. The Council established this newsletter to serve as a forum for the RA community. Wes Snyder of N.C. State University was the first editor, followed by Mike Leahy of the U. S. Air Force.

Five out of six ain't bad! Pictured are former R&A Council/Society Presidents Norm Caplan, George Saridis, Art Sanderson, and current President T.J. Tarn and (center) newly-elected President-Elect Richard Klafter. Not pictured is Y.C. (Larry) Ho.

The IEEE Council of Presidents agreed to conduct a study to determine whether there was sufficient interest and enthusiasm to support yet another IEEE Society and surveys were mailed out to RA Journal subscribers.

After all the studies were completed and a few mountains of IEEE paperwork were processed, Council President Larry Ho proudly announced in the newsletter that on January 1, 1989, Robotics and Automation would become the IEEE's newest society. Prof. Art Sanderson of was the first president of the newly born society.

**Robotics & Automation Council/Society Presidents**

- George Saridis, Rensselaer Polytechnic Institute
- Y.C. (Larry) Ho, Harvard University
- Arthur C. Sanderson, Rensselaer Polytechnic Institute
- Norman Caplan, National Science Foundation
- T.J. Tarn, Washington University
- Richard Klafter, Temple University (1992 President-Elect)

**Journal/Transactions Editors**

- George Bekey, University of Southern California
- Russell Taylor, IBM

## Around the World with R&A

| Year | Site | General Chair | Program Chair |
|---|---|---|---|
| 1984* | Atlanta. | J.F. Jarvis | R.P.C. Paul |
| 1985 | St. Louis | K.S. Fu | T. Lozano-Perez |
| 1986 | San Francisco | A.K. Bejczy | R. Suri |
| 1987 | Raleigh, NC | Y.C. Ho | A.C. Sanderson |
| 1988 | Philadelphia | T. Pavlidis | R.B. Kelley |
| 1989 | Scottsdale, AZ | G.A. Bekey | J.M. Hollerbach |
| 1990 | Cincinnati | R.A. Volz | A.J. Koivo |
| 1991 | Sacramento | T.C. Hsia | T.J. Tarn |
| 1992 | Nice | G. Menga | G. Giralt |
| *And coming attractions...* | | | |
| 1993 | Atlanta | W.J. Book | J.Y.S. Luh |
| 1994 | San Diego | W.A. Gruver | H.E. Stephanou |
| 1995 | Nagoya, Japan | T. Fukuda | S. Arimoto |

*IEEE International Conference on Robotics, Spons. by IEEE Computer Society Technical Committee on Robotics

## Bits and Pieces

*C.S. George Lee, Purdue University*
*Vice President for Technical Affairs*

I would like to take this opportunity to keep you informed of recent activities relating to the Society's technical affairs.

**• Technical Committees**

The TAB (Technical Activities Board) members agreed in principle to form at most 18 Technical Committees (TCs): 8 in robotics areas, 6 in automation areas, and 4 in robotics and automation areas. As of today, 18 technical committees have been established. Their chairpersons are:

- Computer and Robot Vision (Chairpersons: Kim Boyer and Seth Hutchinson)
- Flexible Manipulators (Chairperson: Alessandro De Luca)
- Manipulation (Chairperson: Matthew T. Mason)
- Medical Robotics (Chairpersons: George Bekey and Russell Taylor)
- Micro Robots and Cellular Robots (Chairpersons: Paolo Dario and Toshio Fukuda)
- Mobile Robots (Chairperson: Yuan F. Zheng)
- Robot Dynamics & Control (Chairpersons: Oussama Khatib and M. Vidyasagar)
- Robot Motion & Path Planning (Chairperson: Vladimir J. Lumelsky)
- Teleoperation and Telerobotics (Chairperson: Thurston Brooks)
- Intelligent Instrumentation and Measurement (Chairpersons: Janos Sztipanovits and Byron Purves)
- Parallel/Distributed Robot Computing Systems (Chairperson: Amir Fijany)
- Programming Environment in R&A (Chairperson: Vincent Hayward and Giuseppe Menga)
- Sensor Integration and Fusion (Chairperson: Ren C. Luo)
- Assembly and Task Planning (Chairperson: Damian. Lyons)
- Computer-Aided Production Management (Chairperson: Debra Hoitomt)
- Computer-Integrated Manufacturing (Chairperson: Walter Trybula)
- Discrete Event Dynamic Systems (Chairperson: vacant)
- Manufacturing System Integration and Applications (Chairperson: Fernando Nicolo)

If you are interested in any of the activities of the above technical committees, please contact the respective chairperson(s). The address, e-mail, and phone number of all the TC chairpersons are listed elsewhere in this Newsletter.

**• Distinguished Lectures Program**

The VP for Technical Affairs, with recommendation from the TAB members, requested a budget from the AdCom at the May 92 AdCom meeting to form the Society's Distinguished Lectures Program (DL Program). The main objectives are: 1) to foster better relationship between the Society and both local and student sections, and 2) to assist local and student sections in recruiting new members.

Initially, the DL Program will have about 20-25 distinguished lecturers (DLs).

***Guidelines:***

- The local and student sections can select up to two Distinguished Lecturers (DLs) per year. The presidents of the local/student sections submit their application to the Person-In-Charge of the DL Program.
- Based on the availability of funds, the Person-In-Charge of the DL Program approves the requests.
- The DL Program pays for the travel expenses for all the DLs while the local/student section pays all the meals and accommodations for the invited DLs. If necessary, the DL program may assist the local/student section in paying some of the meals and accommodations for the invited DL
- The invited DL plans his/her travel and requests reimbursement from the Person-In-Charge of the DL Program after his/her visit.

## Call for AdCom Nominations

The Robotics and Automation Society currently has an 18-member Administrative Committee (AdCom) rotating on three-year terms.

Beginning next year, we need to fill six vacant AdCom positions by election in October. Mr. Norman Caplan, Chairman of the Nominations Committee, is working closely with Professor T. J. Tarn, President of the Society, to come up with a slate of candidates for the six vacant AdCom positions.

I strongly urge anyone who is interested in the affairs of the Society to volunteer himself/herself.

There are two channels to be nominated for election to the AdCom. As stated in the Society Bylaws, anyone can be nominated with petitions signed by twenty-five (25) or more members of the R&A Society. These petitions must be received by Mr. Caplan (Address: National Science Foundation, BES, Room 1131, 1800 G Street, N.W., Washington, D.C. 20550) or me (Address: Dept. of Electrical Engineering, The Ohio State University, Columbus, OH 43210) by September 1.

It is also possible to be nominated through the Nominations Committee. Just send Mr. Caplan your updated short bio, resume and your areas of expertise.

Although the Nominations Committee may not be able to nominate everyone who volunteers to the AdCom, the Society has many appointed positions that may be able to use your talent and service.

*David E. Orin*
*The Ohio State University*
*R & A Society Secretary*

## Four Constitutional Amendments Approved by AdCom

At its May 11 meeting in Nice, France, the Administrative Committee (AdCom) of the IEEE Robotics and Automation Society approved four amendments to the Constitution...All of these are to Article V on Administration.

The amendments are concerned with the Term of Society Officers, Election of President and Vice-Presidents, Voting Rights of President-Elect, and AdCom Membership of Standing and Technical Committee Chairpersons.

With approval of the Technical Activities Board and Executive Committee of the IEEE, the proposed amendments will go into effect unless at least five percent of the voting members of the Society object in writing within 60 days after the publication of this notice.

Questions related to the amendments may be addressed to the Secretary of the Society and Chairman of the Committee on Constitution and Bylaws: Professor David E Orin, Department of Electrical Engineering, The Ohio State University, Columbus, OH 43210.

### Amendment #1: Term of Society Officers

The term of office for the President and other officers is presently one year. However, this does not give adequate time for the President to learn the intricate structure of the IEEE and to serve within it. With this amendment, the term of office would be two years.

**Article V -- Administration**
**Section 3: Society Officers**

**Current wording:** The officers of the Society shall be the President, Vice-Presidents, the Secretary and the Treasurer each having a term of one year as defined in the Society Bylaws.

**Proposed wording:** The officers of the Society shall be the President, Vice-Presidents, the Secretary and the Treasurer each having a term of two years as defined in the Society Bylaws.

### Amendment #2: Election of President and Vice-Presidents

With this amendment, the President and Vice-Presidents would be elected from the Society membership at-large and not just from the membership of the AdCom. This would

## Email Directory

Changes

| Name | Affiliation | Email | FAX |
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| **Dick Theobald** | **Lockheed/Houston** | **theobald@aio.jsc.nasa.gov** | **(713) 333-7201** |
| **Guillermo A. Jaquenod** | **University of La Plata<br>ARGENTINA** | **guille@pir.edu.ar** | **+54.21.25.40.24** |

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allow a wider participation in the work of the AdCom and is consistent with our approach to electing the President in the past few years.

**Article V -- Administration Section 4: Election of President and Vice-Presidents**

**Current wording:** The Administrative Committee shall elect from its membership a President and Vice-Presidents as defined by the Society Bylaws.

**Proposed wording:** The Administrative Committee shall elect from the Society membership a President and Vice-Presidents as defined by the Society Bylaws.

## Amendment #3: Voting Rights of President-Elect

This amendment gives the President-Elect voting privileges on the AdCom as is presently the case with the Past-President. This is especially significant at the Fall meeting of the AdCom when the President-Elect is appointing a Secretary and Transactions Editor as well as Chairpersons for the Committees, etc.for the coming year.

**Article V -- Administration Section 7: Past-President Ex Officio Member**

**Current wording:** The Past-President shall be an "ex officio member with vote."

**Proposed wording:** The Past-President and President-Elect shall each be an "ex officio member with vote."

## Amendment #4: AdCom Membership of Standing and Technical Committee Chairpersons

With this change, the Standing and Technical Committee Chairpersons would be ex-officio members of the AdCom but without vote. This keeps the voting membership of the AdCom to a reasonable size and is consistent with our present practice.

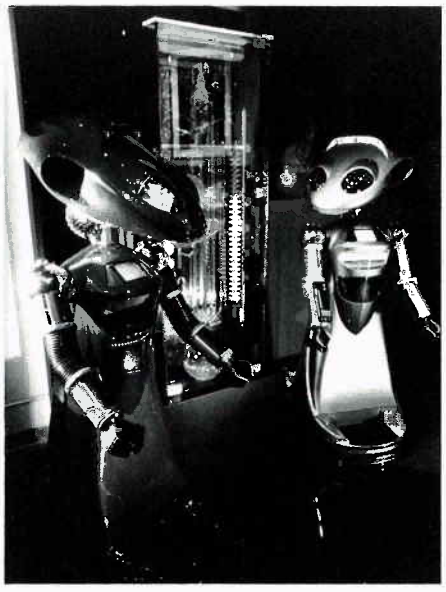
**Article V -- Administration Section 11: Establishment of Standing and Technical Committees**

**Current wording:** The Administrative Committee may establish Standing and Technical Committees needed to cover specific functions and areas of the field of interest, as prescribed in the Bylaws. All appointments or reappointments as defined in the Bylaws to committees and similar posts will be for a term of two years, or until successors are appointed, or the committee is dissolved, except where other specifically-designated terms of office are established by the Administrative Committee. Committee member reappointment can be made without limit. Standing and Technical Committee Chairpersons are appointed by the Society President with the approval of the Administrative Committee. They shall be ex officio members of the Administrative Committee with vote. The Society President may establish ad hoc committees of finite duration to fulfill specific needs. Ad hoc committee chairpersons shall be ex officio members of the Administrative Committee without vote.

**Proposed wording:** The Administrative Committee may establish Standing and Technical Committees needed to cover specific functions and areas of the field of interest, as prescribed in the Bylaws. All appointments or reappointments as defined in the Bylaws to committees and similar posts will be for a term of two years, or successors are appointed, or the committee is dissolved, except where other specifically-designated terms of office are established by the Administrative Committee. Committee member reappointment can be made without limit. Standing and Technical Committee Chairpersons are appointed by the Society President with the approval of the Administrative Committee. They shall be ex officio members of the Administrative Committee without vote. The Society President may establish ad hoc committees of finite duration to fulfill specific needs. Ad hoc committee chairpersons shall be ex officio members of the Administrative Committee without vote.

The amendments are submitted by the Committee on Constitution and Bylaws:

*David E. Orin, Chairman*
*Robert B. Kelley*
*C.S. George Lee*
*Harry E. Stephanou*
*T.J. Tarn*
*Russell H. Taylor*



**Contrary to the predictions of cynics, setting the Robotics and Automation Conference in Nice did not result in a wholesale exodus of conferees to Monte Carlo and the attractions of the Cote d'Azure.**

**However, these 6-foot robots were too busy star-gazing at the Cannes Film Festival to attend technical sessions at ICRA to learn how they work. These robots which have appeared in movies and on TV, operates via sophisticated electronics borrowed from state-of the art industrial robots. (Photo courtesy International Robotics, Inc. 611 Broadway/Suite 422-A, New York, N.Y. 10012)**

## NEW ARRIVALS

• **Tarek M. Sobh** University of Pennsylvania. *Thesis*: "Active Observer: A Discrete Event Dynamic System Model for Controlling an Observer Under Uncertainty." December 1991 *Advisor:* Professor Ruzena Bajcsy. *Currently:* Research Assistant Professor of Computer Science at the University of Utah 3190 Merrill Engineering Building, University of Utah, Salt Lake City, UT 84112.

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## Engineers Challenge Presidential Candidates to Keep US. Technologically Competitive in Global Marketplace

***Pender M. McCarter***
***IEEE-US Activities***

*Note: IEEE-USA promotes career and technology policy interests of nearly 250,000 U.S. IEEE members. Its activities are paid for by U.S. members only.*

"I'm concerned about the survival of our high-tech workforce. In the long run, I'm concerned about the United States' ability to function as a world power in the decades to come. In other words, I'm concerned about our nation's future," said IEEE President Merrill W. Buckley, Jr. at a news conference on April 13.

Buckley challenged the Presidential candidates to reveal their plans to foster the growth of new technologies and the electronics industry to keep America competitive in the global marketplace. IEEE United States Activities has also called on the League of Women Voters to hold a Presidential debate on technology concerns.

According to Buckley, electronics is the largest manufacturing industry in the United States. One out of every nine manufacturing jobs is in electronics. One out of every 25 jobs is related to electronics. Three times as many people are employed in the electronics field as in the automotive industry -- nine times as many as in basic steel. But in the last two years, 150,000 jobs have been lost in American electronics. A recent Congressional Office of Technology Assessment study reveals that almost 40 percent of the estimated 342,000 defense engineering positions available in 1990 could be eliminated by 1995.

The IEEE-USA asked the candidates 10 questions about how, if elected President, they would:

- Ensure that industrial technology policy is made an integral part of our national economic policy?
- Help industry produce high quality and marketable products?
- Improve education in order to ensure a technologically-literate workforce? Rejuvenate the declining U.S. electronics industry and restore jobs?
- Encourage long-term investments to revitalize the manufacturing base in the U.S.? Enhance Federal support for the development of commercially-relevant civilian technologies?
- Maximize the commercial return on our investment in defense R & D?
- Ensure that foreign acquisitions of U.S. high technology companies will not threaten long-term U.S. competitiveness and national security?
- Overhaul U.S. antitrust laws to promote strategic partnerships in U.S. industry?
- Improve U.S. global competitiveness of U.S. products through appropriate trade policies?

## TAB Sponsors Design and Manufacturing Initiatives

Striving to better serve the needs of IEEE's non-research members, a new initiative is being undertaken within the IEEE Technical Advisory Board (TAB) in the area of Design and Manufacturing Engineering. In order to initiate activities specific to the applications- oriented engineer, TAB has established an experimental structure to develop proposals in this area.

Seventeen IEEE Societies/ Councils are represented on the TAB Advisory Board for Design and Manufacturing Engineering, to oversee coordination of future projects. With the support of the Advisory Board, a nine-person Steering Committee composed of Society representatives and industry experts will explore and develop new programs.

The Steering Committee for Design and Manufacturing Engineering will be looking at methods to increase IEEE effectiveness in such fields as manufacturing technology, design, concurrent engineering, environment/health/ safety, economics, technology transfer, human factors, quality and testing. It will explore a wide range of activities from workshops and conferences to publications aimed at non-research engineers in the field. Proposals for new activities in these areas will be welcomed by the committee.

***Conference on Environment, Health and Safety***

This conference, aimed toward the design and manufacturing engineering community will be the first

*See "Design & Manufacturing",p.18*

**TECHNICAL COMMITTEE CHAIRS (cont.)**

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***Discrete Event Dynamic Systems***
- (vacant)

*Winner of ICRA'92 Best Video Presentation*

# The Hummingbird Minipositioner: Robotics Too Fast to See

*E.J.P. Karidis, L.C. Zai, D.G. Manzer, L.F. Durfee*
*IBM Research Division*
*T.J. Watson Research Center*

The Hummingbird minipositioner [1] presented in the Video Proceedings of the 1992 IEEE Conference on Robotics and Automation is a high-performance, three-axis servo-mechanism designed specifically to provide extremely fast and accurate positioning of a small probe tip or other low-mass device on or above a nearly planar object.

The performance capabilities include peak X-Y accelerations in excess of 500 $m/s^2$ with a 1 mm stroke. The entire minipositioner assembly weighs less than 1 Kg and is designed to be virtually reaction-less during X-Y motion, allowing it to be easily mounted to and carried by a variety of conventional, large-area positioning systems. Servo control of the Hummingbird minipositioner is provided with a multi-Transputer-based parallel-processing controller with integrated high bandwidth drivers as described in [2].

Several key aspects of the Hummingbird design are shown, including the dynamically balanced five-bar linkage configuration, custom actuators and sensors, and the integral torque cancellation actuator.

The Hummingbird system is then shown performing contact probing of a high-density circuit board at up to 50 cycles/second, where each cycle includes one X-Y move, ranging from 225 microns to 5 mm in size, plus two Z-moves (one down and one up).

Stroboscopic techniques and high-speed video camera are used to reveal the distinct X-Y and Z-axis moves occurring at a peak rate of 150 moves per second. An additional demonstration is provided of the minipositioner probing several grains of ordinary table salt so as to form the letters "IBM" out of 49 probe marks, with approximately 20 micron spacing, placed on each grain of salt in less than one second.

Forget the Cannes Film Festival! For cinematic excitement, Nice was the place! Prof. Peter Luh presents Dr. John P. Karidis and Li-Cheng R. Zai of IBM's T.J. Watson Research Center with the award for the best video presentation. (Conference photos are by Wes Snyder unless otherwise noted)

## Acknowledgments

The authors gratefully acknowledge J. Pawletko, G. McVicker, R. Comulada, R. Brown, M. Goldowsky, P. Bodenweber, and R. Olyha for their significant contributions to the development of the electromechanical systems; S. Williams, M. Mastro, L. Landermann, K. Ho, and P. Liaicona for their significant contributions to the servo-controller development; K. Short, M. Reed, R. Churchwell, and M. Wenk for their contributions to the on-going software effort; C. Treppeda for his production of the videotape; and L. Matthew for her narration.

## References

•1. J.P. Karidis, G. McVicker, J.P. Pawletko, L.C. Zai, and M.P. Goldowsky, "The Hummingbird Minipositioner--Providing Three-Axis Motion at 50 G's with Low Reactions," *Proceedings of the IEE International Conference on Robotics and Automation, 1992.*

•2. L.C. Zai, L. F. Durfee, D. G. Manzer, J.P. Karidis, M.P. Mastro, K. C. Ho, and L.W. Landermann, "Control of the Multi-Axis Hummingbird Minipositioner with the MARC Multi-Transputer Controller," *Proceedings of the IEE International Conference on Robotics and Automation, 1992.*

***Editor's Note: To order a copy of the Video Proceedings see the ad in the 1993 Call for Papers.***

# FIAT Tour Shows that the Future is Now

A busload of conference participants left at dawn Friday morning to drive to Turin, Italy to tour the FIAT manufacturing plant.

Unlike many older plants, where managers try to fit robots into the existing structure to replace human workers at certain tasks, the Fiat plant was designed from the ground up to integrate robots into the manufacturing process so that automation can result in improving the efficiency of human workers, rather than attempting to replace them.

The FIAT plant apparently gives a lot of tours because the bus tour was exactly that; the bus drives right through the factory and stops at automated workcells. The net result is a close-up view of the system and process.

The plant is heavily automated. There are 3500 welds on a FIAT car body, and all are done by robots.

The FIAT car body travels through the factory on an Automatically Guided Vehicle (AGV). Sometimes the AGV is carried along a conveyor, and at other times it follows a wire buried in the factory floor.

The car bodies were routed to different workstations for different operations. There appeared to be no predetermined pattern to this, indicating that routing was perhaps occurring on-line. The system was a good example of computer integrated manufacturing.

The AGVs were able to keep on track remarkably well, although "wranglers" were assigned to corral the occasional stray, giving a whole new meaning to the concept of "spaghetti western".

The plant employees seemed to casually accept their robot partners and to be confident of the safety of their environment -- to the point that as one visitor noticed, women on the assembly line wore open toed shoes or even sandals instead of the steel-toed work boots commonly worn by American workers in automobile factories.

*Thanks to ICRA Chair Giuseppe Menga for arranging the FIAT tour and to Alan Desrochers of RPI for contributing to this report.*

## Germans and Russians Consider Joint Research Effort

The remarkable events of the past year in Eastern Europe were evident in Nice as seven papers from the former USSR and one paper from Bulgaria.

Participants from the former Soviet Union reading the R&A Society newsletter at the banquet.

"Germany is beginning a tighter collaboration with the Russian colleagues on the Mars rover projects. We are supposed to have a closer look at the new Mars-96-rover vehicle and its autonomy features at our DLR center in Oberpfaffenhofen."

"The IEEE Robotics and Automation Conference provided us our first opportunity to start a more detailed discussion of this project. Visits by DLR personnel to Moscow and Petersburg will follow."

(The former Institute for Flight Systems Dynamics, has been renamed "Institute for Robotics and System Dynamics" and is co-directed by Prof. Hirzinger and Prof. R. Ackermann.)

Among the distinguished scientists from the former Soviet Union and other eastern European countries who were listed as participants in the conference were *Nemec Bojan*, Jozef Stefan Institute, Lubiana, Slovenia; *Branislav Borovac*, Univ. of Hovi Sad, Yugoslavia; *Kiriazov Petrov Kiriazov*, Academy of Science, Sofia, Bulgaria; *George Kovacs*, Computer and Automation Institute, Budapest Hungary, *Jazna Maver*, Univ. of Ljubi Jana, Slovenia; *Igor Mikhailovich Makarov*, Russian Academy of Sciences, C.E.I.; *Edward K. Potemkin*, Mechanical Institute of St. Petersburg, C.E.I.; *Vladimir S. Syromyatnikov*, NPO, Moscow, C.E.I.

## Thanks!

***Gerhard Hirzinger***
***Tutorials and Workshops Chair***

I think that the tutorials and workshops at the IEEE Conference in Nice have been a real success. None of the originally announced events had to be cancelled, and I believe the average quality has been high. I would like to thank all the organizers and speakers for their valuable efforts.

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# Philips Prize

The 1992 Philips Prize for the best student paper was awarded to Mr. Xavier Lebegue of the University of Texas at Austin, Electrical and Computer Engineering Department for his paper *Extraction and Interpretation of Semantically Significant Line Segments for a Mobile Robot.* His co-author was Prof. J.K. Aggarwal.

The award was presented at the conference banquet by Mr.Teun Hendriks of Philips Laboratoires, Briarcliff Manor, New York. . He also recognized the other finalists in the Philips Prize competition,. who were provided with travel money by the IEEE RA AdCom to attend the conference. The other finalists and their papers are:

R. Sharma - *A Probabilistic Framework for Dynamic Motion Planning in Partially Known Environments*

O.J. Sordalen, co-author Prof C. Canudas-de-Wit - *Evaluation of an Exponential Control Law for a Mobile Robot: From Regulation to Tracking*

A.K. Ramadorai, co-authors Prof. T.J. Tarn, Prof. A.K. Bejczy - *Task Definition, Decoupling and Redundancy Resolution by Nonlinear Feedback in Multi-Robot Object Handling*

T. Cao, co-author Prof. A. C. Sanderson - *Sensor- based Error Recovery for Robotic Task Sequences Using Fuzzy Petri Nets: From Regulation to Tracking*

M.D. Berkemeier, co-author Prof. R.S. Fearing - *Control of a Two-Link Robot to Achieve Sliding and Hopping Gaits*

**Teun Hendriks presents the $1000 Philips Prize for the best student paper to Xavier Lebegue from the University of Texas at Austin.**



**Everyone expected great things of the banquet at Nice, and we were not disappointed. Smoked salmon, lamb and wines from Provence. No rubber chickens here!**

**Antii Koivo and Bill Gruver "hanging out" at the reception.**

# Large Scale R&D Projects: National and International Policies

*"The center of interest in research is often somewhat off center."*

This cryptic observation from one of panelists at this discussion at the ICRA92 reflects the effect that political and economic forces have on research priorities.

Norm Caplan of NSF and past president of R&A moderated the lively discussion with representatives from US NASA, NSF, and DoD, Japan MITI and European community Community ESPRIT and TELEMANN programs, all of whom emphasized that their opinions were their own and not official policy statements.

As the growth of multinational countries signifies the realization of a truly global economy and as the problems which must be addressed require ever increasing amounts of money and manpower, the need for multinational research programs becomes clear. The large scale projects under discussion all involve two or more institutes, states, funding agencies, and or countries. However there are lots of problems since programs are much easier drawn up on paper than put into practice.

"There are many fine words about collaboration, but it comes down to the question of intellectual property."

Ways of dealing with the intellectual property question include emphasis on what the EEC terms "precompetitive R&D" which include development of standards and protocols which are clearly of benefit to all participants, concentrating on projects related to space, undersea exploration, and nuclear safety, and deliberately avoiding obviously sensitive areas, and carefully designing the structure of the program to ensure that marketable results will belong to the contractors.

One panelist, interestingly enough, not a Japanese, emphasized that a crucial requirement for joint projects is a strong working relationship and trust between the key people on both sides. Otherwise the inevitable problems of incompatible hardware and software, slashed travel budgets, and multiple bureaucracies can nitpick a cooperative venture into inertia. In the presence of this element of personal trust other problems can be resolved. Without it, the most well-conceived project is probably doomed. Exchange and sabbatical programs, which remain the most common form of collaboration between Japanese, European, and American institutes, may very well hold the promise for a truly global research community.

Governments from Italy to New York State (which has the ninth largest economy in the world) are all interested in research which will promote economic and industrial development, particularly in depressed areas.

For instance, the European Economic Council's ESPRIT program has three major goals: 1) to promote European industrial cooperation; 2) to pave the way for standards; and 3) to promote technological development. Proposals for ESPRIT funding must involve a combination of researchers from at least two different countries and must address well defined problems.

There has been a recent increase in emphasis on environmental and health issues.

Basic research programs such as the "Vision as Process" consortium, which was formed to address problems dealing with integration and control in real-time vision work closely with industrial partners. Proposals for applied research must involve industrial and academic organizations from two or more countries.

The EC projects have had a major impact on the European research landscape, in large part because they provide a mechanism to force universities and industries to work together. Now, industries routinely attend academic conferences to see what the universities are doing.

This is in contrast to the United States where, as one panelists observed, "the US and NSF have created an army of robotics specialists, but the robotics industry in the US has declined."

In spite of all the rhetoric about technology transfer, the message academic researchers constantly hear from their peers is "you shouldn't do too much of those applied industrial projects *(if you want to get published and promoted)."*

This message persists even in the face of contrary evidence such as the four Ph.D. projects which came out of a single joint industry-university project.

**The Panelists**

- **Norman C. Caplan, NSF, Chair**
- **E. Marsh - NSF Engineering**
- **Y. Kamayama - U.S. Naval Postgraduate School**
- **H. Stephanou -RPI, New York State Center**
- **F. Nicolo -Italy**
- **H. Van Brussel -Belgium**
- **C. Weisbin-JPL**
- **B. Tolley- EEC**
- **R. Robertson-EEC**
- **C. Thurel- EEC**
- **K. Fujimura-Japan**

# Automation and the Bottom Line: Meeting the Challenges of the 90s

*Dr. Luigi Francione*
*Executive Vice President FIAT S.p.A.*

*Luigi Francione was the banquet speaker at ICRA'92. Since December 1990 he has been Executive Vice President of the Holding Company Fiat S.p.A., with responsibilities over the following business Sectors: Industrial Components, Vehicles Components, Batteries, Production Systems, Metallurgical Products, Corporate Advanced Research Centre.An engineer by training, he has been with FIAT since 1966 and has had extensive in-plant engineering and managerial experience as well as administrative responsibilities at the corporate level.*

As an executive and a European, even more than an Italian, I am deeply honored to be invited to speak at this dinner which celebrates the first ever European edition of this prestigious conference.

In the film that preceded me, we tried to offer you the highlights of process automation as it has been achieved by the Fiat group in its factories.

Our intention was to show you how car bodies or truck cabs, engines or transmissions use the same technical ideas in the various stages of the production process.

We, of course, work in the automotive field, but the concepts that underlie our automation processes may obviously be transferred to other industrial sectors.

Rather than my own direct experience with automation, however, I should like to talk about the factors that are influencing company expenditure decisions in this specific technological area, in the present geo-economic situation.

We can start, I think, from an undisputed fact: ***We are living through a crescendo of change in competitive conditions.***

This change is evident, for example, in the ongoing transformation in the power relationship not only within individual sectors, but also between nations and entire economic areas.

Another aspect of the change is the process that is leading to the formation of large trading regions.

This, as we all know, is taking place in Europe, but it is also taking place in North America, in Asia and in the Pacific. Moreover, the change will affect more than the structure of competition: it will also influence the behaviour of markets and the factors which produce that behaviour.

The demands of consumers today are more and more mercurial and unforeseeable, variegated and differentiated, more and more channelled towards high levels of quality, performance and sophistication.

This set of changes and conditioning is facing businesses with the need to identify their own approach and adjust it, where necessary, in conditions of growing uncertainty and ever-greater risks.

At this moment in time, this uncertainty and these risks are being exacerbated by a period of recession that has intensified price competition to the considerable detriment of company profits and cash flow.

This situation will continue to curb investment and expenditure on plant and machinery in particular. We are unlikely to see the high growth rates of the Eighties again, when spending on plant and machinery touched average annual increases of about 7% between 1988 and 1990.

Rather, we should expect a much more modest growth and perhaps no growth at all.

The prospects do not brighten until 1993 and even then forecasters expect growth rates to be nearly half the level we experienced for much of the Eighties.

This, then, is the overall picture we are facing.

Looked at from a business viewpoint, it means that we shall have to apply much tighter discipline than in the past in order to remain adequately competitive.

I am not saying anything new, if I emphasize the fact that companies will have to make an exceptional effort in terms of efficiency, cost cutting and technological innovation. We shall also need a radical change in the way we do business, both inside the company and externally in our relations with our suppliers, our distribution networks, our consumers.

This change will have important effects on company structure, organization and management philosophies.

Within the area of productive investment, especially spending on industrial automation, it will also tend to emphasize certain approaches that have emerged very clearly in recent years.

So how have company strategies in the field of investment in pro-

cess automation changed?

When we began to introduce these advanced technologies into our factories, our primary objective was to cut manufacturing costs by economizing on labor, while at the same time increasing plant productivity. In effect, we were "mechanizing" processes in order to achieve higher volumes at a constant rate.

Though that remains an important target, it is just one part of a broader objective: to cut global manufacturing costs and guarantee optimum use of all company resources.

In fact, we want plants used to maximum capacity, while products and markets may change.

This can only be attained by making plants flexible and convertible, in effect by cutting downtimes for model changes to the minimum - if not by eliminating them completely.

At the same time, it is becoming increasingly important to eliminate waste as well, by drastically cutting the costs of "non-quality" i.e. rejects, fine-tunings, modifications and so on. In this regard, one important aspect is for automated plant to be designed so that it can also be used for new applications.

Another fundamental aspect is continuously improving process capacity.

Automation is required not solely to supply the "mechanical" capacity for endless repetition of the same operation or, to put it another way, "static" uniformity.

It is required rather to ensure that expected quality levels are maintained, as products increasingly evolve, by means of extensive application of robotics and of programmable management and control systems.

Finally, another piece of strategic thinking that is acquiring more and more importance relates to the use of the most advanced technologies to improve the manufacturing environment by eliminating the most dirty, dangerous and demanding operations, upgrade the physical qualities of the work-place and in general improve the mode of production by encouraging the development of skills by the workforce and promoting their greater and more conscious involvement in the continuous improvement process.

Here, we may say that robotics and flexible automation are also the foundations for a form of progress that has social as well as industrial implications.

In practice, all this has led to the "lean production" approach that now underlies the competitive growth strategies of companies in all the world's main industrial systems.

Systems manufacturers are being asked to respond to this evolution in demand, in various ways.The products they supply should, in fact, be able to guarantee:

- ***operational flexibility,*** namely the ability to produce, at random, various models of the same family of products via the use of robots, programmable machines, distributed intelligence;
- ***fast convertibility,*** namely the ability to put new models into production via the use of reconfigurable systems, simulation environments, CAD, CAM and CAE;
- ***increasing reliability*** via preventive design reviews, expert systems, Total Productive Maintenance (TPM) programmes;
- ***user friendliness;***
- ***system integration*** via information networks, CIM, traceability.

In order to satisfy these demands, the suppliers of automation will have to adopt a variety of approaches.

The first is the supply of modular assemblies or machines that make up the systems of which robots, in so far as they are modular, reconfigurable, programmable machines are a classic example.

Modularity is essential if we are to achieve the necessary economies of scale in the manufacture of identical elements with a multiplicity of uses.

Secondly, we need product standardization; and by standardization I mean building upon the foundations of existing projects, using them as a base on which to build new production systems.

Of course, the combination of standardized subassemblies must not constitute a brake or a constraint on the constant technological evolution

the processes require. A great deal must still be done to create machinery and systems that can be rapidly installed and easily operated.

And even that may not be enough.

In order to encourage new capital expenditure, manufacturers must be able to propose innovative systems and resources able to guarantee finished products with added value in terms of quality, performance and time to market.

It will, however, also be necessary to develop a partnership relationship with customers, so that their spending on automatic systems is the result of an in-depth analysis of the requirements of the entire manufacturing process at the same product design development stage (simultaneous engineering, design for assembly, design for manufacturing).

Essentially, the automation industry is going to be asked, over the next few years, to undergo a profound transformation: we are talking about the transformation from producer of advanced technologies to supplier of services and, as a supplier of services, it will have to meet needs in advance rather than simply respond to them.

But this will only be possible if the industry has the ability to take on board the business challenges of its customers.

To some extent, this transformation might appear to conflict with the imperatives of standardization and cost-cutting.

However, a company's competitiveness will depend precisely on its capacity to find the ideal mix between rationalized, economical production and personalized supply.

I should like, however, if you will allow me, to highlight another paradox facing the automation industry.

To borrow the language of Freud, I should like to call it *the paradox of man's technological libido.*

All of us who have been involved in the design of automatic machines know the thrill of inventing and building systems able to satisfy the most complex needs.

I believe that carried to extremes this pleasure, which is perfectly legitimate in itself, loses a great deal of its positivity. Let us, therefore, avoid inventing a "spaghetti twisting machine".

We must not forget that whatever happens, behind a production line there is always a human being and that no machine, however sophisticated, can ever surpass him in creativity, imagination, intuition or intelligence.

I believe that there is a lot of truth in what we hear more and more frequently: *in the history of industry we first went through a hardware stage and then a software stage and today we are in a "brainware" stage.*

It is the brain that finds the optimum competitive solution in a supply context that now provides an enormous variety of possible solutions. Of course there will be special cases of totally automated factories.

But the more we advance along

the automation front, the more vital the human element will become.

Above all, because more sophisticated machines will make human hands increasingly superfluous but the human brain increasingly essential.

Furthermore, the organization of manufacturing and of companies will need to become increasingly flexible and adaptable to change. And however much machines can contribute in this area, the primary role will always be assigned to human beings with their managerial ability.

This explains why, however much attention companies are devoting to technology, they are now working ever more intensively on organization and the involvement of the workforce.

It is a commitment that is leading us to develop management by processes, integrating responsibilities, decentralizing decision-making, and eliminating barriers between different company functions.

This means, as a consequence, greater attention to the elimination of inessential hierarchies and the simplification of internal bureaucracies in order to endow individuals with greater powers and an increased sense of responsibility to the benefit of overall flexibility and speed of response to market demands.

And this, in its turn, means adopting new working procedures that favor teamwork, horizontal communications, the enhancement of the skills of each worker.

So what is the outlook for investments in automation?

I am convinced that the outlook is excellent if one basic requirement can be met: that a new departure be possible in the global competitiveness of the business system. Competitiveness that is certainly related to cuts in the overall costs of production by means of maximum flexibility and convertibility of plant and, at the same time, the broadest use of the spending tool; it is related certainly to the constant improvement in quality levels; it is related certainly to the general improvement in the manufacturing environment in both physical and professional terms.

But this competitiveness will also depend, and to an increasing extent, on the ability of the suppliers of automatic systems to identify with their customers and thoroughly understand their needs in order to form a long-term partnership, which also means minimizing the investments necessary per unit of product.

I am certain that those who are best able to develop this partnership, those who are able to make of automation a system that is fully integrated in the business system as a whole and is not simply a technological marvel, those who are able to develop more and more complex but "maintainable" machines, machines that are highly sophisticated but at the same time user friendly... it is they who will be the winners of the competition race in the coming years.

# GEARING UP!

***Gearing Up!***, a forum for Great Lakes area manufacturers, will bring government agencies and consortia, academic institutions and private industry together specifically to improve shop floor manufacturing activities. Its purpose is to provide hands-on help toward solving manufacturing problems, improving processes and product quality, and bringing new competitiveness to American manufacturing.

*Gearing Up!* includes hands-on help in four areas of activity:

- **Improving Current Processes:** real-time process control, SPC, plant layout, quick change-over and factory floor management.
- **Applying Available Technologies:** CAD/CAM, modelling and simulation, flexible machining and choosing equipment and computers.
- **Integrating Advanced Technology:** helping manufacturers with computer integrated manufacturing, expert systems, micro-electronic sensors, advanced lubricants and composite materials, and more.
- **Accessing the Resources:** alternate financing, consortia, training, management services, and matching technology to markets, and so on.

In addition to practical exhibits by national labs, government agencies like NASA, technology transfer centers, universities, and state and local development agencies, *Gearing Up!* also offers hands-on technical sessions. Fifty-six sessions are planned, based on input provided by the attending manufacturers. Expert speakers will relate solutions to manufacturers' most pressing problems and concerns.

*Gearing Up! w*ill be held August 25 and 26,1992, at Saginaw Valley State University's Rider Center. Gearing Up! tickets, at $35 per person, and a descriptive brochure are available by calling 1-800 539-1000.

## TAB Design & Manufacturing Initiative

(cont. from p.10)

activity of the group. The conference was proposed to the Steering Committee in late March, during their first meeting. The Advisory Board and TAB approved the conference in April.

Rick Dill is Chair of the TAB Steering Committee for Design and Manufacturing Engineering.

# ICRA93: Atlanta

*Wayne Book*
*Georgia Institute of Technology*
*1993 IEEE International Conference on Robotics and Automation General Chair*

We'd like to welcome you to the 1993 IEEE International Robotics and Automation Conference in Atlanta, Georgia. The robotics research community around Atlanta is proud to serve as the Conference host for the second time in 10 years.

Ten years ago visionaries in the IEEE Computer Society Technical Committee on Robotics searched for a site for a new conference. They chose a city with excellent transportation and conference facilities, with a progressive image, and an attractive location for a spring conference. They chose Atlanta for that conference.

Many things have changed in the past 10 years. The Council on Robotics and Automation was formed in 1985 and assumed sponsorship of the conference, and is now a Society with membership over 5000.

Conference attendance has grown to 750 at the 1992 conference just completed. The conference home has rotated over the U.S., moved to Europe (Nice, France) in '92, and is committed to Japan in '95. The great things reflected in these facts mirror the progress in robotics research. Automation has become our middle name. Although in initial conferences the robotics papers' content overwhelmed other forms of automation, the Society and Program Committee committed themselves to building up this critical component so that ten sessions in Nice were principally on automation and about the same number on sensors.

Atlanta has changed. We think you will notice a lot of improvements. Rapid rail transit will now bring you from the airport to within three blocks of the conference, if you choose. The skyline has grown as our individual and corporate populations have grown. The upcoming 1996 Summer Olympic Games to be held in Atlanta is resulting in some dislocation. You will already notice a new domed stadium that will host Olympic events and will also host the 1993 Super Bowl.

Underground Atlanta, a hollow shell in 1983, has been resurrected to host major eating, entertainment, and historical activities within a short cab, bus or train ride from your hotel. Dine, hear some jazz and see Coca Cola's historical exhibit or Atlanta's railroad origins at milepost zero in Underground. Even the Atlanta Zoo has undergone major improvements to present animals in their natural habitat. My favorite--the gorilla exhibit. Within an hour's drive visit Callaway Gardens with Butterfly house and acres of gardens and three golf courses. Or, visit nearby Stone Mountain Park, with granite sculptures larger than Mt. Rushmore providing the screen for an after dark laser show on weekends.

Of course Atlanta is not all play, and the conference tours will provide options from Atlanta's best, such as the award winning Ford Taurus assembly plant, Lockheed Georgia, Georgia Tech, and the Institute for Paper Science and Technology.

But the heart of the conference will depend on your submission of bright, quality papers. We will provide the boundary conditions: session rooms, guest rooms and exhibit area under one roof.

If you are looking for an extended technical visit, consider combining your Atlanta trip with a visit to the 5th Topical Workshop on Robotics and Remote Systems in Oak Ridge, Tennessee the preceding week. That meeting will emphasize applications to nuclear operations and cleanup. It is sponsored by the American Nuclear Society with technical cooperation from the IEEE Robotics and Automation Society.

As I originally said, we would like to welcome you to Atlanta. So accept this invitation to the 1993 IEEE International Robotics and Automation Conference, and we will.

*Fresh off the Press*

# Coming Soon: Two New IEEE Transactions

## IEEE Transactions on Industrial Electronics Technology

The *IEEE Transactions on Industrial Electronics Technology* is sponsored by the Industrial Electronics Society and edited by Ichiro Masaki. The first test issue will be published in April 1993.

Its scope is electronics technology which is directly coupled with applications and authors are requested to include sufficient background description for readers whose major interests are different from the paper's theme.

For more information contact the editor: Ichiro Masaki, Computer Science Department, General Motors Research Labs, 30500 Mound Road, Warren MI 48090-9055 USA, Tel (313)986-1466; Fax (313)98609356; e-mail: masaki@gmr.com.

To be put on the mailing list, send a business card with "New Transactions" written on the back to the editor.

## IEEE Transactions on Fuzzy Systems

*The IEEE Transactions on Fuzzy Systems* is sponsored by the Neural Networks Council and edited by James C. Bezdek. The first issue is scheduled to apear in January 1993.

*TFS* will publish highest quality archival technical papers in the theory, design and application of fuzzy systems. Readers are encouraged to submit papers which disclose significant technical knowledge, exploratory developments and applications of fuzzy systems. Emphasis will be given to engineering systems and scientific applications.

Subscribers to the *IEEE Transactions on Neural Networks* will receive the first copy of the TFS free. For more information, contact the editor: James C. Bezdek, Division of Computer Science The University of West Florida Pensacola, Florida, 32514 USA Tel.: (904) 474-2784 Fax: (904) 474-3023

jbezdek@ai.uwf.edu
jbezdek@uwf.bitnet

## Vision-Based Vehicle Guidance

This book, based on the Industrial Electronics Society's 1990 Symposium proposes new approaches to vision systems in highway environments. ***(Springer-Verlag, ISBN 0-387-97553-5.)***

**MISSING Your IEEE Transactions or Newsletters?**

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## Robots for Shearing Sheep: Shear Magic

*James P. Trevelyan*

A major lesson of this research project, which used robots to reproduce the very human skill of sheep shearing, was the need for technical experts to be able to communicate with a wide variety of others, including funding agencies; shearers; farmers; the media; and specialists in very different fields. Therefore this book, though written for experts and researchers, as far as possible uses non-specialist language and explains technicalities and specialities in separate issues. *(Oxford Science Publications, ISBN 0-10-856252-7)*

## From the Editors Desk

(cont. from p. 4)

ARRI consortium will appear in future issues.

In past issues I have discussed the need for greater cooperation between industry and academia. A group of individuals from the state of Michigan is sponsoring an event to try and bridge that gap. The objective of *GEARING UP* is to bring government laboratories, industry and academia together to address shop floor applications. Details are in the newsletter. I applaud this effort and plan to attend.

Recently I have made trips to both Sandia National Laboratory and the Jet Propulsion Laboratory to foster efforts to transfer their technology into aircraft depots. When your travel plans take you near one of those locations I encourage you to make arrangements to stop by. Those labs are among the first to apply new theory to practice and serve a vital function in moving new technology into industrial applications. We in the United States need to follow the lead of our European and Japanese colleagues and make better use of our government laboratories. The panel discussion on large scale robotics R&D projects highlighted the variations in the government sponsored research approach of the European, Japanese and United States. Roz Snyder attended that session for the newsletter and shares her thoughts on the discussions in an article later in this issue.

As usual the newsletter has a large section on conference information, both calls for papers and smaller calender announcements. If you are involved with a conference that is sponsored by the society we will be happy to run your full page announcements free of charge. Non-society events are always included in the calender section and can reserve a large space for a nominal fee. Remember the old adage: so many conferences, so little time. So if you have the time to attend a conference or symposium consider sharing your experience by writing an overview article for the newsletter.

In closing, I wish you all a happy and productive summer. When the sun's cancerous rays chase you off the beach, pop open a cold one and your labtop and put together a quick info item for the fall issue. Thanks for your support.

# Robotics at the Johnson Space Center

*Charles R. Price, NASA/JSC*
*Richard T. Theobald, Lockheed/Houston*

The Automation and Robotics Division at the Johnson Space Center operates a set of laboratories which are focused on the development and integration of robotic technologies for space applications. This article describes four of the major laboratories.

*The Robotic Systems Evaluation Laboratory (RSEL)*

The Robotic Systems Evaluation Laboratory provides an engineering environment and testbed to develop, evaluate, verify and demonstrate fixed base robotic systems. The RSEL's primary function is to evaluate the capabilities and effectiveness of remotely operated manipulators to accomplish specific tasks with emphasis on Space Station Freedom applications.

The RSEL has two 7 degree of freedom Robotics Research arms (K1607 and K2107) and a Puma 762. Laboratory support equipment includes force/torque sensors, electromechanical and pneumatic grippers, cameras, a simulated on-orbit lighting room, and two custom built control stations. The equipment is interconnected through an internal Ethernet network. Remote control of the robots over the network is accomplished by using the TeleRobotics Interconnection Protocol (TelRIP), a distributed, multiprocessing protocol.

Tasks supported by the laboratory include a proximity detection and collision avoidance demonstration which assists an operator when working in a cluttered area or one with poor visibility, a closed loop force/torque control scheme applied to a rate controlled manipulator (such as the Shuttle Remote Manipulator System) which controls applied force, control of manipulators with large amounts of time delay which would be typical of controlling manipulators on the Space Station from the ground, evaluation and development of the Robotic System Integration Standards (RSIS) for Space Station Orbital Replacement Unit interface designs, and the evaluation of automated robotic maintenance of the Space Station.

*The Dexterous Robotics Laboratory (DRL)*

The Dexterous Robotics Laboratory is dedicated to the improvement of dexterous manipulation capability for robotic devices. The laboratory supports development and integration of control technology, sensors, adaptive hand grasping and cooperative arm manipulation.

The DRL is equipped with several dexterous arms, a robotic torso, an assortment of end effectors which include parallel grippers, three fingered hands, and the Utah/MIT hand. Systems within the DRL can be connected with a fiber optic communication network or an Ethernet network.

Tasks supported by this laboratory include the Dexterous Anthropomorphic Robotic Testbed (DART) which is the development of a crew equivalent integrated robotic system with the intention of performing IVA tasks in the Space Station Freedom mockup. The Robotic Torso Testbed is a ten degree of freedom hydraulic torso with two arms which will be applied to space suit testing. The lab also supports the evaluation of several Small Business Innovative Research grant activities, such as exoskeleton master-slave devices.

*The Mobile Robotics Laboratory (MRL)*

The Mobile Robotics Laboratory is a development facility that focuses on robotic systems that have a means of locomotion. These robots currently take the form of wheeled devices, a walking vehicle, and a free flying robot. The wheeled device consists of a laser navigation device, a near IR sonar system, and a wireless Ethernet mounted on a Cybermotion base. It is presently being used as a mail delivery robot.The walking vehicle is the six legged ROBIN that was built by Odetics. It is on loan to JSC from the Department of Energy and is being evaluated for its design techniques. The free flying robot is the Extra Vehicular Retriever (EVAR). This vehicle operates on a precision air bearing floor and is a testbed to investigate vision processing, manipulator control, control systems, and software/hardware architectures for a real time autonomous free flying robotic agent.

*The Integrated Graphics Operations and Analysis Laboratory (IGOAL)*

The Integrated Graphics Operations and Analysis Laboratory is a state of the art graphics lab for the analysis of robotic systems. It provides software, model building, engineering visualization, animation, and documentation for all programs supported by the Automation and Robotics Division. It researches algorithms for computer graphics image generation and develops graphics software tools for the assessment of real time and non-real time space operations. The generation of video documentation of simulation results and conceptual scenarios is another product of the IGOAL.

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Houston, TX 77058
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# Multisensory Autonomous Robotic Inspection and Manipulation in an Unstructured Environment

*M. Aspes, M. Bortoli, L. Orsenigo CESI*[1]
*M. Maini ENEL-CRA*[2]

*1. Introduction*

During the past decade, the most important efforts in unstructured robotics have been made in the field of nuclear plant safety and operation, mainly for what concerns the in-service inspection and manipulation of critical plants components.

After the freeze of Italian nuclear power program, increasing attention has been devoted to conventional generation units (gas, oil, coal fired), looking at those plant sections where in- service inspection and manipulation may be tiring or potentially dangerous for human operators, both in normal and in emergency situations.

Therefore, the Automatica Research Center of ENEL (the Italian Electricity Board) has promoted and supported since 1988 an R&D activity in this field, in collaboration with CESI (Italian Center for Electric Power Research), which is in charge of the technical design as well as of the laboratory experiments. The attention has been firstly focused on those actuator/indicator sets which become inaccessible to human operator as a consequence of anomalous conditions in the plant, such as hot water, oil, steam leakage, excessive vibration and so on.

In fact this approach may provide a first generation of intelligent, plant-oriented robots, capable of stimulating the answers and the criticism of operators, in order to be able to design a better defined set of specialized robots.

*2. System Description*

The aim of this prototype is to demonstrate the feasibility of an autonomous robotic inspection and manipulation in a completely unstructured environment.

The mission is to control and operate a valve of a testbed representing an hydraulic circuit using information coming from different types of sensors. The mock up, designed and built with standard components, consists of valves, taps, analog temperature and pressure indicators.

In order to emulate a real industrial environment, no special conditions should be imposed on the circuit nor on the environment in which the robotic system works. In particular any constraint concerning both the approach of the robotic system to the mock up and the vision operations must be avoided.

The hardware set-up for system development is: a ROBOSOFT autonomous controlled crawler mobile robot, controlled by a path planning or in teleoperated way; a UNIMATION PUMA 562, six-degree-of-freedom industrial robot; sensors including vision, ultrasonic and force/torque; a SUN 4/370 workstation running the supervisor.

*3. VALVE MANIPULATION Experiment*

With the purpose of showing the efficiency of the system described in the previous sections an experiment consisting in approaching, locating and adjusting a valve of an industrial hydraulic circuit has been selected.

This experiment underlines the capability of the vision system to operate without any particular lighting conditions and in absence of a uniform backstage.

The manipulation phase makes use of the active compliance behavior of the PUMA robot, implemented by means of a hybrid force-position control in a cartesian space.

The first step of the experiment consists in approaching the hydraulic circuit with the robotic system; the ultrasonic sensors are used in this phase to monitor with low accuracy the distance from the hydraulic circuit and to avoid collisions against possible obstacles.

When the circuit enters the anthropomorphous robot's working area, the approach can be considered completed and the operator can select the valve he wants to manipulate through the monitor.

From now on all the operations are fully automated using the information from sensors and managed by the supervisor computer.

The target circuit can be located in any position and orientation inside the working area and the robotic system has to compute the coordinates of the target valve referred to its coordinate system.

The manipulator orients the end-effector so that the range sensor can evaluate the minimum distance from the task valve. This rough information is useful for the vision system in order to reduce its computing time, by selecting only a part of the image on which the Hough's algorithm to detect the valve center and radius is applied. Using this shape recognition procedure in two different positions, it's possible to evaluate, by telemetry, the distance and the relative position of the target valve from the robot coordinate system origin.

Since the relative orientation of the valve with respect to the robot is unknown, it's necessary in the next step of the manipulation to activate an hybrid force-position control in order to adapt the end effector to the valve surface. In this procedure the robot moves at a fixed velocity along its Z tool axis and wrist movements are allowed to react to the external

See" Multisensory" (Back Cover)

# Calendar

•**August12-14. ISPRS XVII Congress.** Washington DC. *Sponsor:* International Society for Photogrammetry and Remote Sensing. *Contact:* Galaxy Registration, PO Box 4088, Frederick, MD 21701.

•**August 4-7 International Conference on Control and Robotics.** Vancouver, Canada.Sponsor: IASTED Contact: Prof. C.C.H. Ma, Dept. of Electrical Engineering, University of British Columbia, Vancouver, B.C., Canada. V6T-1Z4, Tel: 604-822-2045; Fax 604-822-5949.

• **August 11-13, IEEE International Symposium on Intelligent Control. Glasgow.** *Contact:* Edward Grant, The Turing Institute, George House, 36 North Hangover Street, Glasgow G12AD, UK. Ph.: 041-552-2085.

email: eddie@turing.ac.uk.

• **August 12-14 International Workshop on Emerging Technologies & Factory Automation.** Melbourne, Australia. Sponsors: IEEE Industrial Electronics Society and Swinburne Inst. of Technology. Contact: Dr. Richard Zurawski, Lab. for Concurrent Computing Systems, Swinburne Inst. of Technology, PO Box 218, Melbourne 3122, Australia. Ph. 61 3 819 8036; Fax: 61 3 819 6443 email: rzz@stan.xx.swin.oz.au.

• **August 17-19 8th Int. Conf. on CAD/CAM: Robotics & Factories of the Future,** Univ. of Metz FRANCE. Sponsor: ISPE. Contact: Dr. J.-M. Proth, INRIA LORRAINE Technopole Metz 2000, 4, rue Marconi, 57070 France. Fax 33 87 76 39 77; Ph. 33 87 20 35 00

•**August 24-28 Government Neural Networks Applications Workshop.** Dayton OH. GNN 92, Maj. Steven K. Rogers, AFIT/ENG, WPAFB, OH 45433

•**August 26-28. IAPR Int. Workshop on Structural and Syntactic Pattern Recognition. Bern Switzerland.** (*See Call for Papers)*

•**August 30-Sept. 93 IAPR: 11th International Conference on Pattern Recognition.** The Hague, Netherlands. *Sponsor:* International Association for Pattern Recognition. Four simultaneous conferences:

•*Computer Vision and Applications* (H.Niemann); *Pattern Recognition Methodology and Systems* (J. Kittler); *Image, Speech and Signal Analysis,* (I.T. Young); *Architectures for Vision and Pattern Recognition,* (V. Cantoni). Secretariat, Delft University of Technology, Department of Electrical Engineering, PO Box 5031, 2600 GA Delft, the Netherlands. Tel: 31 15 78 60 52; FAX: 31 15 62 20 00 email:

IAPR@ET.TUDELFT.NL.

•**August 31-Sept. 2 IEEE Workshop on Neural Networks for Signal Processing.** Copenhagen. Spons. by the Computational Neural Network Center (CONNECT).

•**September 1-4. Romansy '92. 9th CISM-IFToMM Sym. on Theory and Practice of Robots and Manipulators.** Udine, Italy

•**September 7-9, 3rd Int. Workshop on Advances in Robot Kinematics**

•**September 7-10. EURO-DAK '92. European Design Automation Conference.** Hamburg, Germany. *Contact:* EURO-DAK;92 Sec., 7490 Clubhouse Rd., Ste. '01, Boulder CO 80301;

•**September 9-16. Manufacturing '92.** McCormick Place, Chicago. *Sponsor*: Society of Manufacturing Engineers. SME's Machining, Tooling and Fabricating Conference at IMTS'92. *Registration:* PO Box 3918, Frederick MD 21701, Tel 301 694 3288

•**September 13-16 22nd Biennial ASME Mechanisms Conf.** Bern, Switzerland

•**September 17-19. IEEE International Conference on Systems Engineering** International Conference Center, Kobe, Japan *Sponsor*:

Pascal Research Institute, Kobe Contact: Professor Kotaro Hirano, Electronics Engineering Department, Kobe University, Japan. *Contact*: Professor B.A. Shenoi, Electrical Engineering Dept. Wright State University, Dayton, OH 45435.

•**September 15-18 ICARCV'92: 2nd Int. Conf. on Automation, Robotics, and Computer Vision.** Singapore. ICARCV'92 Conference Secretariat Associated Conventions and Exhibitions 204 Bukit Timah Road, #04-00 Boon Liew Building, Singapore 0922 Fax: (65) 791-2687 Tel: (65) 799-5470 Telex: RS 28615 E-mail: EMITAL@NTU-VAX.BIT

•**September 16-20. International Symposium on Robotics, Mechatronics and Manufacturing Systems '92.** Kobe Japan. Sponsors: IMACS tech. com. on Control Systems and Robotics and Society of Instrument and Control Engineers, Japan (SICE). Contact: Mr. Yasutaka Saito, Secretariat of IMACS/SICE RM$^2$S '92 Kobe, Society of Instrument and Control Engineers, Japan, 1-35-28-303 Hongo, Bunkyo-ku, Tokyo, Japan. Tel: 81 3 3814 4121, FAX 81 3 3814 4699.

•**September 28-30 13th IEEE/CHMT/EIA sponsored International Electronics Manufacturing Technology Symposium,** Hyatt Regency Hotel in Baltimore, Maryland. The IEMT is a forum for the presentation of research, development, and application of new technologies and systems for use in the manufacture of electronics. The IEMT Symposia are held twice each year: each autumn in the United States and each spring alternating between Europe and Japan.

This year's theme "Integrated Manufacturing: The Future is Now" emphasizes the need for continuous improvement and injection of new technology across the entire manufacturing enterprise from marketing to design to the factory floor. Electronics manufacturing process sessions include semiconductor manufacturing; packaging; multichip module design, manufacturing and test, interconnection technology; board level manufacturing; and inspection and testing. In the area of managing the electronics enterprise there will be sessions on quality management in manufacturing and design, engineering and manufacturing data management, and integrated manufacturing management. Following the EMT on Thursday will be a one day Optoelectronic Packaging Workshop sponsored by CHMT and LEOS. The contact for information about EMT is Bill Moody at (302) 478-7057 and for the Optoelectronic Packaging Workshop, Les Fox at (508) 858-3037.

•**September 30 - October 2, 1992. 30th Annual Allerton Conference on Communications, Control, and Computing.** Allerton House, University of Illinois-Urbana-Champaign.Conference Sect'y Janet Reese, Univ. of Illinois, Coordinated Science Laboratory, 1101West Springfield Avenue, Urbana, Illinois 61801 (217) 333-8553

• **October 1-2 International Workshop on Intelligent Manufacturing Systems. Dearborn MI.** *Sponsor:* International Federation of Automatic Control. *CoSponsors:* ASME, IEEE Control Systems Soc., SCS, SME **Contact:** Dr. Naim A. Kheir, Dept. Electrical & Systems Engineering, Oakland University, Rochester MI 48309-4401.

•**October 6-9 ISIR'92: 23rd International Symposium on Industrial Robots. Barcelona.** Contact: AER-ISIR'92 Secretariat, Asociacion Espanola de Robotica, Rambla de Catalunya, 70, 3r2a, 08007, Barcelona (Spain) Tel 34 3 215 57 60; FAX 34 3 215 23 07.

• **Oct 7 - Oct 10 RNNS/IEEE Symposium on Neuroinformatics and Neurocomputing.** Rostov-on-Don, USSR *Sponsors*: Russian Neural Networks Society and the IEEE Council on Neural Networks. Contact: Dr. Wesley E. Snyder, Dept. of Radiology, Bowman Gray School of Medicine, Wake Forest University, Winston-Salem NC 27157-1022. 919-748-3908, FAX 9 19-748-2870. email: wes@mrips.bgsm.wfu.edu.

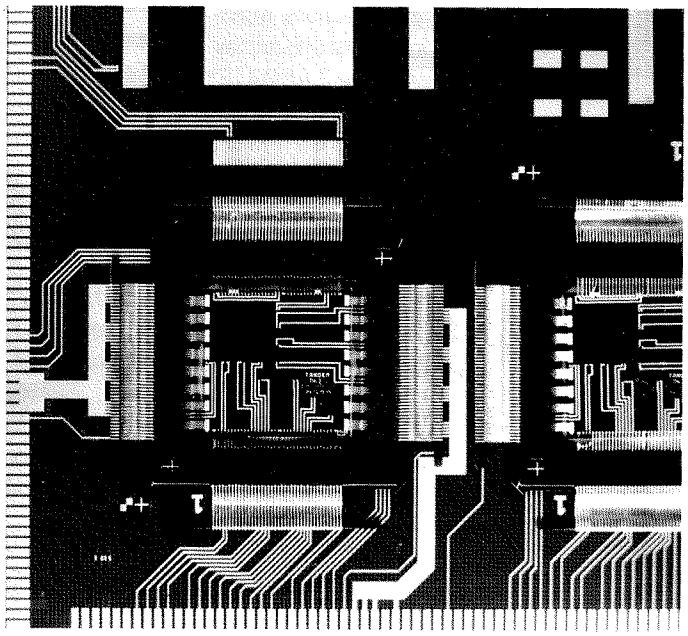
•**October 13-16. VBC'92: Visualization in Biomedical Computing. Chapel Hill, NC.** *Sponsor:* Dept. Computer Science, UNC-CH in coop. w/ Alliance for Engineering in Medicine & Biology, IEEE EMBS, and SPIE. *Contact:* Dept. of Computer Science, CB #3175, Sitterson Hall, UNC, Chapel Hill, NC 27599-3175.

•**October 11-14 MILCOM '92: Communications: Fusing, Command, Control and Intelligence.** San Diego CA. Sponsors: IEEE, IEEE Communications Society, and the Armed Forces Communication and Electronics Association. *Contact*: John Peckham, (619) 592-5153.

•**November 3-6, 1992 IJCNN '92-Beijing: The International Joint Conference on Neural Networks Beijing, China.** ***Sponsors:*** The IEEE Council on Neural Networks, The International Neural Network Society,The China Neural Networks Counci,The IEEE Beijing Section. Contact: Meeting Management, 5665 Oberlin Drive, Suite 110, San Diego CA 92121 Tel 619 453 6222; Fax 619 535 3880.

•**November 3-6. Madrid. 3rd European Conf on Software Quality.** *Contact*: Julio Gonzalez-Sanz AECC-CON-GRHISA C/Velazquez 90, P-5 28006 Madrid Spain. 34 15 75 2580; FAX 34 15 77 3874.

•**November 9-13 ISRAM '92: International Symposium on Robotics and Manufacturing.** Santa Fe, New Mexico. *Contact*: Dr. Ron Lumia (Robotics), Intelligent Controls Group, Robot Systems Division, National Institute of Standards and Technology, Gaithersburg MD 20899 USA, Tel: 301-975-3452; FAX 301-990-9688, email: lumia@cme.nist.gov or Prof. Joe H. Mullins (Manufacturing), Manufacturing Engineering Program, Farris Engineering Center, College of Engineering, University of New Mexico, Albuquerque, NM 87131 USA. Tel: 505-277-0558;



TAB'd Thermal Test Chip in Multichip Module Test Substrate. From IEMT'91. (Photo courtesy Paul Wesling.)

FAX: 505-277-0813.

- **November 15-20. Intelligent Robots and Visual Communications and Telemanipulator Technology.** Boston. *Sponsor*: SPIE. Part of OE/Technology '92; an applications symposium on optics, electro-optics and lasers in industry. *Contact:* SPIE; International Society for Optical Engineering; PO Box 10, Bellingham WA 98227-0010;Tel: 206 676 3290; Fax 206 647 1445

- **November 16-18 ISMCR'92: Second International Symposium on Measurement and Control in Robotics.** Tsukuba Science City, Japan. *Sponsor:* IMEKO. *Contact*: Prof. S. Tache, RACST, University of Tokyo, 4-6-1 Komaba, Meguro-ku, Tokyo 153 JAPAN. Tel: 81 3 3481 4467 FAX: 81 3481-4469.

- **December 2-4, 1992. 2nd Int. Workshop on Industrial Applications of Fuzzy Control and Intelligent Systems.** College Station, Texas. Spons.: Center for Fuzzy Logic & Intelligent Systems Research, Texas A&M Univ. and North American Fuzzy Information Processing Soc. Contact: Sherry Escalante, Dept. Computer Science, Texas A&M Univ., College Station, TX 77843 Phone (409)845-5466 Fax (409)847-8578 email:

  csdept@cs.tamu.edu

- **December 7-9 MVA'92. IAPR Workshop on Machine Vision Applications. Tokyo.** *Contact*: Mikio Takagi, Institute of Industrial Science, University of Tokyo, 7 22 1 Roppongi, Minato-ku, Tokyo 106 Japan.

- **December 16-18, 1992, 31st IEEE Conference on Decision and Control**, Tucson, AZ. *Contact:* Professor T. Basar, Coordinated Science Lab, Univ. of Illinois, 1101 West Springfield Ave., Urbana, IL 61801, (217) 333-3607, (217) 244-1764 (FAX) e-mail: tbasar@markov.csl.uiuc.edu.

- **February 14-18 1993, Medical Imaging VII.** Newport Beach CA. *(See Calls for Papers)*

- **March 28-April 1, 1993 ICNN93: IEEE International Conference on Neural Networks. San Francisco** *(See Calls for Papers)*

- **March 28-April 1, 1993. FUZZ-IEEE: 2nd Int. Conf. on Fuzzy Systems. San Francisco.** *Sponsor:* IEEE Neural Networks Council. *Contact:* Meeting Management, 5665 Oberlin Drive, Suite 110, San Diego CA 92121 Tel 619 453 6222; Fax 619 535 3880. *(See Calls for Papers)*

- **March 10, 1993 12th APEC Micromouse Contest. May 10-12, 1993. IMACS Symposium on Signal Processing and Neural Networks.** SPANN'93 MONTREAL Canada. *Contact:* Prof. Z. Jacyno, Department of Physics, University of Quebec at Montreal, P.O.Box 8888, Station A, Montreal, P. Quebec, Canada, HC 3P8.

- **June 7-10, 1993. 7th Int'l Conf. on Solid State Sensors and Actuators. Yokohama Japan** *(See Calls for Papers)*

- **June 13-16, 1993. CBMS'93: IEEE Computer-Based Medical Systems Symposium. Ann Arbor, MI** *(See Calls for Papers)*

- **June 21-5, 1993. 14th Int. Conf. on Application and Theory of Petri Nets. Chicago.** *(See Calls for Papers)*

- **July 14-16 1993. Intelligent Vehicles '93.** Tokyo *(See Calls for Papers)*

- **August29-Sept.3, 1993. IJCAI'93: Int'l Joint Conf. on Artificial Intelligence.** Chambery Savoie France

# Calls for Papers

*Note: Fax and email submissions are usually not acceptable. Please contact Program Chair for specific details regarding paper preparation before submitting papers.*

- **Medical Engineering VII. February 14-18 '93.** Newport Beach CA. *Sponsor;* SPIE. 4 Conferences: Image Processing, PACS: Design and Evaluation; Physics of Medical Imaging; and Image Capture Formatting and Display. Submissions: 4 copies of abstract by 27 July 1992 to SPIE, Box 10, Bellingham WA 98227-0010. Tel 206 676 3290; FAX: 206/647-1445; Internet: spie@nessie.wwu.edu; Compuserve: 71620,2177

- **12th APEC Micromouse Contest. March 10, 1993**, San Diego. Contact Melissa Widerkehr, Courtesy Associates, 655 Fifteenth ST. NW, Washington DC 2005 USA Tel 202 347 5900.

- **ICNN 93: IEEE International Conference on Neural Networks. March 28-April 1, 1993**, San Francisco. Submissions: Submissions: 6 copies of full papers (8pp max) by September 21 1992 to Dr. Mamid Berenji, AI Research Branch, MS 269-2, NASA Ames Research Center, Moffett Field, CA 94035.

- **FUZZ-IEEE '93: 2nd IEEE Int'l Conf. on Fuzzy Systems.** Held in conjunction with ICNN93 (above). Submissions: 6 copies of full papers (8pp max) by September 21 1992 to Piero Bonissone, General Electric CRD, Bldg. K-1, Rm 5C32A, One River Road, Schenectady NY 12301

- **Solid State Sensors and Actuators June 7-10, 1993** Yokohama, Japan. *Sponsors*: Institute of Electrical Engineers of Japan and Japan Science Foundation. Submissions: 2 copies of a 2-page abstract before November 30, 1992 to the regional chairman. *Europe:* Prof. Jan-Ake Schweitz, Dept. of Technology, Uppsala University, Box 534, S-751 21 Uppsala, Sweden; *NA, SA, Africa & Australia:* Dr. Kurt Petersoen, Lucas NovaSensor, 105 Mission Court, Fremont CA 94539 USA; *Asia & all other regions:* Prof. Akio Sasaki; Secretariat TRANSDUCERS '93, c/o SANSEI International Inc., Fukide Bldg. No. 2, 1-21 Toranomon 4-chome, Minato-ku, Tokyo, 105 Japan.

- **PetriNets'93: 14th Int. Conf. on Application and Theory of Petri Nets. June 21-25, 1993.** Chicago. *Submissions*: 8 copies of complete papers by November 16, 1992 to Marco Ajmone-Marsan, Dipartimento di Elettronica, Politecnico di Torino, Corso Duca degli Abruzzi 24, I-10129 Torino Italy. Phone 39 11 5644032. Fax 39 11 5644099 email: ajmone@itopoli.bitnet.

- **CBMS 93: IEEE Computer Based Medical Systems Symposium. July 13-16 1993.** Ann Arbor Michigan. *Sponsors:* IEEE and Engineering in Medicine and Biology Society. *Submissions:* Timothy J. Kriewall. Ph.D., Sarns, 3M Health Care, 6200 Jackson Road, Ann Arbor MI 48106; 313 741 6276.

- **Intelligent Vehicles '93. July 14-16 '93,** Tokyo. *Sponsor:* IEEE and SAE. *Submissions*: 3 copies of 1 page abstract by December 15 '92 to Ichiro Masaki, Computer Science Dept., General Motors' Research Laboratories, 30500 Mound Road, Warren MI 48090-9055 USA. Tel: 313-986-1466; FAX 313 986 9356; email masaki@gmr.com

- **IROS 93: Int'l Conf. on Intelligent Robots and Systems. July 26-30 Yokohama Japan** Papers are sought on: Dexterous Maniplation, Robust Sensing, Versatile Intelligence, Novel Robotics, Locomotion, Multi Agent Systems, Application Frontiers, Intelligent Motion Control and other related topics. *Summission:* 4 copies of long (25pp max.) or short (10pp max.) by December 1, 1992 to either of the co-chairs: MasatsuguKidode, Kansai Research Lab., Toshiba Corp., 8-6-26 Motoyama-Minami-cho, Higashinada-ku, Kobe; 658 Japan, tel: 81 78 435 3502; fax 81 78 435 3678 or Tomomasa Sato, Research Center for Advanced Science and Technology, Univesity of Tokyo, 4-6-1 Komaba, Meguro-ku, Tokyo, 153 Japan, Tel 81 3 3481 4479 Fax: 81 3 3481 4584.

- **Int'l Conf. on Advanced Mechatronics August 2-4, '93 Yokahama, Japan.** Submissions: 3 copies of 800 word abstract by December 1, 1992 to : Prof. Jun'ichi Takeno, School of Science and Technology, Meiji University, 1-1-1 Higashi-ita, Tama-ku, Kawasaki-shi, Kanagawa-ken 214, Japan, Tel 044 934 9454; 044 934 7912 (Japan) International Tel/Fax 81 44 934 2880.

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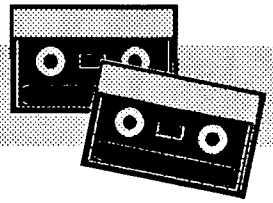

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A qualitative change is taking place in the area of factory automation with the advent of "intelligent factory". This is characterized by the addition of intelligent components to factory environment. This will provide greater flexibility and productivity with reduced capital outlays in the 21st century. These emerging technologies and their applications to factory environment is the topic of this symposium.

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-Concurrent engineering
-Scheduling and control of manufacturing systems
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-Factory computer communications: protocol performance and efficiency, LAN, architectures
-Intelligent automation/process automation
-Intelligent robotic systems: task and motion planing, distributed multiple robotic systems, cellular robotics, robot sensing, sensor integration and fusion
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Prof. Tharam S. Dillon
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| Paper summary submission due: | Jan. 31, 1992 |
| Acceptance notification | April 1, 1992 |
| Final camera ready paper due | June 1, 1992 |

For further information contact Dr Richard Zurawski, Dept. of Electrical & Computer Eng., Swinburne Institute of Technology, PO Box 218, Melbourne 3122, Australia. Ph. +61 3 818 8036, FAX +61 3 819 6443, Email rzz@stan.xx.swin.oz.au

forces with zero force/torque value.

The same adaptive hybrid control, allowing only the X and Y axis translations, is used to center the robot tool on the valve axis. This procedure is helpful to avoid anomalous forces on the robot wrist during the valve rotation, which may cause mechanical stress.

In the last step of the manipulation, the valve handwheel is rotated by a selected number of degrees. The force control operates only the tool Z axis rotation and stops the execution if the torque, applied on the end effector, exceeds a preset value. This is helpful to prevent damages deriving from stressing a closed or locked valve.

During the manipulation it's also important for the operator standing at the console to know whether the circuit has some anomalous vibrations, which normally go along with a failure in the plant. Holding the robot tool in contact with the valve for a few seconds, this diagnostic action can be performed using the force sensor as a vibration measuring instrument. The recorded values and the acceleration frequency analysis are displayed on the console allowing the operator to estimate the status of the system under control.

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