



The Knowledge Foundation's 2nd Annual Conference on  
**Advances in Application of Integrated  
 Commercial Off-The-Shelf Micro-Electro-Mechanical-Systems**

# COTS MEMS 2001

November 29-30, 2001 • Boston Marriott Quincy • Quincy (Boston), MA USA

In it's 2nd year, this international conference is designed to address the challenges faced by MEMS developers transitioning their technologies to the marketplace.

**ENDORISING  
 ORGANIZATIONS:**

**BOSCH**

COVENTOR



MEMS Exchange®



- Assessing and enhancing the maturity of MEMS design, manufacturing, packaging, testing, reliability and quality assurance infrastructure
- Defining meaningful standards and regulations for COTS MEMS across diverse applications
- Pinpointing unresolved component and system reliability and integration issues

Hear the latest from distinguished industry and government leaders covering such MEMS areas as telecom/optical MEMS, networking and packaging, RF MEMS, MEMS foundry, Si and MEMS, microfluidic devices, molecular nanotechnology and photonic MEMS. Conference presentations will highlight the issues of reliability, standardization, metrology, testing and quality assurance.

Some of the critical questions to be addressed will include:

- What are the synergies required to maintain successful COTS MEMS?
- What are the impacts of regulation of venture capital activities on COTS MEMS?
- Does your company have the correct business model for the transition from MEMS into COTS MEMS?
- How to integrate MEMS to achieve system level function?
- How to streamline the physical interface between devices and humans?
- How to overcome barriers for commercializing MEMS?

*Don't miss this unique opportunity to participate in and learn from real-time COTS MEMS roadmapping! REGISTER TODAY!*

**HERE IS WHAT PEOPLE HAD TO SAY ABOUT COTS MEMS 2000:**

*"Thank you. I need a good overview by industry experts in this evolving technology. I got exactly what I needed."*

John Cranney, Vice President - Technology, Unmanned Systems Technology Lab, USA

*"Thank you for being a crossroad of ideas and knowledge."*

Marcel Ecabert, Director, Swiss Foundation for Research in Microtechnology, Switzerland

**ORGANIZED AND SPONSORED BY:**



REGISTER ONLINE AT  
[WWW.KNOWLEDGEFOUNDATION.COM](http://WWW.KNOWLEDGEFOUNDATION.COM)  
 OR CALL (617) 232-7400

**Thursday, November 29, 2001**

8:00 Registration, Poster/Exhibit Setup, Coffee & Pastries

8:50 Chairperson's Opening Remarks

**Chris C. Lumb, President and CEO, Micralyne Inc., Canada**

9:00 Commercialization Issues of MEMS/MST/ Micromachines: An Updated Industry Report Card on the Barriers to Commercialization

**Roger H. Grace, President, Roger Grace Associates**

The last two years have witnessed an unprecedented interest in MEMS, Microsystem Technologies (MST) and Micromachines, collectively called M<sup>3</sup>. Of great interest has been the creation of many new companies whose desire has been to commercialize the technology. During 1999, 2000, and early 2001, a large number of startups, especially in the optical MEMS sector, were created. It is estimated that there are over 900 companies, research institutes, and universities currently involved with M<sup>3</sup> worldwide. Over 200 of these are US-based companies who wish to commercialize this technology. Although this paper focuses on the US market, the commercialization issue is a global one. This paper addresses a number of the significant issues associated with the barriers that have existed to the successful commercialization of M<sup>3</sup> by new as well as established companies throughout the world. These issues include R&D, marketing, infrastructure support and venture capital funding. An M<sup>3</sup> "Report Card" is provided assessing current status of the industry and barriers to commercialization with respect to these issues and compares the grades with those reported from June 1998-2000. Recommended strategies are provided that are expected to help overcome these barriers to commercialization. A product evolution timetable is presented which charts the development of various products including pressure sensors, accelerometers, relays, bio, RF, and photonic MEMS from discovery to full commercialization. Market values and volatility indices are provided for various segments of the industry.

### DESIGN, RELIABILITY, STANDARDIZATION AND TESTS

9:30 Barriers to MEMS Commercialization - An Accelerometer Case Study

**Bob Sulouff, Director, Business Development, Micromachined Products Division, Analog Devices**

MEMS is an enabling technology that has created new opportunities for accelerometers that are used in automotive air bags, consumer products and are slowly overcoming barriers in military applications. This paper examines the surface micromachined accelerometer from Analog Devices as a case study to understand the barriers to commercialization. The barriers can be grouped into two areas, the technical and the business issues. The technical challenges of semiconductor materials and processing, packaging, testing and reliability are all highlighted. The business timing, system integration, automotive expectations and competitive pressures are also discussed.

10:00 MEMS Standardization - *cif* MEMS

**Michael Gaitan, PhD, MEMS Project Leader, National Institute of Standards and Technology**

An overview for the monolithic integration of microelectronics with MicroElectroMechanical Systems (MEMS) in standard CMOS technology is presented. The approach is based on designing glass passivation openings in the integrated circuit that expose the silicon substrate. The MEMS structures are micromachined by wet or dry silicon micromachining as a post-process to the standard CMOS process. This approach to MEMS fabrication can be implemented directly through any CMOS foundry; however, it is formally supported by the MOSIS service and NIST. Applications based on this method are presented including microheating elements, passing microwave elements, and test structures and standards to evaluate the mechanical properties of the thin films used in the IC process.

10:30 Refreshment Break, Exhibit / Poster Viewing

11:00 Design for Reliability of MEMS/MOEMS for Lightwave Telecommunications

**Susanne Arney, PhD, Technical Manager, Micromechanics Research, Lucent Technologies / Bell Labs\***

Optical Micro-Electro-Mechanical Systems (Optical MEMS, or MOEMS) comprise a disruptive technology whose application to telecommunications networks is transforming the horizon for lightwave systems. An overview of MOEMS devices for lightwave telecommunications systems provides a background for understanding a Design for Reliability mindset to facilitate rapid commercialization of such MOEMS research concepts. The impact of materials systems, processing complexity, and reliability requirements on design flexibility, functionality and commercialization of MOEMS is discussed. A tight inter-dependent feedback loop between Component/ Subsystem/ System Design, Fabrication, Packaging, Manufacturing and Reliability is described as a strategy for building reliability into potential MOEMS products while accelerating their development into commercial offerings. \*In cooperation with: A. Gasparyan, M. Haueis, and H.R. Shea, Lucent Technologies / Bell Labs

11:30 Interactive Design of MEMS for Emerging Markets

**Nora A. Finch, Applications Engineer, IntelliSense Corporation**

This talk focuses on the use of MEMS-specific CAD tools to decrease product development time. These tools take into account factors not critical on the macro-scale, allow for optimization within the virtual environment, and result in improved device performance. Specialized CAD capabilities include process dependant material properties, anisotropic etching behavior, microfluidic analysis, and the coupling of multiple physical domains, such as electro-mechanical, electro-magnetic, and thermal-mechanical. By reducing the number of prototyping runs, engineers achieve more rapid market penetration of MEMS devices.

12:00 Designing COTS MEMS into Your System: The Component-System Co-Design Problem

**John R. Gilbert, PhD, Chief Technology Officer, Coventor, Inc.**

All Systems enabled by MEMS pose the following co-design problems. Can the MEMS component be designed to improve the system? Can the system design be changed to allow the use of easier to design MEMS? These are key problems that any MEMS design methodology must cope with - and key problems in the effective insertion of MEMS (and COTS MEMS) designs into commercially viable systems. We will describe the Coventor Methodology and Toolset for attacking this co-design problem.

12:30 Speaker Power Luncheon Sponsored by The Knowledge Foundation

Don't miss the opportunity to meet one-on-one with our conference faculty. Delegates are invited to join participating speakers over luncheon to discuss today's "hot topic" COTS MEMS issues

1:55 Chairperson's Remarks

**Susanne Arney, PhD, Technical Manager, Micromechanics Research, Lucent Technologies / Bell Labs**

2:00 Experiences and Lessons in Building Successful MEMS Manufacturer

**Chris C. Lumb, President and CEO, Micralyne Inc., Canada**

Micralyne Inc. is a leading MEMS supplier, with over 15 years of experience as a developer and manufacturer of micromachined products. Originally a university-owned not-for-profit, Micralyne has now been a profitable and growing MEMS supplier for over three years. This talk will describe our experiences in developing a sustainable model for operating a profitable MEMS business, including an assessment of various financing, product management, and customer/partner selection issues.

## 2:30 MEMS & Positional Assembly Through Molecular Nanotechnology: A Case Study

**James Von Ehr II, President, Founder & CEO, Zyvex Corporation**

The CEO of the first molecular nanotechnology company will discuss MEMS, positional assembly, technology development and commercialization.

## 3:00 Microfluidic Devices: Coupling to the Macro World

**Hugh McManus, PhD, MBA, Vice President/Sales, Nanostream Inc.**

One of the main challenges facing designers of microfluidic devices is coupling to the macro world. This talk will focus on novel ways that Nanostream has developed to address this problem. The talk will focus primarily on microfluidic devices and development laboratories, showing how devices are designed to fit to existing instrumentation platforms. A specific example in the form of a case study will be presented.

## 3:30 Refreshment Break, Exhibit / Poster Viewing

## 4:00 Commercial Off-The-Shelf High Volume MEMS Test & Measurement Production Equipment: It's All About Time-to-Volume

**Thomas A. Cellucci, PhD, MBA, President & CEO, Etec Inc.**

Time-to-volume is a very real issue facing the producers of optical MEMS or MEOMS. Much can be gained from the existing base of knowledge and experience of producing high volume production tools gained in the past few years from more mature inertial and pressure MEMS market segments. In order to minimize the cost-of-test and increase throughput and yield, it is crucial to adopt a system approach to MEMS testing and develop a test philosophy, which at its core, advocates continuity of data integrity from R&D through high-volume production. Commercially available automated test solutions currently exist at the wafer/die level with robust and reliable final test solutions on the horizon. We will present real-world case studies of how fully integrated and automated MEMS test solutions increase throughput and decrease the cost of test and packaging, a large driver in the production of optical MEMS.

## 4:30 Adhesion in MEMS: Test Structure, Metrology and Lubrication Choices

**Maarten P. de Boer, PhD, Senior Member Technical Staff, MEMS & Novel Si Dept, Sandia National Labs**

Tribological issues such as poorly controlled adhesion and friction are limiting the growth of microelectromechanical systems (MEMS) in the wider market place. To address this problem, a MEMS-based tribology test infrastructure is being developed. Deflection curves of simple test structures sensitive to adhesion and friction are measured by interferometry at the nm scale, and properties are determined by comparing measurement results to mechanics models. In this presentation, we will describe test structure and metrology considerations for achieving a tribology lab on a chip, demonstrate that silane coupling agent monolayers significantly reduce adhesion and friction, and explore the limitations of these coatings.

## 5:00 MEMS Commercialization: An Asian Perspective

**Miwako Waga, Associate Director, Asian Technology Information Program (ATIP), Japan**

Technological innovation is a complex process that involves countless variables. Such variables include public and private investments in research and development, future vision, entrepreneurship, and market demand. In the field of Micro-Electro-Mechanical Systems, Japan has played a large role in R&D since the early 1990s, while Korea and Taiwan have expanded investments in recent years to industrialize MEMS technology. This talk will compare these countries in terms of government funding, academic and industrial activity and analyze East Asian characteristics in MEMS commercialization.

## 5:30 Open Discussion: Warm-Up for Tomorrow's Panel

## 6:00 End of Day One

## Friday, November 30, 2001

## 8:00 Exhibit / Poster Viewing, Coffee and Pastries

## 8:55 Chairperson's Remarks

**Michael A. Huff, PhD, Director, MEMS Exchange, Corporation for National Research Initiatives**

## TELECOMMUNICATIONS, OPTICAL, RF AND PACKAGING

## 9:00 Silicon Micromachines for Lightwave Networks

**David J. Bishop, PhD, Vice President, Optical Research, Lucent Technologies / Bell Labs**

MEMS are beginning to have an impact in almost every area of science and technology. The combination of high functionality, small size, low power, low cost, the ability to integrate with electronics and high speed give them clear advantages over other competing technologies. This is especially true in lightwave systems where many devices such as variable attenuators, add/drop multiplexors, switches, dynamic gain equalizers and especially optical crossconnects are being built with MEMS devices and sold in the marketplace. In my talk I will discuss some of the opportunities for MEMS in this space, describe devices currently on the market and present some of the challenges we face in growing this market.

## 9:30 MEMS Mirror Applications in Optical Networks

**Mark F. Krol, PhD, Technical Development Manager, Optical Networking Devices, Corning Incorporated**

Growth in the optical layer of telecommunications networks is generating the need for high port count and high functionality optical technologies. MEMS technology can play a significant role in a number of these important optical networking applications. In this paper, we will review key applications in optical networks where MEMS technology adds high value and discuss various MEMS technology based solutions for these applications.

## 10:00 Integrated Optical MEMS in Telecom Components

**James Wylde, PhD, MEMS Technology Project Engineer, Nortel Networks Optical Components Inc., Canada**

This presentation will discuss the challenges and concepts required to realize the implementation of integrated MEMS devices into optical telecommunication components. The presentation will be a case study of the integration of MEMS with opto-electronic devices (transmitters, detectors, PWG circuits, etc) in the context of a technology program. The focus will be on integration with existing or parallel development rather than stand alone functions. Topics covered will include the considerations required for fabrication, development, and implementation.

## 10:30 Refreshment Break, Exhibit / Poster Viewing

## 11:00 Defining Specifications for Consumer Focused MEMS and the Cost Performance Trade-Offs

**Clifford R. Vaughan, Manager Emerging Products, Motorola**

This presentation describes the design and manufacturing trade-offs involved in evaluating various RF MEMS switches for wireless hand set applications. The selected RF MEMS switch technology will then be compared with current semiconductor PIN diode & FET devices for benefits in the targeted wireless application. Also described are the problems encountered migrating the selected MEMS switch designs into production including the various packaging problems encountered with a low cost consumer focused product.

## 11:30 Low Cost Vacuum Packaging for MEMS

**Thomas R. Schimert, PhD, Engineering Fellow Raytheon Commercial Electronics**

Abstract not available at time of print

## FOUNDRIES

### 12:00 MEMS and Foundry Service Within the Multi-Project Wafer Service at Bosch

*Wilhelm Frey, PhD, Project Manager RTC, Robert Bosch Corp.*

This talk will focus on MEMS at Bosch and the Bosch foundry service. More than hundred customers have joined the latest MPW runs and had their different designs processed in our wafer fab. Academic institutions as well as industrial companies have been among those customers. Several very promising projects are close to volume production now, e.g. highly accurate gyroscopes for automotive applications and aviation. Furthermore, we will discuss our planned approach to use well-established Bosch processes for the generation of a new standardized process sequence in silicon bulk micromachining. This sequence aims at the development and fabrication of passive modules and opens a wide range of biotechnological and medical applications.

### 12:30 Challenges of MEMS Commercialization Through Foundries

*Sonbol Massoud-Ansari, Director of External Services, and Nader Najafi, PhD, President & CEO, Integrated Sensing Systems (ISSYS) Inc.*

Integrated Sensing Systems (ISSYS), Inc. is one of the oldest non-captive MEMS companies in the US. In the last few years, ISSYS has been offering foundry services for MEMS companies, ranging from single step fabrication processes to turnkey product services. This paper discusses some of the critical challenges in successful utilization of foundries for commercialization of MEMS products.

1:00 *Lunch on Your Own*

### 1:55 Chairperson's Remarks

*Roger H. Grace, President, Roger Grace Associates*

## PROGRAMS & IMPLEMENTATION TOOLS

### 2:00 MEMS Program at DARPA: Current Thrust Areas and Future Vision

*William C. Tang, PhD, MEMS Program Manager, Microsystems Technology Office, DARPA*

Microelectromechanical Systems (MEMS) is one of the three core enabling technologies within the Microsystems Technology Office (MTO) of the Defense Advanced Research Projects Agency (DARPA). Together with Photonics and Electronics, MEMS forms the foundation for a broad variety of advanced research projects sponsored by MTO as well as the other offices within DARPA. Research projects are underway to apply MEMS in specific military platforms in all four domains of engagement: air, land, sea, and space. These current thrust areas are showing strong potentials to transition into further development and small-scale production for military uses. The future vision of the MEMS program is to demonstrate all crucial technologies to co-locate on a chip scale all vital functions including sense, compute, actuate, communicate, and power. Strategic new programs will be established to advance the state of the art to fulfill this vision.

### 2:30 The MEMS Exchange: A Flexible and Affordable Environment for MEMS Implementation

*Michael A. Huff, PhD, Director, MEMS Exchange, Corporation for National Research Initiatives*

The MEMS Exchange is a national-level implementation service for MEMS technology supported by the Defense Advanced Research Projects Agency (DARPA), which is furnishing extensive support and access capabilities to the growing domestic MEMS community. A key element of this program is to establish a distributed MEMS processing environment where fabrication and testing of MEMS devices and systems is performed at multiple, geographically dispersed sites located around the country. This distributed MEMS fabrication environment has quickly become a valuable national resource for commercial, academic and Government organizations interested in obtaining rapid, flexible, and affordable access to MEMS technology. This talk will discuss how the MEMS Exchange functions and provide some insight into lessons learned about MEMS fabrication.

### 3:00 Making MEMS a Viable COTS Product: A remote goal or a technological reality?

**MODERATOR:** *Roger H. Grace*

**PANELISTS:** *David J. Bishop*  
*Thomas A. Cellucci*  
*Michael A. Huff*  
*Chris C. Lumb*  
*William C. Tang*

PANEL  
DISCUSSION

4:00 *Group Discussions in the Exhibit / Poster Area. Refreshments*

4:30 **Selected Oral Poster Presentations**

5:00 *Closing Remarks / End of Conference*

## CALL FOR POSTERS

Industry and academic scientists are encouraged to submit poster titles for this event. One-page abstracts (8 1/2" x 11" with 1-inch margins) must be submitted no later than **October 30, 2001** for inclusion in conference documentation. Additional poster submissions will be accepted until **November 15, 2001** but may not be included in conference documentation. Note: If you are submitting a poster, you **MUST** be registered and paid in advance to ensure that a posterboard is reserved for you.

## SPONSORSHIP AND EXHIBITING OPPORTUNITIES

There is no better way to provide exposure for your organization as leaders in the industry than through conference sponsorships. Among other benefits, sponsorship packages include your logo on premarketing materials to promote your organizations participation and expose your company to 10's of thousands of prospects prior to the program — in addition to the highly targeted audience we deliver at the event itself.

Call Alan Abend at (617) 232-7400 ext. 202 or email [aabend@knowledgefoundation.com](mailto:aabend@knowledgefoundation.com) today to for pricing information and customization options.

## COMPREHENSIVE DOCUMENTATION AVAILABLE

Nothing can substitute the benefits derived from attending **COTS MEMS 2001**. But if your schedule prevents you from attending, this invaluable resource is available to you. Please allow 3-4 weeks after the conference date for delivery. *Note: Documentation is included with conference fee for registered delegates.*



# COTS MEMS 2001

The Knowledge Foundation, Inc.  
18 Webster Street  
Brookline, MA 02446 USA

PRSR STD  
U.S. Postage  
PAID  
Knowledge  
Foundation

The Knowledge Foundation's 2nd Annual Conference on  
**Advances in Application  
of Integrated  
COMMERCIAL OFF-THE-SHELF  
MICRO-ELECTRO-MECHANICAL  
SYSTEMS**

November 29-30, 2001 • Boston Marriott Quincy  
Quincy (Boston), MA USA

cover images courtesy of NIST

Bookmark our website at [www.knowledgefoundation.com](http://www.knowledgefoundation.com)  
**REGISTER ONLINE!**

## REGISTRATION FORM

2633 INTERNET

- Register me to attend. Enclosed is a check/bank draft for US\$ \_\_\_\_\_  
 Commercial Rate  Academic Rate (subject to verification)
- Register me to attend &  Invoice me  Charge my Credit Card:  VISA  MC  AMEX  
 Card #: \_\_\_\_\_ Exp.: \_\_\_\_\_
- I cannot attend, but please send the conference documentation.  
 Enclosed is my check for \$299.  Invoice Me
- I wish to present a poster. *Title of abstract:* \_\_\_\_\_
- \_\_\_\_\_
- Abstract enclosed  Title and abstract to arrive by **October 30, 2001**

Name \_\_\_\_\_

Job Title: \_\_\_\_\_

Organization \_\_\_\_\_

Division: \_\_\_\_\_

Address: \_\_\_\_\_

City/State/Zip \_\_\_\_\_

Tel: \_\_\_\_\_ Fax: \_\_\_\_\_

Email: \_\_\_\_\_

What is your primary research area?: \_\_\_\_\_

Registration fee includes lunch on the first day, refreshments and all documentation made available to us by speakers. Commercial registration is US \$1099. Academic/government registration is US \$699. The academic/government rate is extended to all participants registering as full time employees of government and universities. To receive the academic/government rate you must not be affiliated with any private organizations either as consultants or owners or part owners of businesses. Posterboard fee: US \$45. On-site registration is an additional \$100. **Register in advance to secure your seat!**

### OTHER KNOWLEDGE FOUNDATION EVENTS (Simply check conferences that interest you and we will send information to you.)

- Tissue Engineering • October 4-5, 2001 • Providence, RI  Photonic Nanostructures • October 11-12, 2001 • San Diego, CA  
 Biopolymers • October 15-16, 2001 • Boston, MA  RNA in Drug Development • November 12-13, 2001 • San Diego CA  
 Superconductors • November 15-16, 2001 • Boston, MA  COMBI 2002 • January 23-25, 2002 • San Diego, CA

## FAX, MAIL, CALL, E-MAIL TO:

**The Knowledge Foundation, Inc.**  
18 Webster Street  
Brookline, MA 02446 USA  
Tel: (617) 232-7400  
Fax: (617) 232-9171

**E-Mail:** [custserv@knowledgefoundation.com](mailto:custserv@knowledgefoundation.com)

**PAYMENT:** All payments must be made in U.S. funds drawn on a U.S. bank. Please make check(s) payable to The Knowledge Foundation, Inc. and attach to the registration form even if you have registered by phone, fax or e-mail. To guarantee your registration, payment must be received prior to the conference. Confirmation of your booking will follow.

**DISCOUNT ACCOMMODATIONS AND TRAVEL:** A block of rooms has been allocated at a special reduced rate. Please make your reservations by **October 26, 2001**. When making reservations, please refer to the The Knowledge Foundation. Contact The Knowledge Foundation if you require assistance.

**Venue:** Boston Marriott Quincy  
1000 Marriott Drive  
Quincy, MA 02169

### For Hotel Reservations Contact:

**ANDERSEN TRAVEL**  
Phone: (508) 429-6494 or 1-800-229-6494  
Fax: (508) 429-7380  
Email: [suek@andersentvl.com](mailto:suek@andersentvl.com)

The Knowledge Foundation's official travel agent, Andersen Travel will assist you in making all or a portion of your travel arrangements.

**SUBSTITUTIONS/CANCELLATIONS:** A substitute member of your company may replace your attendance at any time at no charge if you find your schedule prevents you from attending. Please notify us immediately so that materials can be prepared. If you do not wish to substitute your registration, we regret that your cancellation will be subject to a \$100 processing fee. To receive a prompt refund, we must receive your cancellation in writing 15 days prior to the conference. Unfortunately cancellations cannot be accepted after that date. In the event that The Knowledge Foundation, Inc. cancels an event, The Knowledge Foundation, Inc. cannot resume responsibility for any travel-related costs.

### UNABLE TO ATTEND?

You can purchase a full set of conference documentation. Simply check the box on the registration form and send it to us along with your payment. Please allow 4 weeks after the conference date for delivery.