Materials Research Science and Engineering Centers

Industry Outreach/Education Activities Survey

Final Compiled Results

Submitted by the Industry Working Group

November 22, 2004

Executive Summary

The Industry Working Group of the Materials Research in Science and Engineering Centers (MRSEC) program - *Mike Rubner, Sanjay Sampath, William Butler, Bill Curtin, David Sellmyer, John Torkelson, Mike Ward (chair)* – distributed a questionnaire to all MRSEC directors aimed at capturing industrial participation and activities in the MRSEC program as a whole. Their responses (21 of 28 MRSECs responded) were compiled into the summary contained herein. Because the aim of this survey was to evaluate industrial participation with the MRSEC program as a whole, none of the responses or activities is identified with any particular Center.

The survey results reveal a rather robust connection between MRSECs as a whole and the industrial sector. A total of 404 industrial partners participate in research with the 21 MRSECs that responded to the survey. Of these, the majority were large companies (210 with more than $100 million in annual revenue) but small company involvement was also strong (110 with less than $10 million in annual revenue). During the three years surveyed (Y2002 – Y2004), MRSECs organized more than 100 workshops and symposia designed to provide exposure to special topics for more than 4000 industrial attendees. The level of these activities showed a marked increase in Y2003 and Y2004, although this increase may reflect a difficulty in retrieving information pertaining to activities dating back to Y2002. The survey also revealed 117 undergraduates and 256 graduate students/postdocs performing research in collaboration with the industrial sector, most supported wholly or partially by industrial contributions. The survey also solicited comments pertaining to other activities not captured by the survey questions, best practices for collaborating with industry, and the status of industrial involvement. The responses reveal differences among the Centers in how they optimize their interactions with companies. Particularly noteworthy are many comments that indicate the value of industry to research and the education of students. Although the Centers have determined best modes of partnership with industry, some comments do reflect the difficulties sometimes faced with respect to intellectual property issues and restrictions on publication. Overall, however, the tone of the comments indicates that the MRSECs find interactions with industry to have a positive impact.

Questions and comments can be addressed to Michael D. Ward, Director, University of Minnesota MRSEC, wardx004@umn.edu. More information about industry interactions and other MRSEC activities is available at www.mrsec.org.

Compiled results from the MRSEC Industry/Outreach Education Activities Questionnaire

Q: *Workshops, Short Courses or Symposia held in **Y2002** with industrial participants, including industrial speakers and attendees*

Title/Area	*No. industrial attendees*
Nanoscience Short Course	36
Workshop on Science and Technology of Nanotubes	5
Franklin Medal Symposium	5
Consortium on Thermal Spray Technology: Kick-off meeting	19
Small Scale – Big Business?	50
Polymer Outreach Symposium	40
Banana Liquid Crystals: Chirality and Polarity	10
Symposium on 'Soft Matter'	5
Introduction to Thermal Spray Technology	15
Life Cycle Assessments for Thermal Spray Coatings	90
Consortium on Thermal Spray Technology: Mid year meeting	15
CSEM Annual Meeting	20
MINT Fall Review	19
Self-Assembled L10 Magnetic Nanoparticles for Recording Media	17
Photonics Workshop	20
MINT Spring Review	125
BASF, Unilever	30
Industrial Outreach Program	80
Course on Innovations	25
Complex Fluids Workshop	25
Nanoimprint Technologies	15
Venture Workshop on Organic and Plastic Electronics	250
TOTAL Industrial participants	**916**

Q: *Workshops, Short Courses or Symposia held in **Y2003** with industrial participants, including industrial speakers and attendees.*

Title/Area	*No. industrial attendees*
Workshop on Nanotechnology and Modern Education	N/A
Micelle Systems Workshop	40
International Symp. on Waterborne, High-solids and Powder Coatings, New Orleans, LA	321
Powder Coatings Short Course	22
International Symposium on Integrated Ferroelectrics	100
U.S. – Japan Meeting on Dielectric and Piezoelectric Ceramics	100
Short Course – Tunable Thin Films for Intel	12
Update for W.M. Keck Smart Materials Integration Lab industrial members	~ 20
Second Annual MRI Materials Day	100
Polymer Outreach Symposium	45
Consortium on Thermal Spray Technology: Year end meeting	18
Photonics	20
Functionalized Polymers	30
Organic Thin Field Electronics: Materials, Devices and Applications	10
Materials Characterization with Near-Field Nanoprobes	20
Solidifying Coatings: Drying, Curing, Structure and Properties	30
Colloidal Dispersion Shorcourse	19
Visit of Siemens Facilities with high school students from Pittsburgh neighborhood. Project: "Powering future Engines. Engineering Materials for hydrogen Fuel Cells"	4
Current topics in magnetoelectronics	10
UCB Chemicals Short Course	6
Advances in Nanomagnetics and Information Technologies	6
Consortium on Thermal Spray Technology: Research Y2 meeting	16
Nanoparticles 2003	20
Update for Center for Optical Technologies	20
Research Review for Members of PSU Nanofab Facility	100
MINT Fall Research Review	19
Micromagnetic Simulations	19
CSEM Annual Meeting	25
MINT Spring Review	125
BASF	25
Industrial Outreach Program	80
Unilever	20
Haliburton	5
Philip Morris	3
Complex Fluids Workshop	22
Associative Networks	48
Creating Value out of Basic Research	20
Nonequilibrium Interface Dynamics: Theory and Simulation from Atomistic to Continuum Scales	11
Imaging & Analysis Center training courses	20
Micro/Nanofabrication Facility	30
TOTAL Industrial participants	**1541**

Q: *Workshops, Short Courses or Symposia held or anticipated in **Y2004** with industrial participants, including industrial speakers or attendees.*

Title/Area	*No. industrial attendees*
Printing Technology Workshop	20
International Symp. on Waterborne, High-solids and Powder Coatings, New Orleans, LA	276
Powder Coatings Short Course	14
Release from Polymer Coatings and Particles Workshop	60
Regional Outreach Sessions	52
Consortium on Thermal Spray Technology: Mid year meeting	15
Facilities 101 Workshop	23
Third Annual MRI Materials Day	70
Wrinkling and Surface Texturing Workshop	10
Biomechanics and Bifunctionalization of Adsorbed Surface Layers	8
Polymer Outreach Symposium	37
Colloidal Dispersion Shorcourse	16
Frontiers in Self-Assembly Workshop	20
Industrial Applications of Polymer Theory Workshop	30
Thinner, Faster, More Uniform Coating Workshop	30
Organic Thin Film Electronics Workshop	10
Nanoprobe Master Course	20
Frontiers in Liquid Crystals and Molecular Self-Assembly	10
Rheology Short Course	40
2004 Virginia Nanotechnology Showcase / Nanomanufacturing	30
Coating Technology Short Course	40
Global Opportunities for Thermal Spray Applications	20
Introduction to Thermal Spray Technology	20
Advanced Concepts in TS Materials Processing	20
Marketing of Thermal Spray Technology	20
Materials and Processes for Energy Systems	125
Thermal Spray Coatings – Advanced Concepts and Applications	N/A
Workshop on Nanotechnology	N/A
General Information Session	50
Advanced Nanomagnetics	10
Facilities 101 Workshop	23
Symposium on Micro- and Nanoscale Laser Materials Processing	20
MINT Fall Resarch Review	50
Tunneling Magnetoresistance for Heads and MRAM	50
MINT Spring Review approximately 10 MINT trips to Sponsor Site	125
BASF	25
Industrial Outreach Program	80
Course on Innovations	20
Molecular Modeling of Polymers	64
CADD method workshop	3
Meeting with Seagate, Veeco and DARPA	4
The Third International Workshop on Nanoscale Spectroscopy and Nanotechnology	10
Inaugural Symposium	50
TOTAL Industrial participants	**1620**

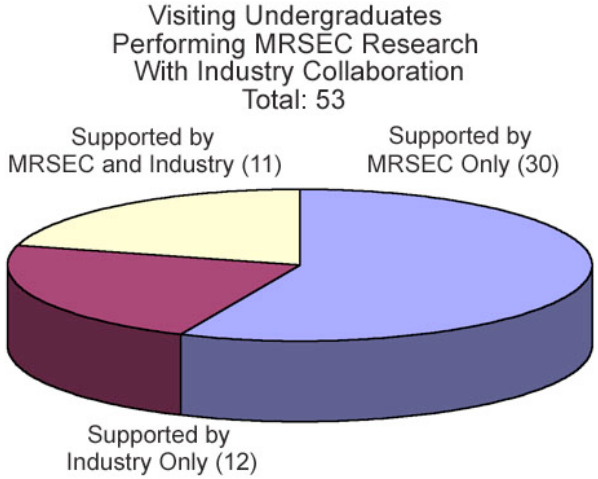
Q: *Any formalized shared internship programs between your REU and industry? If yes, please describe briefly:*

- 13 Centers responded "No," 2 were non-responsive, and 6 offered the following:
- Summer Internship Feeder program in which we match summer research participants with industry internships the following summer.
- An internship partnership with the members of our Industrial Consortium and other companies. Students spend summers and inter-sessions working at the company and conduct research on the company's behalf during the academic year.
- No formal programs, however a graduated student won a corporate sponsored graduate fellowship, which included a 15-week internship at the company's research facilities.
- Center students work with industry either by visiting an industrial lab for a brief period or by working in one of our "Industrial Application Teams" on a specific problem of interest to a company.
- Industrial sponsors support individual REU fellowships.
- Tours with a nearby industrial lab.
- REU students supported by the Society for Energy and Renewable Energy. Students worked to characterize the incoming mixed waste streams and outflow products from a plant that converts animal and vegetable waste to oil and other commodity products.

Q: *Number of visiting (REU or equivalent) undergraduates performing MRSEC research with industry collaboration:*

Total: **53**

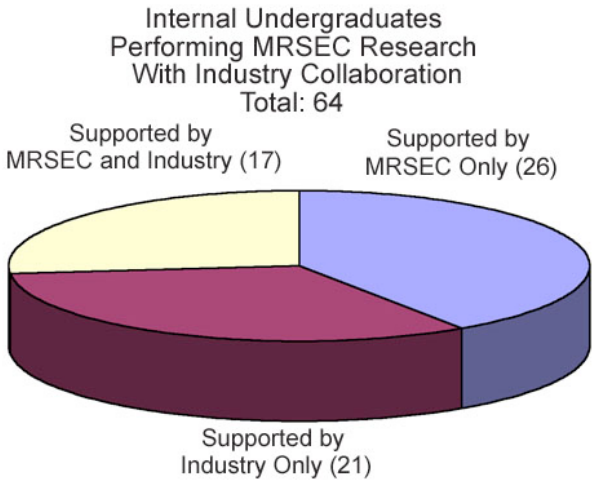
Number supported by MRSEC only: **30** Industry only: **12** Both: **11**



Q: *Number of internal undergraduate students working on MRSEC-related projects with industry collaboration:*

Total: **64**

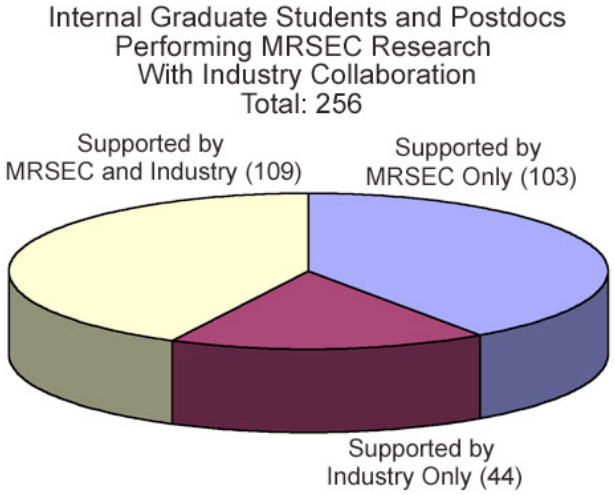
Number supported by MRSEC only: **26** Industry only: **21** Both: **17**



Q: *Number of internal graduate students and postdocs working on MRSEC-related projects with industry collaboration:*

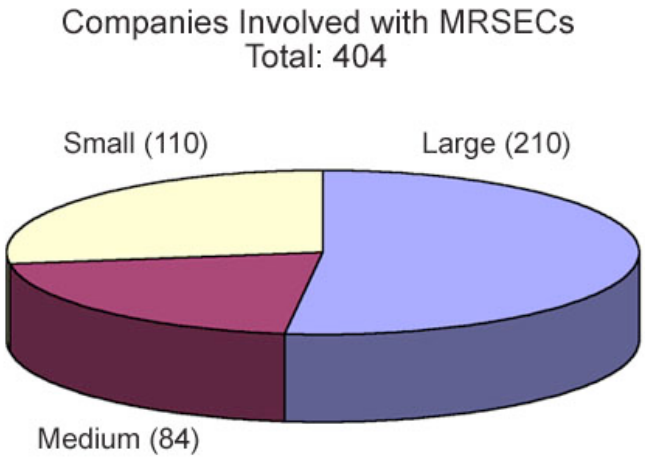
Total: **256**

Number supported by MRSEC only: **103** Industry only: **44** Both: **109**



Q: *How many companies are involved with your MRSEC?*

Total: **404**
Breakdown by Company Size
Large (> $100 million total annual revenue): **210**
Medium ($10 million - $100 million total annual revenue): **84**
Small (< $10 million total annual revenue): **110**



Q: *Other industry-related activities:*

- Very significant interaction with industry, including very substantial licensing of intellectual property generated here.
- Several MRSEC patent disclosures filed this past year.
- Industrial usage of shared experimental facilities, related marketing (Facilities 101 course).
- Encouraging the start-up of new companies spun out of Center research; working to maximize benefits to the US of large company research efforts that have been abandoned.
- Several MRSEC faculty consult with industry. One faculty member will take an industrial sabbatical this year. Several faculty have jointly chaired external symposia with industry at society meetings. Several faculty are involved with industrial partners in projects at national facilities. Several industrial scientists have spent times ranging from a week to a year in our labs. Industrial scientists use our shared experimental facilities. Five industrial scientists serve on the MRSEC's External Advisory Board. Several faculty have started companies based on intellectual property rights developed here. Named lecture series attract industrial scientists. Local industries host participants in our summer programs for high schools.
- Several industry-supported research projects.
- Researchers go to industrial site for scientific interaction.
- There were research collaborations active between our faculty and 22 companies during 2003. Three industrial scientists established residency in our labs to strengthen collaborations. Seed faculty member developed titanium oxide nanotubes arrays as room temperature hydrogen sensors and that technology has been licensed. Field tests of prototypes of those sensors are underway.
- Consortium consists of eleven leading applicators, manufacturers and specifiers working together on pre-competitive research agendas facilitating knowledge transfer between academia and industry. The Consortium also allows rapid dissemination of research results, exposure of students and post-docs to industrial implications of the research and future people transfer.
- Fall Student Poster Session (~ 100 posters – Intercollegiate / interdepartmental)
- In previous few years, industrial participation had been declining with tight economy. Recently, 2004 & 2005, industrial participation is on the rebound and climbing. However, overall industrial funds are down, despite increasing participation – more activity, but less funds available.
- Patents donated from Industry to University.
- Local industry makes extensive use of our central user facilities; approximately 40 regular industrial users from over 20 corporations.
- Nano/microfabrication facility has over 100 regular users, with heavy utilization from industrial partners.
- Annual series of workshops bringing industrial partners and venture capitalists.

Q: *Other comments related to industrial interactions (e.g., successes, best practices, things to avoid):*

- Drawbacks to collaboration are, restrictions on publishing joint research; intellectual property rights; small sums of money are usually involved.
- We found that it was very important to present the information to industry in a manner in which it can be understood and applied. Industry can be a bit skeptical at first of the "value/impact" that MRSEC research can provide both short and long term. However, once industry is aware of the depth of understanding that can come out of industry/academia interactions, the value is easily understood. Many technical companies have lost fundamental scientific knowledge through attrition of research and development personnel. The knowledge transfer that can be established between industry and academia through industrial outreach efforts can provide this crucial link in keeping industry abreast and apart of latest technological advances.
- Prepare students well, so they are aware of the issues facing employment in a private sector, in particular female graduate students. We organized workshops for female graduate students, which were conducted by female faculty who joined the faculty after working in industry. Very successful.
- Connecting to the university's existing industrial interfaces has proved to be valuable, efficient and worth emulating.
- Focus on the science and relationship between the company and the university prior to entering into any IP discussions.
- Our experience suggests that a for-pay company affiliates program with intellectual property rights attached to the membership works poorly. We are currently experimenting with a model where company affiliates pay a small ($5K/year) "K-12 outreach tax" as a fairly painless way to show commitment, and help the Center and community.
- The most effective way to interact with industry is to seek projects that are sufficiently long term that they are suitable for a student's thesis project but also have impact on a company's direct interests. It is also very effective to have industry recruit students who have worked in or in association with a MRSEC.
- Levels of industry interaction vary widely by research topic. Biggest issues center around IP.
- Must listen to the needs of industry and be in contact with them on a regular basis.
- IP issues are most difficult to negotiate.
- Type of financial support (gift vs. grant/contract) is a common point of friction.
- Collaboration with industry (hands-on involvement) is growing, but requires time and patience.
- High-tech industries have significant and growing interest in novel magnetic materials; however, it is necessary to advertise our research adequately to industrial sectors through media and bulletins so as to consolidate the interest.
- Programs aimed specifically at demonstrating the device principles using new materials need to be implemented with an adequate focus on defining the potential and limitations of the suggested schemes. It is also necessary to explain whether the suggested device schemes can be implemented using existing industrial infrastructure or require complete overhaul of instrumentation. Industries generally are quite concerned about this.
- Forging new collaborations with industry is always challenging. Companies have specific needs and timelines, and corporate R&D is under continual pressure to trim costs.

Q: *Trends? Is industrial participation with your center increasing or decreasing?*

- One center responded "steady," three responded "increasing," three were non-responsive, and nine offered the following:
- Industrial participation is increasing. The consortium has provided an entry into the laboratory and many small to large size research projects have spun off of the original research themes. This took some time to establish. The fundamental research needs to reach a point that industry can value and appreciate, but once that has been established the collaborations are highly effective.
- As the second phase of the Center has come up to full speed, it appears the industrial collaboration has increased.
- Increasing – many companies are realizing that they have cut their R&D to the point that they are not generating the ideas they need for new products. They are coming in higher frequency to harvest new ideas!!
- Increasing due to state funding, which provides for an Industrial Partnerships Office and staff.
- It is increasing. We are actively seeking new industrial collaborations and new programs, and now have in the program someone whose task to help develop them.
- Our industrial participation has increased over the last five years and appears to be continuing to increase as our results and tools have advanced. Advancement of tools – from an industry perspective – means making them usable by non-experts. Tool we have generated are likely to find implementation in government labs sooner than in industry. Industry mostly needs well-supported, user-friendly tools, which requires a heavy investment of time unrelated to basic research. Therefore, we have emphasized projects with direct support and involvement of knowledgeable individuals in industry in order to ensure that the participation has impact for the industrial partners.
- Decreasing somewhat
- Decreasing. But as many companies undergo reorganization, the trend may change.
- Given our new "payment required" model, it is likely the number of affiliated companies will go down. On the other hand, new start-ups are in the works, and these companies would likely be Center affiliates. Factors out of our control, such as the general economic climate and capital markets, influence our industrial participation to some extent.
- Notably increasing
- Our nanotechnology programs are providing an excellent vehicle for interactions with industry, and we are finding interest in spin-offs including chemical sensors, rf circuitry and integration of nanoelectronic devices on plastic substrates.
- Industrial interest growing in the development of new ferromagnetic and multiferroic materials for sensor and spintronics applications.
- Industrial collaboration organic electronics expanding.