

Engaging Industry in Lab-Based Manufacturing Education: RPM at Georgia Tech

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Abstract

Leading edge manufacturing technologies present major challenges in education, both for degree students and for continuing education. Creating and maintaining the necessary instructional facilities can easily overwhelm typical university budgets. At Georgia Tech, a unique university/industry partnership has been formed to create and sustain a laboratory for Rapid Prototyping and Manufacturing (RPM), focused primarily on education. This paper will describe the development and implementation of the partnership, and its prospects for the future.

1. What is RPM?

Rapid Prototyping and Manufacturing (RPM) is an emerging collection of materials and process technologies, design and processing methodologies, and business practices and relationships, which together shorten product development cycles, improve product designs, and reduce product development costs. RPM is often associated with additive fabrication processes, such as stereolithography or selective laser sintering, and includes many other prototyping technologies, as well as such conventional processes as CNC machining, and a host of computer-based design, engineering, and analysis tools. RPM is used by leading edge companies in a variety of industries, including automotive, aerospace, telecommunication, industrial machinery, and medical devices.

Companies that are potential adopters of RPM and students who may need to work with RPM share a need for information and education that enables and advances RPM deployment. RPM is one of the fastest growing areas of manufacturing technology today. RPM holds the promise of saving both time and money in bringing new products to market. Other key technologies, including data handling, global networking, CAD, CAM, CAE, CNC machining, investment casting, RTV molding and virtual prototyping, all come together around RPM. But only a few companies are reaping the full benefits of the RPM and its associated technologies. Even companies already using RPM are struggling to keep up with the rate of change, and few students are familiar with RPM and its benefits.

2. Why is RPM Important for Georgia Tech?

Georgia Tech has made a major institutional commitment to manufacturing research and education, as evidenced by both facilities and programs. The Computer Integrated Manufacturing Systems Program (CIMS) was established in 1983, is a recipient of SME's LEAD award, and has over 600 alumni. The Manufacturing Research Center (MARC) was established in 1988, occupies a 100,000 square foot facility, and is the focal point for interdisciplinary manufacturing research on campus. Our goal is to provide students an opportunity for exposure

to and experience with a range of manufacturing technologies. Just as traditional machine shops on campus introduce students to the realities of design and manufacture, time spent in the RPM lab can greatly enhance students' educational experiences -- and increase their ultimate value as engineers and scientists.

The availability of RPM technology has benefits beyond the direct impact on manufacturing education. Currently, the RPM lab is the only place at Georgia Tech where students can go for fast physical prototypes of complex parts and mechanisms. We are convinced that this will become a critical resource for capstone design courses and interdisciplinary team projects across the campus.

RPM makes an important contribution directly, as an integral element of manufacturing education, and indirectly, by enabling design and engineering projects that otherwise would not be feasible.

3. Obstacles to RPM Adoption at Georgia Tech

Upper division and graduate laboratories dedicated to education are surprisingly hard to find at most research universities. Most labs are designed for, and funded by, research projects; it's hard to mix 100 undergraduates with delicate research apparatus.

The truly well-equipped educational labs that do exist generally are owned and funded by a specific discipline. For example, Electrical Engineering has its basic circuits lab, and Mechanical Engineering has the machine shop. Usually, sharing of facilities between disciplines is difficult due to scheduling and funding processes. The traditional inability to leverage resources across disciplines often means that emerging technologies do not become part of the engineering curriculum until they are very mature.

This problem becomes especially apparent in a multidisciplinary area like manufacturing. Georgia Tech does not have a "School of Manufacturing," so how do we handle the hundreds of Industrial, Electrical, Aerospace, Materials and Mechanical Engineering students who want to learn about manufacturing? What about the Management, Computer Science and Industrial Design Students?

Clearly, traditional interdisciplinary boundaries are one key hurdle to innovation in manufacturing education. For most state-supported institutions, like Georgia Tech, another key hurdle is the extreme difficulty of finding new resources to create and sustain new initiatives, like laboratories.

4. A Strategy to Engage Industry

We began talking about a new approach to laboratory development more than two years ago. That was in August 1994, when Georgia Tech faculty members from ME, ISyE, and EE collaborated to win a TRP grant from the National Science Foundation. The \$1 million award was to be used over three years to start educational laboratories in control systems, virtual manufacturing, and rapid prototyping. But how could we ensure that the students' activities in the labs were aligned with industry needs? How would we support the labs in the long run? The answer seemed clear. Get industry *actively* involved.

In late 1994, we began to assemble a business plan for the rapid prototyping activities. Our experiences in running the CIMS program (an industry-sponsored manufacturing education program for graduate students) had taught us that industry responds best to a well thought out plan; something that's written down; something that clearly shows a path to success; something that shows that we are interested in what industry needs -- not just what we need. In crafting our business plan, we addressed issues that we thought would be the keys to long term success: how the activity would be funded; how the budget would be spent; how the activity would engage industry; and how industry partners would benefit from the activity.

In early 1995, we hit the road with the plan in hand. Eleven phone calls had produced eight appointments with Atlanta-area manufacturers interested in RP. One by one, companies listened to the plan, asked questions, and suggested improvements. In each successive appointment, the plan was a little bit better. By April, it was time to pull the companies together.

On April 24, 1995 the eight companies: Siemens, UCB Chemical, Coca-Cola, Durden Enterprises, Lockheed, AT&T, Compression, and Motorola, came to Georgia Tech for our first meeting. The companies told us what they needed:

- 1) an active role in the students' education;
- 2) a better understanding of RPM technologies;
- 3) and the opportunity to work with others (i.e., other companies, faculty and students) to develop and improve RPM applications;

We listened, and these needs and the business plan became the core of our Founding Charter. On October 23, 1995, six of the original eight companies and one other became the founding members of the Rapid Prototyping and Manufacturing Institute -- the RPMI.

5. Current Status

In the fifteen months since founding the RPMI, we have learned a lot about working together. As with most endeavors, it's been those who have participated the most who have reaped the largest benefits. The key participants in the lab have been:

- 1) **Students:** More than 160 students, both graduates and undergraduates, made use of the facility in its first year. We expect the number to triple the coming year. We supported and enhanced their coursework, team projects, theses, and even extracurricular interests. Fourteen Graduate Research Assistants continue to be funded in the RPMI.
- 2) **Faculty:** More than a dozen faculty from five disciplines are involved in RPMI activities. They use the facilities to support their existing courses. Several are developing new courses that will leverage the RPMI's facilities. Many of our faculty are leading thesis work, and are collaborating to propose funded research projects.
- 3) **Industry:** Since our founding, we've added two more member companies: Eastman Kodak and Lucent Technologies. We will work to grow the membership to 15 companies this year. Members have identified and hired key employees from the pool of students they've met in the RPMI; they have hired our students as interns, proposed and led projects that address the group's specific RPM needs, and have been able to put our technical solutions to work in their companies.

Impact goes well beyond the member companies. We share our findings with non-members as well. This is in keeping with our mission of "development and deployment of RPM technologies through education." The primary channel for promoting the technology transfer is our annual national symposium on RPM.

Industry deserves much of the credit for our first year's success, and their role will grow in future years. Our first-year operations and capital equipment purchases totaled approximately \$750,000. Of that, our members funded almost 20%. Thirty percent came from the NSF grant, and the remaining 50% was Georgia Tech's contribution. To sustain our operations, we know that the industry portion must approach 70%. We believe we can reach this goal by the end of the second year.

6. Conclusions

We've suggested that this relationship with industry is unique because:

- 1) We started with a business plan.
- 2) We truly listened to industry and included their ideas in the plan.
- 3) The plan required a true partnership with *active* industry involvement -- not just financial contribution or pay for service.

Our operation of the RPMI also has four crucial characteristics:

- 1) The relationship between constituents is simple. We have no contracts, no promised deliverables, and no formal agreements regarding intellectual property.
- 2) We have only one level of membership. This promotes camaraderie and eliminates squabbles about rank.
- 3) The RPMI is not owned by a particular discipline. Our funds are largely separate from the fiscal concerns of other organizations on campus.
- 4) We are focused on one well-defined set of objectives around a single set of technologies. Members, faculty and students all know why they're involved -- it's their sincere belief that working together toward the common goals will lead them to achieving their personal or their organization's goals. It works.

Clearly, RPMI is still a very young organization, and it would be premature to declare it a template for industry-university collaboration in manufacturing education. The degree of commitment on both sides has been high and this is the key to its early success. However, it has been enormously successful so far. At Georgia Tech, we intend to adopt the RPMI model in other similar areas, where an emerging technology can be the basis for a meaningful relationship with industry, and a vehicle for access to technologies that should be incorporated in a modern manufacturing education experience.

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