

## **Academic/Industrial Partnerships to Enhance Learning and Strengthen Curriculum and Research**

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### **Abstract:**

Industrial partnerships have been a hallmark of Rowan Engineering Programs from the onset. The development of the Rowan Engineering Curricula began in 1994 and included the input of an advisory committee of technology industry leaders. The coursework and laboratories were planned and are being implemented with a strong component of industrial partnerships and industrial experiences for students and faculty.

Rowan has taken a multi-faceted approach to academic/industrial partnerships. Rowan faculty teaches courses on company sites. Many of these courses are designed to meet specific needs of industry and always include industrial input. These courses have a project component that allows participants to use the course content in an application that is relevant to their work. The development and implementation of university/industry designed courses have been especially successful for experimental design and statistical process control and analysis courses.

Industrial projects with experimental work completed at a company site or at the University are also an important part of learning and research opportunities for faculty and students. Academic/Industrial project partnerships leading to important learning and research opportunities are a critical component of Rowan Engineering Programs. Especially noteworthy are those partnerships involving undergraduate/graduate project teams. These opportunities lead to enhanced learning for students and strong support from industry for academic programs. Studies of powder flowability as a function of particle size and reengineering of toner cartridges have been especially successful.

### **Introduction and Background:**

The importance of academic/industrial partnerships in an engineering curriculum cannot be overemphasized. These interactions lead to significant benefits for the academic institution and the industrial partner. Students are exposed to engineering practice as part of their undergraduate experience, and the curriculum can be continuously updated to reflect realistic technological advances. Academic institutions also benefit from the financial and in-kind contributions available from industry. The industrial partner has access to the technical expertise of faculty and the work of students. Often this translates into completed projects for minimal costs. It is also a valuable recruitment tool for industry. Industrial sponsors have the opportunity to observe in detail the technical, social and communication skills of potential employees. Successful

academic/industrial projects can lead to expanded interactions, technology transfer to industry, and financial and in-kind contributions to the academic institution.

Activities designed to expose undergraduate students to engineering practice early in the curriculum are part of many engineering programs [Chaplin, 1997]. There are many examples of programs that include design projects sponsored by industry [Bendrich and Pugsley, 1998]. Strong industrial involvement in engineering education leads to highly beneficial academic/industrial partnerships that have enhanced the academic environment in the United States [Denton (1998), Peters and Timmerhaus (1991)] and other countries [Edward (1998), Grandin and Verduchi (1996)]. Rowan University is unique in that it offers academic/industrial activities beginning in the freshman year.

The Rowan College of Engineering began offering graduate classes in the fall of 1995, and accepted its first undergraduate class in the fall of 1996. From its inception, the Rowan Engineering Programs included a strong industrial component. Leaders in engineering and technical industries participated in the design and development of the engineering curricula for civil, chemical, electrical and mechanical engineering programs. They also participated in the design of a flexible and sophisticated engineering building to accommodate futuristic and comprehensive engineering programs. Industry input and support have been a hallmark of the Rowan College of Engineering.

### **On-Site Graduate Courses:**

One of the first graduate courses offered by the Rowan College of Engineering was an on-site course presented at Sony Music in Pitman, New Jersey. The course, entitled, *Experimental Design in the Manufacturing Industries*, was designed with input from Sony Music management and technical personnel. Sony Music gave its employees time to participate in the course. The one-semester course was scheduled one day per week from 3:00 pm – 6:00 pm. In this way, half of the course was scheduled during regular business hours. Sony's time contribution to this partnership made it possible for more of the technical personnel to participate in the course. It also demonstrated a strong commitment from Sony to the development of their employees and to Rowan Engineering Programs.

The course mainly consisted of a discussion/problem solving format with examples directly relevant to course participants. The class included participants from all departments connected to compact disc manufacturing. For the first half of the course, participants were exposed to general principles of experimental design with specific examples related to their industry. The second half of the class consisted of technical projects that were on going at the site. Groups were formed that included participants from the manufacturing areas relevant to the project. Care was taken to establish reasonable goals that could be accomplished by the end of the semester. There were five projects from different manufacturing areas. Groups presented their proposals to their colleagues for review. These oral presentations accomplished two important goals; participants became more aware of the projects and challenges in other departments and the projects were better defined as a result of the feedback each group obtained from their

colleagues. This format integrated the projects across departments from the beginning. All participants had an opportunity to comment on all projects, and in several cases project goals and technical procedures were revised on the basis of this input.

Once the projects were completed, groups presented their results in class. There was a wide diversity of projects. Some projects involved significant off-line experimental work while others involved trials on the manufacturing and packaging floor. One project involved data analysis with no experimentation. Course participants estimated savings of approximately \$100,000 attributable to the results obtained in the project section of the course. As a result, a second course, entitled *Applications of Optimization techniques in the Manufacturing Industry*, was designed and offered twice at the Sony Music site. This course included a strong statistical process control component and was designed with the same format as the original course. The course was well received and resulted in process improvements.

As a result of these interactions, Sony Music has contributed significantly to the Rowan Engineering Programs. They are a major donor, have contributed a grant for faculty to attend an international meeting, and they continue to provide summer internships for undergraduate students. In addition, two Sony employees are presently pursuing Master of Science degrees in engineering at Rowan University. The equipment and technician support for these graduate projects are provided by Sony to the University.

These courses also assist the faculty involved in the development of expertise in technical applications relevant to industry. However, intellectual property issues need to be addressed. In addition, the University and faculty involved need to make a significant commitment of time and energy. For example, for some of the projects, it was necessary to visit the site and review operations and equipment. This increased the time on-site for the faculty by approximately 35%. Also, course preparation time was approximately 40% higher than for a standard course since it was necessary for the faculty to become familiar with Sony manufacturing processes and operations. These commitments were a significant part of the success of these interactions.

### **Graduate/Undergraduate Projects:**

In addition to the course and project activities at Sony Music, Rowan University is engaged with regional industry in multiple undergraduate and graduate projects. The undergraduate projects are part of the course work required for all undergraduates. One exciting project that began as a graduate project and led to the design of an undergraduate project was recently completed at NER, a toner manufacturer in Glassboro, New Jersey. The graduate student involved is a full time employee at NER and began taking graduate courses toward a Master of Science in engineering degree in the evening. The project involved a study of the effect of particle size distribution on the flow characteristics of toner particles. As part of this research, flow characterization properties were identified and measured as a function of particle size distribution in toners. The impact of additives on the particle size distribution and on the flow properties was also studied. This work was followed with an undergraduate clinic project. The undergraduates worked with the

graduate student to make additional flowability measurements. The effects of additives on flowability were studied. In addition, the undergraduate component included the study of the reengineering of toner cartridges. Students studied the existing reengineering process for a popular cartridge at NER. They validated the reengineering process and developed a process to reengineer a different toner cartridge. All equipment and technician support was provided by NER. In addition, the company gave the graduate student enough flexibility to complete the work in a timely manner. The graduate student obtained a Master of Science degree in Engineering with a chemical engineering specialization in May '99. Additional projects involving undergraduates in the Chemical Engineering and Chemistry Departments will be offered as junior and senior projects in the spring '2000 semester.

### **Discussion:**

The academic/industrial interactions described in this work have led to enhancements in curricula, exposure of students to engineering practice, faculty development, and financial and in-kind support to the Rowan Engineering Programs. In addition, industry has benefited from the technical expertise of the faculty and the work of students. In some cases, the results obtained lead to the realization of significant savings. These types of academic/industrial interactions benefit students, faculty, the University, industry and the region

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