Successful Proposal Collaborations in Polymer Processing and Computer Integrated Manufacturing

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Abstract

The process of developing grant proposal ideas, identifying appropriate programs for submission, developing the necessary contacts, and writing the actual proposal is an arduous one. It is imperative that individuals participating in such endeavors present a proposal that is well defined, well researched, and of value to the audience it is intended to serve, the funding agency, and the community at large.

This paper describes the efforts of the authors in developing laboratories in Polymer Processing and Computer Integrated Manufacturing at GMI Engineering & Management Institute. Tips for developing sound proposals are presented along with case studies that demonstrate application of these tips in the generation of external funding. The paper highlights a mode of operation that is expected to stimulate the interest of educators working in related environments.

Introduction

The Manufacturing Systems Engineering laboratories at GMI address a broad spectrum of manufacturing processes, and students of Manufacturing Systems Engineering, as well as Mechanical, Industrial, Electrical Engineering (well over 500 per year) benefit from exposure to these laboratories. The authors have been extensively involved with supervising independent study projects with undergraduates, resulting in more in-depth exposure to the laboratories for about ten students per year. The authors have also donated much of their time and the use of their facilities to precollege programs providing laboratory exposure to young people considering engineering for undergraduate study.

The cooperative nature of GMI Engineering & Management Institute enables faculty to be aware of changes in the needs of industry and allows industry input in curricular design. Faculty members interact with industry sponsors as they supervise undergraduate theses. Each department is supported by a group of industry representatives who focus on laboratory needs, and who assist in defining that which should or should not be included in the curriculum. In the process, strong ties have been formed between faculty and equipment suppliers, providing direction for future collaboration.

Case Studies:

Four successful NSF ILI grant proposals have been awarded in the past two years to faculty in the Manufacturing Systems Engineering and Chemistry departments. In 1994, a grant for $45,000 with matching funds from the Institute and a 100% overmatch from industry was used to develop a flexible assembly cell (FAC) [1]. FAC is a robot-centered cell for the assembly and inspection of products manufactured in the CIM laboratory and features an assembly robot with integrated vision, automatic identification equipment, supervisory computer control , and extensive sensory instrumentation. Students taking courses in Robotics and CIM have used the cell for various laboratory experiences and term projects. In addition the cell has been used in three independent study projects on cell design, machine vision, and hierarchical control. Undergraduates have also participated in the development of the cell as part of the college work study program. The cell has been used to demonstrate a sophisticated assembly environment to precollege students via summer programs and year-round tours. When fully implemented, the cell will facilitate extensive interaction between CIM and polymer processing students through the assembly and inspection of products that maybe molded on injection molding machines, possibly machined at one of several different machining cells in the facility, and then transported to FAC for final processing. The integration of product design, manufacturing process design, and manufacturing systems design reinforces the approach of learning through synergy.

Also in 1994, a grant for $49,281 with matching funds from the Institute was awarded for the purchase of an injection molding machine with microprocessor control[2]. Industrial ties allowed for this grant to be leveraged such that the purchase of two injection molding machines was possible. The full implementation of this equipment will result in interaction between students of Polymer Processing (IMSE 407) and Computer Integrated Manufacturing (ISME 480) students as the injection molding machine becomes linked to the flexible assembly cell discussed earlier, resulting in a system capable of automated part unloading, degating, delivery, assembly, and inspection. Independent investigations have already been conducted by undergraduate students using this equipment, including a study of the effects of various recycled resin additions to final part quality, and the implementation of Statistical Process Control. Freshmen students have been exposed to the technology made capable by this equipment, as have high school students enrolled in summer precollege programs.

In 1995, the Manufacturing Systems Engineering program received another NSF ILI grant proposal for $69,500 for a Stereolithography Apparatus (SLA)[3]. Again matched by funding from the Institute, this grant resulted in equipment which will be of use and benefit to polymer processing students, CIM students, and metal casting students. When fully implemented, solid models created by CIM students with input from polymer processing students will be downloaded to the SLA for the creation of a rapid prototype. Understanding of the resin curing properties and the necessity for support structures from CIM and polymer processing students will be integrated in the development of an appropriate solid model. The prototype will then be forwarded to metal casting students to be used as a pattern for an aluminum part. Students representing all three (CIM, polymer processing, metal casting) areas of the manufacturing systems engineering curriculum will witness a complete manufacturing process, from part design to part creation, in minimal time. They will also appreciate the impact of Rapid Prototyping and Manufacturing on reducing a new product's time to market.

The final grant, for $47,000, was also funded in 1995, and resulted in the purchase of a fatigue-capable mechanical testing machine[4]. Students of adhesives technology and polymer processing will benefit from this instrumentation, which will allow for accurate measurement of tensile, bending, compressive, and fatigue characteristics of adhesive materials and polymers following a variety of processing conditions. Students of the adhesives technology and applications course, administered by the Chemistry department, and students of polymer processing, administered by the Industrial and Manufacturing Systems Engineering department, will examine together the interactions between processing conditions and mechanical properties. The grant will also supply funds to retrofit an existing mechanical testing machine, such that these accurate measurements can also be conducted on stronger materials such as metals.

Tips For Proposal Writers

Prior to and throughout the proposal writing process, if certain links are developed the process is more likely to be fruitful. These links are described below:

- Develop links with industry.

  Review the best practices in industry and compare these with the current curriculum. Write proposals to incorporate these best practices. Communicate with industry representatives via a departmental advisory board, prospective employers, or student sponsors. Develop a communication with the manufacturers of equipment and materials.

- Develop links with faculty in other programs and departments.

  Find faculty members with common interests and areas of expertise that can be integrated. Demonstrate a willingness to collaborate and share resources. Show how laboratories and curriculum can be bridged to offer a better education to students.

- Develop links with students.

  Through the integration of faculty interests and laboratories, demonstrate the numbers and diversity of students impacted. This may extend out of the classroom to independent study and thesis work.

- Develop links with to precollege level.

  Show how project will benefit future students. Indicate how the proposal impacts the future of engineering and discuss ways in which funding will improve the state of secondary science education.

- Develop links to the community at large.

  Evaluators are increasingly concerned with the investigators ability and intention to evaluate the success of the project as well as to disseminate the results. Clearly outline the methodologies which will be used to measure the program success. Develop a plan to disseminate results to a wide and diverse group.

Conclusion

The Division of Undergraduate Education (DUE), Directorate for Education and Human Resources offers the ILI grant to assist faculty in improving and enhancing laboratories. Among the goals of the DUE are to ensure “the development and wide spread implementation of curricula and laboratories that incorporate

scientific advances [and] interdisciplinary perspectives, " and to ensure "effective linkages between college and the workplace."[5] By focusing on the integration of our curriculum using the proposed equipment and by illustrating the interaction generated with industry, faculty at GMI Engineering & Management Institute have been successful in recent grant proposals.

References

1. W. F. Erevelles and J. A. Abell. (1994). Flexible Assembly Cell. N. S. F./I. L. I. Grant Award.
2. L. L. Sullivan and W. F. Erevelles. (1994). Microprocessor Control of Process Parameters in Injection Molding of Polymers. N. S. F./I. L. I. Grant Award.
3. L. L. Sullivan and W. F. Erevelles. (1995). Stereolithography (Rapid Prototyping) Apparatus for the Polymer Processing and Computer Integrated Manufacturing Laboratories. N. S. F./I. L. I. Grant Award.
4. Daryl J. Doyle. (1995). Tensile Testing Instrumentation for Adhesive Technology and Applications Laboratory. N. S. F./I. L. L. Grant Award.
5. Division for Education and Human Resources. (1995). Undergraduate Education: Science, Mathematics, Engineering, Technology. Washington, D. C. N. S. F. Division of Undergraduate Education.

Biography

Dr. Laura L. Sullivan is an Assistant Professor of Manufacturing Systems Engineering at GMI Engineering & Management Institute, where she has taught Engineering Materials, Advanced Engineering Materials, Polymer Processing, and Polymer Properties. Her research interests extend from polymeric materials and processing to biomaterials. She has conducted research at Baylor College of Medicine in Houston, Texas and currently collaborates with the Urology Research Laboratory at William Beaumont Hospital in Royal Oak, Michigan.

Dr. Winston Erevelles is an Assistant Professor of Manufacturing Systems Engineering at GMI Engineering & Management Institute. His teaching and research interests are in the areas of CIM, Robotics, and Manufacturing Systems. He has a B. S. in Electrical Engineering from Bangalore University, India, and M. S. and Ph. D. degrees in Engineering Management from the University of Missouri-Rolla. He has worked as a Service Engineer and Plant Manager at Mykron Engineers, India. He is an active member of SME, ASEE, and AAAI.

Dr. Daryl Doyle is a Professor of Chemistry and Chair of the Chemistry program at GMI Engineering & Management Institute. His teaching and research interests are in the areas of chemistry, environmental chemistry, and adhesives technology. He has B. S. and Ph. D. degrees from North Dakota State University. He has spoken and written extensively in the field of adhesives and has worked for the Loctite Corporation on a faculty exchange program.