# Developing and Funding Undergraduate Engineering Internships

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## Abstract

Cooperation between academia and industry is essential due to rapid changes in technology and increasing global competition. An important component of this cooperation is the establishment of undergraduate engineering intern programs.

Internship opportunities with engineering companies enhance undergraduate engineering education, as students learn how to transform their theoretical technology background into practical design applications. This experience helps define the student's career direction, and also helps companies identify potential recruits. In order to make these opportunities available to students, engineering departments must develop collaborations with these companies. In addition, outside resources such as government funding will aid in the success of an internship program.

This paper discusses the formation of collaborations between our department and local engineering companies, and the process used to obtain external funding for undergraduate internships. It is hoped that the lessons learned from this paper will provide guidance to other faculty attempting to establish internship programs for their undergraduate engineering students.

## Overview

Cooperation between industry and academia is essential for all engineering fields. Engineering students benefit from intern programs, as these provide practical experience and developmental maturity [1]. By working in an industrial engineering environment, students learn how to translate the theoretical background of their coursework into actual product development. In addition, students are exposed to the interaction of engineering design with corporate concerns such as project managements, finance, and manufacturing.

Employers are more likely to hire engineering students that have some experience and have acquired a basic knowledge on how their specific industry works. Also, the internship experience will increase students' confidence in their engineering abilities, and will increase the likelihood of the students' success in their first years in industry [2].

In order for an internship program to be effective, the university must take an active role in the quality and administration of the intern's experience, and the intern's employer must take an active role in the management and mentoring of the student [3].

An essential first step in establishing an engineering internship program is to identify local companies that would be interested in hiring undergraduate engineering interns. Typically, good resources for contacts may include the university development office and local engineering professional society chapters. Many of our industrial contacts were developed through the local IEEE. While e-mail is a convenient contact approach for the initial contact, we found that follow-up telephone calls and on-site meetings helped to facilitate the development of internship programs, as most corporate officials prefer personal contact.

Another issue with creating internships is funding them. While most companies have budgets to cover student salaries, additional external funding will strengthen an internship program. This additional funding can supplement salaries and cover additional expenses such as supplies and travel. Many state agencies have funding programs for this purpose. Oklahoma universities and companies may apply for funding from the Oklahoma Center for the Advancement of Science and Technology (OCAST) [4] through their R&D Student Intern Partnership program. The stated purpose of this program is to improve Oklahoma's R&D base by supporting undergraduate student internships at Oklahoma R&D facilities. The goal is to encourage undergraduate students to prepare for scientific and technical fields that support high-tech companies in Oklahoma.

This paper describes the approach used by the Department of Electrical Engineering at The University of Tulsa to develop and fund a specific internship project for its undergraduate students. It is hoped that the methods described in this paper will provide guidance to other faculty attempting to establish internship programs for their undergraduate engineering students.

## Funded Internship Project Example

An example of a recent OCAST internship was a project formed from collaboration between The University of Tulsa and Geophysical Research Co. LLC. (GRC). The specific project was to have an intern develop hybrid circuits for oil and gas well gauges under the direction of engineers at GRC. Dr. Manikas would serve as the principle investigator (PI) for the project. The student would work at GRC along with full-time engineers, under the guidance of a project mentor. Intern tasks would include research, development, design, and field testing of the hybrid circuits. As specified by OCAST requirements, the intern would work full-time (40 hours/week) during the summer and part-time (10 hours/week) during the regular academic year (fall and spring semesters). The following sections describe the methods for intern selection, mentoring, and evaluation for the proposed project.

### *Intern Selection*

One undergraduate student in the College of Engineering and Natural Sciences at The University of Tulsa will be selected to work on the project. In order to meet the research objectives of the

project, the ideal candidate would come from Electrical Engineering. The student would be at least sophomore level and have completed the required electronic circuits courses.

The PI will identify a group of qualified intern candidates, with the final selection to be performed by the mentor. The following approaches will be used to inform students about the internship opportunities:

1. Announcements in courses and professional society meetings.
2. Flyers and postings on departmental bulletin boards.
3. Postings at the Intern site of the Campus Career Office.

Interested students will submit a one-page resume to the PI. Depending on the size of the response, the PI may hold pre-screening interviews to reduce the number of applicants to the desired size for the company. The resumes would then be submitted to the mentor for further review, and the mentor will visit campus to interview the candidates. The mentor will then select an intern from this group to work on the project.

***Intern Project Duties***

After the intern has been identified and hired, the mentor will get him/her started on the research project. The intern will work closely with the mentor during the initial stages of the project, and the interns will interact with the regular engineering staff at GRC. The mentor will determine the project schedule, including milestones and deadlines. As the intern gets more familiar with his/her duties, the mentor will monitor their progress using weekly progress reports and meetings. Training and feedback will be provided to the intern based on these reports, meetings, and personal interaction. These activities will be coordinated with the PI to ensure a positive intern experience.

The student intern will start with the first phase of the project, which is to research the necessary chip and die equivalents to the packaged circuits presently used. Using this information, the intern will work with the mentor and engineers to develop a project proposal for developing the new circuit design. The proposal will list deliverables and identify milestones for the project to be tracked through the implementation. When the mentor approves the proposal, the intern would begin the project implementation phase.

***Intern Evaluation***

The mentor will use weekly progress reports, meetings, and observation to evaluate the intern work performance. Interns will be evaluated on their general performance, including work habits and professionalism, and on project performance, including meeting the project specifications and deadlines. As part of the evaluation process, the mentor will provide feedback to the interns and consult with the PI as necessary to resolve any issues that may arise.

The intern will submit a monthly report to the PI, which the PI will review and provide feedback. In addition, the PI will periodically consult with both the mentor and intern to discuss the general progress of the project, and to address any concerns as they may arise.

Near the end of each academic semester, the mentor will complete an OCAST Intern Evaluation Form and submit it to the PI. A copy of this form is included in Appendix I.

The intern will submit weekly progress reports to the mentor which will be forwarded to the PI that describes the work performed by the intern (without including any proprietary information), issues/problems encountered, skills acquired, and benefits accrued. The report writing process will follow the style used by engineers at GRC. The mentor and/or PI will provide feedback on the reports to the intern. These reports will be included as part of the PI's annual project progress report. In addition, the PI will periodically consult with both the mentor and interns to discuss the general progress of the project, and to address any concerns as they may arise.

The intern will present the results of his/her work at the OCAST Annual Conference and at the SPE Annual Technical Conference and Exhibition (ATCE). The SPE ATCE will also allow the intern to network with engineers in the oil and gas industry, and discuss employment and research opportunities.

**Current Status**

The project was funded by OCAST to support one student intern for one year. An Electrical Engineering undergraduate started work on this project in March 2007. The general research objectives are to develop and test a hybrid circuit that will be used in oil and gas well gauges. These gauges measure temperature and pressure inside the wells, and must function under harsh environmental conditions.

The circuit will be designed and tested in the standard fashion of surface mount components. The student intern is currently researching the necessary chip and die equivalents to the packaged circuits presently used. He will then work with design engineers, under the guidance of the mentor, to lay out the ceramic substrate, mount the chip and dies, bond the chips and die as necessary, package and test the completed product. They will be working jointly with a manufacture of hybrid circuits to follow the construction and testing of the circuits. They will be involved in the use of the hybrid package in the product for which it is being designed. This will include field-testing in the well if time allows and to bring the circuits from a prototype stage into production determined by the marketplace.

This is the student's first experience working in an industrial environment. During the first phase of the project, he has constructed an initial circuit prototype and tested it in a temperature chamber. In addition to learning practical applications of his engineering coursework, he has also learned how to interact with other departments, such as purchasing and manufacturing. His mentor also reports that the student's creativity helps to enhance this project. So far, it appears that this internship will benefit the student, the company, and the university. We look forward to further results as the project progresses.

The program described in this paper is just one example of internship programs for University of Tulsa students that have been funded by OCAST. Other active programs include internships with Centrilift, Qual-Tron, and Railroad Signal International. In short, opportunities exist to

create undergraduate engineering internship programs. We hope that the approach described in this paper will provide guidance to other faculty members in this endeavor.

## Bibliographic Information

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[4] Oklahoma Center for the Advancement of Science and Technology (OCAST), http://www.ocast.state.ok.us/.

## Biographical Information

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Theodore W. Manikas is an Assistant Professor of Electrical Engineering at the University of Tulsa. He is a member of the ASEE, ACM, and IEEE. He received the B.S. in electrical engineering from Michigan State University, M.S. from Washington University (St. Louis), and the Ph.D. from the University of Pittsburgh. He is a registered Professional Engineer.

**GERALD R. KANE**
Gerald R. Kane is the Norberg Professor and Chair of Electrical Engineering at the University of Tulsa. He is a member of the ASEE and IEEE. He received the B.S.E.E. from Washington University (St. Louis) and the M.S. and Ph.D. from Rice University. He is a registered Professional Engineer.

**Appendix I. OCAST INTERN EVALUATION FORM**

**To the Student:** Complete your portion of this form. Take the form to your internship company supervisor at the end of the semester. Ensure that the form is returned to Dr. Manikas no later than Friday of the week before final examination week.

Your Name:_____

Semester (circle one): Fall, Summer, Spring Year:_____

Internship Company:_____

Internship Supervisor:_____

**To the Internship Company and Internship Supervisor**: Thank you for sponsoring this internship. This is a request for you to complete your evaluation of the student named above for the student's work this academic term as an intern in your department. Please forward the evaluation by U.S. Mail in a sealed envelope with company letterhead and/or logo to the following address:

Dr. Theodore Manikas
Dept. of Electrical Engineering
The University of Tulsa
600 S. College Ave.
Tulsa, OK 74104-3189

Please evaluate the student using the 1 to 5 scale where 5 is the highest score and 1 is the lowest score. The numeric evaluations correspond to letter grades of:
5 = A, outstanding work
4 = B, above average work
3 = C, average work
2 = D, below average work needing improvement
1 = Failing work.

| Evaluation Criteria | Score (1 to 5) |
|---|---|
| 1. Attendance, timeliness in arriving for work, completed expected number of hours of work | |
| 2. Quality of work completed | |
| 3. Quantity of work completed | |
| 4. Ability to apply learned skills to the internship work environment, including the ability to learn new skills and use them successfully on the job | |
| 5. Appearance in terms of the requirements for dress and deportment within your department | |
| 6. Overall, I would rate this student's internship performance as | |

Please provide any comments that you deem pertinent to the evaluation. You may also wish to provide recommendations for academic training that you would have liked for this student to have completed prior to the internship.

Supervisor Signature:_____ Date:_____
Supervisor Name:_____ Work Phone:_____

***THANK YOU FOR YOUR SUPPORT OF OUR ACADEMIC PROGRAM!***