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Faculty Development Through Industrial Internship

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Abstract

This paper chronicles the experiences gained and lessons learned in completing an industrial internship. As a key emphasis of the first author's (author hereafter) faculty developmental leave, the industrial internship was undertaken at Applied Materials, Inc., which is a global leader in semiconductor, flat panel display and solar photovoltaic products. Engineering and engineering technology are practice oriented disciplines in which both technical knowledge and business practices tend to change rapidly, leading to obsolescence in the knowledge base of an academic. Industrial internships will help to remedy the situation.

The author served with the industrial engineering (IE) division of the aforementioned company over a period of two and half months. During this period, the author participated in all IE staff meetings and worked as the resident "IE" on two projects, each one week long, in which lean manufacturing techniques were deployed to improve key production related metrics. During these projects, the author had the opportunity to work with multiple professionals within the company and external management consultants and thereby obtained the equivalent of a crash course on the implementation of lean manufacturing. These experiences facilitated the development of a new course on lean manufacturing at Texas State University-San Marcos (Texas State hereafter) and to the timely update of technology curriculum. In addition to discussing the experiences, the authors (two of which are from the company) discuss some of the lessons learned in implementing a first such faculty internship in the company and offer hints on how best some of the challenges that were encountered may be obviated.

Introduction

Developmental activities are essential in all professions. The explosive growth in technology and knowledge that has occurred in the last three decades has accelerated the obsolescence in just about any discipline and has highlighted the importance of life-long learning. University faculty has faced the challenge of keeping up with advancements in knowledge for many decades. This phenomenon has particular relevance in the fields of engineering and technology which are practice oriented disciplines. Thus, in addition to the growth in basic knowledge and keeping up with the same, there is the consideration of keeping abreast with the latest engineered devices and systems, skills and techniques, and business practices.

The inability to stay abreast of technological advancements on the part of applied engineering faculty is cited as a major impediment to the engineering technology profession's effort to produce a skilled workforce[1]. However, keeping up with developments in applied engineering disciplines in the academic setting is not "natural". When a faculty member joins the academic profession after recently securing a terminal degree in their discipline or after many years of industrial experience, their knowledge and skills are current. The demands of the academia on a faculty member's limited time are many and varied. In addition to contributing to the basic instructional mission, faculty members are engaged in advising, scholarship and creative activities and myriad forms of service activities including multiple committee assignments. While scholarly and creative activities could contribute toward staying up to date in one's discipline, the nature of scholarly activity at most universities are that they tend to be very highly focused. Consequently, deliberate intervention may be required to ensure that technical faculty stay abreast of technological advancements. Some examples of such intervention include: conferences, workshops, reading trade magazines, consulting, developmental leaves (sabbaticals) and internships[2]. Amongst the different intervention measures, developmental leaves and internships offer the best opportunity for faculty development owing to their length in terms of time and breadth of scope.

Prior Work

A survey of literature reveals several prior instances of faculty internships that have been formally presented or published. This section provides an overview of such material. A key finding was that faculty from all levels, (from high schools and community colleges to universities), have pursued industrial internships. The first example involved eight high school math teachers from the Dayton-Montgomery County in Ohio, who worked in local industries. The teachers worked with engineers, material scientists, marketing analysts, environmental consultants, and physicists. The key goal in this effort was to improve math education in the high school. While the participants' focus was on math education, they found that the internship experiences were even more valuable in that they helped these teachers adapt their teaching methods to include more cooperative learning, open-ended problem solving, writing, and technology, to better prepare students for careers in business and industry[3].

The next work involved an NSF funded center whose mission was to strengthen and expand biotechnology technician education at community and technical colleges throughout the nation. A key motivation in this work was the lack of knowledge about bio-manufacturing processes and the necessary skill sets among community college instructors in the San Diego City College (SDCC). This led to the administration at SDCC and IDEC Pharmaceuticals in the City of Oceanside in North San Diego County to develop industry internships for local faculty. The key benefits of the effort was that academia would develop new, relevant courses and programs in biotechnology manufacturing; the industry partner would gain access to a new, larger pool of local workforce candidates trained according to the industry's own specifications[4].

The last set of references involve university faculty from the engineering technology and construction management disciples who pursued industrial internships. The faculty members represent institutions such as Kansas State University[1], Purdue University[5] , Middle Tennessee State University[2] and the University of Washington[6]. The key objective in the first three internship efforts was to stay abreast of technological advancements. In the words of one of the participants, " Anyone can talk about how important it is to be certified as an ISO 9000 organization or to obtain the Software Engineering Institute's Capability Maturity Model (SEI CMM) next level. This talk is heightened, however, if the professor has gone through the audit, …."[5]. The fourth work reports on the impact that such internships have had on junior faculty's scholarship.

The Current Effort

The author of this paper accomplished an industrial internship at Applied Materials in Austin, TX during Fall 2011, by virtue of support from the developmental leave program at Texas State . After a four and half year stint as an administrator, the author was returning to full faculty status. Therefore, the developmental leave focused on retooling and in gaining up to date knowledge in technology advancements in manufacturing and industrial engineering, particularly in regard to the application of lean principles. The developmental leave lasted 3.5 months, of which the first 2.5 were spent in the form of an industrial internship. An alumni (one of the coauthors) who was highly placed at the company facilitated the process.

One of the key preliminary steps was the execution of a "supplier consulting agreement" between the faculty member and the company that described in detail and in legal parlance the extent and scope of the internship. Fundamental to this document was the inclusion of a non-disclosure agreement (NDA). The author was treated as a "Consultant", as legal documents that described the nature and scope of consultant pre existed, whereas no documents were available that described the duties of the faculty intern. The key elements of the agreement which was ten pages long included:

1. Definitions
2. Engagement and Services
3. Compensation
4. Ownership (of any products developed)
5. Confidential Information
6. Term and Termination
7. Representations, Warranties, and Covenants
8. General Provisions[7]

The day to day internship activities included the following:

1. Participating in industrial engineering meetings, including those where discussions and decisions are made about the company's line design and manufacturing processes.
2. Accompanying a company IE to the manufacturing floor to observe and participate in time and motion studies, and ergonomic work analysis, and material movement analysis.
3. Participating in various aspects of lean manufacturing activities.
4. Participating in value stream mapping for manufacturing processes.

5. Other tasks and activities reasonably requested by the Engineering Director and/or the Industrial Engineering Manager.

All of the abovementioned activities were accomplished by the conclusion of the internship. In terms of specifics, on a day to day basis, the author was treated as an “IE”, and was placed in a cubicle surrounded by other in-house company IEs. In addition to working with one or more specific IEs on short assignments, the author attended 2-3 meetings on a weekly basis where the entire IE team reported on their progress on various projects and their productivity, quality and safety related implications. These interactions gave the author a good sense of the operations and procedures that are common to a globally competing U.S. manufacturing enterprise.

Of great value in regard to learning the principles of lean systems by means of application was the fact that the author was able to participate in two projects at the company, each one week long.. Both projects involved the application of lean principles. Each project involved a team based approach where each team included technicians, engineers, managers, suppliers and sometimes members of upper management. In these teams, the author was treated as the resident IE. The projects typically began on a Monday morning at 8:00 am and concluded at noon on Friday. During the period from Monday through Thursday, the team worked from 8:00 am to 5:00 pm or longer to complete the project. At noon on Friday, the team made presentations to upper management. What made the learning very memorable was that even though the author belonged to one team for each of the two weeks, there were multiple teams assigned to each project that tackled different aspects of one large issue. Each team shared its development with the other teams at the end of each day. Additionally, all teams made their formal presentations to upper management on Friday. The titles of the two projects are:

1. Etch chamber kaizen based continuous improvement
2. AMPS supermarket concept implementation for the MDP chamber line

Both of the projects were successfully implemented. Owing to the NDA, details may not be provided in this paper. However, the following is offered as examples of non-specific benefits to the company as a consequence of project completion and is related to the first project. On this project, the author belonged to a team that focused its lean initiatives on operation 40 (the etch chamber involved eight operations that included operations 10, 20, 30, 40, 50 ,60, 70, and 80). At the end of the week long efforts, the team made changes to the layout and design of operation 40 such that the following improvements occurred: the cycle time improved by 18.6%, the walk distance for the operator was reduced by 99%, and the space required was reduced by 25%.

Lessons Learned

While the faculty internship experience proved to be very valuable, certain important lessons were learned by both the faculty member and the industry. These lessons are in the form of actionable items that need to be factored early in the planning process of the internship to ensure the maximum productivity. First, in the work described, the author and the company representative started meeting at the end of August for an internship that was to begin in September. While preliminary discussions had already occurred between the two parties as to the nature of the internship activities, the legal department was not brought into the process. The legal department got involved in early September. However, given the size of the company and its numerous consultants and contractors, the process of preparing a legal document and getting all parties to sign on the same took nearly two and half weeks. Second, as part of the routine processes for new consultants, the author was required to be screened for drugs and undergo and pass a safety test. While both of these processes were not time prohibitive, they do require the expenditure of some time. In retrospect, the author should have begun these processes in late February, so as to completed them by the beginning of September.

The terms of the author's developmental leave provided for 2.5 months of internship followed by a month of time in which two technical papers were to be edited for submission to journals. This resulted in losing a month of developmental leave that could have been dedicated to the internship, giving the internship a duration of 3.5 months. The company personnel could not assign dedicated projects to the author because of the short timeframe available for project completion. If a minimum duration of 3.5-4 months had been available for the internship, the personnel at the company felt that some dedicated projects could have been assigned.

The first manager who is an engineering director indicated that one of the benefits from the company's perspective is to provide contemporary knowledge to academia and an insight into the needs of industry. This will hopefully guide the curriculum and align the talent pool of students from which they will ultimately recruit. Another benefit to the company is that it would gain a new perspective from a knowledgeable source . The faculty intern brings to the company a different set of eyes and perspective from academia that provides a "purist" approach to the company. This has a positive effect, as the company professionals may lose sight of the way things should be, caught up in the baggage of the way in which they have always operated.

The second manager who is an industrial engineering manager has the following input from the standpoint of general guidelines for the planning of a faculty internship. In terms of logistics, the following detailed planning is recommended:

a. Six Months before assignment
    i. Faculty intern meets with industry sponsor. Review potential industry projects and match with intern's interests.
    ii. Begin the NDA process with Legal department
b. Three Months before assignment
    i. Complete the NDA process
    ii. Review and select industry project(s)
c. One Month before assignment
    i. Start the onboarding process.

        1. Background check
        2. Drug Screening
    ii. Pre-work for industry assignment
        1. General background information on assigned project (non-proprietary)
        2. Training materials (non-proprietary)

d. Two-weeks prior to start date
    i. Complete badge request
    ii. Assign laptop computer
    iii. Assign online training
        1. Safety training
        2. Area specific training
    iv. Submit requests for appropriate software applications (CAD, Oracle, Teamcenter)

e. Start date and first week
    i. Enroll in new hire training for one week
    ii. Assign desk, phone
    iii. Obtain safety PPE
    iv. Develop objectives and expectations

The timeline for activities is summarized in the figure shown below.

Activity	**6 months prior to internship**	**3 months prior to internship**	**1 month prior to internship**	**2 weeks prior to internship**	**1st week of internship**
Review potential projects					
Begin NDA process					
Complete NDA process					
Select industry project/s					
Background check					
Drug screening					
Background research on project					
Study training materials					
Complete badge request					
Assign laptop computer					
Complete online safety training					
Complete online area specific training					
Submit requests for software applications					
Enroll in new hire training					

Assign desk, phone					
Obtain safety PPE					
Develop objectives and expectations for the internship					

Figure 1. Industrial Internship Timeline

In regard to the nature of the project/s to be pursued, the following recommendations are offered. The selection of a project which fits the needs of the faculty intern's objectives while providing benefit to the industry sponsor is a key element of a successful internship. The challenge is in finding a project which allows the intern to start work immediately on the collection of information and data. In many cases, this information is stored in company-specific databases and the candidate is required to invest additional time in training classes in order to access this information. The intern may rely on others for this information or he may decide to become proficient in this data mining process. Tradeoffs should be carefully considered based on time and resource limitations.

Additional considerations for project selection are:

1. Projects which are broad in scope vs. projects which are more narrowly focused.
2. Projects which can be executed with little guidance or support from others vs. projects which require support from others.
3. Projects which require specialized, company-specific training vs. those which require little or no training.

These considerations should be discussed during the first meeting between the faculty intern and the industry sponsor.

An assignment which allows the faculty intern to work within the framework of a lean project or a six-sigma [define, measure, analyze, improve, control (DMAIC)] methodology based project is generally a good option when working with a manufacturing company. These opportunities allow the intern to work as part of a team during the problem identification, data collection, and brainstorming phases. In this manner, the faculty intern has full support from the team and the team leader for much of the data collection and investigation which is required during the development of the problem description. The intern becomes an integral part of the brainstorming and problem-solving process. At this point, he/she has several options. He/she can continue to observe the process, he/she can recommend solutions, he/she can implement recommended improvements or he/she can continue to investigate root causes of the original problem. In some cases, he/she may be asked to facilitate a lean or DMAIC project.

It is recommended that the faculty intern become familiar with DMAIC and lean concepts prior to his/her assignment. His/her sponsor should also offer an opportunity for the intern to become proficient in these areas.

Results and Conclusions

The author's and the company's experience has been that the internship was mutually beneficial. The company essentially secures an additional human resource (in the form of a manufacturing or industrial engineer) that it can direct to the solution of small or medium sized projects. These projects may be typically drawn from areas such as productivity, lean manufacturing, quality, safety or ergonomics. Such problems may not be assigned to the company's engineers because they are involved with everyday operational problems or product or process changes or are on overseas travel. While this has not been the case in this internship, it is possible to have faculty interns work on research issues or be involved with the training of personnel.

There are several advantages for the faculty member. First, the internship presents the opportunity to observe the latest equipment, processes and manufacturing systems in operation. Second, the internship enables the faculty member to gain knowledge of operational processes and protocols in the industry and an insight into how industry goes through the process of forming multi disciplinary teams for the purpose of accomplishing specific goals such as the implementation of lean manufacturing principles in a given section of the factory floor. Lastly, the internship empowers the faculty member by giving him/her confidence in the technical contemporariness of his/her knowledge.

In terms of the institution, such experiences can lead to improvements in curriculum or in research. In the case of this study, the author's internship experiences led to the timely creation of a new course on Lean Principles within the Department of Engineering Technology. While several faculty members were familiar with the concept of lean manufacturing, none had hands-on training in the application of lean manufacturing. The new course was taught for the first time in Fall 2012. Detailed learning outcomes assessment in this course will be conducted in Fall 2013. The catalog course descriptions for the new course on lean principles and the course that it replaced (Methods Engineering and Ergonomics) follows.

Old Course TECH 4345 Methods Engineering and Ergonomics . Principles and procedures of methods engineering to include concurrent engineering, charting techniques, motion analysis, principles of motion economy, human factors, direct time study, standard data systems, predetermined time standards, and work sampling.

New Course TECH 4345 Principles of Lean Systems . The course provides an in-depth understanding of the lean principles such as Value Stream Mapping, 5S, Kaizen, waste, takt/cycle time, visual control, six-sigma, mistake proofing, single piece flow, cell design and pull systems.

To conclude, faculty industrial internships are an excellent means by which engineering and technology faculty could stay abreast of technological developments. Developmental leaves are an efficient means by which these internships may be accomplished because they may imply no additional cost to the department or to the industry. Faculty industrial internships could lead to timely improvements in the technical curriculum, enhance a faculty member's research agenda, and help with the university (this is true of almost all universities) mission of outreach to the communities that they serve. Timing considerations are a key factor when planning for the faculty intern assignment. Early planning and preparation will generally save time during the on-boarding and orientation process.

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