AC 2008-174: SIMULATING AN INDUSTRIAL EXPERIENCE THROUGH ROLE-PLAY FOR STUDENTS ENROLLED IN A RURAL MECHANICAL ENGINEERING TECHNOLOGY PROGRAM.

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Simulating an Industrial Experience through Role-Play for Students Enrolled in a Rural Mechanical Engineering Technology Program.

Abstract

For many students, the end of the fourth semester in a mechanical engineering technology curriculum heralds an awaking in their abilities as fledgling mechanical designers or technologists. Armed with an understanding of basic engineering principles they are eager to spend the summer gaining that all important "first industrial experience". However, for some students here in rural upstate New York, it can indeed be an arduous endeavor to locate an organization willing to facilitate a temporary entry level position for the summer. It is indeed a fortunate student that is able to find gainful employment in a technical field and return to college in the fall with a new appreciation for the term "real word industrial experience".

Through a sincere desire to afford a value added experience for the students enrolled in a Mechanical Engineering Technology curriculum, an independent study course was developed with a rather unique aspect. The intent of this independent study was to function like an internship where the professor would role-play the position of engineering manager for a small mechanical design company. Students interested in participating in the course were required to submit a resume and schedule an interview time with the engineering manager. Several position vacancies were posted and students were encouraged to apply for one of the positions within the company. Seven students were "hired" to facilitate a variety of different functions within the organization. Since a variety of individuals with varying degrees of academic experience applied for positions within the company, the company was structured such that everyone would find it challenging. The freshman and sophomore students would function as drafters, the juniors and seniors were expected to work as designers and project engineers. Role-playing a technical position in this manner affords students an opportunity to refine their ability to interpret customer specifications, make the required design decisions, and communicate their conclusions technically, mathematically and graphically.

In order for academics to provide the requisite skills and abilities that industrial constituents require from graduates of engineering technology curriculums, students must be able to analyze and validate a host of considerations during the product design and development phase of a component. This should not be limited to interpreting design requirements and customer specifications, but should also include exposure to applicable codes and standards, intended and un-intended mode of product usage, hazards of human and non-human origin, ethical concerns, and any internal or external influences on the design team that might impact the final product's design. Role-playing an industrial scenario provides an excellent opportunity for students to develop these skills which are essential for employment in an ever-changing global electronic community.

Introduction

All too often "static" assignments are created where a specific answer is required to receive full credit for the problem. Using this approach, there typically can be no deviation from the correct answer. For many engineering technology courses, this is of course an excellent way to foster cognitive retention for fundamental engineering technology principles. However, it should be noted that this is not the only means of delivery. Respectfully, this "plug and chug" approach to problem solving typically does not emulate all the facets found in an actual industrial setting. This situation is further augmented by the students growing dependency on their calculators and the common belief that the answer displayed by their calculator must be correct.

In industry, the role of the mechanical designer and technologist is that of a problem solver. Rarely, does the customer supply all the information in the form of design requirements for a nice and easy "static" completion of the project. Rather, the projects take on a "dynamic" feel, where constant interaction with the customer and outside vendors is commonplace in order to render a safe and cost effective product. The scope of the project is often likely to change as the design specifications are further refined as fabrication, manufacturing, and assembly parameters are added. This combined with the fact the product may be made on the other side of the planet does indeed provide the fledgling mechanical designer or technologist with a challenging set of obstacles that need to be addressed in order to meet and exceed the needs of their clientele.

Arguably, one of the major objectives for the post-secondary engineering technology academic is to meet the needs of its student clientele and industrial constituents by preparing mechanical designers and technologists for rapid entrance into a hyper-competitive global workforce. If this statement is true, then it is essential we expose our students to a "dynamic" approach to problem solving where critically thinking through the problem is present. This way the student will be afforded the ability to nimbly react to changes and revisions on projects in industry. Using the simulation techniques found in role-playing scenarios is one way to afford our student clientele the means in which to better cope with the "dynamic" nature of industry.[1] This paper will discuss how to implement such an endeavor in the classroom.

Simulating an Industrial Experience through Role-Play

Few could argue that one of the most appealing aspects of an engineering technology curriculum is the experiences afforded students in the laboratory setting. Indeed, many engineering technology students excel in coursework that fosters the tactile-kinesthetic educational domain. A host of students here at Alfred State College have alluded to the benefits experienced in a laboratory setting where they are able to apply the theory presented during lecture. This added dimension of application has been cited numerous times as the main reason for selecting an engineering technology curriculum over an engineering science curriculum. If the aforementioned can be agreed upon, then simulating an industrial experience can also afford another opportunity to develop these requisite skills. Since many students have limited life experience combined with little to no industrial experience, the addition of a simulated industrial experience can indeed augment the affective educational domain of the student.[2]

Here at Alfred State College, an independent study course was developed in order to simulate an industrial experience using role-playing scenarios as the educational delivery vehicle. This independent study course was largely based on a sophomore level mechanical design course where students would work for a small mechanical design company located in rural upstate New York. In order to participate in the course, students were required to submit a resume and schedule an interview. The professor served mainly as the engineering manager for the company. However, as the course progressed throughout the semester, the professor role-played a variety of different positions within the organization. These different positions ranged anywhere from fabrication personnel to the shipping manager in order to emulate all the various interactions that the student might experience when in industry.

The first step in this endeavor was to recruit a group of willing students that wanted to participate in such a unique classroom experience. To start, posters were placed around the engineering technology building giving a brief description of the course and what was to be expected of the students interested in enrolling. The poster promised a unique educational experience. In order to garner interest from only serious students, a scheduled meeting time of Fridays from 7:00 ~ 10:00 pm was selected. Within one week seven students had submitted resumes as indicated by the initial poster. Upon receiving these resumes, the professor transformed himself into the role of Human Resources Manager.

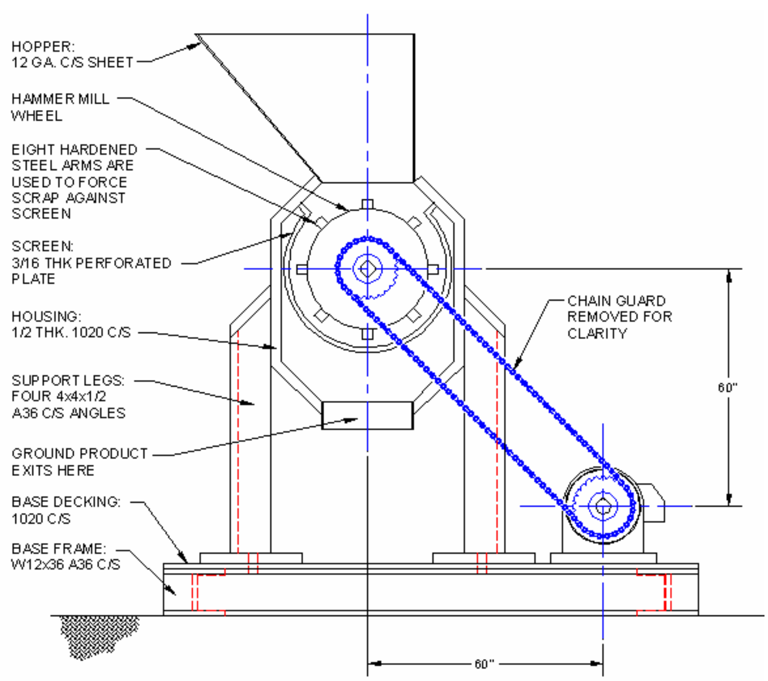
All seven student interviews were conducted back to back on a Friday night. Seven chairs were setup outside the professor office and the students were not informed as to the order at which they would be called in for the interview. At the beginning of each interview each student was asked to quantify "why they wanted to work for this company". All prospective students were asked the same questions and solicited to determine what type of position they were looking for within the organization. The prospective candidates were also asked to quantify their academic strengths and weakness. The following chart illustrates the results of the interview process.

Student Number	Grade Level	College Curriculum	GPA	Identified Strength	Identified Weakness	Position
One	Freshman	CAD AAS	3.00	2D CAD	Communication	Drafter
Two	Sophomore	MDET AAS	2.88	Fabrication	Calculations	Fabricator
Three	Sophomore	MET AAS	2.76	Design	Conflict Resolution	Designer
Four	Junior	MET BS	3.82	Calculus	Communication	Designer
Five	Senior	EMET BS	3.90	Digital Logic	CAD	Designer
Six	Senior	MET BS	2.10	3D CAD	Conflict Resolution	Designer
Seven	Senior	MET BS	3.25	Management	Calculations	Project Manager

The positions within the organization were assigned based on the academic experience and strength of the student. Just like in industry, the company would seek to exploit strengths and reinforce weaknesses of its personnel. Since a variety of individuals with varying degrees of academic and personal experience applied for the positions within the company, the company was structured such that all students would find in both challenging and interesting. This structure afforded the professor the ability to regularly put students into situations outside of their comfort zone. This was done in order to further illustrate the dynamic sequence of events one often finds while in industry. Since the students would be role-playing technical positions similar to the ones that they would be applying for in industry, they were afforded the opportunity to refine their ability to interpret customer specifications, make the required design decisions, and technically communicate their conclusions.

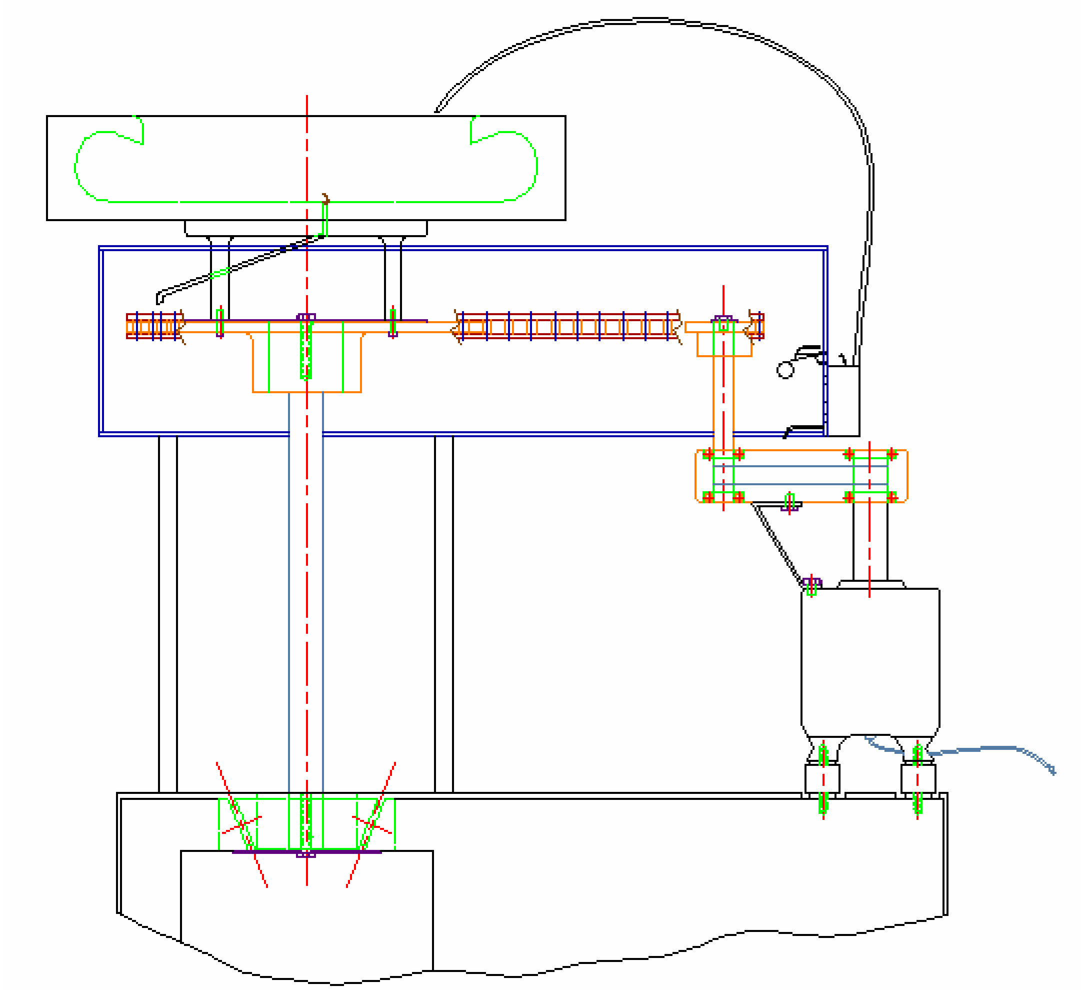
Once the seven positions had been assigned within the organization, the students were ready to start working on assignments. Each assignment represented a different type of product that needed to be designed. The design team was supplied with varying degrees of technical detail and clarity from the customer. As is often the case in industry, the students needed to review the project and determine exactly what the customer wanted and needed. This was then compared with what the customer was willing to pay. At first the projects were relatively simply in complexity in order to build continuity within a group of individuals who had never worked together before. The following is an example of the first assignment the group experienced.

A pallet manufacturer seeks the means to recycle old damaged wooden pallets by grinding them in a hammer mill. Use a diesel engine to supply rotary power to the hammer mill drive. Provide a means of separating and collecting the nails from the wood. The intended run time for the system is less than one hour per day in a “hostile” environment.



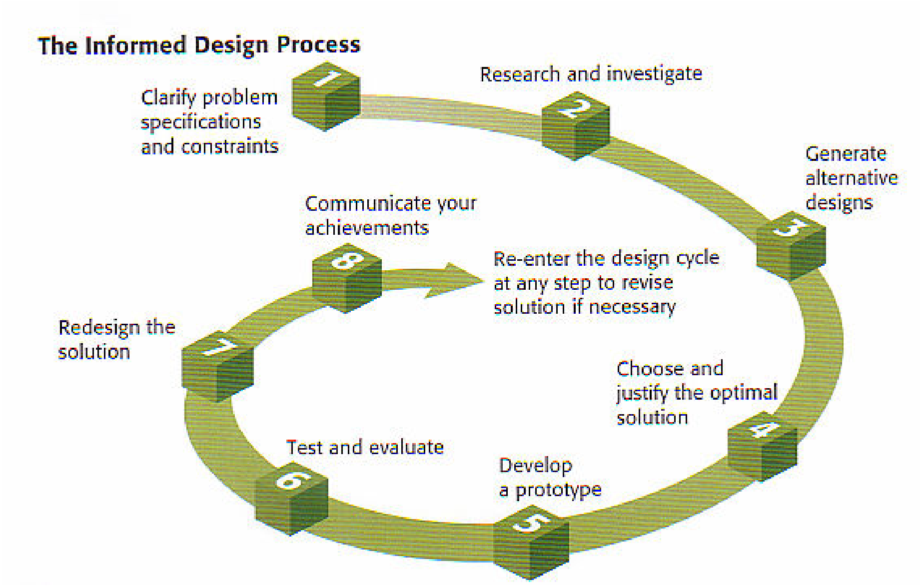
This system sketch was provided as a starting point. As we progressed through the semester, less and less information was supplied in an attempt to foster more creativity.

The following illustration is an example of the student work. Note, the dimensions, notes, and item bubbles were removed for clarity.



The projects were first given to the project manager. His responsibility was to give an initial review of the project and provide the engineering manager with the number of hours of engineering time required to complete the project. Now, this is a challenging task even for the most seasoned engineer. Having spent twelve years in industry prior to entering academia, this was always the most challenging aspect of any assignment. The importance of supplying an accurate estimation became especially critical when the repercussion for an incorrect estimate of engineering hours meant the company would make less profit. The project manager was required to provide a detailed accounting of how long calculations, drawings, and fabrication would take for each assignment. Once complete, the engineering manager would review for technical accuracy and validity. There were a host of occasions the project manager needed to revise the information previously submitted and request additional charges from the customer. The request was not always granted in order to illustrate the seriousness of estimating engineering hours correctly.

After the initial bid was accepted by the customer, and an actual job order was generated, the entire design team sat down to review the project. It was at this time when the group was given a chance to review the design specifications and start to brainstorm the best way to complete the project. The students used the Informed Design Process developed by Burghardt and Hacker. [3] The informed design process was developed as an analytical road map for students to follow when proceeding through an engineering design challenge.



During the design procedure students were asked to comment on any specific external influences that impacted the way they interpreted the projects design criteria. It was illustrated that societal issues, aesthetics, and possible litigation are all factors that can shape the way a product is developed.[4] In addition to the aforementioned external influences, students were also asked to comment on any internal influences that impacted the way they interpreted the project design criteria. It was also illustrated to the students that an individual's sense of social problems, ethics, and morals can also shape the final design of a product.[4] Having the students identify any internal or external influences they considered assisted in reinforcing the affective educational domain by pointing out the need to recognize the diverse attitudes, feelings, and emotions experienced by each member of the design group.

It was very interesting to observe the behavior of the design group as the two individuals who identified conflict resolution as a weakness began to posture for dominance. Several times, throughout the semester, these students needed to be reminded that they were not the owner of the company, and their opinions would be taken under advisement by the engineering manager. It was challenging for many of the students to accept that their ideas would not be cost effective, especially when they began to research the cost of specific components. Simply put, arriving at a final design that everyone agreed upon was indeed the most challenging aspect of this endeavor. The project manager did an acceptable job in keeping order and making certain the group remained on task.

However, there were more than an acceptable number of heated disagreements. The engineering manager was forced to intervene on one occasion where the disagreement appeared to be developing into a physical altercation. This incident resulted in the professor putting everyone in a “time-out”. The professor felt that since the appropriate level of maturity was not being exhibited in the class then the students would be treated as children and not adults. This lack of professionalism resulted in the professor delivering the following ultimatum, “any further incidents will result in the student being dropped from the class by the professor”. To further illustrate the seriousness of this transgression, a writing assignment was assigned where the students were required to interview a human resource director to determine how “the real world” would handle this situation. The paper required the students to focus and reflect on what would happen in industry if a verbal disagreement resulted in a physical altercation.

Of the six assignments handed out during the course of the semester, it was the last one that truly emulated an industrial setting. It is believed that it took that long in the semester for the students to become accustomed to accurately role-playing their positions within the organization and functioning as a team. It is also believed that the varying levels of maturity experienced at the start of the project drastically improved as the students were exposed to more and more situations where they were forced to function beyond their comfort level.

Each person within the organization was forced on several occasions to perform tasks that afforded opportunities to exploit their strengths and reinforce weaknesses. For example, the project manager was asked to go to the machine shop and interview machine tool students to gather information on the CNC programming capacity at Alfred State College. Since the project manager had an extreme dislike for anything that had to do with the possibility of getting his attire soiled, he was asked to function at a capacity outside his comfort zone, as is often the case in industry. Another example was a conversation that the drafter had with the customers design supervisor. One afternoon the customer placed seven phone calls to the drafter’s cell phone asking specific questions about revisions he had made to the drawings. This situation, and others like it, drastically enhanced his communication skills over the course of the semester. By the last project, the drafter eagerly awaited the opportunity to engage the customer.

Another example of how this role-playing simulation enhanced the student’s exposure to an actual industrial experience was when one customer confronted the design team with several ethical and moral dilemmas. This particular customer was relentless in attempting to solicit the project manager to overlook certain industrial codes in order to reduce the cost of the project. Several attempts were made by this customer at bribery to not only the design team but the owner of the company. When the entire design team threatened to resign if the owner of the company continued to place greed over the health and safety of the consumer, a tremendous sense of accomplishment was felt by not only the students but the professor as well. It should be mentioned that the students were clearly calling the professors “bluff” here. Threatening to drop an elective course in college is one thing but when “in the real world”, threatening to resign from a corporation has many other ramifications. Since none of these students have ever had a mortgage, car loans, or children…how could they possible understand? This professor believes that the as the individual evolves from a student to a technologist, a certain level of maturity and growth must be present in order to complete this development.

What did we learn?

Since there was such a diverse group of students, the first obstacle was to ensure that everyone would be on a level playing ground. This was essential to establish first so the freshman and sophomores were not intimidated by the upperclassmen in the course. At the start of the semester the students were informed that the grade for the course would also be based on the growth and development exhibited by the student in addition to the technical accuracy of the calculations and drawings.

The most apparent issue that manifested itself with this endeavor was the maturity level of the students. As expected, many of the students had no idea how to role-play, not to mention what is acceptable behavior in the relatively conservative field of mechanical design. This was an issue right from the beginning of the semester. Most of the time spent during the first class meeting was spent explaining to students that in order for this endeavor to work, they needed to "say what they mean", and "stay in character". This means that the students needed to remember the role they were playing and who they were talking to. In order for this simulation to be a value added experience for everyone, it was explained that a high level of seriousness and professionalism was expected. This proved to be easier for some more than others as illustrated earlier. As the semester progressed, and the students began to experience the intricacies of how industry works, they began to see how certain behaviors were affecting the design team. Possibly the single best success of the simulation was watching the two confrontational students listen to the ideas and concerns of another individual and recognize the importance of team work.

Another independent study of this nature is planned for the fall 2008 semester. One critical change will be to solicit the assistance of colleagues to assist in the role-playing of the vast array of roles (characters) needed. Simply stated, there were times when the students, and the professor for that matter, had to stop for a moment and remember who they were talking to. Additional faculty involvement would drastically reduce any inconsistencies in role-play.

Conclusion

This educational endeavor afforded students the ability to experience some of the many issues that may be experienced when they enter industry. Even the limited exposure this simulation offered in dealing with issues such as timeliness, deadlines, group dynamics, conflict resolution, continuous improvement, morals, and ethics is much more than typically seen in many engineering technology courses. The simulation of an industrial experience through actual role-play afforded students several opportunities to translate emotions, thoughts, and ideas into overt observable behaviors. Rare indeed is the opportunity for students to experience a "hands-on" opportunity to develop aspects of the affective educational domain in post-secondary mechanical engineering technology education. The use of a role-playing scenario can be effective tool to provide these opportunities to your students.

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