AC 2007-1743: IMPLEMENTING HANDS-ON LABORATORY EXERCISES IN UNDERGRADUATE EDUCATION

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Implementing Hands-On Laboratory Exercises

In Undergraduate Education

Abstract

Feedback from our industry partners has made it clear that the education received by the Industrial Technology and Industrial Distribution students with hand-on experience will have an advantage when they enter the working world. Combining course lectures and materials with problem-based evaluations of case studies and hands-on activities simulating real-world logistics and manufacturing decisions provides students with an enhanced ability to foresee and respond to industry problems when they arise.

During the spring semester in 2006, our students, with the help of our industry partners in our Industrial Technology (IT) and Industrial Distribution (ID) programs began working in the Supply Chain Management Technology Laboratory (SCMT). This on-campus facility houses warehouse and logistics equipment, such as conveyers, racking systems, and an RFID (Radio Frequency Identification) tunnel, as well as software systems and equipment that allow students to accurately simulate the customer order process, stocking, shipping and receiving functions that are found in a manufacturing environment. This lab environment is useful in furthering the ability to offer students the opportunity to engage in hand-on, problem-based projects.

The primary objective of the lab's hands-on learning strategy is to provide the opportunity for students to integrate their course lecture learning with interactive exercises. These exercises require students to use and develop their skills in areas such as; identifying and defining problems, improving logistics and manufacturing decision making ability, implementing current process design methodologies, and working in a team-centered environment. The equipment currently in the lab includes: inventory stocking shelves, bar-code scanning systems, and computer with software. This software helps students solve logistics problems, determine Supply Chain Management (SCM) strategies and implement Product Lifecycle Management (PLM) methodologies.

This paper will discuss the design and implementation of the exercises and activities that have been introduced in the SCMT lab. There will also be a brief overview of the process for evaluation and the future plans for additional lab equipment and learning activities.

Body of the Paper

Many say that experience is the best teacher. Students can successfully complete a plan of study at the top of his or her class having learned, in theory, everything

they can possibly know about a given field but without the opportunity practice the skills identified in the acquisition of knowledge. Some industrial partners perceive this education as incomplete. Traditionally educational institutions provide students with a great deal of 'book-learning' but provide little or no hands-on experience. In addition to an industry outcry for individuals with 2-5 years of experience prior to starting most jobs, there is a great deal of research that suggests that individuals with experience are better able to benefit companies immediately when they begin their careers.

The Skills Approach to leadership is one that supports the idea that "knowledge and ability are needed for effective leadership." (Northhouse, 2004) Because many of our students enter the workplace in leadership positions, one of the aims of the hands-on lab is to offer students the opportunity to develop the skills that support the knowledge that they gained during lecture sessions. With experience of any kind, the students' ability to contribute to the workplace is enhanced and they are more likely to use their skills in a leadership capacity.

Students majoring in Industrial Technology and Industrial Distribution most often find themselves employed in transportation, logistics and warehousing industries. These industries are fast growing industries (see Table 1) and in their ideal employee would have a detailed understanding of the inner working of industry processes and procedures and experience.

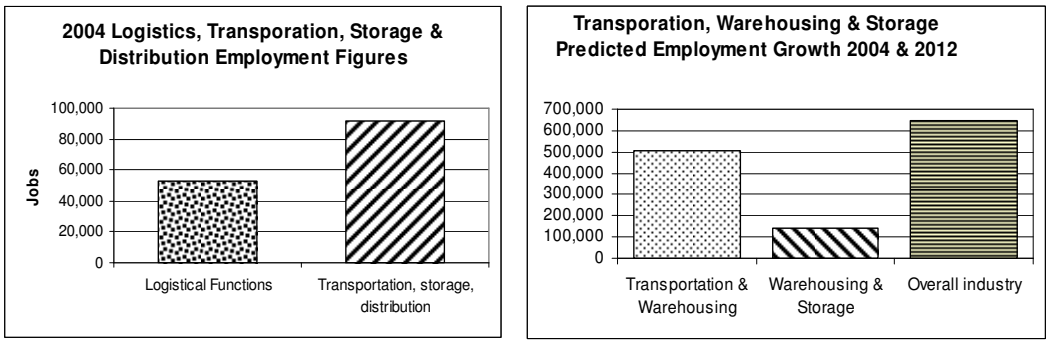

Table 1: Industry employment figures. U. S. Department of Labor

Revenue in the logistics, transportation and warehouse industries is also on the increase.

- **The Logistics Industry (TDL) reported revenues exceeding $936 billion***
  - $593 billion was transportation related,
  - $300 billion was warehousing related,
  - $43 billion was industry-related services.

- **The International Warehouse Logistics Association (IWLA) points to growth prospects of between 12% and 15% for the logistics industry over the next several years***

*Base upon the most recent year with complete data reported (FY 2003)

These employment and financial growth figures help to reinforce and encourage our student's desire to learn and be prepared to face future employment needs.

Students recognize the value of and need for experience when entering the job market. They are encouraged to take advantage of every opportunity that presents itself to engage in industry internships, work coops and/or any other experiential opportunity that gives them a chance to apply what they have learned in the classrooms. Students see the value of experience as they approach the end of their formal education.

There is no doubt that formal education is not equally important as experience. A worthwhile college or university education will give students a foundation of information that will propel them into the work environment ready to take on leadership roles. Katz, 1995, suggests a researcher specializing in the study of leadership approaches, suggests that effective leadership in the workplace depends on the leader having three personal skills. First there are the technical skills are those, which demonstrate the leader's proficiency in specific work activities. Next, human skills or people skills that a leader uses with upper-level management, peers and subordinates and finally conceptual skills, those skills that demonstrate the individual's ability to translate ideas and concepts in to successful projects.

Lab activities are one way of giving students some of the experience necessary to help students gain a competitive edge when entering the job market.

Project Description

This IT/ID Supply Chain Management Technology (SCMT) lab project focuses on the enhancement of a traditional classroom format by tying the information delivered during class lectures with hands-on laboratory activities that reinforce the lecture materials. These activities give students the opportunity to evaluate problems then identify and implement solutions. Student lab-activities address real-world problems such as those that occur in manufacturing and logistics environments.

Principles of learner-centered teaching are key elements in the effective implementation of these lab exercises. The goals of learner-centered teaching are to create "independent, autonomous learners who assume the responsibility for their own learning (Weimer, 2002). The learner-centered teaching goals for this lab focuses are to:

- Motivate students to become fully engaged in lab activities
- Foster creativity
- Develop problem solving skills
- Promote processing of ideas
- Increase interaction and development of team building skills

In fall 2006, six hands-on lab activities where designed and tested in a senior level Industrial Distribution required course, Global Transportation and Supply Chain Management. Topics for the six activities were:

1. Beer Game$_1$ (with no supply chain interaction/communication) a manufacturing process simulation game (Kaminsky & Simchi-Levi, 2006)
2. Supply Chain Management Process
3. Supply Chain Production, Transportation
4. Just-In-Time Product Management
5. Product Picking and Packing
6. Beer Game (with supply chain interaction/communication)

Each activity was introduced to the students during the semesters-weekly 50-minute lab session that was held after the lecture that was conducted earlier in the same week. Again, the primary goals of these activities were to provide students with a chance to engage in situations giving them the opportunity for hands-on practice of the knowledge and skills introduced in the classroom.

Lab Sessions

As mentioned, lab sessions were conducted in the IT/ID SCMT Laboratory following the presentation of topic-related information by the course instruction. The physical layout of the lab (Figure 1) is designed in such a way as to allow students to conduct meeting, planning and review sessions (learning and teaching), conduct supplier, distribution and end user activities by participating in hands-on learning activities that replicate the processes in a supply chain flow.

Lab scenarios divide groups of students into teams or work units where they will compete against the other teams. Activities and tasks that replicate situation that might be encountered in a real-world manufacturing environment are given to the students. The teams are challenged to organize themselves job functions such as those performed by suppliers, in a warehouse and distribution setting, and by shipping and delivery personnel.

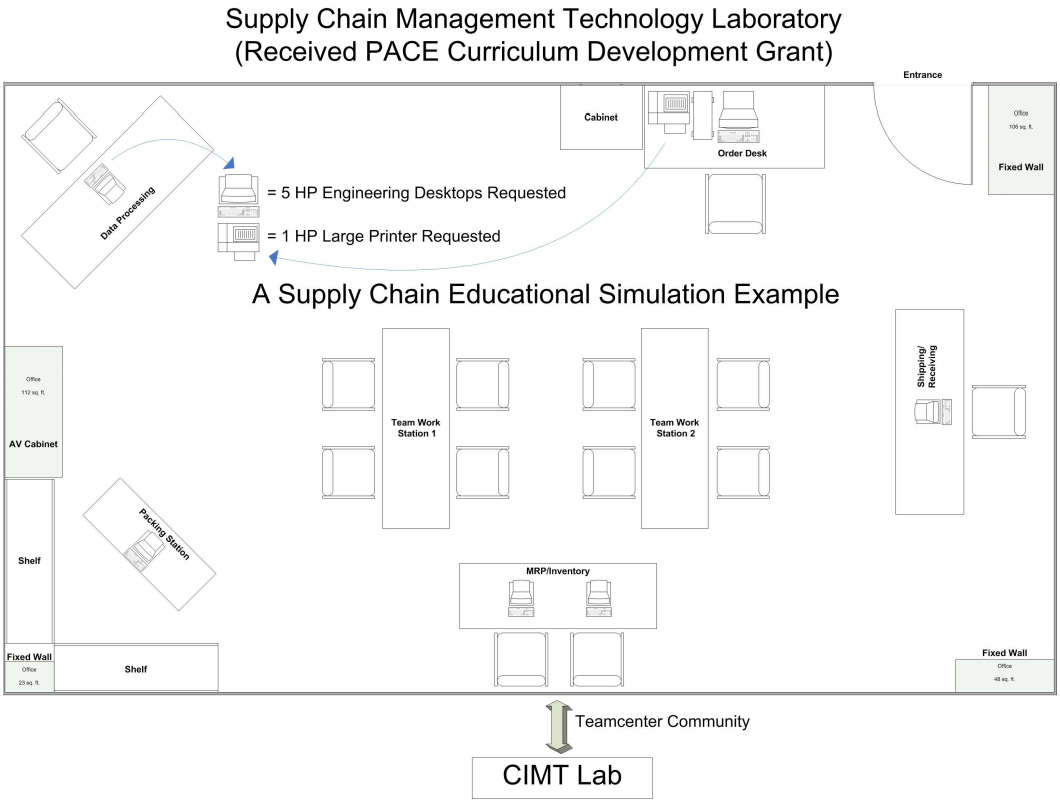

Figure 1: Supply Chain Lab Layout

Detailed information about the *Purpose* of the lab, the lab activity *Organization,* a description of the *Situation,* the lab *Goal,* and the lab *Schedule* (see Appendix A) is provided to each team and then they are given time to plan and identify their strategy. Once the students have established a plan they begin to implement that plan.

Since each lab has a different manufacturing process emphasis each lab has different requirements and goals. The challenges ranged from building bridges with tinker toys, organizing and implementing the most effective delivery and transportation process and establishing a supply chain distribution strategy for the Beer Game.

What we learned

One of the limitations of this introductory semester of this lab project was time. The lab design team, which was made up of six graduate students, was charged with the responsibility of designing and implementing six labs for the fall semester. Lab sessions were conducted every other week with students enrolled in the class divided in an “A” and “B” group to control the number of students in the lab at any given time. Groups met on alternating weeks and they were given topic-related reading assignments and questions for the week they did not attend the laboratory class. The result of the weekly requirement to deliver a lab was that the team fell short in the area of including adequate assessment tool to confirm or negate the effectiveness of each of the lab sessions.

Through observation and student feedback the lab team was able to gain enough important information and valuable lessons learned related to the use of labs as supplemental instruction for traditional classroom instruction. Some of these lessons included:

- An unexpected but delightful observation made by the development team was how much the students enjoyed competition. The first lab exercise was had a research focus and very little more. They worked in teams finding information and answering assigned questions. They completed the tasks but the results of the pre and post exercise surveys (see Appendix B & C) provided no measurable or meaningful data beyond suggesting that there was very little taken away from the exercise. The nature of the next exercise included a competitive element and though there was no pre or post survey (an area that we recognize as a need to improve) the students were able to clearly articulate the processes and goals of the exercise and the way they would improve their performance if given the chance to do it again.
- The importance of providing students with very detailed task information. Though there were instructions, they did not include as much detail as students needed. This information should include step-by-step requirements for the activity with clearly designated goals and objectives and a timetable each aspect of the activity.
- Roles and responsibilities should be stated in the activity instructions. Though one of the goals of every exercise is to have each activity reflect the student's leadership skills, we found that they were not clear about which roles should be included to complete a given task and/or what the specific responsibilities of each individual entailed.

Overall feedback from student's participating in the labs was positive. They were challenged by the activities and enjoyed the competition that was inherent in dividing them in to teams. They also indicated that they gain a better understanding of the manufacturing processes after actually engaging in them. Students indicated that having in their minds that they would need to use the information and skills that were presented to them during class lectures to 'win' the lab challenges, they began listening more carefully.

Students also provided feedback for ways the labs might be improved. First, they expressed a desire for more time in the lab. As mentioned earlier in the paper, labs were conducted for either group "A" or "B" biweekly for 50 minutes. There was not enough time to plan and find a team rhythm in the allotted time period. General consensus was that labs exercises were effective and fun.

Student also gave us helpful insight about things like the importance of considering the physical layout of the lab for different exercises (see basic layout in Figure 1). For example: The "Supply Chain Management Process" exercises required students to evaluate cost vs. schedule and to determine from which

location they should purchase materials. One location was “local” but did not always have the parts. The other location was two hours away “Chicago” but they could guarantee the parts were in stock. We located both vendors in the classroom and students suggested that we move one of them to another location in the building.

The Teaching Assistant’s (TA’s) were also able to provide valuable input about how to improve lab exercises and lab use. Not unlike student feedback, the TA’s also though that time were an issue. The competitive nature of the students was one of them more interesting observation. They appeared to feed off of the challenges and they actually had fun.

Future Plans

Since this class is not being offered this semester there is time to implement improvements. Some of these improvements will include:

- Edit, clarifying and improving lab instructions to give the next group of TA’s and students the ability to effectively conduct lab activities.
- Identify, develop and organize supplies for each lab.
- Develop appropriate lab evaluation and feedback mechanisms for determining the effectiveness of the labs.

Appendix A:

Global Transportation and Logistics Management Lab

The following is an outline giving information about today's lab assignment and instructions on how to execute it.

Purpose

The purpose of this lab exercise is to give you some hands-on experience with a quasi-real-world supply chain and production problem in a competitive environment.

Organization

This exercise is divided into three phases: Planning, Execution, and Review.

Situation

Your company makes small bridge assemblies from raw materials supplied by two suppliers: a local supplier and a distant supplier. Your company is in competition with local companies for the local bridge assembly business, as well as for the relatively scarce raw materials that support your production environment.

Local Supplier

One of your facilitators takes on the role of the local supplier. The local supplier offers excellent service, quality, and turnaround time, but also tends to be more expensive than any other option. The local supplier is also somewhat less likely to have an item in stock.

Distant Supplier

Another of your facilitators takes on the role of the out-of-town supplier. The distant supplier tends to offer better prices, has a better selection, and is more likely to have a part in stock. Unfortunately, the distant supplier also has a slower turnaround time, which can be mitigated somewhat by paying a slight premium for rush delivery.

Transportation Costs

Each supplier has a transportation charge associated with each order. The distant supplier's transportation cost is higher than that of the local supplier.

Orders

Order must be individually issued for like materials. For example, you can submit an order for 10 'A' parts, and a separate order for 10 'B' parts. Both orders will incur their own transportation charge. Single orders containing different parts will be rejected, and time will be lost.

Goal

Your challenge is to quickly design and execute a supply chain and production strategy that will allow your manufacturing company to make more money in the next 30 minutes than your competitors.

Schedule

1. Introduction (1 minutes)
2. Organize into groups of four or five. (2 minutes)
3. Facilitators will hand out: (1 minute)
   - Bill of Materials
4. Visual work instructions
5. Accounting Chart
6. Order slips
7. Review the materials (5 minutes)
8. Facilitators answer brief questions (1 minute)
9. Each group discuss and write a brief document the following:
   - Your group's order processing and supplier strategy:
10. The impact order-processing rules (as discussed in the text) have on total order-processing time:
    - The challenges and opportunities you foresee in completing the supply chain and constructing your bridge:

11. Show your answers to the Quality Assurance Facilitator (one of the lab TAs), who will review them in the order received and either accept the document or request further information.
12. Once the facilitator accepts your document, he or she issues your group investment capital with which to purchase raw materials from your suppliers according to your strategy.
13. Do the following to purchase raw materials:
    - Write a material orders on an order slip, one slip for each order. Specify your group number, the supplier, and whether delivery is being expedited.
14. Deliver the slips to the appropriate supplier's facilitator (lab TA), who will accept payment.
15. Your order will be processed in the order in which it was received.
16. Order slips will stop being accepted with five minutes remaining in the lab.
17. As you receive parts, build your product according to the visual work instructions.
18. Once your product is completed, the Quality Assurance facilitator will inspect your work for defects, and then pay your group the market rate for your product.
19. Go back to Step 8.

At the end of the lab period, the manufacturing group with the most profit wins.

Appendix B:

IT 434 – Global Transportation and Logistics Management

Lab 1: Post-Test

1. Identify the four (4) components of a good corporate strategy.

2. What activity is **NOT** considered a part of the internal process flow?

   a. Produce tracking
   b. Warehousing
   c. Forecasting
   d. Material handling
   e. All are internal processes

3. Identify three (3) **different** suppliers of **different** products for each supplier for Dick's Sporting Goods (in other words, don't use Nike for all three suppliers or shoes as the only product).

Appendix C:

IT 434 – Global Transportation and Logistics Management

Lab 1: Pre-Test

1) Identify the four (4) components of a good corporate strategy.

2) What activity is **NOT** considered a part of the internal process flow?

   a) Warehousing
   b) Material handling
   c) Product tracking
   d) Forecasting

3) All are internal processes

4) Provide 3 possible suppliers for a McDonalds restaurant and identify products that they might supply.

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