A Practical Approach to Engineering Education at New Mexico State University

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Introduction

Colleges and Universities exist primarily to develop the fullest potential of all students, affording them opportunities to pursue a variety of avenues of success. The job offers that these students receive are determined by how industry perceives the institution. If the engineering college has a good reputation, students are sought by industry and ultimately are offered better positions at a higher salary level. In the past coments about how when engineers are hired they are not effective members of the engineering team for from 46 months to a year. If you are Boring and hire 2500 new graduates a year, this translates from 1250 to 2500 man years lost. If we find a way to improve production by saving 1 minute we are ecstatic. But we ignore the tremendous savings of preparing our students to be effective members of the team from day one. Doctors are required to be effective from the first day, why not engineers. To accomplish this we need to modify or improve on certain skills. Education delivery needs to be built around learning effectiveness. To do this a University must put a major emphasis on active learning. The New Mexico State University (NMSU) Engineering Department recognized this fact and developed the Advanced Manufacturing Center (AMC). The Advanced Manufacturing Center combines the standard classroom studies with a practical "hands on" approach to engineering education. This paper will deal with how this can be done from both an education and economic standpoint.

The Advanced Manufacturing Center is to the Engineering and Businesses Colleges what the University Hospital is to the Medical College. Ideally students will go to class in the morning and work at the manufacturing center in the afternoon. Much in the same fashion as a medical student who goes to class in the morning and makes rounds with a physician in the afternoon. The hospital, as is the AMC, is a working environment, with real projects. As the medical hospital has real patients, so the AMC has real customers expecting products of specified quality to be delivered in a timely manner. These projects will range from:

1. Develop a design for a customer
2. Preparation of prints in various electronic formats
3. Build first Prototype
4. Develop first production model
5. Programs capable of being used as an NC model
6. Reengineering an existing product for manufacturability or to reduce cost

The Facility

To accomplish the task the NMSU engineering department has purchased a 27,000 square foot facility in an industrial park and filled this facility with about $7,000,000 worth of equipment. The equipment was acquired from several sources, donations from government facilities, to outright purchase of leading edge equipment by the engineering department. These purchases included a state of the art Stratasys rapid prototype unit as well as a Cincinnati Milacron NC milling machine. The facility has

additional capabilities; its CAD shop can work with Pro E, CADCAM, CAD 13 or Anvil 5000. The Fabrication area has a full complement of cutting and welding equipment such as heliarc welders and plasma cutting torches. The machine shop has numerical control and manual lathes as well as Bridgeport's and vertical mills. The assembly shop is setup to do electronic assembly work including the stuffing of boards.

The facility was then run, as an independent factory, required to pay its own way. The building was purchased by the issuance of bonds. It is the responsibility of the Center to retire these bonds as well, as to pay any long-term obligation due for the equipment. New state of the art equipment is always being sought and purchased so that when students leave the AMC they can go to any manufacturer as an employee and be able to step right in an advise as to the latest techniques, not learn about them on site.

The Administration and Organization

The administration of this facility is a unique balance between experienced personnel from industry and academia. The industry personnel added a "sense of urgency" while academia maintained and expanded the relationships with the faculty and staff of the University. The staff was responsible for establishing a new manufacturing program within the engineering college. The Center staffing was developed as a blend of student and full time personnel. The students filled the entire middle management and working positions and are responsible for the management, design and delivery of products required by customers. For instance a graduate student working on a masters in Industrial Engineering, was selected to integrate a total systems software package into the AMC. This package consisted of all the modules that would be necessary to run a paperless factory. It contained:

1. A quote capability
2. An order rollover from quote
3. A purchasing module
4. A shop planning and scheduling module
5. A financial reporting module
6. A bar-code reading capability for task and material

It was this students' job to select the hardware, install the system, and develop a training program to introduce the related tasks for the office and shop personnel that would be using the program. The student had the responsibility for preparing a gantt chart showing the process and timing for system integration.

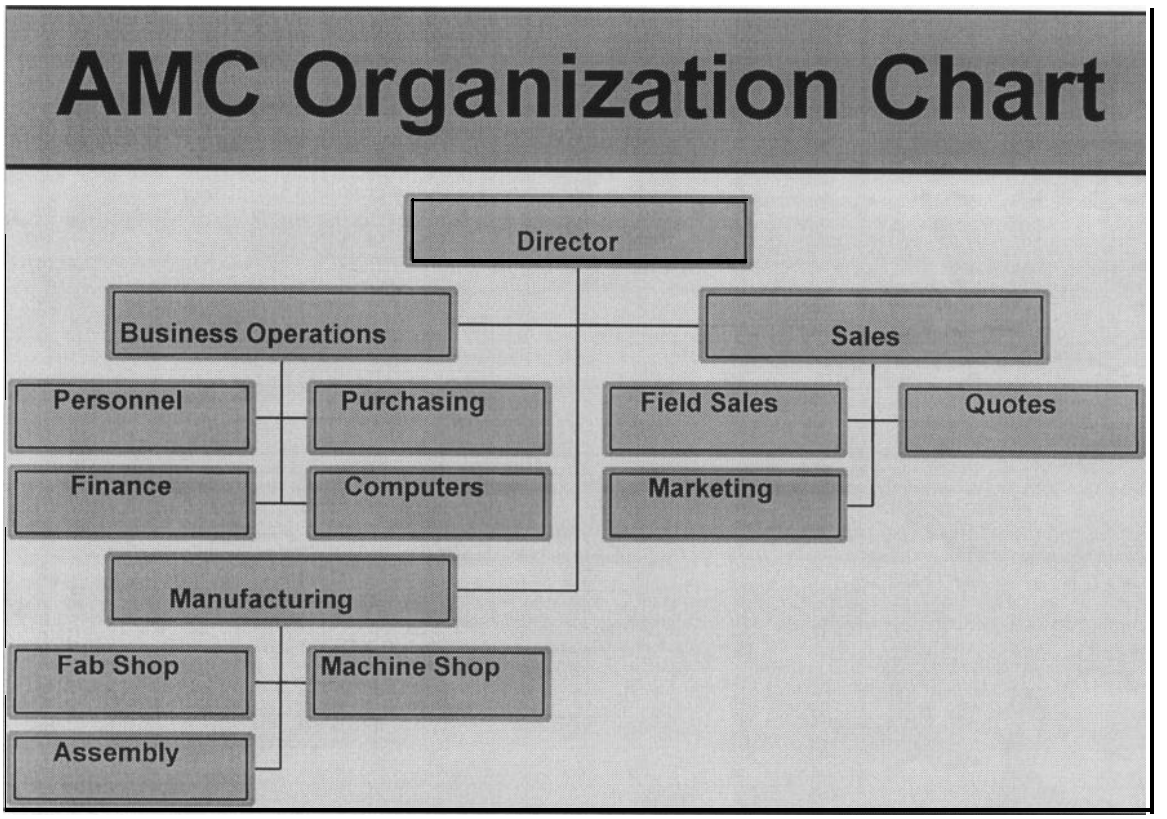
In addition faculty are recruited, and paid, for work on specific tasks that fit their expertise. In this manner the faculty is kept abreast of what is going on in industry. By being part of these task teams they are able to understand more fully the time tables and pressures that inustry works under. In this manner they are better able to prepare students for their future role in industry.

The Organization chart shown below indicates your standard small company organization. Doctor Hensel, is not only the Director of the AMC but is the main interface with the faculty of the University. He is also a Professor on the staff of the Mechanical Engineering Department. The next layer of management all come from the industrial sector and provide "hands on experience" .The next layer down would be all graduate students, For instance in the Business Operations group, the next level of management would consist of four groups:

I. Personnel
2. Purchasing
3. Financial Reporting
4. Computer
5.

Each of these groups is headed by a graduate student. These students are required to report weekly to their mentor, prepare operational reports, and to attend weekly management meetings. They may also be

required to prepare any special reports required by their mentor for project evaluation. They are also responsible for maintaining their groups employment level. This means that they must interview any potential employees, prepare necessary paper work to hire them, ready the work station, and finally to instruct the new hire on his/her duties. The group head must also review the students performance at least once a semester. These management functions are difficult to teach in classroom setting and must be experienced in order to maximize learning impact.



The Products

The products that are manufactured by the Center are solicited from industry in the same way that any firm would compete for this opportunity. The difference is that the Center will take high risk jobs that require either additional engineering, or engineering for manufacturability. Much like the University hospital, which maintains a research position so that its students are being taught the very latest in techniques. The Manufacturing Center maintains a balance between normal manufacturing and leading edge development of equipment, tooling, and manufacturing techniques. Some of the Projects undertaken by the AMC were.

1. Design and build a Tumbleweed Collector
2. Design and build equipment for a tire recycling company
3. Build a Biological Detection System to company specifications
4. Redesign and build a prototype gem cutting and polishing machine
5. Redesign and build products for an aircraft company
6. Design and build an Automatic Cashier Machine
7. Engineering design studies for various projects in industy

The work comes from several sources and serves a different purpose for the AMC.

1. Entrepreneurs - The individuals that comprise this group generally have only an idea of what they want to do. They come to the AMC with sketches, or a working model built in their garage. They generally have not completed the engineering required to make their product work well, have little or no knowledge of design for manufacturability, and are usually ignorant of how to protect their personal property rights. In these cases the AMC helps develop a product that will, in the future, have an impact on the local economy. Services are provided at affordable rates with payment stretched out to give the entrepreneur a chance to get his new company up and running. In some cases the AMC will provide marketing and sales help in addition to the engineering. Again this is a situation where everyone wins. The entrepreneur gets his product to market, the state wins as jobs and gross receipts sales tax are increased, the student wins in that he/she is in an active learning environment, and the AMC wins by providing a more comprehensive educational program.
2. Research Grants - Work is solicited from various government agencies to help maintain the AMC on the leading edge. This research work might consist of studying the effects of various cutting tools on exotic metals. Again the similarity of the University hospital and the AMC is apparent. The hospital also maintains a research arm to keep its students ahead of industry standards.
3. Industry - Work is solicited from companies. This work serves several purposes. It provides a base of manufacturing to keep the machine and fabrication shops busy. It also allows companies to select a student to handle a particular redesign. This student would work on the project for a semester. Upon completion of the work the student will work for the company for the summer or take a semester off to work for the company on a coop basis. In either case, the student gets to follow his project and to see the application of his product within the company. The student then would return to NMSU, and the AMC, to complete his education. Upon graduation the company will generally offer the student a permanent position. Everyone wins in this type of situation. The company has had a chance to see the student in operation before he is hired. The company gets a product redesign done at very competitive rates. The company gets a new hire that is familiar with their operations and procedures and can hit the ground running when he is hired. There is no costly break in period of non-productivity. The student gets a job offer, he knows the company and individuals that he will be working with, this makes him more comfortable with the environment and gets him acclimated at a faster rate. NMSU and the AMC win by providing engineers and business people who are more productive. Faculty are closer to industry and can tailor there classes to conform with industry requirements. As a result the University will be able to attract students for these programs in greater numbers, and with greater capability.

Students

Students who-work at the Center are paid for up to twenty hours per week. The students represent a problem in scheduling that make flexible scheduling in industry look easy by comparison. In addition to their work some students take independent study and fulfill either research or long term project commitments while working at the Center. In addition projects are brought to the Center by customers that require a much greater amount of design work before they can be manufactured. These projects are handled by senior design classes under the supervision of a project engineer and a mentor, usually a faculty

member, assigned by the AMC. The assignment of an AMC mentor assures continuity if the semester is completed before the project comes to fruition.

An ideal example of this coordination of effort was the "Tumbleweed project". The New Mexico Department of Highways and Transportation came to the University with a problem. Tumbleweeds collecting along the median of the highway were a hazard to traffic. Two men were assigned to walk with pitchforks and toss the tumbleweeds into the back of a truck. After collecting ten to fifteen of these, the truck was full, and three men would take hours to go to the dump and dispose of the tumbleweeds. This effort was not only dangerous for the workmen but was also time consuming and indfftcient. The DOT wanted a machine, that would be compatible with their present snowplow hitches, work using only the hydraulics available with the vehicle, travel at thirty miles per hour, and collect and pulverize tumbleweeds. The Dot was willing to pay for the development of this machine. The Center, with the help of a senior design class, designed, built, demonstrated and delivered this unit for field trials seven months from the date of receipt of the contract. A total of twenty-one students participated in this project. One graduate student was assigned the responsibility of Program Manager. This task required the student to manage the program in such a manner as to insure a timely delivery within the budgetary restraints of manpower and material dollars. The Program Manager "picked" his management team. This team consisted of personnel from various parts of the organization. Once the program team is formed, the program manager was responsible for setting each team members goals, to monitor their progress, and to report to management on the project status.

When a student is hired he/she is assigned to a section, which is an on line function, or a project, which is a deliverable product. Project personnel are generally Seniors or Graduates students as these functions generally require a broader view as well as good planning skills. A student is assigned to a section, but is pulled into a project for its duration. At the completion of the project he is returned to section. Project personnel report to different mentors than do section personnel.

Matrix Program Management

Program Control

Projects

Function Team	Program Managers	Project Engineers	Business Personnel	Design Engineers
Business Operations				
Manufacturing Operations				
Sales Operations				

one of the three functional areas, Finance, Manufacturing, or Sales. When a project is quoted a Program Manager is assigned from one of the functional groups. The program manager reports to program control mentor. Once he is assigned he is instructed on project control techniques. If the Quote is turned into an order, the program manager selects a team from all the disciplines. It is this groups responsibility to insure timely delivery of a product that meets a predetermined quality level.

Summary

Students who participate by working at the AMC are rewarded on several planes: they are paid for their work, they acquire skills that will improve their communication with shop personnel, they begin to see how a corporation operates, and they have a greater appeal to companies seeking new engineers. The University gains in that the students are required to maintain a certain grade point average to work at the AMC. Faculty gains with a closer relationship with industry. Thois opens doors for research and grants. Students strive to get into the program as the AMC has the best toys in town.

Biography

Raymond Castellani came to New Mexico State University from the Howden Group of companies out of Glasgow Scotland. His past positions have included President of Howden Thermal, and finally as Vice President of Howden Group America, in charge of Marketing and Engineering, and Chief Financial Officer of The Delta Group of Companies. At present he is the Associate Director of Business Operations for the New Mexico State University Advanced Manufacturing Center. He is also a College Professor in the Department of Mechanical Engineering