Work-In-Progress: Recruitment of Pre-engineering Students via an Advanced Manufacturing Curriculum Pathway

ABSTRACT:

Students that have been involved in the Advanced Manufacturing Initiative (AMI) through a Department of Energy Grant have supported the overall pathway into the Pre-Engineering Educational Consortium (PEEC) program. Using engineering related activities presented in the Advanced Manufacturing Summer Institute and the Advanced Manufacturing Course AMI-101 “3D modeling for advanced manufacturing” offered at Cankdeska Cikana Community College and Turtle Mountain Community College and available to other TCU’s via Telecom, AMI has increased the interest in Engineering and has resulted in students becoming a part of the PEEC program.

CONTEXT:

Several of the Tribally Controlled Colleges, TCCs, in North Dakota participated in a NSF sponsored program to generate more Native Americans into engineering. The program is called Pre-Engineering Education Collaborative, PEEC, and has seen a certain amount of success. having graduated 6 degreed engineers from this collaborative to date [1]. One of the concerns with any such sponsored program is to ensure continued recruitment and resulting institutionalization of the program. Critical to recruitment is the drive to stay relevant and attractive to the next generation of students. This is particularly challenging in the reservation communities which are under-resourced, not only in a financial sense but in a technological and a human context as well. A part of attracting students to these types of efforts is to emphasize the portability of skills learned locally. Theoretical training is easily enough accomplished, but the engineering discipline needs to be supported by hands-on opportunities for practice. The under-resourced nature of tribally controlled colleges severely limits the opportunities for applying such hands-on practice particularly in the high overhead engineering laboratories. This North Dakota PEEC collaborative used computer aided design and drafting as the very first course in the introduction to engineering sequence and provided some excitement within the student community. The students sitting in an under-resourced community still have access to communication on the web and YouTube, since these media resources tend to go everywhere, and these students understand that there are more options available than simply sitting passively in a lecture room trying to internalize concepts that can easily overwhelm them as it does with many mainstream students. This is particularly exacerbated by the tribal students lacking an understanding of the engineering profession and the extent of courses required to complete the prerequisites for an engineering degree. The target population for recruitment on a reservation usually hasn't uniformly had the opportunity to learn the perseverance and support skills needed to take advantage of the amount and breath of courses required for an accredited engineering degree. For many it could seem like a task without end.

ISSUE:

The issue that needed to be addressed in this recruitment effort was to provide an experience that illustrated some of the satisfaction of engineering without requiring significant amounts of preparation and study to accomplish. This experience had to be relatively low-cost, portable, and expandable to many industries in a variety of contexts. The experience would be better if it were intuitive and was able to demonstrate a level of difficulty which could be surmounted with straightforward application of effort. Safety and small environmental footprint would add to the attractiveness of such an experience that would allow participation numbers that could vary and would provide the opportunity for virtual connections with multiple users and instructors at different sites. The experience could also build upon the context of students having a certain high familiarity with aspects of programing and, in particular, computer-based games.

APPROACH:

Based on some of the above considerations, it seemed extremely fortuitous that an opportunity opened to members of the consortium that provided the resources to get some competent 3-D printing machines that could be used for advanced manufacturing. This was an Advanced Manufacturing Initiative, AMI, that was supported by a grant from the Department of Energy. This was a timely opportunity since the mainstream institution in the collaboration was also bringing on board multiple rapid prototype capabilities to augment the design process. This allowed students with minimal mathematical training or engineering based design experience to actually see and handle the fruition of a thought process that could conceivably answer a technical requirement or need.

Setup would allow students to work with predefined plans and process steps to produce parts and pieces that could come together to form objects (e.g. drone bodies or low-cost scientific weather stations [2]). Students could further develop the skills learned by attending the 8-week Advanced Manufacturing Summer Institute coordinated by AMI and hosted by a partnering institution. The students learn about mechatronics, metrology, and enhance their CAD capabilities from supplemental training and working on a project. The project gives the students a sense of the engineering design process as they reverse engineer a drone kit and construct a 3D printed model from an original design. The final design is judged on efficiency of the materials used, durability of the drone, and the overall usability of the product.

IMPLEMENTATION:

The program was set up to be built on 3 significant pillars: educational curriculum, research and development and outreach. The program had support from several national laboratories including Department of Energy laboratories at Sandia and Boulder Colorado. The educational curriculum used local instructors to interface with the students to follow nationally developed lesson plans. The plans pointed towards production of parts that could be used on national laboratory projects that demonstrate to the students the utility of this technology in a variety of circumstances. It illustrated the portability of the technology and the opportunity for remote employment. The students were also recruited to participate in summer workshops/classes/tutorials where they experienced campus life, earned credits and received some insights to a professional career. These were all significant points within the PEEC program at its initial conception. The advanced manufacturing R&D was done by the instructors in the program with the help of their more advanced students to give them some insight into the academic opportunities. Outreach provided a connection between school accomplished activities and industrial rewards illustrating some of the advantages of such a career. National laboratory partners travel to the TCCs in the AMI for industry days where professionals discuss engineering career paths with high school and early college students. A more in-depth analysis of this program is provided by the American Indian Higher Education Consortium, AIHEC [3].

Turtle Mountain Community College, a member of the AMI, has utilized the knowledge and technology gained from the program for outreach activities aimed at recruitment of students. Robotics competitions are hosted by the college that encourage critical thinking to solve problems or complete missions. Designs of the robot must be modified and improved in between rounds to maintain a competitive edge on the competition. This gives younger students an introduction to the engineering design process where there are strict deadlines to be met, requirements to follow, and tasks to complete. A second outreach activity was implemented within a bridge program for graduating high school students. The aim of the program was to give a glimpse at a variety of STEM fields and help students prepare for the academic, financial, and personal issues that can be faced during college. As an introduction to engineering, the students were tasked with choosing between creating a 4x4x4 LED cube programed with an Arduino chip or constructing a desktop 3D printed wind turbine. Initial instructions were provided to help the students build a prototype of the model. However, the students were required improved the original design in some manner. This could range from redesigning individual parts to make them easier to install/aesthetically pleasing/more efficient, investigating the effects of different infill/thicknesses/materials, or any other modification the student decided to impose. This gave the students the freedom to be creative, but a justification for each change needed to be examined and prior to reprinting and hypotheses describing what the students anticipated would occur as a result of the proposed redesign was required.

RESULTS TO DATE:

To date, several students at advanced manufacturing schools in the consortium have participated in both programs, PEEC and AMI. Some of the students have been PEEC students first then joined AMI following interest in that manufacturing program and methodology. Other students were in the AMI program first but then realized that if they wanted to continue with the R&D aspect, they needed to get involved with furthering their education and therefore needed an engineering degree. There were other students that attended the Advanced Manufacturing Summer Institute but still didn’t follow on with either program. Some of this could have been due to a rather broad recruitment nest that included art majors among others.

DISCUSSION:

Currently, it seems that this opportunity has benefits in multiple facets in that it can provide a satisfaction component to the CAD course in PEEC where students can actually see their designs materialized. It also provides an opportunity to engineering students to see the place of prototyping in the development of solutions to engineering problems. Rapid prototyping and 3-D printing could also provide support for hands-on competitions and experimental activities such as wind tunnels and flow tanks might require. At its core, it becomes a rapid way to get something in the hands of students. Hands-on activities implemented within a curriculum aimed at minority students can aid with their connectivity to their chosen profession. One of the significant future tasks of this effort is to quantify all of the above statements in a way that can make this opportunity transport to a variety of institutions and communities. Although this activity is been going on for almost a year, numbers to date have been anecdotal and there has been no clear focus for a unified recruiting effort that transcends the somewhat random approach for aspects of the current situation.

REFERENCES:

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[2] 3d Printed Automatic Weather Station (3D-PAWS),

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[3] AIHEC. (2016, March 17). Tribal College and University/AIHEC Advanced Manufacturing Network Initiative Phase 2 Plan. AIHEC.