AC 2011-21: EDUCATIONAL OUTCOMES EMBEDDED WITHIN ENERGY CONSERVATION PROJECTS

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Educational Outcomes Embedded Within Energy Conservation Projects

Abstract

During the summer of 2008, the NIU College of Engineering and Engineering Technology received funding from the United States Department of Energy to study modes of energy conservation in the railroad industry. Specifically, the projects looked at reducing the usage of diesel fuel in the operation of today's modern locomotives. The project lasted one and a half years, and five project tasks examined unique aspects energy conservation in the common locomotive. The team studied the usage of alternate fuels as a suitable alternative to using straight diesel fuel, where cost, availability, emissions, and material wear are key considerations. The team also studied the usage of fuel cell power systems in the propulsion of the train. The team examined many safety and power issues that centered on the use of alternative energies and green materials. In addition to energy sources, the team examined the thermal and emission reduction of the locomotives. With new federal regulations coming in the future, this area will not only reduce the energy consumption, but companies will be required to comply with federal regulations. The research and design team also studied the usage of energy efficient materials in the railroad industry. It was found that components can be made lighter and have longer life spans if alternative materials are used. Finally, the team looked at tribology issues in the railroad industry. Friction issues constitute many energy inefficiencies of the locomotive, from the wheels rolling on the tracks, to the friction in the massive 16 cylinder engines, to the other wear surfaces of the locomotive; friction issues greatly reduce the efficiency of the train.

Much work was completed in developing new energy efficiencies in this important industry, however, more importantly from an educational stand-point, the work completed was interdisciplinary and it included faculty and student teams from across the College of Engineering and Engineering Technology. The overall project included ten faculty members from four different areas of engineering and technology were involved in this work. In addition, the project used the expertise of over 20 undergraduate and graduate students. In addition to the work which was developed, the project management was an important portion of the project, from an overall perspective down to each student component. In each of the five tasks, the design teams set out to satisfy a set of project milestones and objectives. In satisfying the project outcomes, it was necessary to fulfill the outcomes and objectives of the specific educational programs, and thus the related accreditation outcomes and objectives. Students in all areas made positive impacts on the project and much was accomplished towards energy improvement in the railroad industry.

Introduction

Within the educational goals in any engineering and/or technology program, there are a series of programmatic learning objectives and outcomes which must satisfied. Typically, the outcomes and objectives are developed by the faculty members in conjunction with the regional industry that hires the graduates upon graduation. As such, the programmatic contents will vary based upon the region and constituents of the program; however, there will also ways be a fundamental core which is common to all programs that are similar in title. Within engineering and technology programs, it is desirable to introduce the students to industrially based applications and theory that will be encountered after graduation upon entering industry [1,2,3,4]. This practice is done at nearly all institutions, however, the format that is followed varies widely. This inclusion is, typically, done through experiential learning techniques [4,5]. Two modes of experiential learning situations which are frequently used include internships and applied research problems within the curriculum. The College o Engineering and Engineering Technology at Northern Illinois University deals has developed one mode of project and real-world integration through large-scale cross-disciplinary projects.

Objectives and outcomes developed for each program detail what skills and knowledge each graduate will possess at the end of their studies. It is these objectives and outcomes which are at the heart of the assessment process and also at the heart of any accreditation which may be sought by the departments and colleges. In fact in most cases, the use of experiential learning is at the core of the students learning in any program. Many of the objectives and outcomes in any engineering or technology program can be or is satisfied through the use of experiential learning. In most cases, students are given real-world issues and placed on teams with others (sometimes interdisciplinary) and provided with open-ended problems that they must solve. While engineering and technology programs have used these types of experientially based problems in their curriculum, the engineering and technology departments at Northern Illinois University have modified this common practice somewhat [6,7,8]. In the fall semester of 2008 the College of Engineering and Engineering Technology (CEET) at Northern Illinois University received a $1.0 million grant from the U.S. Department of Energy to study and provide energy efficient solutions for the railroad industry. The authors of this paper served as the principle investigators of this project. Working with this old and established industry was very interesting and rewarding throughout the project. As an industrial model for the railroad industry, the PI's worked with Norfolk Southern Railroad, as a representative company for the entire railroad industry. It was this large project that the authors developed numerous small faculty led projects and even smaller student led and derived projects. Through these students projects, the authors and faculty members in the college had a vehicle to introduce experientially based projects in all areas within the college and more importantly, cross-disciplinary projects across two or more areas within the college. Through these student and faculty/student projects, we were able to satisfy the objectives and outcomes which were developed in each of the college programs.

Overall Project Tasks

The grant which was received looked at many areas within the railroad industry in which energy savings can be realized. The series of projects which were conducted by North Illinois University used the Norfolk Southern Railroad as a model for the industry as a whole. The overall project had five unique tasks which were in areas of importance within the rail industry. The NIU Engineering and Technology research teams looked at these areas and provided unique solutions to the railroad industry in energy the conservation. The tasks areas included the following,

- Alternate Fuels

Typically, all of the companies in the long haul transportation railroad industry use 100% diesel fossil fuel (petro-diesel) as it source of locomotive fuel. The project team examined the usage of various blends of bio-based diesel fuels for the railroad industry. The team determined that bio-diesel fuel is a suitable alternative to using straight diesel fuel, however, the cost and availability across the country varies to a great extent. The team determined that some of the emission properties dropped substantially, while other particulate properties increased with the use of bio-diesel. In addition, the team determined that there are issues with bio-fuel and engine part wear as this type of fuel interacts with the engine parts and surfaces. In developing the needed storage facilities for railroad fuel depots, the research team examined the safety issues concerning the use and storage of bio-diesel. Existing fuel infrastructures were studied. It was determined that since the bio-diesel has a finite shelf life, and must be mixed in the various grades on site, there are large infrastructure costs incurred as part of the switch to the bio-diesel product. The team determined that current production of bio-diesel is through the use of soy products. The fact that this is a food stock means that there are large price fluctuations based upon market costs. This will change in later generations of the product, as production migrates to the use of algae, or non-food stock based materials. However, at this stage in the supply chain which has been developed for the current generation of bio-diesel, supply is limited to certain areas of the country, and use in other areas means that the fuel needs to be transported to these unserved areas.

- Utilization of fuel cells for locomotive power systems

While the application of the fuel cell has been successfully demonstrated in the passenger car, this is a very advanced topic for the railroad industry. There are many safety and power issues that the research team examined. The railroad industry wanted to utilize the fuel cell as an auxiliary source of energy, thus, employing a smaller, more efficient diesel power plant to provide power. The net result would be a cost and fuel savings over various regions and terrains. The design team determined that an SOFC (solid oxide) cell was best for this purpose. On board gasification of biodiesel will be used for the fuel. Major components include SOFC, gasifier, gas cleaning, heat exchangers for heat recovery/preheating and cooling. This cooling system has to remove heat from the fuel cell stack using bi-polar plates and remove heat from electric motors and inverters. A part of the excess fuel from fuel cell stack can be burned in the combustor to supply necessary heat to steam reformers, steam generator and air-preheater. In addition, due to the large amount of heat generated through the breaking system, it has been put forward that a regenerative breaking system should be developed for the locomotive system, similar to that used in a Toyota Prius.

- Thermal and emission reduction for current large scale diesel engines

The current locomotive system generates large amount of heat through engine cooling and heat dissipation when the traction motors are used to decelerate the train. The research team evaluated thermal management systems to efficiently deal with large thermal loads developed by the operating engines. To do this the team researched nano-particles suspended in the cooling fluid used by the engine. Through the introduction of nano-particles, there is an increase in the rate of cooling since the fluid is able to effectively absorb more heat from the engine.

According to a recent study conducted by the U.S. Environmental Protection Agency (EPA), locomotive diesel engines contribute significantly to air pollution in many of our nation’s cities and towns. Since control plans for on-road vehicle emissions have been put into effect, locomotives could become the primary source for dangerous air pollution in the country. In addition to the requirement of reduced greenhouse gases such as carbon dioxide, the individual air pollutants to eliminate are particulate matter (PM), hydrocarbons (HC), and the oxides of nitrogen (NOx). Many studies are focused on achieving cleaner emissions and improved performance of diesel engines through use of alternative fuels, specifically biodiesel and improved thermal management of exhaust heat and cooling of the engine. The study of biodiesel is relatively new, particularly the study of how biodiesel can have an effect on the emissions of large scale diesel engines. Understanding all the above through experimental and computational analysis helped to identify concepts to be incorporated into the operation of every day diesel engines. The primary goal of this research was to understand how various changes in diesel engine operating conditions can change emissions and thermal efficiency and to be able to successful predict these changes through computational fluid dynamics modeling including combustion modeling. The work will specifically address how the operating systems design for large thermal loads effects the emission factors for diesel emission components such as, greenhouse gases like carbon dioxide, carbon monoxide, oxides of nitrogen, hydrocarbons, and particulate matter. Developing related experimental and computational analysis identified several concepts that can be incorporated into innovative design and operation of diesel locomotives. A simulation model for the combustion process and heat transfer performance of the diesel engine was developed and the results for emission compositions and thermal load were analyzed and compared with the experimental data.

- Use of Composite and Exotic Replacement Materials

Currently on the structure of the locomotive, there are components which are poorly designed from an energy standpoint. Many of the current components are not designed to reduce the vibration and sound loads, as well as fatigue and wear due to environmental issues. The research team examined and redesigned certain components using new materials and coatings to provide the needed protection. Through design, analysis, and testing, new parts that can withstand the hostile environments have been developed. Through discussion with railroad engineers, it was determined the following components could benefit through re-engineering.

- ♦ Induction tube – Exhaust ports on engine get clogged with the exhaust soot. The design team looked at new coatings and manufacturing methods for this important part. The coatings used offered low friction at high temperature, and significant cost savings.
- ♦ Air brake hosing – Current hose is subject to wear and fatigue – It was determined that at various points on the train, the pressure differential in the air hosing dropped significantly. This drop was due to cable wear, and through the study of acceleration of the cars, it was determined that the wear can be eliminated using alternate mounting techniques. Thus, maintenance, longevity, and cost issues were addressed.
- ♦ Coupling knuckle – Adjacent cars which are attached together put heavy fatigue loads on the coupling knuckles; which in turn fail at inopportune times. The research team studied the failure and solutions of this component. In this case, there were no small-scale modifications that could be found to remedy the problem. The railroad industry wanted a low-cost lightweight, easy to install solution. This solution is not possible, unless there is a major redesign on the knuckle assembly that has been used for over fifty years.
- ♦ Brake shoes – Current backing plate for the shoes allows for cracking as the material wears. It was found that significant longevity of the brake shoes could be realized through a novel redesign of the backing plates of the shoes. This would be a low-cost fix and implementation, however, the current shoes have been in usage in the industry for many years, and the industry would be resistant to change.

- Tribology Applications

The main task objective was to identify tribology issues in the Railroad industry which will play a significant role in the improvement of energy usage and to develop solutions which will result in friction modification to improve energy efficiency. The team looked at new and modified lubricants, wear surfaces, and nano-lubricants. The lubes were analyzed for traction, and heat generation based on numerical models and actual wear tests were conducted on the materials. Bearing parameters, and load capacities, as well as seizure loads were evaluated using ASTM tests, and the lubes were tested on full scale models. It was determined that through low-cost modification in the current lubes, beneficial properties could be enhanced.

Project Deliverables

Each of the tasks had the following milestones that had to be met,

Task 1 - Alternative fuel project

Quarter 2 - Research into grades and availability of bio-diesel in regions of usage, develop emissions and delivery economics and distribution model including consumption needs.

Quarter 4 - Report on distribution model for NS railroad and report on performance of fuel usage on diesel engine simulator.

Task 2 - Utilization of fuel cells for locomotive power systems

Quarter 2 - Report on power consumption of system and the availability of the desired fuel cell system. Report of the safety and ergonomic issues concerning usage of fuel cell system

Research into refueling issues and developing system map for NS railroad, as well as development of an off-line power management system to control all power usage on locomotive

Quarter 4 - Report on refueling and energy distribution systems as well as development of an off-line power distribution system.

Task 3 - Thermal and emission reduction for current large scale diesel engines

Quarter 2 - Report on thermal analysis of systems and economic and safety applications of nano-particles use in cooling plant and develop laboratory set-up for testing of nano-particles.

Quarter 4 - Report on benefits and specification of the use of nano-particles in locomotive cooling

Task 4 - Use of composite and exotic replacement materials

Quarter 2 - Report on components chosen and modifications in manufacturing and materials to be used for replacement parts. Work with outside company to construct parts for testing and then with railroad to conduct tests. Develop manufacturing and economic study to compare parts.

Quarter 4 - Report on test and analysis, and comparison of old and new parts developed.

Task 5 - Tribology Applications

Quarter 2 - Report on frictional issues and current lubrication used and develop new lubricants for each desired task as needed and corresponding test procedures needed to analyze new lubricants to compare to current. Research and provide economic, safety, and environmental analysis.

Quarter 4 - Report on testing conditions and results of new lubricants and compare to current lubricants used. Develop report on economic and safety aspects of replacement lubricants.

College Involvement

As project PI's, the authors were tasked to develop a suitable faculty team to undertake the project. Due to the applications orientation of the work, it was decided that the Department of Technology would play a lead role. In addition, since the project was more mechanical in nature, the majority of the faculty members on the project would have backgrounds in mechanical engineering. It should be noted that the project was highly interdisciplinary, where many other faculty from electrical and industrial were included. In all of the above project tasks and deliverables, there is a need for all faculty members from all different areas to work together on interdisciplinary teams in the completion of the work. This interdisciplinary team oriented aspect of the project carried through into the students selected and how the student research teams were assembled. It should be noted that these aspects of the project were one of key objectives and outcomes from within the college engineering and technology programs. In total, the year and a half long project employed well over 20 graduate and undergraduate students. As was stated, all of the college departments were involved in the project, the Department of Technology took a leadership role, and the technology faculty were involved in most aspects of the project due to the applications oriented goals. As such, the outcomes and objects which are being discussed in this work are from the point of view of a technology program. With that said, most of the objectives and outcomes cross into the realm of any engineering program.

Department of Technology Outcomes and Objectives

Colleges across the country have developed programmatic outcomes and objectives which govern the direction of the given programs. At the center of the NIU Department of Technology program are the following core educational Outcomes and Objectives.

ATMAE and ABET (TAC) Learning Outcomes: An engineering technology program must demonstrate that graduates have:

Designator	Outcome
A	An appropriate mastery of the knowledge, techniques, skills and modern tools of their disciplines.
B	An ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering, and technology.
C	An ability to conduct, analyze and interpret experiments and apply experimental results to improve processes.
D	An ability to apply creativity in the design of systems, components or processes appropriate to program objectives.
E	An ability to function effectively on teams.
F	An ability to identify, analyze and solve technical problems.
G	An ability to communicate effectively in writing.
H	An ability to communicate effectively orally.
I	Recognition of the need for, and an ability to engage in lifelong learning.
J	An ability to understand professional, ethical and social responsibilities.
K	Respect for diversity and knowledge of contemporary professional, societal and global issues.
L	A commitment to quality, timeliness, and continuous improvement.
M	An ability to program computers and/or utilize computer applications effectively.
N	An ability to use modern laboratory techniques, skills, and/or equipment effectively.
Additional ATMAE Outcomes	

O	An ability to manage projects effectively.
P	An ability to design, manipulate, and manage industrial systems.
Q	An ability to manage or lead personnel effectively.

Department of Technology - Manufacturing Engineering Technology - Program Objectives

Manufacturing engineering technology graduates will:

- Obtain the skills to adapt to the changing needs of the society and provide solutions to better society.
- Acquire a well-balanced knowledge in the theory and practice within the areas of manufacturing.
- Perform in an ethical society, and thus, provide effective, responsible, and articulate leadership in our complex society.
- Understand the need for obtaining new knowledge, including technological advances, and be able to continue to learn and be capable of self-renewal.
- Seek and apply creative and analytical insight in the solution of engineering-type problems.
- Communicate effectively both orally and in written form, using many presentation styles.
- Function as part of an interdisciplinary team.
- Acquire new forms of knowledge and the ability to utilize this knowledge.
- Become familiar with new technology and recognize its implications.
- Have the academic and professional competence sufficient for productive employment and advancement within their respective industry.
- Understand and undertake the advanced study required for leadership in the manufacturing realm.
- Interact within a diverse student team and population.
- Apply a liberal arts and science education to real world problems.
- Be technically prepared for making a seamless transition into leadership, management, and service positions in business, industry, education, and government.
- Have the ability to improve productivity, safety, and the well being of society through combining scientific, engineering, and management knowledge with technical skills.
- Understand the need for flexibility in the face of change and consistency in the pursuit of excellence to provide lifelong learning by recognized national and international leadership.

The above objectives and outcomes are very broad and allow the programmatic faculty the latitude to develop a quality Manufacturing Engineering Technology program which meets the needs of the regional industry. Therefore, students are obtaining high-paying quality employment after graduation.

Involvement of Department Students – Development of Teams

The project PI's developed five unique encompassing tasks for this project, where each task is overseen by a faculty task leader. This individual's goal was to develop the specific task and form an interdisciplinary faculty team to complete the task. I addition to the faculty members on the team, students were heavily involved. In each task, there approximately 5-10 graduate and undergraduate students who were employed by the project. Of particular importance to this discussion are the undergraduate students, who were involved in many different areas within each task. Students involved in the project served as,

Research Assistants – Students worked with the faculty to undertake initial research on the topics. In addition, these students interfaced with the companies on which the railroad tasks centered. The students also worked with the faculty and graduate students in performing the computer simulations and analysis on the various parts of each task. Finally, each assistant assisted in writing their portion of the quarterly and final reports and presentations which were needed

Laboratory Assistants – Since this project and each of the tasks were heavily experimental in nature, students assisted in researching and developing the appropriate laboratory tests that were required. As such, the students were required to interface with railroad company representatives and the representatives of the companies from which we purchased the test equipment. These same students worked with machinists and by themselves to build the experimental test stands, and also to conduct the experiments. Working with the faculty members involved in the specific tasks, the students reduced the reams of data.

Senior Project Teams – In all of the programs across the college, undergraduate students are required to take the year-long senior projects course, and several of the projects on-which the design teams worked included aspects of various tasks. These projects were smaller, more condensed versions of the overall tasks, however, the students researched the concepts, set-up experiments, and obtained the results needed.

Independent Study Assistants – During the year-long project, several tasks had undergraduate students working on independent (for credit) study projects. These projects typically required research and analysis, as well as reduction of data. All students were required to submit written reports detailing their work, as well as visual presentations of the work.

The above four areas of inclusion of the undergraduate students offer many unique opportunities in which the students had the ability to work on research. As a result of this overall project, there were many papers submitted in which the students provided input for their areas of involvement.

Fulfillment of Department of Technology Outcomes and Objectives

Assessment is also a main objective of all engineering and technology programs [9,10]. Now that one has the project tasks and the student involvement, as well as the program objectives and outcomes, it is important to examine how these are fulfilled through project work.

Learning Outcomes:

Designator	Outcome	How outcome is fulfilled through undergraduate project involvement
A	An appropriate mastery of the knowledge, techniques, skills and modern tools of their disciplines.	Project allows students to use learned course techniques in research setting
B	An ability to apply current knowledge and adapt to emerging applications of mathematics, science, and technology.	Project allows students to use learned course techniques in research and lab setting – data analysis requires technical and statistic analysis
C	An ability to conduct, analyze and interpret experiments and apply experimental results to improve processes.	Projects requires students to develop laboratory experiments or perform numerical analysis and then data reduction.
D	An ability to apply creativity in the design of systems, components or processes appropriate to program objectives.	Project requires students to design components and lab set-ups, as well as design how tests and numerical analysis should be conducted.
E	An ability to function effectively on teams.	All tasks were completed as a team, thus all students working on the project must fit into the team sequence.
F	An ability to identify, analyze and solve technical problems.	Projects require students to develop laboratory experiments or perform numerical analysis and then data reduction.
G	An ability to communicate effectively in writing.	All students required to provide written reports to the faculty leader
H	An ability to communicate effectively orally.	All students required to provide oral reports to the faculty leader and other project teammates.
I	Recognition of the need for, and an ability to engage in lifelong learning.	Through work on the project students understood the need to continue to get involved in advanced technical concepts and research
J	An ability to understand professional, ethical and social responsibilities.	Projects required making choices in various areas – required professionalism and social choices
K	A respect for diversity and knowledge of contemporary professional, societal and global issues.	Working with many different companies, the students saw the global issues that arose, as well as the issues of green engineering and energy conservation.
L	A commitment to quality, timeliness, and continuous improvement.	Working with many different companies, the students saw the need for quality, as well as the issues of green concepts and energy conservation.
M	An ability to program computers and/or utilize computer applications effectively.	All students were involved in experimental or numerical analysis, thus utilizing the computer and its applications.
N	An ability to use modern laboratory techniques, skills, and/or equipment effectively.	Projects require students to develop laboratory experiments or perform numerical analysis and then data reduction.
O	An ability to manage projects effectively.	All students had to work with the task members and be involved in the management of components of the given task
P	An ability to design, manipulate, and manage industrial systems.	Most students were involved in design aspects of either system components or experimental processes
Q	An ability to manage or lead personnel effectively.	All students had to work with the task members and be involved in the management of components of the given task thus they saw and developed management skills

Department of Technology - Manufacturing Engineering Technology - Program Objectives

Manufacturing Engineering Technology Program Objective	How objective is fulfilled through undergraduate project involvement
Obtain the skills to adapt to the changing needs of the society and provide solutions to better society.	Working with many different companies, the students saw the issues of green engineering and energy conservation and how to use these skills in design.
Acquire a well-balanced knowledge in the theory and practice within the areas of manufacturing.	Project allows students to use learned course techniques in research and lab setting – data analysis requires technical and statistic analysis
Perform in an ethical society, and thus, provide effective, responsible, and articulate leadership in our complex society.	Projects required making choices in various areas – required professionalism and social choices. In addition, students must develop time-line and track progress, developing leadership skills
Seek and apply creative and analytical insight in the solution of engineering-type problems.	Project allows students to use techniques obtained in the program in research and lab setting – data analysis requires technical and statistic analysis. Many tasks involved design of components and experimental set-ups
Communicate effectively both orally and in written form, using many presentation styles.	All students required to provide written reports and oral presentations to the faculty and other teammates, as well developing and making presentations each quarter.
Function as part of an interdisciplinary team.	All tasks were completed as a team, thus all students working on the project must fit into the team sequence and communicate with team members and other faculty.
Acquire new forms of knowledge and the ability to utilize this knowledge.	Students on design teams required to research topics involved in the given tasks. From this information teams redesign product or develop experimental set-up.
Become familiar with new technology and recognize its implications.	Project allows students to use learned course techniques in research and lab setting – data analysis requires technical and statistic analysis
Have the academic and professional competence sufficient for productive employment and advancement within their respective industry.	Project allows students to use learned course techniques in research and lab setting – data analysis requires technical and statistic analysis. The work involved will prove positive in obtaining employment
Understand and undertake the advanced study required for leadership in the manufacturing realm.	All students had to work with the task members and be involved in the management of components of the given task thus they saw and developed management skills
Interact within a diverse student team and population.	All tasks were completed as a team, thus all students working on the project must fit into the team sequence with other team members from different areas of engineering and technology and ethnic backgrounds
Apply a liberal arts and science education to real world problems.	All students have a varying background in the liberal arts areas which helps them interact with group.
Be technically prepared for making a seamless transition into leadership, management, and service positions in business, industry, education, and government.	All students had to work with the task members and be involved in the management of the given task.
Have the ability to improve productivity, safety, and well being of society by combining scientific, and management knowledge and technology skills.	As part of designs, students looked at safety concerns of the designs.
Understand the need for flexibility in the face of change and consistency in the pursuit of excellence for lifelong learning by recognized national and international leadership.	Through work on the project students understood the need to continue to get involved in advanced technical concepts and research

Understand the need for obtaining new knowledge, including technological advances, and be able to continue to learn and be capable of self-renewal.	Through work on the project students understood the need to continue to get involved in advanced technical concepts and research

While the inclusion of this project in the Manufacturing Engineering Technology curriculum is a benefit to a few students in the program, it does provide the students with the outcomes and objectives. This project was inclusive and had a scope which was large enough that these objectives and outcomes where satisfied.

Conclusion

In an era of global competition, a better-educated and trained workforce will separate the winners from the losers. In addition, engineering and technology programs must develop objectives and outcomes which will drive the educational development of the program. In most cases, these programmatic objectives and outcomes are industry driven so that our graduates have the skill sets needed to obtain quality employment after graduation and be able to make a positive impact from the first day of employment. In addition, each program must track the ability of the program to follow these outcomes and objectives and provide assessment data for accreditation and any other reviews, including internal reviews. Thus, any learning avenue which allows the program to successfully fulfill these outcomes and objectives positively impacts the students and the technical program. In addition, since it is the desire of the program and students to obtain employment post-graduation, it is a goal to develop learning avenues which will develop industrially oriented projects for the students. The College of Engineering and Engineering Technology at Northern Illinois University has developed a mode in which select students from all of the engineering and technology programs can work as part of interdisciplinary teams in large-scale applied research projects. These projects allow the students to work as part of a research and development team with a group of faculty members from the college. As a result of this project and as was shown in this paper, students and the programs are provided with a new mode of completing the education outcomes which results in students working on high level research projects.

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