ATMAE
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The Association of Technology, Management, and Applied Engineering

ATMAE 2011 Conference
"Rethinking the Future"

Wednesday November 9 - Saturday November 12, 2011
Crowne Plaza City Centre - Cleveland, Ohio

2011 Conference Proceedings

- > Review Process & Statistics
- > Presentation Abstracts
- > Proceedings Papers

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ATMAE 2011 Conference Presentation Abstracts and Proceedings Papers

Review Process & Statistics for Presentations and Papers

This CD-ROM of the *ATMAE 2011 Conference Presentation Abstracts and Proceedings Papers* is the result of the work of many authors in technology, technology management, and applied engineering degree programs throughout the United States who gathered to share their work at the 2011 Annual ATMAE Conference, "Rethinking the Future," in Cleveland, Ohio, November 9 - 12, 2011. This CD-ROM includes all of the conference presentation abstracts that were accepted through peer-review for presentation and publication (except those withdrawn by the authors), and the Conference Proceedings Papers (that are based on accepted presentations) which were accepted through a secondary peer-review process.

The reviews of presentation proposals and conference papers were led by ATMAE Division Presidents and Focus Group Chairs. The proposals and papers were reviewed in a double-blind process by a panel of at least three ATMAE members with expertise in the topical area. Using the review criteria (posted on the ATMAE website), panelists evaluated and ranked each paper, and a cumulative rank-ordering system was used to help select the presentations and papers.

The ATMAE 2011 Conference Presentation Abstracts were subject to a double-blind peer review process. In 2011, the peer-review process led to acceptance of 77% of presentation proposals, 190 of 245 proposals submitted. Some proposals were withdrawn after acceptance and are not published in the Proceedings.

The ATMAE 2011 Conference Proceedings Papers went through a similar process. Authors of accepted conference presentations were invited to submit full papers based on their presentation abstracts. The *Conference Proceedings Papers* were selected in a double-blind peer review process, with panels of at least three reviewers involved in reading and reviewing each paper. In 2011, of 190 accepted conference presentations, 41 were expanded into longer papers and were submitted for the peer-review process. The double-blind peer review process led to acceptance of 49% of the papers submitted, for a total of 20 ATMAE 2011 Conference Proceedings Papers. These 20 Conference Papers represent 10.5% of the proposals accepted for presentation at the 2011 ATMAE Conference, and only 8.2% of proposals submitted.

Best 2011 ATMAE Conference Proceedings Paper: *"Converting Legacy Maps into 3D Models"* (Graphics track), by Mr. Andrew Kellie of Murray State University. This paper was selected in a blind peer-review by four members of ATMAE's Executive Board from the eight papers evaluated as best in their respective review tracks.

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Conference Presentation Abstracts (by track):

- *Administration:* Chair, Randy Peters; F. Michael Ayokanmbi, Mike Beauvais, Mahyar Izadi, David Melton, Marion Schafer, Douglas Schauer
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- *Teaching Innovations:* Chair, Randy Peters; Mike Beauvais, Denise Gravitt, Samson Lee, Dan Lybrook, Marion Schafer

Graduate Student Research Presentation Abstracts:

- Randy Peters, Chair; Marion Schafer, Shawn Strong

Conference Proceedings Papers (by track):

- *Administration & Teaching Innovations:* Randy Peters, Chair; F. Michael Ayokanmbi, William Brauer, Mamie Griffin, Mahyar Izadi, Sudershan K. Jetley, Zaki Kuruppalil, Soo-Yen Lee, Bruce Marsh
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- *Safety:* James Wright, Chair; Horlin Carter, Dilip Shah, James Wright

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Administration

Appreciative Model: A Paradigm in Positive Organizational Change

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Need: For any organization to be fully successful in its mission, it is imperative that all the constituents of that organization be motivated to work toward the common goal of that organization. The big question is: How does an organization get everyone onboard, and motivated toward the common interest and or Mission of the organization? This is not an easy task. That said, Davis Cooper Rider (1990) describes how positive images used in appreciative model help to generate and direct action which in turn generates positive feeling for building and sustaining momentum for change in an organization, business, industry, a college or a university. The need to embrace innovative appreciative model that is documented to create synergy, boost morale and involve all constituents in a positive way in an organization is so paramount to organizational changes and success today.

Overview: This presentation focuses on the appreciative model. It is a method that is proven to effectively get everyone in an organization fired up about knowing their place in the organization and valuing their own contribution as well as collectively valuing others within the organization. This method not only results in positive feelings on the part of every stakeholder but it builds sustaining bond that binds everyone in the organization together to the end that each member goes to work fired up to make a difference in the organization and as a result contributing to the bottom line and to the vitality of everyone in the organization becomes an achievable goal.

Major Points:

- What is appreciative model and why is it life sustaining for any organization?
- How and what individuals can do to apply this model on a daily bases
- What are the five basic steps to the appreciative model
- Application of the model to a department, a unit of an organization or to the entire establishment.

Summary: Research shows that people experiencing positive feelings are more flexible, creative, integrative, open to information and efficient in their thinking. As a result, participant will understand what this model is and how to apply it in their own personal setting for a positive result.

A Novel Use of Data Mining on Determining College Students' Academic Performance

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Need: Each academic year, college administrators have to make important and comprehensive decisions on: 1) admission acceptances and scholarship offers for incoming freshmen, 2) financial aid or assistantship for continuing students. It was reported that the use of standardized test scores solely to make those decisions has shown to be problematic; multiple measures (triangulation) could be used to predict student success. During the course of study major consequences of poor academic performance are lengthening the total time for graduation and dropouts. There is a complicated mixture of variables that influence students' performance in the registered courses. However, it is necessary to investigate the root causes considering various important attributes of a college student. Data mining technique can be an effective tool in this investigation.

Overview: This work reports a novel use of data mining technique to study the comparable and contrasting effects of seven most widely used variable measures: 1) age, 2) gender, 3) high school grade point average, 4) American College Test or Scholastic Aptitude Test (ACT/SAT) score, 5) credit hours taken, 6) credit hour passed, and 7) current college CGPA of a college student. It provides a methodology for predicting college students' academic performance during their freshman, sophomore, junior and senior years at a university of the United States.

Major Points:

- Predicting a student's success is a process of determining in which group a student belongs.
- A student must have certain academic skills in order to have acceptable performance and stay in a course. Effective cognitive traits such as persistence in achievement and motivation are also important. A desire to achieve higher GPA is often cited as an important drive to make good performance. However, the seven common attributes of a student listed in the Overview should be investigated first.
- Very few studies have been conducted to identify the comparable and contrasting effects of those variables on students' academic performance. There was little research on using data mining techniques to predict such administrative issue.
- This study employed two data mining techniques (decision tree and association rule) on ten year's (1992-2002) of data for 8,208 students. Decision tree is effective in finding the contrasting and characterizing patterns of different classes (variables). Association rule is effective in finding the patterns of highly associated attributes (variables).

Summary: This study presents comparable and contrasting effects of seven cognitive and non-cognitive variables for predicting college students' academic performance. Using data mining techniques, analysis revealed that the student's age has very significant effects on cognitive variables, which influence students' college performance of science or engineering and non-science or non-engineering students, whereas it is affected by gender, hours taken and trend of hours passed for non-declared major students. The empirical evaluations have shown that data mining algorithms can be useful tool to the college administrators for analyzing student database.

Meeting the Needs of the American Workforce with 2+2 Programs

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Need: The growth of jobs in the US during the next decade will not necessarily require a Bachelorette Degree, but however will require technical or occupational skills not learned in a general K-12 education. In order than to best meet the needs of these openings the preferred method of education will be the combination of a two year vocational program with the addition of a technical managerial four year program to prepare individuals to lead this high performance workforce into the future. Over the next few years the US Manufacturing industry is going to see a major shift in the requisite skills of all its employees. The need to have individuals graduating from four year institutions that are prepared to meet these practical need has never been higher than it is now. The questions remain what skills do these graduates need to possess, and where will the students come from. The need for programs that allow "technically competent" students to transfer from two year community colleges into capstone four year management programs designed specifically for technical industry is the best route to prepare these students for the roles of tomorrow.

Overview: As the labor market becomes more complex high school and college students are becoming more confused. This confusion comes from the stress of not understanding what the future holds for them and the education and training that is necessary to get on track for their career goals.

Major Points:

- Review of competencies of 2 year technical programs
- Review of competencies of 2+2 technical managerial programs
- Review of skills needed in the high performance work place

Summary: Students preparing for the workforce need to understand the skills that they will need to succeed are going to be technical in nature, and not automatically obtained by just earning a bachelorette degree. The leadership skills for US industry will need to be obtained through occupational training and education combined with technical managerial skills in a 2+2 hybrid program in order to be ready to lead the industry into the future.

Departmental Change: Innovation to Create a New Future

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Need: Effecting significant change in a university department is not easy – particularly when it is not mandated! Effecting such change across two departments is even more difficult. The proposed presentation will be to share the impetus and process used to effect the merger of two successful departments in Purdue University's College of Technology to preemptively create a flagship academic unit clearly positioned to lead the College into its dynamic future.

Overview: Inspired by a challenge by the College's Dean, Dr. Dennis Depew, the Department of Organizational Leadership and Supervision and the Department of Industrial Technology considered and envisioned the synergies potentially created by a merger of the two departments. Emerging from the deliberations was a vision of a Department of Technology Leadership and Innovation.

Major Points:

- Challenge from the Dean to create a new future
- Creation of a Task Force consisting of the 2 department heads and faculty from each department.
- Task force deliberations and analysis; rationale for merger
- Process for choosing a new departmental name
- White paper generation and submission to the Provost and Board of Trustees
- February 4, 2011 merger approval
- Next steps; the challenge of implementing the vision and realizing the synergies and potential.

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Summary: This session will overview the process used to effect this merger, discuss the forces propelling it, the process used to select the new department name, the approval process including the university faculty senate, and highlight the tensions that creatively influence the convergence of two successful, non-endangered departments. The roles of the Dean, the faculty, and the interim department head will be described to understand the impact each had on the process. This case study approach will offer other departments and leaders the opportunity to gain from our experience and avoid some of the inevitable missteps that occurred and learn from the successes.

How Engineering and Engineering Technology Advisory Boards Can Advance Program Development

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Need: During these stressful economic times, institutions of higher learning are getting less of their budgets from gifts, in the case of private institutions, and less from their state legislatures, in the case of public institutions. The solution to this problem is for programs to get funding from alternate sources.

Overview: Due to their contacts with industry, engineering and engineering technology departments can work with these industries, especially members of their industrial advisory boards, to get both equipment and cash for their programs. These programs also have alums working in industry, who become members of the programs' industrial advisory boards, and want to help out the colleges from which they obtained their degrees. This is to their own enlightened self-interest. If the program from which they got their degrees becomes better, this can only increase the status of their degree. Shown here will be examples of how working with alums' industries can result in major donations.

Major Points:

- Need for funding from alternate sources
- Working with your Industrial Advisory Committee
- Development
- Examples of resulting successes

Summary: Attendees will understand how to use Industrial Advisory Committees to obtain additional funding for their programs, i.e., both equipment and cash. In so doing they can advance the goals of their programs and turn out better prepared graduates, who can then "hit the ground running."

Partnership: The Importance of Academia and Workforce Relationships to Assist in Curricula and Student Development

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Need: How do we prepare students to compete in an every-changing and global workforce? This is one of the questions that continue to be on the minds of administrators and instructors who desire to assist students transitioning into the workforce. Many students may conclude post secondary academic programs, but have not developed the certain expertise to prosper in the workforce. Those who complete post secondary programs (often four-year college graduates), may encounter difficulties in the transition due to a lack of work experience (Kim, 2006). As the modern workforce becomes more competitive and globally diverse, it is pertinent that students not only acquire academic proficiencies, but they should develop professional work experiences. In addition, curriculum developers and instructors must be more aware of workforce demands in order to better prepare students for career development. Well-defined partnerships between academia and the workforce will continue to serve as an instrumental facet in bridging the gap classroom theory and workforce application for preparation for desired careers.

Overview: To fortify external partnerships between academia and the workforce, approaches should be designed to reveal the systematic procedure of the transition from the academic environment to the workforce. In addition, there must be the implementation of the planning, designing, and execution of school-to-work transition initiatives for technical programs that adheres to the contemporary workforce, the fluctuating economy, and the increase of competition and global diversity. After students complete an academic program, especially those in the STEM disciplines, they should have acquired commendable experiences that would link their academic and professional experiences. To assist in this venture, workforce representatives should communicate the changes and demands to academic leaders, and the two units must work collaboratively on developing meaningful academic programs. These programs must incorporate foundational information, theory, application, and workforce experience.

Major Points:

- Enhance the knowledge of the purpose of academic mastery, career preparation and progression, integrated academic and technical programs, effectual partnership models;
- Assess current academic and workforce/occupational trends; and
- Identify how to integrate academic and workforce/technical programs.

Conclusion: This study will examine the importance of academia and workforce partnership. This research will also help to further explain key components to enhance global workforce diversity and competition. By strengthening the marriage between academic and workforce, students will be prepared for the ever-changing technological workforce and meet the demands of competition and globalization.

Common Meeting Time: Benefits and Implementation Strategies

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Need: A Common Meeting Time (CMT) is an organization's reserved block of time that allows for meetings/events on a standard day and time throughout the year. Valuable time and resources are wasted each semester (ex. faculty, secretaries, and students) by repeatedly analyzing schedules to find a common time to meet. Regardless of this outcome, there still is a loss of attendance and communication at the college and university level because all departments don't share the same meeting time. Additionally, there is a negative impact on student organizations and student work groups who struggle to find their own meeting time that doesn't conflict with work, homework and family responsibilities. Having a CMT policy improves communication by enabling maximum participation of faculty and staff at various unit level meetings.

Overview: Using survey research of ATMAE institutional members, the presenters have found that CMTs are a widely accepted practice at many universities with 58 percent having CMTs. Of those that do not have a CMT, they expressed a strong desire to learn how to implement one. This presentation will discuss the most common practices for holding a CMT, the advantages and limitations of a CMT, and how to implement this policy to ensure the greatest success.

Major Points

- Need
- Benefits
- Common Practices
- Limitations
- Recommendations

Summary: The survey data indicates that roughly 60 percent of respondents currently have a CMT and the remaining institutions wish they had one. Using the data to illustrate the acceptance of common meeting times in academic institutions, we have found the benefits of a CMT include but are not limited to, attaining increased information sharing as a result of better meeting attendance, and reduction of wasted time and resources by eliminating redundant schedule planning.

Graduate Faculty Workloads: Recognizing Scholarship and Student Engagement at the Comprehensive Institution

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Need: The character of graduate work is one of scholarly endeavor with highly qualified graduate faculty who work with students to culminate their experience through the completion of a graduate project, thesis, or dissertation. Inherent in this activity is the expectation that faculty will devote themselves to produce scholarly works of their own, spend time counseling and guiding students through the process, and serve as members or chairs of thesis, project, or dissertation committees. Additionally, an increasing expectation is the generation of external support for programs, research, and regional economic development, on which graduate faculty and students frequently collaborate.

Overview: Research was conducted with twenty-four comprehensive institutions of higher education on graduate faculty committee workloads. Workload policies are set at the department, college, or university level. Institutional policies vary greatly in their perspective of thesis or dissertation workload in relation to the teaching workload. Institution polices for thesis/dissertation committees are assigned as credit hours, teaching units, additional compensation, reduced load, or as negotiated by the faculty member. Universities may allow faculty workloads to vary, but some universities count graduate committee work as assigned credit hours while others count it as part of the expected research and service load. The most liberal policies provide for both release time and additional compensation while the most conservative policies consider graduate committee work as unpaid overload. In order to maintain a high standard of excellence it is in the best interests of institutions to establish a policy for graduate faculty thesis, project, and dissertation committee workloads as the number and size of technology graduate programs increases.

Major Points:

- Teaching, research, and service expectations
- Current thesis/dissertation committee workload practice at comprehensive higher education institutions
- Recommendations for future practice

Summary: What is the expected workload for graduate faculty at a comprehensive university? Attendees will learn about graduate faculty workload models at various institutions and assess implications for current and future practice in technology management graduate programs.

Technology Management Master's Degree Consortium

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Need: The demand for advanced degrees in technology programs is increasing, but the number of resources is shrinking. Some programs have capped their graduate degree programs because they lack qualified faculty to teach the courses. This, in turn, is causing a decrease in the number of individuals with advanced degrees in technology. In addition, stringent requirements by the Department of Homeland Security are reducing the number of qualified foreign nationals with H1B visas in technology. An unintended consequence of this is that technology departments now attempt to "steal" qualified faculty from other institutions and represents a short-term solution to a long-range problem. According to the U.S. Bureau of Labor Statistics (BLS) Occupational Handbook 2008-2009, significant post-secondary teaching opportunities will arise to replace large numbers of faculty retiring over the next decade. Doctoral and master's degree recipients will experience favorable job prospects over the next decade. "Prospects will be best for instructors in specialties that pay well outside of the teaching field, such as construction and manufacturing technology" (BLS, Job Outlook, 2008-2009). In addition, technical professional managers in the construction trades, industrial operations, and engineering are projected to grow as much as seven percent over the next six years.

Overview: Four universities developed a cooperative consortium model to collaboratively offer a Technology Management Master of Science degree. The program provides students with a graduate education in technology management, industrial, or career and technical education. The consortium goals are to offer face-to-face, blended, and fully online courses with some specialized offerings. The curriculum is flexible to meet student interests, professional goals, and the technical/managerial needs of its constituents. The program strives to be seamless from the student perspective, have consistent admissions requirements, coursework expectations, and advising requirements.

Major Points:

- Current and project program demand
- Consortium process and assumptions
- Consortium model
- Future challenges and directions

Summary: Presentation on developing a cooperative graduate program among multiple higher education institutions. Development of a state-wide consortium based master's program.

The Use of Social Networking Media Sites in Recruiting and Retention Efforts

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Need: The recent downturn in the economy has placed constraints on the efforts to recruit and retain students and will likely present a significant challenge for the foreseeable future. However, the need to continue with recruitment and retention can not be marginalized due to the difficulties that we now face. Therefore, we must adapt to this era and search out methods to better accomplish our tasks. Currently, there are emerging, and even maturing, internet sites that are commonly referred to as "social networking" (SN) that can easily be employed to reach millions of users worldwide. Most of these SN sites are free to set up and use, and many are already in common use by high school as well as university level students. It is through the use of a few of these carefully selected SN sites that our academic programs can be advertised, and recruitment and retention initiatives can be strengthened.

Overview: This paper details how SN sites can be employed to increase and enhance recruitment and retention programs. It does not propose that these sites be the sole means used for recruiting and retaining students, nor not necessarily to be the prominent means of thus. However, when used properly these SN sites offer a quick and efficient means to reach both current and prospective students. Internet sites such as Facebook (www.facebook.com), Youtube (www.youtube.com) and Twitter (www.twitter.com) are popular examples of these aforementioned SN sites. These sites allow the user to exchange messages, photos and videos with everyone, or among a selected group. Further, there is the option to link and exchange information among the sites. For example, a short recruitment video can be created and uploaded to Youtube. A link to this video can be placed on a Facebook page or be discussed on Twitter. This paper will give the reader a better understanding how to organize, plan and execute a SN site in order to better improve communication with current and prospective students.

Major Points:

- Overview of SN sites
- Organization, planning and initial start up
- Coordination of SN sites
- Conclusions and recommendations

Summary: Readers of this paper will receive information on the setup and use of SN sites to improve retention and retention efforts. Further, the paper covers how these SN sites can be linked together, and how they can best be used in the overall effort to better communicate with students.

Mobile Web and HTML5 Mobile Apps for Higher Education

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Need: Mobile applications are a rapidly growing segment of the global mobile market. These applications are software that run on a mobile device and performs certain tasks for mobile users. In a short period of time, mobile devices have become a significant medium for web browsing and online applications. Apple's iPhone and Google's Android based devices are the two most popular platforms. As more and more people, especially younger generations, start to use the devices for their web access, it's possible that mobile web users may surpass desktop web users in the near future. Higher education needs to realize this trend and start to build mobile applications and adapt content to the mobile medium. Technology students face challenges in this quickly rising area but meanwhile find great learning and career opportunities.

Overview: In this presentation, we will present the on-going effort on mobile application development at our institute. In particular, we will focus on three completed projects: university home page, tours to university arts center, and surveyCentral mobile. The university home page is the core mobile web site/app for our institute. This service provides access to iTunesU, course descriptions, campus map, email, university event calendar, university news feeds, local weather, person directory, campus map, shuttle schedule, and social sites. The mobile home page may be opened in a web browser or downloaded as an HTML5 app for both Android and Apple devices. Arts Center Tours is an app that serves as a mobile e-guide for selected exhibits at the arts center at our university. This app provides basic information about the art works as well as supplemental materials including video/audio/text descriptions, photos, and maps showing the locations of subjects of landscape paintings. surveyCentral is a tool for creating online surveys and forms developed at the Center for Academic Technology Support using PHP and MySQL. It has been updated so that survey pages can perform device detection. If the client is a mobile or hand-held device, the survey is optimized for that device. By adapting surveyCentral to a mobile environment, it provides a tool for faculty and students to use mobile devices for collecting survey data or recording other field data.

Major Points:

- The rapid growth of mobile computing.
- HTML5 and mobile application development.
- The movement to mobile technologies at our university.
- Mobile app 1: university home page.
- Mobile app 2: Arts Center Tours.
- Mobile app 3: surveyCentral mobile.

Summary: The trend towards mobile applications is very exciting now. We will be happy to present the related effort at our institute. By adapting services and contents to a mobile environment, faculty and students will be able to utilize their mobile devices and enhance their teaching and learning experiences.

Persistence Factors of Women in Information Technology

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Need: The use of information technology is pervasive throughout society. This has spawned a high demand for professionals with the knowledge, skills, and abilities needed to design, implement, and maintain the complex technology that drives our economy. Despite this opportunity, there are very few female information technology (IT) professionals entering into and remaining in the field. The prevailing areas of research have focused on the circumstances that decrease the likelihood of girls and young women from entering the field of information technology. Despite years of research and programs to correct the under-representation of women in IT, the number of females pursuing technology degrees and careers has continued to decrease.

Overview: Regardless of the decline in female representation in IT, there are still a number of women who have chosen to enter and maintain careers in the information technology industry. It was the goal of this study to approach the issue from a different perspective. Instead of focusing on the conditions that dissuade females from choosing to pursue IT careers, this study explored the factors that have enabled those women to maintain careers in information technology. This presentation will highlight the findings of a multiple case study of women that entered into and stayed in the field of information technology. The presentation will then explore the implications of these findings on information technology academic programs.

Major Points:

- Identification of the reasons why females are choosing not to enter academic programs that lead to a career in information technology.
- Historical strategies for increasing female involvement in information technology and their limitations.
- Description of the methodology for investigating the career persistence factors of women in information technology.
- Highlight the findings of the study and their implication on higher education programs in information technology.

Summary: The U.S. Department of Labor has projected that the demand for professionals in information technology will continue to grow. The dilemma for the U.S. economy is that there are not enough individuals to meet the demand for information technology professionals. Despite the job opportunities, the number of women pursuing careers in information technology continues to decline. This presentation explores the findings and implication of a recent study investigating the factors that contribute to a woman being able to have a sustained career in information technology.

Evaluation of Faculty Teaching and Course Content by Students: Effects of Changing the System

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Need: Administrators in technology programs recognize that the evaluation of faculty members' teaching in the classroom and course content are critical metrics and are often used in personnel decisions affecting tenure, promotion, and salary. One common method for administering these evaluations is through an end-of-course instrument completed by the students. As research has revealed that many factors can affect students' ratings, administrators need to be aware of potential biases and how changes to the evaluation system may affect outcomes.

Overview: Although there is no shortage of complaints about student evaluation of faculty and course content, little research and information is available to assist program administrators in fairly overseeing the process. The result is that administrators and faculty alike are often unaware of the effect any changes to the system might have. Drawing from the authors' experiences as they underwent a change from a paper-and-pencil system to one that was completely online, this presentation helps administrators understand potential differences in ratings, participation, and other factors that affect student evaluation of faculty and program courses.

Major Points:

- Existing research on student evaluation of faculty and courses
- Advantages and challenges of student evaluation methods
- Sample instruments used previously and currently
- Statistical analysis of student ratings of faculty
- Best practices to encourage participation
- Leadership, potential pitfalls, and administrative concerns
- Conclusions and recommendations

Summary: Attendees will understand the challenges and opportunities offered by student evaluation of faculty and program courses. The effects of changing the evaluation system are covered as they relate to the administrator of a technology program.

OLS Plus IT Equals TLI? - A Case Study of Departmental Merger and Change

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Need: In these very difficult economic times, every day brings news of cuts to education at all levels. Universities are coping using an array of strategies. This presentation will address issues surrounding these change implementations. The intent is to help provide a sense-making framework for these types of occurrences.

Overview: In our college, two departments - Industrial Technology (IT) and Organizational Leadership and Supervision (OLS) – are in the process of merging into one new department- Technology Leadership and Innovation (TLI). This merger has now been approved by the Purdue Board of Trustees. It is full speed ahead. This forum is a continuation on a presentation at last year's conference and will consist of members of each merging department discussing the process of merger. IT and OLS are both accredited by ATMAE.

Major Points:

- The change process
- Characteristics of each department
- Merger events and timelines
- Application of theory to practice
- Comparisons between academia and industry

Summary: Attendees will better understand principles of change and how to effectively initiate and implement change.

Creating the Environment for Innovative Learning in Technology Programs

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Need: The recent economic transition has placed renewed emphasis on America's community college system. Specifically, the need for community colleges with technology programs to become the catalyst for change. Charged with the daunting task of retooling the American workforce, the community college stands on the threshold of a new era in educational delivery. Many community colleges will rely upon current faculty and organizational principles to achieve this objective. This presentation outlines three key elements for engaging successful leadership during times of change. Having recently transitioned from 20+ years of industry experience into the academic realms, the presenter will share business strategies that are replicable to the technology arena.

Overview: The writer believes three elements are strategic to success in the current institutional environment. The first element calls the leader to be aware of the organizational culture. Organizational culture's can become blind to the necessity for change. The second element calls the leader to be cognoscente of the peripheral working environment. Understanding implies that the leader continual seeks to experience and know more about the consumer, market, competition, minorities, and related issues vital to advancing the organization and stakeholders (Clawson, 2010). The final element calls the leader to move the organization from its current position to the next level of leadership. Although difficult for some, successful leaders will analysis the situation, calculate the risks, and move forward. Ineffective leaders will become traumatized by indecision unless rescued by a watchful manager. The writer believes these elements are vital because they directly affect an individual's ability to drive innovation within an organization.

Major Points:

- Three elements for engaging successful leadership in Technology program.
- Driving innovation in Technology programs by understanding the learning paradigm.
- Understanding the learning institutions influence on environment, strategy, and organization design.
- Achieving the ultimate result of sustaining change.

Summary: Attendees will understand that leadership not only involves many aspects of individual behavior, but also has broader implications for this new era of transition for community colleges. The elements presented will challenge administration, faculty, and students to understand the paradigm of change that's facing Technology programs across the United States.

Associations of Instructors' Behavior on Students' Attitude towards Classes in Technology and Engineering Programs

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Need: Administrators in technology and engineering programs put a lot of emphasis on methods and materials by which instructors can attract the attention of students and get them engaged in the teaching content. However, a major aspect of defining the students' attitude towards educational materials and classes in general is the instructors' behavior at different stages of the semester. Furthermore, the students' perceptions of the instructional material affect the ability of the instructor to effectively deliver the course content in classes. This interaction between the instructors and the students in a class room can set both of them on a path to success if done thoughtfully and properly.

Overview: A comprehensive review of literature suggests plausible methods and techniques on how to get students involved in class. However, little research is available on how the attitude of the instructor in first class affects the students' perspectives on the material. In addition, the variation in instructors' attitude also has an association with student learning outcomes. Drawing from the viewpoints of existing and new technology and engineering faculty in different ranks, including full, associate, and assistant professors as well as contracted faculty, this presentation summarizes the experiences of others in an attempt to help administrators and instructors identify and develop a thoughtful process of integrating students in the class room to maximize dissemination of knowledge.

Major Points:

- Challenges unique to engaging students in the class room
- Identified stages of behavioral change and their effects
- Initiation stage:
    - First lecture
    - Setting out the rules
    - Intermediate stage (remedial stage)
    - Modifications in teaching style and assessment strategies
- Final stage
- Best practices and potential pitfalls
- Solutions to help faculty overcome their dread of a particular class or student
- Conclusions and recommendations

Summary: Attendees of this presentation will garner critical insights on the challenges and opportunities faced by students in technology and engineering program classes including both best practices and potential pitfalls. The three defined stages are covered as they relate to developing a process of student engagement.

Using Data from Teaching Evaluations to meet Assessment Criteria and Improve Teaching Effectiveness

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Need: Assessing and improving program effectiveness is a vital concern for all administrators. Teaching effectiveness is one critical area that must be assessed. This presentation takes a look at closing the loop on teaching effectiveness based on statistical analysis.

Overview: Assessing program effectiveness is necessary for continual improvement. Utilization or implementation of assessment data, however, can be difficult, especially in the area of teaching effectiveness. This presentation describes how statistical analysis with Minitab was utilized in student evaluation of teaching to provide a data driven basis for action designed to improve teaching effectiveness within the department.

Major Points:

- Evaluation instrument details
- Comparison of mean scores
- Looking at variances
- A master teacher identified
- Professional development activities
- Feedback from faculty

Summary: Attendees will learn how the department was able to easily analyze data specific to faculty members and develop a plan for improving teaching effectiveness.

A New Approach to Integrating a Plus-Two Bachelor's Degree in Technology with a Two-Year Associate's Program

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Need: Economic realities are causing some educational institutions to reevaluate their provision of all four years of a traditional Bachelor's degree program in Technology. In locations where such programs are in close collaboration with two-year partner institutions, it makes sense to facilitate a much higher level of curriculum integration between programs than has previously occurred. We will propose a model for curriculum integration in this presentation and discuss how it is being implemented at a satellite location of a major Midwestern university.

Overview: Divestiture of the first two years of lower-division courses in a four-year technology program and articulation of courses with a similar two-year Associate's program can provide the four-year institution with the means to conserve limited resources. A well-designed plan for curriculum integration is the key to making this successful. Such integration can actually improve the overall quality of instruction by causing existing resources to be more efficiently allocated. By rewriting both curricula to ensure that the first two-year program meets entrance expectations for the completion program and the completion program has more liberal requirements for matriculation, a curricular synergy between the programs can be developed. We will discuss how this was accomplished at our location.

Major Points:

- Need for requirement for programs to fit the resources available for teaching them
- Identification of appropriate partnerships
- Development of rotating core curriculum
- Identification of matriculation channels
- Final integration of programs

Summary: Attendees will develop an understanding of the curriculum model that has been implemented at our university to allow us to convert what was previously a four-year degree program to a degree completion program, using a high level of integration with an appropriate partner institution.

How ATMAE Accredited Programs Can Benefit from the Higher Learning Commission's Academic Quality Improvement Program Strategy Forum

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Need: Universities and colleges frequently have their own external accrediting bodies of whose standards they must meet. Some of ATMAE's members institutions are accredited by the Higher Learning Commission (HLC) of the North Central Association of Colleges and Schools (NCA), one of six regional accreditation agencies in the United States. An alternative accreditation program developed by the HLC is available to some of ATMAE's program intuitions. This program, named Academic Quality Improvement Program or AQIP, provides an alternative process for well-established institutions to maintain their regional accreditation, focusing on ongoing and continuous improvement of programs and services. As a part of the AQIP program, institutions select action projects based on their own particular goals and values and document their plan and achievements toward this plan. Assisting institutions in developing its plans AQIP uses direct processes including AQIP's Strategy Forums, Systems Appraisals, and various other services designed to provide ongoing feedback to the institution. "The Strategy Forum brings together teams from diverse colleges and universities for three days to generate and test new improvement strategies in a creative, supportive environment" (AQIP, 2011). This presentation will review the presenters' experiences participating in the Strategic form held May 18- 20 of 2011 and how this process can relate to ATMAE accreditation, and programs strategic planning and continuous improvement.

Overview: This presentation will review the AQIP process and how it can benefit ATMAE member programs in the accreditation process.

Major Points:

- Program Strategic Plans
- Institutional Strategic Plans
- Strategic planning Methodology
- Accreditation and Strategic Plans and Program/ Institutional Quality Improvement Systems
- Conclusions

Summary: At the end of the presentation the attendees will understand the AQIP process and how it can relate to ATMAE accreditation.

Implementing a "Grow Your Own" Program to Achieve Departmental Personnel Needs

Dr. Tim Obermier
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Need: Department Chairs responsible for staffing academic units are struggling to hire qualified personnel with doctoral credentials. This problem has been well documented in the Construction Management field, but it is prevalent in other fields as well. Without properly qualified faculty a Department can lose political clout on campus, which can cascade into budget losses, difficulty shepherding faculty through the promotion and tenure process, and result in decreased departmental research productivity. Meeting accreditation requirements is also a significant concern. One solution is to resort to "cannibalization" from other programs. While solving a personnel problem for one school, it creates problems for the entire profession. "Grow your own" practices need to be examined to determine acceptable solutions to replacing or adding faculty with essential credentials.

Overview: This presentation will provide an overview of how the University of Nebraska Kearney structures "grow your own" positions to allow for a successful transition from an instructor level position to a tenure track professorial position. Past attempts to force individuals into degree completion by setting hard fast deadlines were largely met with failure. In the past few years, an approach to monitor and support degree completion progress tied to the annual evaluation has seen significant success. This process tied to converting an instructor level position into a full time tenure track position can ensure qualified faculty for programs. Specific practices have to be followed to be able to convert an instructor to a tenure track position, and specific language must be included in the position search.

Major Points:

- Internal and external concerns with lack of credentialed faculty
- Unsuccessful efforts to achieve credentialed faculty.
- Best practices for "grow your own" programs.
- Structuring an instructor position for conversion to full-time tenure track status

Summary: Practices utilized by the University of Nebraska Kearney to "grow" Ph.D. faculty to meet institutional personnel requirements will be explored. These practices could serve as a model for other institutions to develop credentialed faculty.

Delivering a Master of Science Program in Engineering Technology to Cohorts of Chinese Nationals: An Analysis of the Challenges, the Benefits, and the Pursuit of Continuous Improvement

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Need: The presenters will discuss the administrative and educational challenges that resulted from hosting a cohort of master's degree students from China, and the benefits realized by all of the parties involved with these efforts. They will focus on the challenges that resulted from cultural differences, from the language barrier, from the need for students to complete the program on an accelerated timeline, and from the need to establish organizational infrastructure to support the cohort. They will also highlight the benefits that have accrued to students, faculty, and the university and outline the plans being implemented to realize continuous program improvement.

Overview: Starting with the 2010-2011 academic year, the Department of Industrial and Engineering Technology at Central Washington University began hosting cohorts of master's degree students from Liuzhou, a city in the Chinese Guangxi province. Most of the students are employees of the Liuzhou Municipal Government; some are employees of nationally-owned industries, such as the Shanghai Automotive Industry Corporation (SAIC). A second cohort will follow in the 2011-2012 academic year. The university is also in negotiations to host further cohorts. The first cohort was comprised of 20 students, who enrolled in the department's M.S. in Engineering Technology program. The Office of Continuing Education worked with the department chair and with university administration to establish procedures for matriculation, arrange for housing, schedule courses, pay instructional and support costs, etc. The department chair and the program coordinator worked with other departmental faculty members to establish a plan for delivering the program on an accelerated schedule, while also meeting the needs of the department's American master's students and minimizing the impact on undergraduate programs. Significant educational challenges arose from cultural differences, the language barrier, increased class sizes, and the mixing of Chinese with American students.

Major Points

- What academic and administrative challenges were involved?
- What differences between Chinese and American cultures had the greatest effect on instruction and learning, and what methods were effective in addressing the challenges that arose from these differences, as well as from the language barrier?
- How are governance and industrial activity interrelated in China; how do these relationships affect the perceptions of Chinese students when instruction is in the context of American industry?
- How can the department assess success in the classroom and gage customer satisfaction, both for the students and for their sponsors? How can these assessments be used to improve the program in the future?

Summary: Delivering the MSET program to Chinese cohorts has given rise to many challenges, but they have not been insurmountable. Addressing these challenges has provided significant benefits to the program, the department, and the university, and it has paved the way for continued success in the future.

Inserting Ethics Instruction into Course Content: Case Study

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Need: The issue of ethics, especially applied ethics, has become a significant issue in our current society, an environment that we are preparing our students to enter and succeed. Are we preparing our students to deal with ethical issues in our society? This presentation will outline and discuss what I did to introduce instruction on applied ethics into the curriculum of two of my courses which I currently teach at University of Wisconsin – Stout. I personally feel that we as educators need to integrate more discussion of ethical conduct into our curriculum to better prepare our students for the marketplace when they graduate. This was my attempt to do so.

Overview: I inserted two week's worth of ethics instruction into the curriculum. This was not a classical discussion of ethical theory, but rather a very basic applied approach to ethical issues. My intent was to bring to my student's attention ethical issues in the marketplace with the hope that they would have a greater sensitivity to the ethical issues that they might encounter and thus be better prepared to deal with those problems. In this presentation I will explain how I set the stage for discussion of ethics, both fixed and situational. I will show the results of an ethical survey with twenty ethical issues impacting students personally on a daily basis which I have given to my student for the last five semesters. I will outline some of the ethical standards recognized and accepted in business, and what they mean to each student. I will share a group discussion question related to some major ethical disasters in current history, in which the students discuss these disasters in groups and then in the class as a whole. Lastly I will show the results of a survey taken by my students for the last four semesters, and also taken nationally, regarding whether a person would work for a company which violated some ethical norms. I will also share two studies on ethics, one of which motivated me to take this approach.

Major Points:

- Set the stage for discussing ethics within a current course.
- Outline some of the ethical standards recognized and accepted in business.
- Discuss how using current ethical disasters can illustrate the impact of ethics on business.
- Demonstrate how two ethical surveys impact the student's understanding of ethics.
- Share two studies which motivated me to insert ethics into the curriculum.

Summary: Attendees will be presented with the need to consider applied ethics instruction, will hear of my efforts to insert ethics into the class content, and will walk away with some ideas as to how they can do likewise if they so wish and feel the need as I did.

Articulation Agreements - It's a Matter of Communication

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Need: Academic articulation agreements have been in existence for over one hundred years. Institutions have struggled with writing and implementing these documents. Once the agreement has been signed, communicating its purpose to students, faculty and staff becomes a priority. This paper examines if this has occurred in one example between post-secondary institutions – university and community college.

Overview: Today, articulation agreements can be defined as a process that involves meeting the requirements for course acceptance from institution to institution. They are still meant to help the transferring student, regardless of whether s/he is transferring from high school to community college, or community college to university. The level of complexity may be higher today, but the agreement is typically defined in such a way as to ease the transition from one institution to the next. Articulation agreements may also be seen as providing a natural pathway to the next institution. It becomes a pipeline or process that facilitates the transition for students from one institution to another. A typical articulation agreement will discuss issues such as course equivalency, course acceptance, acceptable grades, etc., and those items that could affect the student as s/he transfers to the next institution.

Major Points:

- Historical perspective of articulation agreements
- Typical communication problems for community colleges and universities
- Student transfer issues from community college to university
- Overcoming challenges to help students matriculate to the university

Summary: Attendees will understand the history of articulation agreements as well as understand the problems that institutions incur regarding the development and the rollout of articulation agreements. It will also cover the work that was completed at the University of Houston with Lone Star College to the increase the number of transfer students since the implementation of its articulation agreement in 2005.

International Industrial Tours and Excursions Promote Growth and Status of Tech Programs and Provide Global Perspective to Students

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Need: Clearly, the manufacturing world reaches beyond the borders of the United States, and yet most American Technology and Applied Engineering students have very little exposure to the global realities of our manufacturing world. Study abroad opportunities are gaining increased emphasis in many curricular areas of higher education; however, such opportunities are not common in the Technology field.

Overview: This presentation will discuss the procedures for developing industrial tours and excursions and the many benefits for the Technology Program, its faculty, students, and other participants.

Major Points:

- The rich history of tours of industries at Ohio Northern University
- Benefits of international tours to program and participants
- Developing a strategy for global perspectives in manufacturing program
- Developing global contacts and opportunities
- Funding issues for international travel
- Pointers and procedures in setting up international tours and excursions
- Summary of our tour to Switzerland and Germany
- Motivating session attendees to set up their tours

Summary: Today's transportation and communication technologies are creating world competition and realities that are heavily impacting the manufacturing world and therefore the futures of our students. By immersing our students in studying other cultures, societies and multi-national corporations through international tours and excursions they will be better prepared to lead their companies, increase their confidence in world matters, and handle the issues that arise in their future. Not only will international experiences help the students, it will also help technology programs establish stronger ties to alumni and gain status in the university community.

Sustainable Workforce Development Through Employability Skills Education

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Need: A student needs employability skills in order to gain and sustain employment, as well as advance in the workplace. These employability skills include basic reading, writing, mathematics, critical thinking, interpersonal, and affective skills. Students entering the workplace need decision-making skills, problem solving skills and the know-how to function successfully on their own. Vocational programs play a major role in implementing employability skills into their programs and helping students prepare for employment. Mostly, vocational programs are a vehicle for helping educators and businesses build students' cognitive skills, which are needed for a full and successful career.

Overview: This presentation will provide data on how educational programs can better prepare young graduates to fulfill their obligations and roles in the workforce as employees. Sustainable workforce development is a key component in compelling academic institutions and business to seek for better strategies that will equip students entering the workplace with newer ways of thinking, better techniques for managing, and newer ways of working effectively. This presentation will also provide recommendations on how to promote vocational programs to develop and put into practice teaching skills and techniques to prepare students for the demands of the workplace. Employability skills education can build the partnerships between colleges and employers as an effective means to provide industry with employees who are better prepared for work, which is a benefit for all parties involved.

Major Points:

- Overview of Workforce Development
- Employability Skills Education
- Vocational Programs
- Challenges Facing New Graduates
- Benefits of Preparing Students for the Workplace

Summary: This presentation will provide data on how to better prepare students for successful careers in the workplace through employability skills education. Employers are depending upon vocational education programs to help increase employability skills for students entering the workplace which offer the latest technology and delivery systems through sustainable workforce development. Sustainable workforce development can be implemented through vocational education programs which are designed to improve employability skills through work-based learning, internship, co-op, and job shadowing.

Best Practices in Developing Relationships with Business and Industry

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Need: Workforce and economic development in the state of Maine requires innovative and effective relationships between University of Southern Maine (USM) and business and industry (B&I) for research, development, and commercialization activities. USM is developing models and procedures with business and industry through a well-focused set of initiatives that engage faculty and students with expert practitioners and information technology leaders in mutually beneficial collaborations. These models, particularly the establishment of a memorandum of understanding (MOU), should prove useful to other Universities that need to improve their outreach to business and industry.

Overview: USM has been working successfully with business and industry for many years; however, many factors ranging from the "dot-com bust" to most recent economic downturn to a shortage of computer science and technology graduates has caused USM's Institute for Information and Innovation (I&I) to redouble its efforts to strengthen its relationship with business and industry in the region. Typical of current and impending workforce demands, a single large corporation in Portland will require five hundred (500) new information technology employees over the next five years. Students need to be recruited early, retained, and appropriately educated and prepared for these jobs. I&I's advisory board made up of information technology leaders and business owners in the area have joined forces to develop practical and operationalizable models and procedures for growing the technical workforce in Maine. In this presentation, Dr. Wilson will discuss the history, the development process, components, and the implementation of the MOU detailing the importance to both business and industry and USM.

Major Points:

- Memorandum of Understanding (MOU) is a powerful vehicle for collaboration
- Industry Tours and Presentations are instrumental in improving and updating communications
- Coop and Internship "Pipeline" is an essential component of fueling workforce development
- Collaborative Projects provide opportunities for information and expertise exchange
- On-line "resume book" accelerates the hiring and placement process
- On-line "Experience" information exchange allows students and B&I to "shop"
- Outreach to K-12 is critical to develop the STEM workforce

Summary: The coordinated and systematic efforts to develop and sustain research, development and commercialization relationships have resulted in regular business and industry tours and presentations, a systematic approach to arranging internships and coops, and standard procedures for collaborative projects. The MOU between USM and business and industry has been the key to these successes.

ATMAE Alumni - A Trends Analysis and Demographics of 2006 ATMAE Accredited Programs Alumni

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Need: The ATMAE accredited programs alumni survey results were among the indicators that created the need for changing the name of NAIT to ATMAE. A trends analysis of ATMAE graduates will help to determine the market value of our graduates, and to help promote ATMAE programs. This presentation presents the data obtained from selected ATMAE accredited institutions alumni of 2005 regarding their positions and responsibilities, salaries, job satisfaction, professional achievements, qualifications, and promotions. The data presented will contribute to the revision and development of the discipline.

Overview: A review of literature regarding the need for obtaining feedback from alumni will be presented. The results of the surveys will be analyzed, and the process of developing, validating, and administering the questionnaire will be discussed

Major Points:

- The salary trends during the past five years will be explained.
- Positions held by ATMAE graduates as well as their responsibilities and salaries will be presented.
- Highest academic degree and qualifications of graduates will be presented.
- Perceptions of graduates regarding potential improvement in programs and courses will be discussed.
- The professional impact of ATMAE accreditation on program's graduates will be discussed.
- Graduates perception of ATMAE certifications such as CTM, CSTM will be discussed.

Summary: Although ATMAE has recognized the importance of programs graduates feedback by asking ATMAE accredited programs to conduct an alumni survey and disseminate the results, a review of literature indicates that very limited research data is available on alumni perceptions of their programs. This presentation will provide a trend analysis of ATMAE alumni of 2006 at the national level.

How to Recruit and Retain Qualified ATMAE Faculty: Establishing a Benchmark and Enhancing Visibility in a Market Driven Economy

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Need: Faculty shortage in ATMAE programs and how will the next generation of ATMAE faculty be prepared is a major concern. Diversity of background among faculty and administrators is a unique characteristic of ATMAE programs. However, at this critical time during which rightsizing, restructuring, and downsizing of programs have become a new norm in the institutions of higher education, ATMAE professionals need to network together in order to provide and maintain a consistency of purpose and enhance the professions' visibility in accordance with the ATMAE's new mission.

Overview: The days of "wood chips and metal shaving" as a major descriptor of our programs is long gone. The diversity and dynamics of our technological programs as well as the paradigm shift in instructional and funding models has been the catalyst for administrative innovation to sustain program quality. Our organization has changed its name and mission to the Association of Technology, Management, and Applied Engineering (ATMAE) which truly reflects the purpose of our programs. The main thrust is to learn from our past experiences, and continually improve our practices in order to not only stay competitive but also take a leadership role in the development of the national economy.

Major Points:

- Internal and external challenges with market value and faculty salaries will be discussed.
- Integrating research grants and contracts as a contemporary model for funding departmental operations will be introduced.
- The strategic directions for industrial technology and the role of new ATMAE leadership will be discussed.
- The socio-economic roles, positions and responsibilities of ATMAE alumni will be explained.
- Internal and external efforts with market value of faculty salaries will be discussed.
- The focus of IT programs in the future will be discussed.

Summary: The presentation will provide ATMAE professionals with a database regarding the challenges faced by and opportunities existing for the ATMAE professions in the 21st. Century.

Trends and Characteristics of the ATMAE Faculty - A Demographics Study

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Dr. John Sutton
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Need: The primary purpose of this presentation is to present the 2010 demographics data collected to determine the characteristics of the ATMAE faculty, and to update the data on the Demographics section of the ATMAE website: http://atmae.org/index.php?option=com_content&view=article&id=11&Itemid=28

The data will exhibit the salary, positions, field of preparation, background, employment status and projected retirement of ATMAE faculty, and administrators. The data will enable the ATMAE professionals to look forward and address the critical issues such as market value, program recognition, professional visibility, that impact the development of the ATMAE profession and recruitment and retention of qualified professionals in the discipline. The Demographic data is used to benchmark the salaries among ATMAE accredited institutions.

Overview: A three-page survey information form has been posted on the ATMAE web site, and communicated with the department chairpersons, department heads and administrators of the ATMAE accredited Associate and Baccalaureate programs. The questionnaire focuses on key characteristics of ATMAE faculty including salaries, primary field of preparation, teaching and research responsibilities, academic status, earned degree, age and gender, and retirement status in the academic year 2010-2011.

Major Points:

- The salary range of IT faculty/staff will be presented and compared
- Faculty salaries will be compared with similar disciplines.
- The primary field of preparation of ATMAE faculty will be discussed.
- Recruitment strategies will be introduced
- Teaching/research responsibilities of ATMAE faculty will be described.
- Academic rank of ATMAE faculty will be presented.
- Qualifications of ATMAE faculty will be discussed.
- Benchmarking of ATMAE faculty salaries with closely related disciplines such as Engineering, Engineering Technology, Management, and Business Administration will be discussed.

Summary: This presentation will provide ATMAE professionals with an accessible, relevant, and recent database regarding the key characteristics and qualifications of faculty members who currently teach in ATMAE accredited programs. The data will assist the ATMAE organization and ATMAE leaders to make informed decisions regarding the future of the profession.

Construction

Study of Renewable Energy Toward Green Construction

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Need: Green construction concept minimizes energy consumption during and after construction. Today, many countries have invested significant economical resources aimed at reducing the high consumption of energy in construction. Sustainable construction allows the opportunity to reduce fossil fuel consumption and to reduce costs while minimizing impact on earth. The growing trend of renewable energies during and after construction makes minimum impact on the future ecology of our planet. Current growing practice of LEED needs to be addressed more in the construction industry and also that need to be introduced to students to make more marketable upon graduation.

Overview: Utilizing green construction technologies is a good step towards improving the environment. Green construction can be defined as creating structures and using processes that are beneficial to the environment while being resource-efficient throughout the buildings life cycle. Major renewable energy systems such as solar panels (i.e. photovoltaic panels), wind energy, geothermal, and biomass are the possible resources on the construction industry. The study of green construction from renewable energy sources has been conducted from students together with habitat for humanity at Morehead, KY.

Major Points:

- Understand the social, economical and environmental impacts of constructing residential home green construction
- Use of renewable energy (solar and wind energy) to produce electricity at home construction
- Discuss about LEED in the area of renewable energy

Summary: Green construction allows the opportunity to reduce fossil fuel consumption and to reduce cost while minimizing impact on earth. Major renewable energy such as solar panels (i.e. photovoltaic panels), wind energy, geothermal, and biomass are the possible resources on the construction industry. The study of green construction from renewable energy sources has been conducted from students together with habitat for humanity at Morehead, KY.

Computer Simulation of the Mechanical Properties of Asphalt Highways with Laboratory Measurements

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Need: Asphalt Concrete is commonly used in highway and runway pavements. Asphalt concrete is very popular around the world because it is low cost compared to other pavements like smooth pavement, and asphalt is a recyclable material. A crack or distress is developed on the pavement because of its failing material strength and the amount of traffic. There are different types of cracks on asphalt highways namely fatigue crack, rutting, and temperature crack. This research focuses on determining mechanical properties of asphalt mixtures using computer simulation and compares them to laboratory measurements, to predict the crack of highway pavements.

Overview: The mechanical properties and performance of asphalt concrete is governed by the properties of the aggregate gradation, shape, surface texture, modulus (or stiffness) and properties of the asphalt binder grade; binder modulus, asphalt–aggregate interactions, asphalt content, and air void distribution. The multiphase asphalt concrete is divided into aggregate, sand mastic and air void phases on the modeling. The sand mastic phase includes fine aggregate and asphalt binder. Discrete Element Model (DEM) of asphalt concrete is used to predict the dynamic modulus and creep compliance. Computer modeling reduces the laboratory cost and we can impose a number of different loading conditions on an asphalt specimen and infer results, which is a good 'first step' towards a full scale analysis.

Major Points:

- Predict mechanical properties (modulus) of asphalt pavement using computer simulation
- Compare computer simulation properties with laboratory measurements
- Use mechanical properties of asphalt mixture to predict asphalt pavement crack

Summary: The micromechanics-based discrete element modeling can simulate and characterize the mechanical properties of an asphalt specimen. It can also simulate and characterize the mechanical properties of an asphalt mixture specimen to reduce the laboratory cost.

Building a Sustainable House with Alternative Heating and Cooling

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Need: Rising fuel prices, concerns for our environment, and recent downturn of world economy are all pressures that have people searching for ways to conserve energy, maximize the use of renewable energy, and reduce the dependence on fossil fuels. For most people, housing might be the largest portion of energy consumption. While many people are looking for "high tech" solutions to the nation's energy needs, we currently have the technology to supply most, if not all, of our heating and cooling needs, using "low tech" renewable sources. High tech solar electricity and wind power systems are hot topics in renewable energy today. However, low tech do-it-yourself solar thermal, bio heat generators, and alternative building methods may be the answer for homeowners to lower energy usage and costs. Students who understand how to utilize alternative heat, cooling, and residential construction methods are poised to truly change energy usage of the entire nation.

Overview: In this project, we study sustainable home heating and cooling approaches, design a sustainable house plan, and build the house. This presentation will give an overview of the design of our sustainable house. The house has two stories and approximately 2800 square feet. We will discuss the basic design of hydronic heat exchanger, the methods used to heat the water, the ground/air heat exchanger for air conditioning, as well as the dry stack construction. The hydronic heat exchanger includes one solar collector that has approximately 900 square feet and two 3000-gallon water tanks for heat storage. The solar collector uses a drain back design. The ground/air heat exchanger uses 900 feet of 4-inch diameter PVC pipe buried 6 feet under the ground. Two bio-digesters with a combined output of 7 million BTU will provide backup heat. The bio-digesters rely solely on the heat produced by decomposing plant materials. Room temperatures, solar collector efficiencies, heat storage, etc. can be monitored and controlled through Internet using cell phone or laptop computer.

Major Points:

- Building with thermal mass
- Heat inputs from solar thermal and bio-heating
- Heat storage and radiation
- Passive cooling
- Monitor and control system

Summary: This presentation looks at a 2800 sq/ft farm house being built using alternative building, heating, and cooling methods. We introduce how each part of the system works and how they work together, with an emphasis on bio-heating.

A Time to Draw: Old-Fashioned Architectural Drafting: An Experiment in Basics

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Need: The seismic shift from traditional drafting to CAD applications is irreversible. However, some basic drawing and visualization skills are being lost in translation. We don't want to throw out the baby with the bathwater so to speak. This presentation is based on an existing lower level drafting class curriculum, where manual drawing was used as a pedagogical strategy to reinforce drafting fundamentals

Overview: The presentation will examine the role of drawing in visualization, drafting, and design process, in the context of architecture & construction. It will then proceed to outline a design and drawing project assigned to a junior level architectural drafting class in a Midwestern university. The design/drawing lab work was aligned as far as possible, with lectures on related topics. The semester long project resulted in the production of a set of blueprints for students' designs, and served to reinforce the theoretical principles of architectural drawing. The presentation will outline project progress updates with example student work. The project exercise will be used to illustrate the importance of the skill of drawing in comprehending and manipulating 3-dimensional spatial design. The presentation will identify key skills that may be enhanced by such an exercise. It will include a discussion of students' feedback on the project, and identify possible pitfalls and potentials. The discussion will conclude with a reassessment of the role and need for manual drawing work in architectural drafting curricula.

Major Points:

- Drawing as an act of understanding form, shape, size, & scale
- Drawing as an aid to design: process more than product
- Seep holes of CAD: conceptual clarity: structure/ design/ function
- The design/drawing project assignment
- Timeline/ Process/ Deliverables
- Students' feedback/ reflections
- Pitfalls/ Potentials - assessment

Summary: Attendees will understand the relevance and need for manual drawing work in lower level architectural drafting classes as a way to fathom the design and building process. The design/ drawing project presented here can be used in drafting courses in construction technology programs. Students' feedback on the semester long exercise can be used as a benchmarking tool to further assess and refine this project.

Presence of BIM Course in Construction Management Program Curriculum

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Need: A report published by National Institute of Standards and Technology (NIST) in 2004 suggested loss of $15.8 billion annually due to poor interoperability and data management. As a solution to this problem many construction companies adopted Building Information Modeling (BIM) which is "a digital representation of physical and functional characteristics of a facility". BIM is considered as a platform for collaboration between different stakeholders at different phases of the lifecycle of a facility. Thus, it important to educate the Construction Management (CM) students about BIM at an earlier stage in their academic career, as they are the future of the industry.

Overview: The primary objective of this study is to examine the curricula for BIM or 3D CAD courses offered by CM programs in different US Universities based on the following factors: (1) course level, (2) required prerequisite, (3) course description, (4) learning outcome, (5) instructional method.

Major Points:

- Importance of BIM in Construction Industry
- Overview of offering BIM courses offered by different CM Programs
- Variation in the course descriptions and Learning outcomes
- Discussion on different instruction methods adopted
- Discuss about the future directions of BIM education in CM Programs

Summary: Audience will gain insight on the significant variation in instructor qualifications and expertise, course description, course objectives, and learning outcomes of the BIM and 3D CAD course. In order to provide the future workforce a comprehensive education about BIM or 3D CAD, the different professional organizations should come forward in developing systematic and uniform curricula for courses on BIM and its variants.

A Multi-Objective P-Median Model for Logistics Facility Locations: An Environmental Sustainment Initiative

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Need: Facility location decisions are considered the most critical part of the supply chain and are vital for efficient and effective flow of goods and materials. Engineers and planners continue to recognize the uncertainty regarding future conditions with facility location decisions and realize the fact that transportation decisions are often on short notice in response to facility changes. Environmental Justice (EJ) assessment has traditionally focused on identifying distributive effects to protected populations. In order to sustain in regards to socioeconomic needs logistic facility locations/relocations must be deigned for optimal location requirements.

Overview: Location criteria used to establish where a facility might be successful may vary considerably depending on its service, its location, and its specialization. We present a model for multi-objective decision analysis with respect to the location of commercial facilities in areas where protected populations are present. A p-median model is used in combination with social and economic factors based on census data to determine locations for such facilities for sustainment purposes. The first objective measures accessibility to existing and proposed facilities. The second objective measures socioeconomic characteristics for a study area and the third objective focuses on satisfying land use requirements. This paper focuses on various Environmental Justice (EJ) initiatives, such as environmental health and safety laws in minority and low-income areas while attempting to provide optimal facility locations that can be sustained over time.

Major Points:

- While this issue has long been recognized as part of EJ initiatives, no quantitative comparisons of logistics facility location decisions on protected (low-income) populations have been reported in literature.
- In terms of environmental sustainability, it is important for logistics facilities to be built and located in areas where supply and demand are feasible
- Various socioeconomic factors are integrated with Geographic Information Systems (GIS) to determine the extent of impact of supply chain facility locations on protected populations.
- The results indicate that it is important to consider local social and economic effects, in addition to regional planning objectives when determining where facilities will be located.

Summary: The proposed modeling approach would help planners and engineers to understand the interrelationships among local communities, facilitating more scientific and economically equitable planning for logistics facility construction projects.

Teaching Construction Sustainability as a Technology System

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Need: All industries, including the construction industry, are requiring critical thinking, leadership skills and knowledge of green/sustainable practices. These areas are challenging to teach, but we must also be able to teach our students how to manage these issues after they graduate, similar to how they will manage other technology systems such as safety and quality. The basic steps in safety and quality management also pertain to sustainability management, it is just a matter of degree- how to identify and quantify what the clients/owners want, and how the designers, contractors and suppliers will achieve these criteria or goals.

Overview: How faculty can incorporate safety and quality management teaching techniques into sustainability management course in a construction program. This presentation will include aspects of the design process, construction materials and methods, documentation, and rating system(s) such as LEED 2009.

Major Points:

- Basic technology systems and what is involved including why safety, quality and sustainability can be managed similarly in construction.
- Basic green and sustainability construction management issues and how they can be managed and taught.
- Examples of Sustainability forms and procedures
- Options and materials for a construction sustainability course.

Summary: This presentation will introduce the newest construction technology system "Sustainability Management" and summarize how it can be taught similarly to Safety and Quality Management. It will also discuss appropriate courses where sustainability management discussions can be included, and the instructional materials and options available for faculty.

Integrating Students from Construction Management and Architectural Design: A Case Study of an Interdisciplinary, Team-Based Immersive Learning Course

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Need: As construction project delivery methods continue to multiply and evolve, industry is demanding that graduates from construction management programs are adequately prepared to use these new approaches. Additionally, graduates are expected to be "team players" not only with other contractors, but with the myriad of design professionals that are involved in the construction process. By working on interdisciplinary teams with students from architecture, construction management students are better prepared to implement new project delivery methods and succeed in industry upon graduation.

Overview: Although interdisciplinary, team-based approaches are used on virtually every construction project, they are not yet commonplace in the construction education classroom. This presentation presents a case study of a successful immersive course involving students from the construction management and architecture departments in two different colleges. Drawing from the viewpoints of the two lead faculty members involved in the course, this presentation helps construction educators lead the entire process of creating or refining an interdisciplinary course, from planning through execution.

Major Points:

- Student challenges unique to interdisciplinary teams
- Best practices for teaching and teaming
- Faculty selection, preparation, and perspectives
- Industry involvement
- Planning considerations
- Administrative issues and solutions
- Leadership
- Potential pitfalls
- Conclusions and recommendations

Summary: Attendees will understand the challenges and opportunities of developing an interdisciplinary, team-based course with construction and design students, including best practices and potential pitfalls as they relate to the construction educator.

Design in Construction Management

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Need: Most of the Construction Management Programs in the US institutes of Higher Education focus on field operations and management. In their line of work in the construction industry, project managers (graduates of Construction Management Programs) interact extensively with engineers who provide the design of the structures. These project managers should have a workable knowledge of the design process. Lack of such a background can lead to delays, miscommunications, and even to potentially serious construction problems. This presentation is specifically on the topic of design courses in the Construction Management Programs.

Overview: In a typical construction project, the architect consults with various types of engineers to furnish the design of a structure. This includes civil, structural, environmental, mechanical, and electrical engineers. After transferring the design into construction documents, project managers assume responsibility over the construction phase. It is essential that these project managers have the ability to transfer this design into a real structure safely and efficiently. This presentation outlines the importance of design courses in the Construction Management Programs. It provides a comparative analysis on the ways in which various US Construction Management Programs deal with the design component in their curricula.

Major Points:

- A brief overview of Construction Management
- Design in Construction Management curriculum
- Comparison between various US Construction Management Programs
- Accreditation issues
- Recommendations

Summary: This presentation outlines the importance of design courses in the curriculum of Construction Management Programs. It outlines, in a comparative manner, how various Construction Management Programs handle design in their curricula and it provides recommendations in this regard.

Construction Conceptual Cost Estimate Assessment through Latent Semantic Analysis

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Need: Conceptual cost estimates represent the first benchmark upon which owners define their financial capability of performing a construction project. The dynamic nature and the characteristics of the construction industry create a requirement for an extensive amount of coordination between the different parties, different expertise, and the production of a massive amount of documents in diversified formats. All of these factors impose a high level of burden on the design team and a larger one on the estimators. At the conceptual estimate stage, these factors affect the accuracy of the developed estimate which is based on experiences and previous knowledge. Such an aspect imposes a high level of risk on owners and developers due to the uncertainty associated with the conceptual estimate. Consequently, the accuracy and quality assessments of these estimates are crucial.

Overview: In an effort to facilitate construction conceptual cost estimate (CCCE) assessment, a number of researches in the construction industry developed expert systems, mathematical models, and machine learning (ML) models. Although those studies resulted in significant contribution, none of them utilized Latent Semantic Analysis (LSA). Therefore, the current research task proposes an automated LSA model to assess the accuracy of CCCE through percentage error analysis. The models developed made use of data from a set 80 completed projects worldwide. It is conjectured that this research stream will help in relieving the negative consequences associated with CCCE that are based on incomplete set of documents.

Major Points:

- Conceptual cost estimate challenges in the construction industry
- Methodologies for assessing conceptual cost estimates in the construction industry
- Identified factors that affect conceptual cost estimates
- LSA model development methodology
- Achieved Results
- Discussion and derived conclusion
- Future work recommendations

Summary: Attendees will (1) develop an understanding of the challenges faced due to uncertainties in conceptual cost estimates; (2) gain knowledge about the strength of LSA as a tool for the development of CCCE assessment. The lowest percentage error achieved through the developed model was 1.6%.

Developing Experiential Learning in the Construction Management Classroom

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Need: Experiential learning has mostly been limited to co-op and internship experiences where the student obtains a position with a company for a short duration. During this time, the ability to learn the different facets of the construction industry is limited to the duration of the experience. While this affords exposure to the industry, the short duration limits the ability of the student to really learn the intricacies of the construction industry. In this presentation, the set up and model of delivery for "Experiential Learning in the Classroom" will demonstrated from an educational and industrial standpoint. Results from this curriculum set up will be shared during the presentation.

Overview: The enormity of the construction industry demands that the aspiring construction professional have extensive experience in every dynamic of the construction process. The challenge for educators is to develop those metrics that meet the demands of the industry. The integration of actual experiential learning within the classroom develops those abilities with on-the-job training with industry partners on actual projects as they mature. The focus of this presentation will be how this was developed in a "Construction Bidding and Estimating" course where industrial partnering allowed students to further develop and hone their skills while working within the confines of a company structure. Additionally, information will be presented on how the integration of technologically advanced communication is aiding in this type of delivery model.

Major Points:

- Development of a curriculum to engage students with regional companies.
- Development of a model where students can actively engage in company operations.
- Identification and use of communication aids with the student and company.
- Integration of "real world" experience for the student in the construction industry.

Summary: The models presented will show the benefits of developing an experiential learning experience in the classroom that will engage in actual real world applications that companies are currently involved.

Green Globes and Alternative to LEED for Smaller Projects

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Need: There is general agreement about what constitutes green building best practices, and most assessment methodologies have remarkably similar criteria. What differs is the way in which these are delivered. By having a variety of credible options, people can choose the one that meets their needs with the result that more buildings are built or retrofitted to high standards of energy performance. This also helps to generate healthy competition to ensure low cost and user-friendly design and client service.

Overview: The major green building standards such as LEED, Green Globes, BREEAM, the GBC tool, and the Minnesota Design Guidelines have more similarities than differences in what constitutes best energy and environmental practices. However, the Green Globes system does have a number of distinct attributes in the way the program is delivered, such as the online questionnaire-driven assessment, and automated reporting, which greatly reduce the time and cost of producing a submission.

Major Points:

- Brief Comparison of Green Globes to LEED.
- Why Green Globes is ideal for smaller projects.
- Why an online system.
- Cost to have a building comply with Green Globes compared to LEED.
- What the verification process entails.
- Why you should obtain third-party verification.
- Green Globes Professionals and Assessors

Summary: The strength of the Green Globes system is that it is written in plain language so it's easy for beginners as well as experienced practitioners to be up and running in minutes. The system is questionnaire-driven. Users are walked through a logical sequence of questions that guide their next steps and provide guidance for integrating important elements of sustainability. Once each questionnaire is complete, the system automatically generates a report written in lay terms with suggestions for improvement and helpful supplementary links and information.

Tools for Optimization of Assets in Construction Logistics

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Need: A systematic approach to optimize assets in construction logistics have profound impact on the cost factor for any new construction or maintenance project. Optimization is the search for better solutions. Many problems in industry have non-unique solutions, and optimization is a systematic way of generating these non-unique solutions and finding the best solution of the set. The successful completion of a project within budget largely depends on allocation and efficient utilization of needed resources. In other words, optimization of assets is of paramount importance in realization of a project without any cost overrun. All construction or maintenance project involve complex supply chain issues, since materials and equipment come from multiple sources and require extensive task coordination. Thus, Optimization requires informed decision making at a variety of levels, from the planning stages, to construction, and finally operation and maintenance. The development of analytical tools to optimize resource utilization is crucial, since even marginal cost efficiencies can yield very high aggregate benefits.

Overview: All construction or maintenance projects require asset management tools for efficient allocation and utilization of resources. There is much potential for the application of artificial intelligence (AI) in a construction asset management framework. AI is the creation of computer programs that use human-like reasoning concepts to implement and /or improve a process or task. The AI shell is interfaced with databases containing asset information including asset locations, and databases containing construction or maintenance schedules and associated asset needs. Since different databases and other information streams use different protocols and conventions, exceptional challenges occur for developing such a system.

Major Points:

- Construction Logistics
- Optimization Techniques
- AI-Based System Architecture
- Interface Design
- System Implementation

Summary: The purpose of this topic is to evaluate different techniques available for asset management in construction and present an AI-based system to manage assets in construction logistics and infrastructure types of problem, using a commercial AI-Shell. Importance of special interfaces with databases will be covered.

On the Role of Commissioning in a High-Performance Green Building Delivery System

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Need: In the wake of the intensified global competition for energy resources and the growing concern for the cost of building operation and maintenance, commissioning (Cx) has been recognized as a pivotal component in a high-performance green building delivery system. For instance, USGBC's LEED building performance rating system incorporates commissioning as criteria for earning its building certification, both ASHRAE 90.1 and 189.1 encompass commissioning in the standard for delivering high-performance green buildings, furthermore, federal and state governments are increasingly requiring commissioning be processed in the building delivery system for government facilities. It is imperative for building construction related professional and academics remain updated with regard the role of commissioning in a high-performance building delivery system.

Overview: In response to the heightened demand of building performance based on stricter criteria for energy efficiency to reduce energy consumption and to lower the cost of building operation and maintenance, commissioning (Cx) functions to ensure the outcome of the building delivery system to meet owner's project requirements (OPR) and comply with the basis of design (BOD). In this presentation, the notion of high-performance buildings based on the latest standard 189.1and other relevant building rating systems, such as LEED, will be reviewed. Further, the process of commissioning involved in a building delivery system, which consists of predesign, design, construction, operation, and performance verification will be analyzed and evaluated.

Major Points:

- The need of high-performance green buildings
- Commissioning in the building performance rating system -- LEED
- An introduction to the standards for designing and evaluating building performance
- The framework of a building delivery system
- The essential elements of building commissioning
- Discussion on the value and effectiveness of building commissioning process

Summary: The demand for high-performance green buildings has been witnessed over the past decade, mainly due to the heightened cost of energy and competition for water supply. Echoing the social economical phenomenon, industrial standards and rating systems pertaining to building performance have been reformulated. Commissioning, as a relatively new discipline in the building design, construction, and operation industry, has been adopted to ensure the outcome of a building delivery system to be able to comply with design intents and to meet owner's project requirements. The role of commissioning is pivotal in delivering a high-performance building project.

Cost Justifications for Investing in LEED Projects

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Need: Many studies have been completed on green building construction, yet cost justification for this type of construction projects has not been thoroughly examined. This research seeks to determine what type of cost considerations building owners and operators place the greatest emphasis on when deciding to build an environmentally friendly building.

Overview: The study of sustainability has been examined across many disciplines and continues to be at the forefront of many global organizations' and government's commitments to promote energy and environmental stewardship. Sustainability as it relates to construction has been thoroughly defined and developed by the United States Green Building Council (USGBC). This leading Green Building certification body has developed a rating systems for building construction referred to as the LEED (Leadership in Energy and Environmental Design) certification standards. The practice of constructing building facilities that meet the LEED certification standards encompasses the overall goal of meeting the shelter needs of today without compromising the ability of future generations to meet their needs. This study aims to determine the key cost justifications informing pursuit of LEED certification, and to ascertain the satisfaction of project owners as to the value of LEED.

Major Points:

- The study involves a student/professor team examining 30 LEED-certified projects within southeastern Michigan counties that have been completed and occupied by the building owners.
- Data collection is through a series of interviews and questionnaires with building operations and facilities managers, as well as owners using a predetermined list of questions to help identify the environmental aspects of the projects and the cost justifications for pursuing LEED certification.

Summary: The results from this research help to pin-point and define the most important outcomes building owners and operators seek as they set out to construct a sustainable building built to the LEED certification standards. The presenters will share their experiences from this study, findings, conclusions and recommendations.

Construction Management Curriculum Alignment with the Practice of Current Construction Industry

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Need: This study is an effort to align with the needs of the construction industry at Morehead State University. The construction management (CM) program curriculum is compared with other CM programs at different universities in Kentucky. Sustainability, Building Information Modeling and LEED practices are ever-growing practices within the industry that need to be introduced to students to make sure that they are well-versed in these concepts, making them more marketable upon graduation.

Overview: Six Colleges/Universities (NKU, EKU, WKU, MoSU, MuSU, and ITT Tech) offer programs in Construction Management in Kentucky. Students that graduate from the CM program at MSU are marketable in the local job market; however matching the curriculum to the current practices in the industry will improve their job prospects by making sure they meet the expectations of prospective employers.

Major Points:

- Determine how the CM curriculum at MSU compares with CM curriculum at other Universities in Kentucky
- Determination of current key Methods and Concepts that should be taught at the University level according to construction professionals and University faculty.
- Provide a curriculum that increases the marketability of the graduates of the CM program

Summary: This is a study with the intent to determine how the curriculum of the CM program at Morehead State University compares to other CM programs available to students in Kentucky and align the program with the construction methods and concepts presently used by professionals in the industry. This curriculum audit will align the program with the industry and prepare students graduating from the program to with knowledge of current construction practices.

Precast/Prestressed Concrete Helps Rethinking the Future of Construction Technology

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Need: The presentation emphasizes the fact that Precast and Prestressed Concrete products stand today as a great promise for better building methods and materials. It shows that the progress achieved in this area of construction technology offers a unique solution to many of the construction industry applications and challenges, particularly in the areas of infrastructure construction, rehabilitation, and maintenance.

Overview: This paper presents a brief overview of the theory and applications of Precast and Prestressed Concrete technology in various projects over the past decades. Included also is an up-to-date, state-of-the-art report on where this fascinating technology stands and where it is headed.

Major Points:

- Historical Background
- Peculiarities of Precast and Prestressed Concrete are discussed and compared to those of other conventional construction methods and materials
- Illustrations of specific applications of Precast and Prestressed Concrete and the many challenges facing the construction industry -- including manufacturing, maintenance and repair -- that were solved through Precast and Prestressed Concrete technology

Summary: As the construction industry works its way through the new millennium, it needs to consider new building materials and innovative methods to face the challenges of the future. Precast and Prestressed Concrete technology has a remarkable potential through quite a variety of interesting features, properties, and applications.

Building Information Modeling: A Software Review for Curriculum Development

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Need: Architects and contractors are moving rapidly toward Building Information Modeling (BIM). Autodesk Revit is a core BIM program that generates easy to understand 3D models. Other software programs extend Revit to enhance scheduling, estimating, and planning. A review of these programs is needed to understand how, where, and to what extend these programs are to be incorporated into the technology program curriculum.

Overview: Traditionally construction documents have been individual 2D drawings. This approach makes coordination between the design team and construction team difficult and error prone. With BIM a single project file contains the database for plans, elevations, details, and schedules. Changes are updated throughout the project automatically. 3D models enable better visualization of how a building goes together and thus understanding the designer's intent. In addition to Revit, other software programs such as Revit Structure, Revit MEP, Navisworks, Ecotect, and Green Building Studio provide for accurate and fast estimating, scheduling, collision detection, and sustainable design analysis.

Major Points:

- Limitations of current construction documents.
- Advantages of BIM.
- Review of BIM software.
- Extended software programs that should be included in the BIM course.
- How and where to include BIM software in a technology program.

Summary Attendees will understand the advantages of BIM software for technology and to what extend it should be incorporated into the curriculum.

Building the Future by Reviewing the Past: The Journey of Ancient Windcatchers to Passive-Cooling Sustainable Ventilation System

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Need: Energy limitation and global warming are one of the biggest challenges facing our era. The building sector is one of the major energy consumers in the world. Together, homes and buildings consume 40% of the energy used in the United States today. According to the U.S. Energy Information Agency, homes and commercial buildings use 71% of the electricity in the United States and this number will rise to 75% by 2025. We need to have a future sustainable approach to all aspect of construction.

Overview: Wind catchers have been served as a cooling system, used to provide acceptable ventilation by means of renewable energy of wind in the earlier time in traditional Persian-influenced architecture in Middle East. The majority of present buildings are dependent on air-conditioning systems and electricity, subject to fossil fuels and growingly unable to adapt to a warming climate. However in the past when the energy wasn't easily available and the machines such as air-conditioner did not exist, the designers' of buildings had to rely on other strategies to maximize the comfort of the internal environment.

Major Points:

- Windcatchers come in various designs: uni-directional, bi-directional, and multi-directional. The operation of the tower depends on wind conditions and the time of day.
- One of the most common uses of the windcatcher is as an architectural feature to cool the inside of the dwelling, and is often used in combination with courtyards and domes as an overall ventilation / heat management strategy
- In a windless environment, a windcatcher functions as a solar chimney. It creates a pressure gradient which allows less dense hot air to travel upwards and escape out the top.

Summary: Even though based on the cultural and ecological changes not all the traditional methods can be applied but many of these technologies are energy efficient and sustainable and the challenging key is to learn their principal and fundamental and integrate them to the 21st century construction.

Distance & Online Learning

Characteristics of Student Success in an On-Line Construction Graphics Course

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Need: There is much ground-breaking still to be done in establishing successful DOL courses with a CAD-based emphasis due to factors such as sophisticated hardware and software needs, drawing submission and feedback techniques, and other challenges.

Overview: This presentation examines elements of success for students enrolled in a DOL summer course in construction graphics. In this laboratory-based course, students were required to develop in-depth skills in professional sketching, 3D modeling with Google SketchUp™, and 2D/3D drafting with Autodesk AutoCAD™. The major challenges of teaching this as a DOL course included: 1) hardware and software requirements necessary for CAD-based solutions; 2) "on-screen" evaluation techniques required to give appropriate feedback; and 3) relevance of interactive techniques common to other DOL courses.

Major Points:

- What were the primary characteristics of student success?
- What were the major inhibitors of student success?
- What hardware and software issues proved most challenging?
- What DOL delivery methods were most affective?
- Were there traditional DOL techniques or technologies that were irrelevant or impractical for this particular course?

Summary: Student success in DOL courses characterized by technical sketching, 2D and 3D CAD techniques, and extensive hardware and software requirements can be enhanced with a variety of techniques and technologies.

Show Me the Evidence! Critical Thinking Skills in an Online Technology Research Course

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Need: With the proliferation of information and increased access to resources online, the need for undergraduate and graduate technology students to rapidly identify, evaluate, and synthesize information has never been greater. Formulating solutions to the complex, multi-faceted problems requires an understanding of the context within which it is framed. This is foundational to the problem solving process, building on existing published work in the discipline, identifying gaps in the existing literature, formulating hypotheses, and gathering quantitative or qualitative evidence from multiple sources that support or reject the hypotheses are needed, all while developing a research project proposal. Online research is a key component of the 21st century technologists' repertoire needed in the workplace.

Overview: The presentation will discuss the need for online undergraduate and graduate research-oriented technology courses emphasizing development of critical analytical skills and examining existing literature in the discipline. Involving students in research prepares them to solve complex, multi-faceted problems, and make knowledgeable decision about integrating new technologies with existing systems, a task that is often required of technology graduates. Structured strategies are required for retrieving information that is relevant and significant to the problem solving process. Using group interactions for sparking discussion about the fundamental and powerful concepts topics within the context of issue helps students consider multiple viewpoints.

Major Points:

- Rethinking the specialized needs of populations served by technology and educational research courses
- Online student research in technology, critical thinking skills, and the problem solving process
- Effective ways to search for information online
- Evaluating sources of information – bibliographic databases, keyword searches, identifying authentic sources, considering assumptions, eliminating bias
- Emphasizing intellectual standards of clarity, accuracy, relevance, significance, breadth, and logic in the technology research course
- Analysis of published quantitative, qualitative, mixed-methods research articles relevant to the research hypothesis, while relying on suitable descriptive and inferential statistics for conducting data analysis
- Effective communication regarding progress in developing a research proposal and report

Conclusion: Conducting quality research in technology requires a significant amount of intellectual effort and time. Identifying a suitable research problem, determining research hypothesis, searching for relevant sources of information, selecting a suitable research methodology, conducting the study, interpreting the data, and documenting the research work provide opportunities for advancing the present state of technology. Preparing students for taking on this enormous task requires familiarization with the process. Online research-oriented courses in technology will prepare them for evaluating information pertinent to complex real-world problems, and lead to the development of higher-order thinking skills essential in creating a knowledge-based, technologically-resourceful society.

Determining the Impact of Incorporating Live/ Face to Face Class Presentation Videos into the Delivery of Online Courses in Technology Programs

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Need: The purpose of this specific study is to investigate if recording live or face to face classes for use by online students enhances student learning. Many universities are offering more and more classes via the internet as part of their distance learning programs. Current thinking is that course content delivered via distance learning is equivalent, even superior in some instances (Department of Education, 2009), to traditional methodologies of course delivery utilized in traditional classroom environments. This study does a comparison of such courses and determines if the use of the recordings of live courses affects student learning in online courses. The intent is to develop a set of best practices while identifying the pros and cons of using this innovative instructional methodology. The study groups consist of 12 to 15 separate classes of Industrial Management students enrolled in a single course, INDM 4210, hosted by the University of Central Missouri over a two year period.

Overview: Little pedagogical research exists identifying if differences exist between online courses using recordings and those that do not use this communication technique. Of those studies that do exist, the bulk (Department of Education, 2009) use meta-analysis because statistical sample sizes tend to be anemic. Also, according to Bender (2003), it is beneficial and important to vary the learning activities in online courses. Instructional technologies vary between courses, instructors, majors and universities. With the growth of online degree programs it is necessary for researchers to pay closer attention to the impact various course delivery methods and technologies have on distance learning and investigate their use. This study is a robust review of the impact and student perceptions of the use of video in online course delivery.

Major Points:

- Do video recordings enhance student learning in online courses?
- Will attendance in online courses be affected?
- Will the recordings be viewed by all students?
- Will grades be affected: higher/lower?
- What are the pros and cons of using recordings of f2f classes in online courses?

Conclusions: Information presented in this study will serve as a reference to help establish a baseline of best practices for online instruction using video recordings. The goal is to establish guidelines for faculty to incorporate innovative instructional methods, like video recordings, to enhance student learning.

Development and Delivery of Online Lean Six Sigma Training: An Innovative Partnership between Industry and Academe

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Need: Research suggests that traditional approaches to employee education and training, such as face-to-face lectures and asynchronous video tutorials, are limited in meeting current and emerging employee development needs and in addressing employer constraints. A major challenge is developing and offering effective training modes that meet these training needs and, at the same time, acknowledge resource limitations that employers and employees continually face. Globalization, technological advances (in practically every position) and the growing need for skilled process improvement leaders are just few of the reasons why industry currently requires flexible, high-level skills training.

Overview: A leading University and a Fortune 100 company established an innovative partnership to investigate various e-learning technologies and training options to develop and deliver Lean Six Sigma Green Belt training online to employees worldwide. The project presented many challenges in creating a rich, experiential learning format that engages learners with the necessary knowledge and approach that prepared participants for immediate practical application of the knowledge and skills learned online. We produced nearly 50 learning modules that participants complete in a matter of weeks in preparation of Lean Six Sigma Green Belt Project Leader certification. In addition, we learned key lessons in the process that can improve similar collaborative projects.

Major Points:

- Growing need for flexible and effective employee training
- New technology in distance education is available to help satisfy emerging development needs
- Universities can leverage their expertise in collaboration with industry to design and deliver successful training programs that address challenging industry needs
- Lessons learned, including pros and cons in technology selection and in collaborative development

Summary: Attendees will take away a number of lessons learned in what it takes to collaborate with industry to develop and deliver a major online training program (Lean Six Sigma Green Belt training). They will learn about the e-learning technologies used in this process to facilitate engaging and effective online learning.

How to Offer Online Quality Coursework without Losing that Traditional Face-to-Face Feel

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Need: As consumer demand for quality products becomes the norm, students graduating from technology-related programs are required to have an in depth knowledge of incorporating quality in processes and services related to their careers. With the increased demand of distance learning courses, quality concepts which include difficult analytical and mathematical concepts have become a challenge to effectively teach online. With class-capture software such as Tegrity, students have the ability to better grasp the concepts related to quality coursework without struggling to email their instructors for further clarification.

Overview: A way to continually improve the student's retention of quality concepts through online education is to implement the use of a software program that will capture the face-to-face- feel of a traditional lecture without all of the technical problems associated with most video capture methods currently available. A class-capture software program such as Tegrity allows students to go back and review their quality course from anywhere, at anytime, using any web browser and even a hand held mobile device. Students in quality courses can now quickly replay difficult to comprehend quality concepts such as Six Sigma, pareto curves, fishbone diagrams, Lorenz curves and more. The instructor can show the student, visually, how to construct and interpret these concepts as well as give traditional lectures.

Major Points:

- Methods for using class-capture software for effective teaching
- Comparison of class-capture software programs
- Demonstration of class-capture software

Summary: This presentation will focus on effective methods for enhancing a distance learner's educational experience as well as improving an instructor's capability to explain difficult concepts. Presenters at this session will also demonstrate the use of class-capture software for online and traditional face-to-face lectures.

Rethinking Teaching Courses Based on Students' Perception about Online and Web-Enhanced Courses

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Need: It is very important that courses are developed and taught with planning. Instructors' success begins with development of a well planned course. Students can learn effectively from a well designed course, and it will be a happy experience on both sides. Whether a course should be face-to-face, web enhanced, hybrid, or online; a careful research should be done. There was a need to investigate what formats of courses students like. As a result, an empirical study was conducted at two educational institutions.

Overview: An empirical research study was conducted to examine the perception of graduate and undergraduate students about taking online courses versus web-enhanced courses. A questionnaire survey was performed at two educational institutions. A five-point Likert's scale was developed to collect data on questions related to online and web-enhanced courses. It was found that online courses were not for everyone and all courses were not best suited for the online format. Online courses were preferred over web-enhanced in terms of flexibility and convenience, however web enhanced courses provided better learning experience. In addition, it was found that there must be training workshops for both students and instructors to use online tools effectively. There were some valuable suggestions about improving teaching-learning experience.

Major Points:

- Introduction
- Review of Literature
- Research Methodology
- Data Analysis and Findings
- Summary, Conclusions, and Recommendations

Summary: The purpose of this study was to compare the perception of students about completely online courses against web-enhanced courses. Data were collected from both graduate and undergraduate students enrolled at two different higher education institutions. The results of this study will enable instructors to rethink their teaching strategies in various course delivering methods.

Teaching Large Courses Using Online Technologies: Lessons Learned and Future Challenges

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Need: Courses delivered entirely online allow universities to enroll a large number of students, but these large classes pose several challenges to educators. Two major challenges of large online learning environments are the development of appropriate learning activities and the encouragement of significant learning interactions between students. This presentation will discuss strategies used to encourage participatory learning and student interaction in a technology course with an enrollment of 170-200 students. Recommendations for managing other details of large courses in an online format will also be offered.

Overview: Courses with student enrollments of 100 or more provide an efficient means of delivery, but may prohibit conventional ways of introducing learning activities and providing for interaction between students. The strategies used by instructors to both actively engage students and utilize new online course technologies will be discussed. Challenges of managing a large online course will be presented, with an emphasis on planning appropriate learning activities and assessing student learning within the large course learning environment. Unresolved issues related to large online courses will also be discussed.

Major Points:

- Challenges of large enrollment online courses
- Strategies used to encourage learning and interaction of online students
- Suggestions for planning and assessment with large numbers of online students
- Discussion of continuing issues in large enrollment online courses

Summary: Attendees will learn strategies for optimizing engagement and interaction between students in a large enrollment online technology course. Suggestions and future challenges of managing large online courses will also be shared.

Blended Delivery Methods for More Student Interaction

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Need: Education is seeing the advantages of offering different strategies and technologies to aid in the learning process. A combination of classroom, web courses, and interactive television are often utilized. Many face to face classrooms use websites that allow students to gain access to course materials. Online courses are becoming one of the most popular modes of delivery in higher education. Some online courses lack interactivity among the students and faculty. This lack of interactivity make some students feel disconnected. The blended classroom (combing face-to-face and online) is becoming popular in many universities. Research has found that the higher the interactivity, the higher the completion rate of courses. This presentation provides techniques for using the blended class delivery to foster effective student interaction.

Overview: Challenges to an effective class include increasing interactivity while fostering student learning. Appropriate course design, quality and effectiveness of the instructor improve the learner's satisfaction and learning. Because students are social, interactivity in the classroom is necessary. Education is seeing the advantages of offering different strategies, including the blended classroom to aid in classroom interactivity.

Major Points:

- Reasons for moving toward blended classroom delivery
- Challenges of teaching a blended classroom
- Techniques for achieving interactivity in the blended classroom
- Lessons learned

Summary: Attendees will understand how to develop interactivity in blended classrooms. This presentation provides techniques for creating an effective blended course that may be beneficial to educators interested in implementing blended courses into their curriculum. In addition, the results of a survey given to students will be presented.

Hybrid Delivery: First-Year Pilot Testing of Moodle 1.9 and 2.0 LMS at Cal State University, Los Angeles

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Need: With today's decreasing budgets for education, university campuses are looking for more economical ways to deliver hybrid and online coursework without having to cope with increasing user and maintenance costs associated with Blackboard/WebCT. One such approach is to look at open source LMS systems and share the costs, maintenance and services among campuses. The 23 campus California State University (CSU) system has begun to explore this model by pilot testing Moodle 1.9 and 2.0 at host campuses. California State University, Los Angeles is participating in this effort. Hybrid course delivery is important to meeting the needs of our commuter students and therefore, we were asked to participate in the pilot program.

Overview: California State University, Los Angeles has used WebCT (now Blackboard) as the preferred LMS for hybrid and online delivery for years. At part of a 23 campus CSU system, Cal State L.A. and other sister campuses are looking at alternative LMS systems due to the high annual maintenance and support costs involved with Blackboard. A pilot test of an open source system called Moodle 1.9 hosted at a sister campus (San Francisco State University) began in the fall quarter 2010 at Cal State L.A. and migrated in March 2011 to Cal State Fullerton A report on the progress made over the past year and how hybrid delivery was being used in the Industrial Technology program and for first-year engineering students enrolled in lecture and lecture/laboratory courses.

Major Points:

- Overview of Blackboard/WebCT at Cal State L.A.
- CSU system study
- Overview of Moodle Open Source LMS
- Pilot testing Moodle in 2010 and 2011
- Learning resources used to ramp up to Moodle
- Implementation strategy and campus policies for hybrid course delivery
- Lecture and lecture/lab experiences with Moodle
- Student feedback
- Goal of matching materials to learning outcomes
- Importing materials from Blackboard/WebCT into Moodle
- Future plans

Summary: This presentation provides a status report after one year of pilot testing an LMS system called Moodle. The pilot test involved hybrid course delivery to students in several majors on campus including Industrial Technology and freshmen engineering students at California State University, Los Angeles.

Electrical, Electronics, & Computer Technology

Design and Simulation of Electric Motor Control Unit for Dual Engine Hybrid Tractor

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Need: The aim of this research is the design and simulation of control unit system for hybrid tractor. Control unit manages power sharing between combustion engines and electrical motors. In this design, engine supplies all energy need when low or normal power needed. Electrical motors are auxiliary power sources for tractor and they provide extra power when power demand is more than normal condition. Synopsis Saber simulation software is used for the study. Outcomes of this study will be provided with full paper submission.

Overview: The depleting fossil fuel resources, global warming impacts, high oil presses and gas emission requirements for companies are leading to the research on efficient, environment friendly, less fossil oil dependent solutions. Hybrid vehicle technology is providing a solution all this problems. Today, all major automotive brands have hybrid vehicle models with various kinds of hybrid configurations. Successes of hybrid automobiles expended the application area of hybrid technology. Agricultural and construction equipment industry is one of them. Power demand from tractor is high. It is higher when it is full loaded with all equipment but use of tractor in fully loaded condition is rare. Design of tractor engine to meet energy need in fully loaded condition is not optimal solution for producers and customer because larger engine size means higher po rtion cost for producers and high fuel consumption for customer. Use of hybrid technology can help to solve this problem.

Major Points:

- Investigate the viability of an unique control unit for hybrid electric vehicles
- Design and analysis of a control unit for a hybrid tractor

Summary: Attendees will be introduced current EV technologies, modeling and simulation of hybrid electric vehicle systems. Current and future challenges will be demonstrated. Methods to increase performance with a control unit will be shared with academia. A simulation of a hybrid tractor motor control unit will be presented.

Development of Voice Over IP, Wireless and Security (VPN) Laboratory

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Need: Traditional curriculum in networking has focused on static/dynamic routing, basic security (Access Lists), Network Address Translation (NAT) and basic network administration, this curriculum generally emulates the CISCO Certified Engineer Associate (CCNA) curriculum. . The market at this point is in need of a professional capable of handling the modern challenges of networking like building Voice Over IP networks, implementing security by using Virtual Private Networks in a wired and wireless environment. The need to have advanced administrative skills by using tools that allow the professional in networking to control the flow of information, the type of connections allowed and advanced authentication is another skill in demand.

Overview: This presentation outlines the design implemented at Eastern Illinois University Telecommunication laboratory in order to better prepare the networking professional the market is demanding. The design can be implemented with a modest investment in equipment, yet the educational results will position our graduates for the current challenges in networking and networking management. The design has the unique characteristic to be implemented as a complement of typical laboratories existing in university facilities, without the need to modify substantially any current topology.

Major Points:

- Design of a Wireless Network with Security
- Design of Virtual Private Network (VPN) connections
- Design of Authentication Authorization and Accounting (AAA) and Access Control using Network Access Serves (NAS)
- Design and implementation of a Voice Over IP (VOIP) architecture

Summary: Attendees will be exposed to the planning, design and implementation of a laboratory network that is designed for teaching wireless networks, wireless security, VPN and VOIP concepts as well to the design and use of an access and authorization system for a network and the technical problems associated with these technologies. The main focus of the discussion will be the need to incorporate these technologies in our laboratories to better prepare our students for the challenges of the market that now go beyond knowing the traditional curriculum in networking.

Secure and Efficient Management of Wind Power Generation with the Application of Wind Tunnel Attachment on a Wind Turbine

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Need: Wind power generation with the use of a wind tunnel attachment on a wind turbine may lead increased output, efficient and secure production of wind energy. In May 2008, the US Department of Energy issued a report entitled 20% Wind Energy by 2030: Increasing Wind Energy's Contribution to US Electricity Supply. In order to reach this national goal, new technologies on wind turbines must be investigated. This paper presents design and implementation of a wind tunnel attachment on a small-scale wind turbine. It also includes feasibility and necessity of such an applied technology management project for academic institutions. The US Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) tested a 10-meter diameter research wind turbine in the world's largest wind tunnel. A wind tunnel attachment on the wind turbine will be tested for the first time directly instead of standard way of testing wind turbines inside wind tunnels. This is expected to increase output power and provide more stable operation that extends the life span of the wind turbine.

Overview: Design and construction of a wind tunnel attachment for the wind turbine and statistical analysis of the recorded data may drive the interests of wind turbine manufacturing corporations to produce more efficient and cost effective wind turbines with the wind tunnel attachment systems. In addition to bringing efficient way of developing wind turbine manufacturing, wind energy efficiency may be increased in the low speed winds and total durability of wind turbines may be increased due to the eliminated turbulence formed by unsteady winds.

Major Points:

- Design and implement a wind tunnel integrated to a wind turbine
- Investigate wind turbine output power with and without wind tunnel.
- Increase the efficiency and enhance overall management of wind power system
- Increase the durability of wind turbines
- Promote sustainability and renewable energy education in US colleges
- Increase awareness of Science Technology Engineering and Mathematics (STEM) among the students.

Summary: Wind energy management with the wind tunnel attachment does present a viable, environmentally friendly way of alternate energy production. Operation of wind turbines in wind tunnel is expected to impact overall power output positively and provide enhanced reliability and extended life span for the new generation wind power systems. There is no CO2 emission expected on the development of wind tunnel attachments to the wind turbines.

Virtual Desktops: Administrating VMware's vSphere 4.0 and View 4.5

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Need: At most institutions there are a push to reduce the number of physical computer labs while still maintaining the number of applications available to the students. To accomplish this task many institutions are implementing virtual desktop labs. The problem is many institutions do not have the resources to hire outside consultants to help implement a virtual desktop environment. This presentation will explain the components of VMware's vSphere 4.0 and View 4.5. It will provide the steps required to install, configure, administer and evaluate costs associated with implementing a basic virtual desktop environment. The goal of this presentation is to share the learning curve that was encountered, allowing others to benefit from the successes and mistakes made by the presenter.

Overview: The objective of this presentation is to give the attendee a roadmap to implement and setup of a low cost virtual desktop environment for evaluation purposes. The presentation will provide a step by step approach that covers all aspect needed to install and configure virtual desktops using an entry level low-cost server. The main focus of this presentation is to provide the attendee the experience of administrating a virtual desktop environment and provide them with the tools needed to make intelligent purchasing decisions.

Major Points:

- VMware's ESXi Hypervisor, VCenter and Connection Server
- Using VSphere Client to access ESXi and VCenter
- Preparing Virtual Desktop images
- Deploying Desktops
- Accessing Desktops with VMware View Client

Summary: The introduction of virtual desktop into an existing computer infrastructure can be challenging. This presentation will provide the attendees the tools needed to start offering virtual desktops. The attendees will understand the challenges involved in administrating a virtual desktop environment and a roadmap on how to scale the solution to meet their particular institutional needs.

Community Wind Education in Coastal North Carolina

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Need: Roughly one-third North Carolina's economically viable land-based wind resources (500 MW) are located at the coast. However transmission infrastructure limitations as well as public unfamiliarity of wind energy technology pose significant barriers to developing the state's coastal onshore wind resources. Through education, and by better describing the wind resources in partner communities, this project will help foster the development of community wind projects that are not subject to transmission limitations. These projects will familiarize the public with utility-scale wind technology, and illustrate how wind energy can work for coastal communities in North Carolina.

Overview: The present adoption of renewable energy technologies—which some see as the first step toward transitioning our economies to operate within an energy budget determined by the flow of contemporary solar energy, rather than a stock of fossil solar energy—relies on at least two key human capital inputs: (1) people trained to install and maintain renewable energy technology; and (2) people who understand why the technology is important to meeting the environmental and economic improvement goals of coastal communities. Education is critical to building both classes of human capital. The goal of this project is to help coastal North Carolina communities make efficient use of their wind energy resources while strengthening their long-term economic health. The development of community wind energy can be an important tool for sustainable development in coastal communities because it provides energy that: (1) has no fuel costs; (2) does not contribute to air and water pollution; (3) helps to improve energy security; (4) stabilizes electricity costs; and (5) helps to reduce carbon footprints. The project goal will be achieved using an education-focused community wind methodology to: (1) train university students in wind energy technology; (2) integrate wind energy technology into coastal public high school curricula; and (3) perform wind resource assessments for coastal public high schools. The methodology, scope of work and results are presented.

Major Points:

- Wind energy education and outreach
- Wind energy resource assessment

Summary: A Community Wind Education and Job Training project intended to better position the coastal communities to harness the local economic benefits of wind energy technology is presented. Such projects can provide job skills needed for local students to work in the wind energy industry which may be a significant employer in coastal communities in the coming decades.

A Hybrid Renewable Energy System - Wind and Solar

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Need: Many communities face various economic and environmental challenges because of global economic restructuring as well as environmental degradation from local and regional poor water quality- due to pollution and eutrophication or global climate change resulting from the anthropogenic exhaustion of the carbon absorption capacity of the atmosphere and oceans. By developing local renewable energy resources these communities can take concrete and visible steps toward reducing their contribution to global climate change while broadening their economic bases.

Overview: It has been recognized by society at large that renewable energy development offers an opportunity to address these economic and environmental challenges. However, The present adoption of renewable energy technologies—which some see as the first step toward transitioning our economies to operate within an energy budget determined by the flow of contemporary wind and solar energy, rather than a stock of fossil solar energy—need to be at least economically feasible to invest in the required infrastructure.

This presentation provides the methodology to obtain solar power data and wind speed time series data, collected daily at 5-minute intervals covering a time span of few years, from instruments mounted at 74 m (245ft) tower height located in west Texas plains. The statistical approach to model the distribution of the wind speed data is discussed. Finally the calculated solar and wind power data are used in a complementary mode to design a hybrid renewable energy system. Results are discussed and conclusions are presented

Major Points:

- Energy Resource Assessment
- Statistical Analysis
- Hybrid Energy System

Summary: Many communities see the adoption of renewable energy technologies as a solution to overcome economic and environmental challenges. Audiences are presented with a systemic approach to collect data and assess wind and solar energy resources. Results are utilized toward designing a modern wind and solar hybrid power system.

Teaching Electronics Technology Lab Experiments Using a Laptop and an Electronic Board

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Need: There is an increasing need for teaching electronics labs at a distance. There have been many studies on how this can be achieved. There are critics on doing electronics labs using computer simulation. Advances in technology have made possible that now students can actually do hands-on labs at a distance inexpensively and effectively.

Overview: This presentation will discuss how students can use their laptop or a desktop and an electronic board (EE board) to perform lab experiments. Built around a large solderless breadboard where students build their experiments using real electronic devices and components, the EE board includes oscilloscopes, waveform generators, power supplies, voltmeters, reference voltage generators, and 32 digital signals that can be configured as a logic analyzer, pattern generator, or any one of several static digital I/O devices. All of these instruments can be connected to circuits built on the solderless breadboard using simple jumper wires. The EE board combines everything needed to design and test electronic circuits in a single "all in one" device which makes it an ideal solution for performing labs at a distance. The EE board software makes it easy to acquire, store, analyze, produce and reuse analog and digital signals. A high-speed USB2 connection ensures all EE board instruments respond in near real-time. The data files are stored using standard formats, making it easy to share data between instruments, and to export data to word processors or graphics editors. This means well documented student lab/project reports can be completed using standard office tools, and submitted electronically. Now the online electronic labs can be as effective as the onsite ones.

Major Points:

- Brief introduction to the electronic board (EE board).
- Demonstration of an analog circuit using the EE board.
- Demonstration of a digital circuit using the EE board.
- Demonstration of how to export data to word processors.

Summary: Students majoring in electronics can take online classes and do laboratory experiments. These laboratory activities can be done either at school or at a distance. This will benefit students who can't attend classes due to work conflict or job related traveling. The electronic board (EE board) will be used to demonstrate how this can be done in this presentation.

Preparing a New Workforce for a Sustainable Economy

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Need: The potential for growth in the renewable energy industry is excellent, even in a sluggish economy. Renewable energy technicians with one-year certificates and with two-year degrees are currently in demand, and that demand is predicted to grow as the industry grows. The community college is well positioned to provide the training needed for many of the emerging job opportunities in renewable energy, in large part because of the speed with which community colleges can adapt to shifting workforce opportunities. Recognizing the need for and potential of renewable energy programs, Illinois Valley Community College committed to an aggressive timeline for planning and offering those programs.

Overview: This presentation will focus on model renewable energy programs being developed and offered at Illinois Valley Community College with support from a National Science Foundation grant. Two certificate programs for wind energy technicians are already being offered and work has begun on certificates for technicians in other renewable energy industries. These certificates will lead to a new, model Associate in Applied Science degree in industrial technology being developed as a career pathway from renewable energy and related industry certificates to a 2 + 2 Bachelor's degree.

Major Points:

- Model wind energy technician certificates, basic and advanced.
- Plans for model certificate program(s) in other renewable industries.
- Ideas for integrating existing courses into new renewable energy programs.
- Outline of a model A.A.S. degree in industrial technology to lead from certificate programs in renewable energy and other industry certificates to a baccalaureate degree.
- Renewable energy training equipment and laboratory setups.
- Staffing issues and solutions.
- Costs and strategies for developing effective and cost-efficient programs.
- Reasonable but aggressive timelines for program development.
- Methods for engaging renewable energy industries in collaborative efforts
- Efforts to promote public awareness.

Summary: Attendees will emerge from this session with an understanding of the effective, efficient, and adaptable process for designing and offering renewable energy programs utilized at IVCC, including the areas of curricular design, equipment, staffing, industry collaboration, and costs.

Is Nuclear Energy the New Alternative Fuel?

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Need: Public fear of using nuclear energy has limited its use worldwide. It has been around for quite some time but most people only are aware of the accidents that have occurred. The efficiency of nuclear power should have it in the forefront of the search for a greener energy source. This presentation will take a look at the pros and cons of nuclear energy as a viable power source and how it compares to some of the other alternative energy sources that are available.

Overview: At a point in time in our history, nuclear power was to be the energy of the future. But accidents at the Three Mile Island nuclear reactor and at the Chernobyl nuclear power plant changed the way most people viewed the use of nuclear energy. While these accidents were not desirable in any way whatsoever, many of the details were exaggerated by the media. Time has passed, studies have been done, and data has been collected. With the information now available is it time to re-evaluate the further development of nuclear power as a possible answer to the alternative energy question. With the advances in technology and a better understanding of how to harness the power of nuclear fission, nuclear energy could be the new green form of energy. This presentation focuses on how nuclear energy compares to other currently used alternative energy sources.

Major Points:

- How nuclear energy is viewed
- Facts and Myths about nuclear energy
- Comparing nuclear energy to other currently used alternative energy sources

Summary: Attendees will hear facts about the use of nuclear energy as a possible "new" alternative energy source and how it compares to other currently used alternative energy sources.

Incorporation of Dissipation in Physical Models for Spintronic Devices

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Need: In 1988, the first experimental evidence of the phenomenon of "giant magnetoresistance" (GMR) was discovered in thin multilayers of ferromagnetic and antiferromagnetic materials. Since then, the solid-state device engineering community has been able to turn this effect, in which a reversal of the polarization of the electron's spin degree of freedom from layer to layer results in as much as a 100% change in resistance, into commercially important advances in magnetic memory devices for computers. This proposal will present a technique to model and simulate the behavior of spintronic devices that go beyond memory applications. In particular, the presenters will use a transfer matrix technique to model the flow of electron spins through a "SpinFET" (Spin Field-Effect Transistor), and will also model the loss of spin coherence as spins traverse the channel of the device. This loss of initial spin polarization is acknowledged to be a principal stumbling block to successful realization of these novel devices.

Overview: The first presenter is a Co-PI on an NSF-EPSCoR grant to the University of Kentucky for the establishment of a Center for Advanced Materials (CAM-UK). Both presenters are involved in the development of simple models for the transfer of electron spins across thin barriers between magnetic materials, and have developed further a scattering/transfer matrix technique to simulate the "spin current" through these devices. This spin current can take place either alone, or in conjunction with electric current flow. The expectation for such devices is that they will make for more compact, and particularly less power hungry, devices in computer systems of the future. In particular, this presentation aims to model accurately the losses in spin coherence, as well as Ohmic losses due to electron current flow.

Major Points:

- Nature of Spintronic devices and their present role and future prospects.
- Development of models based on a transfer matrix technique to simulate the flow of electron spins in a new type device, the SpinFET

Summary: The presenters hope to bridge the gap between the physics of spin transfer and the circuit behavior of such devices within systems through models that allow for simpler evaluation and calculation of such behavior for a specific candidate device, and to include the mechanisms of loss as well..

2.4GHz Wireless Communication Project with MRF24JMA and IEEE 802.15.4 on a PIC Training System

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Need: EECT focuses on both "hands-on and mind-on" design work and the practice is to integrate existing technology products into real world applications. Teaching the RF concepts can be complex, tedious, and sometimes confusing. However, if it is implemented in a real-world project approach to learning by using an existing RF modules that lead to developing clear understanding and meaningful experiences in successfully applying the concepts that makes these subjects interesting as well as challenging to learn. By integrating the RF transceiver module with a pre-developed PIC training system eliminates many uncontrollable variables. This project provides useful tools that make teaching of complex RF subjects appealing and it can easily be adopted in many potential applications.

Overview: Wireless communication becomes popular and widely used in almost every electronic product in our daily life. A project based model can be used as an effective instructional strategy to enhance learning about complex RF concepts and technologies. The project method can lead to improved understanding and create interest by actively engaging the student with hands-on and problem solving and critical thinking activities. This project is based on a previously developed low cost PIC microcontroller training system that is coupled with RF communication that can be used in a variety of hands-on applications. A 2.4 GHz RF transceiver package (MRF24J40MA) that was developed by Microchip, Inc. provides the benefits of a compact, low-cost, and easy to use product with a few or small additional parts count that includes all components less the power supply. The IEEE 802.15.4TM-2003 rules, standards, and software protocols designs with SPI interfacing are the center of the project. The student assessment process includes a live demonstration of the student-designed functions using a pair of the RF modules with PIC trainers.

Major Points:

- Comparison of various available RF modules.
- Introduction of IEEE 802.15.4TM-2003 rules and standards.
- Hardware and software designs of the project.
- RF communication protocols with SPI interfacing.
- Cost effectiveness analysis of using a 2.4 GHz MRF24J40MA RF transceiver.
- Potential uses of this project design in other applications.

Conclusions: Teaching RF communication and making it easy to understand and interesting is a challenging task. Implementing RF will encounter many obstacles that usually end with malfunction results that are hard to trouble-shoot. Putting the existing RF transceiver module with a pre-developed PIC training system eliminates many uncontrollable variables. This project provides useful tools that make teaching of complex RF subjects appealing and it can also easily adopted in many potential applications.

What Color is Your Hat? Critical Thinking Activities in Computer Network and Security Courses

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Need: Securing network devices and computer systems is of considerable importance in this era of information consolidation and mobility. It requires rethinking the traditional way in which computer systems and networks have been secured. The need for network administrator to wear different hats in the workplace, especially with regard to the management of security related issues is vital. Students in computer technology programs need to learn about active network defense and compliance network penetration testing (white hat), noncompliance penetration testing without detection by operating personnel (black hat), or a blend (grey) for reducing the threat to the systems they manage. This requires students to evaluate and synthesize information while using strong critical thinking skills for creating strategies that alleviate present and potential future security risks to computer networks.

Overview: The presentation will discuss strategies which technology faculty members can use for encouraging critical and creative thinking while solving problems related to computer and network security. In order to foil attacks on computer networks systems computer technology students should be familiar with robust, open-source and free software tools. This also sometimes requires maintaining a balancing act between assuming the persona of a cracker and of a hacker, or between considerations for the resources required and the convenience involved. Using structured in-class and laboratory activities students can learn about and implement the proper procedures for securing computer networks, while strengthening critical thinking skills.

Major Points:

- Security-related vulnerabilities in typical computer systems and networks
- Need for wearing different hats while performing handling issues related to network security
- Legal aspects of penetration testing computer networks
- Open-source and freeware tools for securing computer networks
- Using scenarios and case studies for analyzing hardware and software security
- Practical information, procedures, guidelines for securing computer systems and networks
- Strengthening thinking skills of computer technology students so that they can prioritize information, analyze, and synthesize security-related solutions for use in modern computer networks.

Conclusion: Strong technical and critical thinking skills are needed while designing, maintaining, or troubleshooting security in computer networking systems. Building a secure online work environment may require the network administrator to step into the role of potential network intruder and subsequently use tools to reduce vulnerabilities that have been revealed by various types of penetration testing. The presentation will provide recommendations about the use of appropriate physical security, passwords, encryption, and software tools, in wired/wireless, local or remote networks. Students in computer technology programs learning can be introduced to these concepts through various class, online and laboratory activities, assignments, and projects. Equipped with this knowledge, skills and professional attitudes regarding the appropriate use of security-related tools, students will be able to mitigate security threats in computer systems and networks.

An Overview of Ad-Hoc Routing Protocols

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Need: Use of wireless communication is increasing and there are many fields that are touched by the development of this new technology. Implementation of ad-hoc wireless networks should strive for a minimum of bandwidth consuming overhead. There are many problems associated with this type of network and based on much research, we discuss some routing algorithms to improve the quality of services parameters for these types of networks.

Overview: Quality of service is considered as a great concern in computer networks. For transmitting data between source and destination, many factors should be considered to guarantee data delivery. The delay, packet loss, cost and other factors are the main problems in every communication exchange. Hence, in order to gain the most advantages, many studies have been done and many solutions have been offered. In this paper, we discussed quality of service in mobile ad-hoc networking and we presented specific algorithm to overcome these problems.

Major Points:

- Destination-Sequenced Distance-Vector Routing (DSDV):
- The Wireless Routing Protocol (WRP):
- Ad-hoc Demand Distance Vector routing (AODV):
- Dynamic Source Routing (DSR):
- Light-Weight Mobile Routing (LMR):
- Associativity-Based Routing (ABR):
- Quality of service

Summary: Ad-hoc networking requires an efficient dynamic routing protocol which must be able to follow a high degree of node mobility and changes in networking topology. In this paper we introduced several protocols which are used in ad-hoc networking. We briefly described the protocols' characteristics and algorithms, and we discussed how to improve quality of service in this type of networking.

Design and Analysis of Bidirectional Buck-Boost Converter for Interrupt-Free Motor Drive Application

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Need: The use of renewable energy generating from photovoltaic (PV) array and wind turbine has recently increased. Almost all of the renewable energy processing system contains battery or ultracapacitor storage to conserve generated dc electrical energy. In order to save dc electrical energy into the battery, a charging circuit is necessary. For the inverter dependent motor drives, such as the three-phase brushless motor, switched-reluctance motor, and induction motor, a discharging circuit to boost the battery voltage to match with a necessary dc voltage level for the applied motor inverter is needed. The charging-discharging function can be implemented into a bidirectional buck-boost topology to implement a low-cost interrupt-free motor drive system. The interrupt-free motor drive could provide a continuous operation for the mission critical application.

Overview: The proposed interrupt-free motor drive system is implemented based on a buck step-down and boost step-up dc-to-dc converters. The buck converter charges the storage devices during normal operation. When the main power source from ac power line or renewable energy source is not available, the boost step-up converter takes over the system to provide a proper intermediate dc bus voltage for the motor drive inverter. The presentation consists of the overall block diagram of the proposed interrupt-free motor drive system, analysis and design of subassemblies, and experimental verification of the proposed system.

Major Points:

- Need for an interrupt-free motor drive
- Need for a low-cost charging and discharging converters
- Design and analysis of the proposed buck-boost bidirectional dc-to-dc converter
- Empirical verification of the proposed interrupt-free motor drive system with a switched reluctance motor
- Efficiency evaluation of the proposed system

Summary: The interrupt-free motor drive system is proposed based on buck-boost dc-to-dc converter and ac power source and various renewable power sources. The viability of the proposed system has been illustrated with a fractional horsepower SRM. The system performance during both steady-state and transient states and overall system efficiency during charging and discharging modes are evaluated experimentally.

Integrative Learning of Biomass Renewable Energy

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Need: In order for the Earth to continuously support human lives, we need to achieve sustainability for the global social, economic, and environmental systems that meet "the needs of the present without compromising the ability of future generations to meet their own needs." To accomplish the global sustainability, we must develop policies and technologies that embrace a diverse range of energy solutions, especially renewable energy. Renewable energy offers great potential for the world to reduce dependency on fossil fuels, and leads to cleaner environment, better preservation of natural resources, and more economic opportunities to the communities. It is imperative that our students should be educated in terms of global sustainable development through clean and renewable energy. Integrative learning is one of the effective ways to motivate and engage students in the leaning process.

Overview: Audience will be informed about a campus-wide initiative on biomass renewable energy. The construction of a new Renewable Energy Center at the university exemplifies the institution's leadership and commitment to a sustainable energy practice. The new energy center will offer students the first-hand opportunity to learn how renewable energy is utilized to support the needs of a campus community. In order to fully integrate student learning with opportunities brought by the Renewable Energy Center, the university has endorsed the establishment of Center for Clean Energy Research and Education (CENCERE). CENCERE promotes an interdisciplinary collaboration across the campus, including academic departments/schools, facility planning and management as well as student body. A new graduate level course on biomass renewable energy is being offered.

Major Points:

- Urgency to address green house gas and renewable energy
- Institution's initiative on biomass renewable energy
- Campus-wide Center for Clean Energy Research and Education
- Integrative learning of biomass renewable energy
- On-going research and integration with student learning

Summary: The construction of a new Renewable Energy Center on campus exemplifies the institution's leadership and commitment to a sustainable energy practice. Audience will be informed about a campus-wide initiative on biomass renewable energy. Student learning of biomass renewable energy has been closely integrated with the energy center.

A Fieldbus Simulator for Controller Area Network

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Need: Industrial control networks such as Foundation Fieldbus, Profibus, Devicenet, Controller Area Network (CAN), called fieldbuses, are extensively used in control system implementations. While these networks can be built in hardware, it is important to study the performance via simulation before implementing them. There is a need to understand the existing and emerging simulation tools for fieldbuses. This presentation considers a software simulation tool for CAN, called CANoe, and discusses its application in an experimental setup.

Overview: CAN is a popular fieldbus network used in most of the modern automobiles. Bosch developed the CAN protocol, which has since been standardized internationally as ISO11898. The CAN protocol corresponds to the data link and physical layers in the ISO/OSI reference model of the digital communications. CANoe, developed by Vector CANtech, is a software tool capable of simulating a CAN based system. It includes an interactive development environment, which makes it easy to create, modify, and compile an application-oriented, C-like language called CAPL. The CANoe simulations provide performance characteristics of a CAN system through its trace and statistics windows. CANoe also allows replacement of some of the simulated software modules with hardware Electronic Control Units (ECUs) and allows further developments. These hardware software interactions are illustrated with a PIC microcontroller based CANstart hardware module which then provides communication features for digital and analog inputs/outputs (I/O). The CANstart board is interfaced with a stepper motor in an experimental setup. The communication between the board and the stepper motor is achieved using CAN protocol through the CANoe software.

Major Points:

- An overview of the fieldbus networks will be presented
- An introduction to CAN will be given
- CANoe simulation software for CAN will be introduced
- Operation of the CANstart board will be explained
- A stepper motor interface and its control in CAN environment will be discussed

Summary: This presentation will provide ATMAE professionals a general understanding of fieldbus networks, with an in-depth overview of CAN. Importance of software simulation tools for development, testing and analysis of fieldbus networks will be explained using CANoe software for CAN. An experiment consisting of stepper motor interface and its communication using CAN protocol in CANoe environment will be discussed.

Pilot Solar Thermal Power Plant Station in Southwest Louisiana

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Need: It is fundamental to the quality of daily life that we have access to an abundant and uninterrupted supply of energy. It is undoubtedly the key ingredient in all sectors of modern economies. Colleges and universities have an increasing role in growing economic development and community revitalization. The goal of this project is to purchase, install, produce power, and evaluate the commercial viability of a 20 kW pilot solar thermal power plant for the first time in Louisiana.

Overview: Solar thermal power plants have proven successful in other parts of the world and in other states with similar climates, but the technology has never been tried or tested commercially in Louisiana. All components in the system are commercially available and have proven successful in other states; therefore this project qualifies as an Innovative Commercial Technology. The plant installation is under way on five acres of land that was donated to the University of Louisiana at Lafayette by the City of Crowley, Louisiana.

Major Points:

- Create or retain jobs, create renewable energy
- Offset the production of greenhouse gases
- Purchase and install the equipment, test the completed system
- Operate the system to produce renewable power, and report on the findings of the pilot project
- Students involve in the project learn about alternative environmentally friendly solar energy usage.

Summary: The global economy is totally dependent on an abundant and uninterrupted supply of energy. Solar thermal plants are one source to meeting this need, but the technology is untested in Southwest Louisiana. The project will determine the feasibility of using this technology as a commercial application. The project is expected to create or retain 2.29 full-time equivalent jobs, produce 171,806 kWh of energy annually, and provide a learning environment for students.

Fault Detection and Isolation Applications of Unmanned Ground Vehicle

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Need: Recent years have witnessed a strong interest and intensive research activities in the area of unmanned vehicle systems in spacecraft flight, unmanned aerial vehicles, autonomous underwater vehicles, etc. Unmanned vehicles will be harmful and/or mission will fail when they have fault in their components. The unmanned vehicles are vehicles that work in the field solely under computer control. Fault Detection and Isolation (FDI) is complicated by the presence of manufacturing differences and the deterioration during normal operation, and the complexity of an accurate UGV mathematical model.

Overview: The presentation will give a brief historical perspective of unmanned ground vehicle control systems, and FDI. This will be followed by the new state of the art FDI which are being used in the related field. The selected FDI methods for our UGV were also presented.

Major Points:

- Virginia State University develop unmanned golf car
- Explanation of system needs to have fault detection and isolation system

Summary: The conference participants will gain an understanding of FDI applications for UGV.

A Social Humanoid Autonomous Robotic Platform Project

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Need: Robotics in industry, education, and personal interests has become an outstanding part of our lives and are quickly immerging as a factor in the way we will live in our future. For this reason, it is becoming increasingly important to make robotic products easier to use, easier to find, easier to understand, and most importantly easier to purchase. In this presentation, we will present a solution to this need that provides an affordable approach to introducing robotics and autonomous mobile devices into modern homes and educational facilities to enhance the everyday living and learning experiences of individuals and institutions of any income level.

Overview: The Social Humanoid Autonomous Robotic Platform (SHARP) project is an android project that was created with the intent of making learning about androids and robotics easier for the novice, diverse for the expert, educational in the classroom, and useful in the home or business. The project centers itself on its simplicity, low cost, and expandability. By keeping these targets in sight, the SHARP Project has the potential to be a proper and affordable fit in nearly every modern setting. The introduction of the SHARP project lays the groundwork for people of many ages, incomes, and educational levels to take advantage of robotics technology. The presentation will feature an appearance from a personal android project named "GENESIS" as an example of the SHARP projects features. The features of GENESIS include voice recognition, speech synthesis, and responses to various sensor stimuli.

Major Points:

- Needs for an affordable yet versatile robotics platform
- Expectations of the SHARP Project
- SHARP as a learning tool and the curriculum to go with it. (From basic electricity to new developments in artificial intelligence.)
- Comparison between SHARP and similar academic/industrial projects
- Where you will see SHARP in the future.

Summary: Viewers of the presentation will be informed of our project to make robotic and android technology both affordable and user friendly in the near future. They will observe the SHARP Project in action as we discuss the current model being developed at the university, as well as future models and directions of the SHARP project.

Performance Analysis of Voice VPN

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Need: Convergence of Virtual Private Network (VPN) and Voice over Internet Protocol (VOIP) technologies is an emerging area in today's business world. Deploying voice traffic over a data network is a simple but sensitive task. The primary objective of this research is to identify the impact of voice traffic over VPN performance in an enterprise setup. The project evaluates behavior of different protocols and identifies latency factors that measure throughput of VPN data and voice traffic. It will serve as a basis to improve quality of services (QoS) of VPN for voice traffic and will recommend appropriate protocols. We believe that the convergence of technologies will create interest and opens new directions of research for both graduate and undergraduate students. It would be a great opportunity for students to build their market driven expertise in computer networks and data communication. Emerging telecommunication technologies and skill requirements create great job opportunities for technology students who are well prepared.

Overview: Voice communication among different offices is the most common communication scenario within an enterprise. A Voice VPN provides an ideal opportunity for companies to build their own voice intranet and communicate with branch offices as well as remote site users. In this presentation we will introduce Voice VPN architecture and functionality. We will explain how to use Opnet simulator to create various network scenarios, generate desired traffic, collect data, and analyze network performance. In addition, we will present statistical results gathered from simulation, analyze the performance of Voice over VPN, and give recommendations of using Voice over VPN in an enterprise setup. Market demand for voice based VPN is increasing rapidly and is considered as a mainstream communication technology for today's business world. Simulation based result of voice VPN model will reflect the overall network performance and identifies latency and error rate if any. We will also explain that how data and voice traffic can be converged together without compromising overall network performance and efficiency. This project will provide us fundamental understanding of VOIP and VPN technologies. It will create further research opportunities for technology students to evaluate the performance of different network technologies and recommend alternate solutions to achieve better quality of services.

Major Points:

- VPN and VOIP architecture
- Analyzing latency factor of voice traffic over VPN
- Analyzing performance parameters
- IPsec architecture and its limitation for voice traffic over VPN
- Graphical representation of simulation based statistical results

Summary: Convergence of two distinct technologies, virtual private networks (VPN) and voice over internet protocol (VOIP), brings great research and career opportunities for technology students. We will analyze the VPN network performance using different performance metrics and recommend appropriate protocols to achieve quality of services for voice traffic over VPN.

Storing and Maintaining Virtual Machines in Computer Technology Labs

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Need: Many computer technology programs have adopted virtualization technology in their curriculum to run virtual machines on desktop environments. A computer technology lab typically needs to support several classes and each student in a class may need to access several virtual machines. It is therefore important to examine how to efficiently and effectively store and maintain those virtual machines in the lab environment. The main goals of this study are to 1) experiment with different approaches to reduce the storage requirement of multiple virtual machines; 2) identify the techniques to reduce human errors, such as preventing students in one class from removing or modifying virtual machines of another class.

Overview: In a computer technology lab, students from different classes need to run their own virtual machines for their labs and projects. The storage requirement of a virtual server, such as Windows Server 2008, can be fairly large and the time for a student to create a new virtual machine and patch the virtual machine is very time consuming. Many of those virtual machines are very much alike except they have different system security ID, computer names and network settings. Instead of having multiple instances of those similar virtual machines, a better solution could be applying user specific settings over a common base virtual machine. This will not only save the storage space but also make it easier for students to back up their virtual machines. There is no need to store the entire virtual machines. Simply archive the configuration settings. This study will explore possible enabling techniques, such as VMware Snapshots, VMWare Clones, and Windows System State. The presentation will highlight our results and strategies describing how lab managers can incorporate the findings into their own environment.

Major Points:

- The need for a better VM storage strategy.
- An ideal architecture of storing and maintaining Virtual Machines
- Study on VMware snapshots
- Study on VMWare clones
- Study on Windows System state backup and restore.
- Results of the study.
- Strategies for participants to incorporate results into their own lab environments.

Summary: The audience will learn from this presentation what techniques can be used in Computer technology labs to significantly reduce the storage need and effectively backing up multiple similar virtual machines. The results of this study can also help IT industry to examine alternative back up strategies on virtual machines.

A Learner-Centered Teaching in a Linux Class

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Need: Operating systems other than Microsoft Windows have gradually gained more market shares and importance. Students majored in the information technology therefore need to broaden their knowledge and learn how to operate and manage Linux/Unix environment. The challenge is how to get students motivated and be able to quickly grasp the new concepts by expanding their existing knowledge. With traditional lectures-centered teaching, many students quickly lost their interests by the time instructors began teaching shell commands. There is a need to reinvent the teaching pedagogy and shift a Linux/Unix class more learner-centered.

Overview: In this funded project, we creatively redesigned a Linux class where learning is centered on students and other learners. Two major characteristics of this project are: 1) students are encouraged to apply their knowledge in Windows OS to Linux environment; 2) students are expected to develop a series mini-training videos to teach those general public who are interested in learning Linux but have Windows experiences only. Topics covered in the class are defined by both students and faculty. Lecture time is also reduced to its minimum to cover the fundamentals and extreme difficult concepts. The results are students become more engaged and motivated in this active learning experience.

Major Points:

- Why teach Linux/Unix
- What were the students feedback
- How to get students be an active Linux learner?
- Implementation details of this funded research
- Findings of this project
- Conclusions and future works

Summary: We would like to inform audiences the challenges in teaching students Linux/Unix OS. We would also like to share the experiences we have when implementing this funded research: what is working and what is not. We firmly believe the creative teaching methods we adopted in this class can be easily applied to other classes as well.

The Current Map and Future of Alternative Energy Degrees

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Need: A detailed literature review is conducted to share a detailed comparison of the alternative energy systems, related course work, and academic degree programs in U.S. and non-U.S. institutions. Alternative Energy related courses and degree programs are researched and summarized based on degree and/or program requirements, curricula, related and offered departments, equipment used, year that courses begin, etc. This summary gives a brief presentation of how and why a sustainable energy degree or program should be a viable part of a forward-looking institution. This study also covers the type of equipment, costs of equipment, components, course/lab work, and the installation needed to establish renewable energy courses and programs. The cost of the installation and equipment for the alternative energy programs in the market is summarized for the future developments.

Overview: Fossil fuels are being depleted and careers in alternative energy sources are becoming more frequent every day. Careers and public interest in alternative energy technologies are increasing due to over-use of fossil fuels, increased gas prices, global warming and environmental issues. These concerns cause public and government entities to be increasingly interested in switching from fossil fuels and to increase the use of sustainable energy systems to address current issues. In this phase, many schools including K-12 schools, junior colleges, and 4 year institutions have been searching and implementing alternative energy related courses or degrees (Associate's, Bachelor's, and even a Master's degree) to offer their student more information to compete in job research. An alternative energy technologies college course or degree offers a college graduate several advantages in the process of job hunting in the competitive job market. Alternative energy college courses and degrees can have a definite impact on earnings potential and job availability.

Major Points:

- Describe course curricula for alternative energy programs
- Share findings on number and status of courses and degrees in U.S. institutions
- Compare degrees and curricula between U.S. and non-U.S. institutions
- Investigate type of equipment implemented to conduct lab sections of courses
- Study cost of existing Alt. Energy educational training equipment available
- Learn existing public, private and government support to Alt. Energy education
- Determine current and future job market for alternative energy graduates

Summary: This extensive study gives detailed information about alternative energy course curricula and degrees for interested academic faculty, program coordinators, administrative people, and the public in order to provide a reliable source of information to enable research and instruction about alternative energy systems.

Two Successful Student Projects: Solar Air and Solar Water Heating Training Units

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Need: Solar air and water heating systems are a supplement to traditional heating systems and can dramatically reduce heating costs. Five undergraduate and graduate students built both solar air and solar water portable training units (called mini-labs) as part of their independent study classes in Industrial Technology Program. Both units are portable and can be tested in different conditions and are being used in lab sections of renewable energy class. Students involved in this project learned to distinguish between solar electric and solar thermal and can understand the uses of both; have knowledge of how to identify a proper site for a solar thermal system, and have resources to explore local installation options. Initially wheeled carts were designed using a computer design, and drafting software tool with all major components were shown in the design. After the design of a complete system (with real dimensions), wheeled carts were built to test the solar heating systems in different locations. The air circulation and quality of warm air can be tested at different times of day and in different weather conditions.

Overview: Students graduating from engineering and technology programs are involved in buying, managing, and trading alternative energies during their careers as part of their job requirements. It is essential for engineering and technology students, at a minimum, to be familiar with renewable energy technologies and their applications and implementations. Establishing courses in renewable energy with an adequate research laboratory will involve undergraduate and graduate students, faculty, and community in learning about alternative energy and its impacts in detail. Hands-on renewable energy related classes, labs, and projects promote alternative energy education at university campuses. A fully functional laboratory delivers applied energy education workshops for local community colleges, secondary/high school science/technology teachers and students and the general population, especially, who are not exposed to state-of-the-art renewable energy information.

Major Points:

- Viability of solar air and water heating systems
- Describe applicability of the system
- Investigate efficiency of both systems in different locations and angles
- Study how these systems vary in four seasons

Summary: Attendees will understand how industrial technology students successfully accomplished two different projects with minor faculty advisement by taking independent study courses. Project hints will be shared with attendees to involve undergraduate students in industry level projects.

A Small Scale Prototype Wind Turbine Design and Development

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Need: This project is a student project has been accomplished from scratch in a production lab of Industrial Technology program as an independent study course. Students were enrolled in Renewable Energy class in the program requested to involve in various applied projects. This is the one of the projects, an electronics major students developed to use in his farm for small scale applications. This project involves harnessing the wind as a source to generate DC power from a propeller driven device that stores the power generated in batteries. This is a small prototype driven by a propeller that is connected mechanically to a generator. The power developed by the generator will be transferred to a battery storage system to store this power for use as needed in a farm.

Overview: The technology of transforming the kinetic energy of the wind into useful mechanical power has been applied by man since antiquity. Wind energy is, together with energy from streaming water utilized by a water wheel, the oldest source of power applied by mankind. Historical evidence suggests that the energy from the wind has been utilized this way for at least one thousand years. Modern use is for the production of AC electricity for industrial and home usage. Large scale wind farms are in use in California and are growing in other regions of the country. This production is small and only accounts for a fraction of one percent of the consumption of power in the U.S. Large amounts of land are needed to supply the same amount of power as can be generated by a coal or gas powered generation plant. This leaves for many hurdles to be overcome before wind generation can become a substantial part of our power production.

Major Points:

- Describe modeling of a wind turbine
- Investigate viability of home made wind turbine
- Study materials
- Share test results

Summary: This student project gives detailed information about how students can build systems with low cost to promote renewable energy technologies. Details such as cost, materials, laboratory environment will be shared with interested academia.

Beyond Exercise: How to Save Energy While Working-out on a Treadmill

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Need: Energy efficiency is the goal to enhance the operation of any system. It can be improved in different scales, from power plants to the appliances in our everyday life. Moreover, knowing that there is no system with 100% efficiency the idea of converting energy loss into potential energy is significant. This study analyzes treadmills where typically a large amount of available energy provided by the user simply goes to waste through heat, mechanical ware, friction, etc. The purpose of the current study is to quantify the available energy and come up with estimation on the amount of financial and energy savings.

Overview: There are three types of treadmills available commercially: One, the motorized treadmill which is operated by an electric motor. The basic components of a typical treadmill are motor, flywheel frame, rollers, deck, belt and electronic control system. The motor runs the belt and the control system simulate the exercise programs by changing the belt speed. Two, the manual treadmill which does not have a motor. Three, the manually powered controllable treadmill which is the combination of the above treadmills. In this type of treadmill the operator runs the belt, however a battery operated console is available for display and controlling the speed. The battery is charged while the operator is working out.
There are advantages and disadvantages for each of the above systems. The manually powered controllable treadmill is a promising design. It is not driven by electricity, the operator creates the motion of the belt. However they are equipped with a battery operated display and control system. A small portion of the energy that the athlete generates during the exercise course is used to recharge the battery. The energy required for operating the display system is less than 5% of the power that the operator generates, where does the remaining 95% go?

Major Points:

- Summary of existing treadmill systems
- Increase efficiency of a treadmill
- Quantify the available energy during an exercise cycle
- Suggestion on how to harvest the excess energy
- Determine the amount of financial and energy saving

Summary: The purpose of this study is to propose a viable solution to take advantage of the available energy in a treadmill during an exercise cycle. The amount of energy that is generated by the operator is quantified. A portion of this energy is used to recharge the batteries for display and control system. The remaining net available energy will be harvested using generators and saved is larger rechargeable batteries. This excess energy if harvested properly is enough to generate an enormous amount of saving in power consumption. It will then provide remarkable savings for residential and commercial buildings. To further clarify this, assume a gym having 50 treadmills. Let the gym operation hours be 6:00 AM – 12:00 AM. If conservatively 50% of the time the treadmills are being used, the minimum amount of net available power will be almost 78 kW. That is 624 kW-hr power can be potentially used in the gym. According to US Energy Information Administration, in September 2010 the average retail price of electricity in New York State was 15.86 cents per Kw-hr. For this case study the amount of saving will be more than $35,000 per year.

Security Techniques on Smartphones: A Reality Check

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Need: The smartphone market has experienced rapid growth lately. Many people are adopting iPhones, Android phones or other smartphones for personal use and business needs. Moreover, smartphone devices now consume more web traffic. Nevertheless, how secure are those smartphones? In Nov 2010, it was reported that viruses targeting smartphones hit millions of cell phone users in Russia and China. Many fear that the smartphone will be plagued by malwares in the near future. It is therefore, necessary to identify and examine the security vulnerabilities on the smartphone platforms and determine what current security techniques can alleviate these risks and what users and IT people can do to enhance the smartphone security in the future.

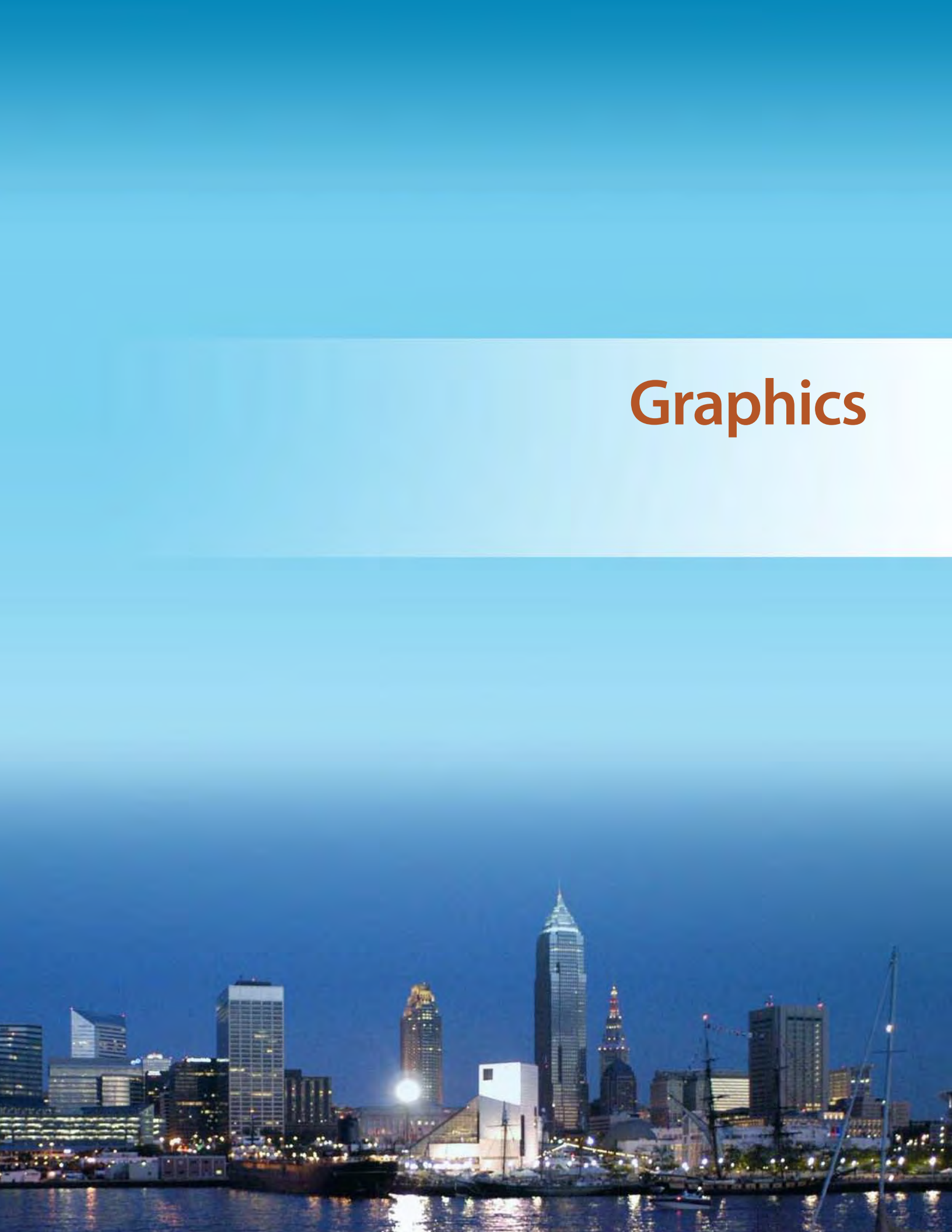
Overview: As the use of smartphone technology shifts from personal use to more business-oriented use, many organizations have gradually supported Blackberry, iPhone, Android phones and Windows Phone 7 in the work place. From a security perspective, mobile devices are the weakest link in an enterprise IT infrastructure. Are smartphones ready for the business use? This presentation will begin with an introduction to real-world smartphone security incidences, followed by a vulnerability analyses. Then, security techniques that can be utilized by both IT professionals and end -users will be explained. Security architecture and features of popular Smartphone operating systems, such as iPhone, Android and Windows Phone 7 will be compared. In conclusion, security recommendations will be extended to software developers and end-users.

Major Points:

- Real world Smartphone security attacks
- Smartphone vulnerability analyses
- Security techniques
- Platform comparisons
- Recommendations to the users and the developers

Summary: The audience will learn from this presentation what the security vulnerabilities and risks are for smartphones, and what the countermeasures that can be applied to reduce the security risk. This presentation will also give security recommendations to end users and IT professionals.

Graphics



Final Phase: Study on Four Major Command Input Systems in Autocad

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Need: Design trends in the United States and around the world continue to mutate and expand as new programs and techniques are developed. Drafters appear to be specializing into programs that allow speed and productivity to increase. In the current economy, in which company and designer survival is based on profit margins, any small change in productivity is greatly needed. It is with this in mind that we have finished the final phase of our research into the four major AutoCAD command inputs systems used in industry.

Overview: The University of Central Missouri has developed a system of command inputs in AutoCAD called Ecllipse-101. In our first phase we tested 60 commands and the various command inputs available in AutoCAD. The results were tabulated and preliminary results were noted. The final phase includes 41 additional commands with a result of 101 commands total. This study does not include an all keyboard input system without the use of a mouse since this system appears to be obsolete in the current workplace. The Ecllipse-101 system is designed to provide an ergonomic input system used with a mouse application and ergonomic keyboard entry. This system is designed for power drafters and their design speed requirements.

Major Points:

- Description of the additional commands of the research
- Ergonomic effect on design time.
- Application in the workplace.
- Statistical data and results.
- Recommendations and conclusions.

Summary: It is the purpose of this study to give industry another option for productivity. All possible variations of command inputs would be difficult or impossible to study individually so the major ones were included in our study.

The Status of Desktop Rapid Prototyping

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Need: Rapid prototyping uses 3D part files to build models to verify the form and fit of parts simply and cost effectively. Traditional prototyping is expensive and requires considerable time. Being able to verify a design early in the process saves considerable time and money compared to making changes later in the manufacturing process. Recently, additive technology systems have become more compact and less expensive. A technology that cost a minimum of $40k-$125k a few years ago now cost only $7,500 to $10,000. There are even details available on the internet to build your own additive modeling system for $500.

Overview: Rapid prototyping is the automatic construction of physical objects using additive manufacturing technology. The first techniques for rapid prototyping became available in the late 1980s and were used to produce models and prototype parts. Additive systems for rapid prototyping can typically produce models in a few hours, although it can vary widely depending on the type of machine being used and the size and number of models being produced simultaneously. 3D printers give designers and concept development teams the ability to produce parts and concept models using a desktop size printer that allows them to shorten their design cycle and propel their businesses forward.

Major Points:

- Most desktop 3D printers are larger than the average inkjet printer, but substantially smaller and less expensive than standard prototyping systems
- Desktop 3D Printers are ideally suited for an office, home or modeling shop, have no special requirements and are simple to use
- Desktop printers are becoming much less expensive
- Plans and components for RepRap, a build-it-yourself open-source RP machine, are on the internet

Summary: Rapid prototyping has begun to mature as a technology and the machines are smaller and less expensive than they used to be. While industry still uses large, expensive, high performance machines, there is a new category of desktop 3D printers on the market. Attendees will understand the cost benefits and time savings incurred when using desktop 3D solid modeling to verify the form and fit of parts as they are being designed. The presentation will also review the various desktop 3D printers, including 3D printers for under $1,000. Sources and information about RepRap will also be provided.

Perceptions of Engineering Graphics Professionals Regarding ATMAE Engineering Graphics Certification

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Need: The ATMAE Certification Board is proceeding with a specialty examination in Engineering Graphics (EG), and it is imperative to examine the perceptions of established professionals in fields related to EG.

Overview: In the spring of 2011, a survey was [will be] conducted with various professionals in institutions with EG programs. Using the membership of the Engineering Design Graphics division of the American Society for Engineering Education (ASEE/EGD), and EG faculty in Associate and Baccalaureate programs accredited by ATMAE, individuals were surveyed to examine perceptions related to the ATMAE specialty certification in Engineering Graphics. This presentation examines the results of the survey, with recommendations for further research.

Major Points:

- What perceptions exist, both positive and negative, among EG professionals with respect to an ATMAE specialty certification in EG?
- What differences, if any, exist between ASEE/EDG member perceptions and ATMAE member perceptions?
- What differences exist, if any, between the perceptions of ATMAE Associate Degree program faculty and Baccalaureate program faculty?
- What possibilities exist for the ATMAE specialty certification in EG being used as a program assessment tool at various institutions?

Summary: As ATMAE continues to develop, implement, and promote a specialty certification in engineering graphics, it is important to monitor and validate the certification process with input from professionals in the field.

Saturday Technology Academy: Youth Learning in Graphic Communication Programs

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Need: A Saturday Technology Academy (STA) was offered in the fall of 2010 for underrepresented populations of high school students in Guilford County located in North Carolina who had an interest and/or curiosity in technology. The STA program was designed to increase the number of students who pursue and succeed in careers related to science, technology, engineering, and math (STEM), by offering a program to students in grades nine through twelve. The academy was geared towards attracting nontraditional students into the technology field. The need to increase the number of nontraditional students in STEM and related fields is apparent because of data supporting the underrepresentation of women and minorities among professionals in these careers. Ultimately, the STA's goal was to provide a pipeline of diverse students participating in STEM school programs.

Major Points:

- Promote interest in technology programs through the development of a Saturday academy by educating high school students about technology careers.
- Help high school students understand technology by engaging them in challenging technology activities (screen printing, print media, electronics, video communications, etc.) to develop their problem solving skills and manipulative skills through hands-on activities.
- Improve high school students' awareness of technology and the role of technology in their lives.
- Develop high schools students' ability to communicate effectively in a technological world.
- Create a marketing strategy in order to promote the project and technology programs as vital sources of education, research, and service within the profession of technology.

Summary: Students learned and understood technology principles, engaged in technology activities, and improved their awareness of technology and the role of technology in their lives. Participants visited laboratories and learned about the many technology programs at North Carolina A&T State University. Faculty coordinated lectures in classroom and laboratory settings which allowed participants to improve their problem solving and manipulative skills through hands-on activities.

The Photo-Graphic Designer: Creating Vision of Photographic Competencies

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Need: Today, design education programs across the country are faced with several issues as they attempt to prepare students to enter the profession. Design educators are struggling to determine the best way to equip entry-level designers with the vast amount of capabilities necessary for well-rounded design professionals. How does digital photography fit into a broad-based curriculum that prepares design graduates for careers in the field? Design programs across the country and world attempt to effectively incorporate digital imaging processes into the curriculum.

Overview: Designers today need to have a comprehensive understanding of the technical and aesthetic qualities of digitally created images. One of the required knowledge sets includes the ability to capture and manipulate digital imagery utilized in creating visual communication solutions.

The digital photography course model discussed in this presentation will attempt to provide solutions to programs that have a limited amount of credits designated towards photographic and electronic imaging processes and concepts.

Major Points:

- Facility and equipment considerations for effectively delivering a photographic and electronic imaging course
- Course objectives and proposed digital photography project topics
- Capture and post-capture processes in the creative workflow
- Theory and application of photographic principles and guidelines
- Importance of critique in the development of a "photo-graphic designer"

Summary: Attendees will examine and discuss the photographic skills and knowledge required by design professionals to effectively create, evaluate and utilize digital photography in their design workflow. The curriculum implementation discussed in this presentation will serve as a model to prepare design graduates with the necessary photographic competencies required by design-related professions.

Networking: The Power of Collaboration Beyond the Classroom Walls

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Need: In today's difficult economy, programs are being asked to be more accountable for the success of their programs and their students. Universities attempt to ensure this success through a variety of avenues. Additionally, funding shortfalls are making it more and more difficult to bring those "extras" to your program and curriculum. Overcoming these challenges may require looking at things in a new way. One of the ways is by adopting a philosophical mindshift from networking yourself to the critical nature of networking your program. Creating and utilizing a networking strategy with industry brings resources, assets and other benefits to your program, thereby adding value to you, your program and your students.

Overview: Networking your program is vital to ensure student and program success through curriculum refinement, expanded learning opportunities, and avenues to leverage assets that bring, "more for less", to your program. This presentation is a case study in one programs' use of networking with industry professionals and organizations. The benefits that can evolve from this extension beyond the classroom walls include growth and development for students, the faculty and program. Developing an active and engaged advisory board, increasing real world student connectivity to industry, and the increasing visibility and credibility of your program are all benefits of deliberate networking and collaboration strategies that will be discussed in further detail through this presentation.

Major Points:

- Importance of networking your program
- A process for executing a programmatic networking strategy
- Implications for student, faculty and program
- Recommendations for measuring the results and utilizing the results for leveraging additional assets and opportunities

Summary: Attendees will understand how the power of networking collaboration can benefit themselves, their students and their program. An overview of Bemidji State University's networking strategy will be covered in this session. This strategy can serve as model for other graphics and design programs in their efforts to enhance program and student success.

Converting Legacy Maps into 3D Models

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Need: Legacy mapping refers to hardcopy maps showing past work. Such mapping is often the result of significant field work and intellectual effort, and represents a substantial monetary investment. Much legacy mapping currently exists as proprietary industrial information, and in the absence of new exploratory data may still be current, even if completed decades ago. Use of legacy mapping is facilitated when map data are available in digital format. This research describes methods suitable for converting legacy mapping to digital data in a production environment.

Overview: This research relates experience in hardcopy-to-digital conversion of legacy mapping of three oil fields in the Illinois Basin, and the presentation of digitized data as standard map products. Three questions are addressed: (1) How can digitizing work flow be organized to decrease cost and time? (2) What basic work products can be directly output during legacy map conversion? and (3) How can legacy map conversion deliver immediate utility?

Major Points:

- Protocols were developed to standardize the digitizing process and ensure quality control
- A suite of standard map products were produced for each oil field immediately following digitizing
- Plotting and posting of three dimensional models of existing fields provides a "training set" for subsurface visualization

Summary: Attendees will understand the importance of adopting standard graphics procedures for map conversion, the need to ensure quality control for digital graphic data, and the importance of supplying products for immediate professional and managerial use during legacy map conversion.

File Management in Print Production: A Teaching Methodology that Mirrors the Graphic Communications Industry

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Need: Common errors within print production can bring operations to a standstill. Clients routinely submit work that includes problems associated with missing files, missing fonts, incorrect bleeds, and/or incomplete instructions. Tracking down clients to clarify instructions and fix problems takes time. This not only escalates production schedules; it directly affects the bottom line. Charged back to the client, this wasted time results in expenses that balloon today's printing cost. Technology program educators and industry can both benefit with a way to educate future clients.

Overview: Proprietary preflight software currently exists. Its use assists print providers in the evaluation of client's files before the work begins. If errors exist, the preflight specialist opens a dialog between the print provider and the client. Through this communication, the problem is corrected in as an efficient manner as possible. However, identification of a problem is not the same as the elimination of its errors. The desired outcome is the education of the client. The file management system discussed within this presentation introduces graphic communications students to a method of evaluating files before they are turned in for grading. First created to eliminate the frustration of grading complex image files, this organizational method mirrors basic concepts desired within the industry. Including a short reflective paper provides vital information regarding the job and reinforces the importance of communication whether between faculty and student or print provider and the client.

Major Points:

- Identify the steps of the preflight process
- Define common mistakes during file transfer in print production
- File management functions within InDesign
- Logical organization of files for print
- Inclusion of intermediate files for emergencies stored in a folder named DoNotUse
- Action by students mirrors preflight and communication requirements within print production
- Conclusions, recommendations and questions

Summary: Attendees of this presentation will understand a File Management system that mirrors important industry concepts and assists the organization of student files. This prepares students to correct potentially costly mistakes before submission to print.

The Future of Time-Lapse Photography is Now

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Need: Time-lapse photography can be used in time and motion studies or to view a construction project, but it is simply amazing to capture the subtle changes of light, shadow, motion and metamorphosis that the eye cannot see in the beauty that surrounds us. Videos can be made from still images taken at regular intervals of sunrises and sunsets, the motion of a city coming to life in the morning, or the blooming of a flower.

Overview: Time-lapse photography is not new, but with the features in some of the new single lens reflex (SLR) digital cameras and with the new features in Adobe Photoshop, it can be brought into the classroom, industry and home.

Major Points:

- Some of the new digital SLR cameras have interval timer shooting built in.
- Separate devices called intervalometers can be attached to other cameras for time-lapse photography.
- Adobe Photoshop can now import a large number of images in a sequence and then render them into a video.
- This presentation will provide information, instruction sheets and demonstrate the creation of high quality time-lapse photography

Summary: There are many technical and entertaining uses of time-lapse photography. This presentation will demonstrate recent developments in digital cameras and Adobe Photoshop to provide attendees with the ability to provide this technology to their own students.

From Camera Obscura to Digital Color Management: Imaging Curriculum Topics and Methods

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Need: Imaging is one of the major components in the graphic communications field, whether that includes traditional, digital, or the entire spectrum. The aspects of imaging in the field of graphic communications can be represented by the following: capture, manage, manipulate, and output. These are the functions students need to become familiar with and competent in to be successful in their careers. The challenge as an educator is providing students appropriate activities and opportunities to experience these aspects of imaging, in a way that will relate to current and future industry practices.

Overview: For educators, there is an immense wealth of information to choose from when planning the imaging curriculum. Topics can range from the very beginning of philosophers recording observations about imaging and images focused on a flat plane, as with the camera obscura, to the current and future technology of digital cameras and output with color management. Deciding which topics are most relevant is a daunting and crucial task for course and program developers. In addition, possible teaching methods cover a wide gamut as well. The technology classroom presents unique challenges and opportunities for education. Choosing a lecture vs. hands-on format, having students working in groups vs. individually, these are choices to make for the best teaching practices possible. In addition, with so many students having previous experience with digital and sometimes traditional imaging, it is important to identify and incorporate their previous knowledge into the course. The issues and suggestions for implementation of digital imaging courses will be presented based on the experience of developing and teaching them at the University of Northern Iowa.

Major Points:

- The history of photography – how much is relevant to teach now? Balancing historical and contemporary topics.
- Photoshop – are we teaching software or something more? What happens when the tools change (and they will!)?
- Accreditation and advisory boards – how much guidance can we use?
- Engaging students – how do we best teach our "digital native millenials"? What do they bring to the course from their own experience?

Summary: Participants in this presentation will be shown the decision-making process utilized when planning and/or revising a Digital Imaging course within a Graphic Technologies program. Presenter will discuss the many considerations for topics and methods of teaching. Participants will be invited to share their own challenges and successes for teaching digital imaging.

Trends in Media Convergence

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Need: This presentation is needed to discuss the trends in the visual communication technology industry related to cross media demands. These trends have a significant impact on education and the scope and sequence of curriculum. Many times programs add on courses or learning outcomes to try to address specific issues but do not accomplish the desired results. This presentation will identify a plan for proactive curriculum development to address media convergence.

Overview: Traditional programs related to print, photography, interactive media and video have done an outstanding job preparing professionals for those respective fields. However, the evolution of the internet, new hardware and software in these industries has mandated that students be prepared to work in a cross-media environment. This presentation will address the state of media convergence, how to break down the borders between visual media in coursework, helping faculty adapt to cross-media, continuing education for faculty, and to discuss prime industries that demand and utilize media agile professionals.

Major Points:

- Defining media convergence in visual communication technology
- Industry evolution affecting print, web, photo and video
- Industry expectations for future employees, managers and leaders
- Examples of curriculum modifications to meet current and future learning outcomes

Summary: Over the last 15 years, the industries related to visual communication technology have changed. Instead of only addressing the knowledge and skills of specific visual media such as print, video, interactive media or photography, it is important that students are able to work in a cross-media environment. Curriculum must address these needs and work across the visual media tracks to create a new "culture" of visual communication technology.

Incorporating the Smartphone into our Graphics Programs

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Need: This presentation focuses on using a barcode scanning application on a Smartphone. Scanlife is the software application used for this technology. Scanlife allows you to incorporate barcode readers in your technology program and turns your camera phone into an all-in-one bar code reader so it is easier than ever to quickly access websites, product pricing, and to read barcodes.

Overview: A barcode is an optical machine-readable representation of data, which shows data about the object to which it is attached. Originally, barcodes represent data by varying the widths and spacing of parallel lines, and may be referred to as linear or 1 dimensional. Later they evolved into rectangles, dots, hexagons and other geometric patterns in 2 dimensions (2D). Although 2D systems use a variety of symbols, they are generally referred to as barcodes as well. Barcodes originally were scanned by special–optical scanners called barcode readers; scanners and interpretive software are available on devices including desktop printers and Smartphone.

Major Points:

- Barcode Background
- Scanners Barcode Readers
- Benefits
- How you turn a camera phone into a bar code reader
- Scanlife Software
- Importance of incorporating scanners barcode readers in your technology program

Summary: This will be a demonstration on how to scan to launch a mobile website using a barcode application with the use of a Smartphone. The objective of the presentation is to increase the visibility of information.

Is the Printing and Publishing Curriculum Servings the Needs of the Students Today?

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Need: The purpose of this project was to discover whether or not today's printing and publishing curriculum prepares students for the changing printing workforce. In this research project the current courses in the Printing and Publishing department was examined to determine which learning objectives best fits the industry today and in the future. As the printing industry changes with new technology and companies converting to digital presses, skill sets of the past are becoming obsolete. With these skills slowly fading away, companies are training and looking for employees who can lead the company in the 21st century.

Overview: The expansion of digital services and value added services such as variable data printing (VDP), website design, graphic design, and digital asset management (DAM) has opened and will continue to open up opportunities for employees with these skills. Many companies, and usually the more successful companies, train their employees in areas where it is needed, but some do not have the capability due to budget constraints. A survey was constructed and distributed to various printing firms both digital and non-digital that asked questions about skill sets, importance of different printing workflow procedures (pre-press, press, post-production), and hiring trends. Along with conducting the survey, research was conducted on digital printing trends and proposing curriculum changes for the program using the data collected from the survey response. As the printing industry changes with new technology and companies converting to digital presses, skill sets of the past are becoming obsolete. The following is a list of topics covered in the research: Need for the Study; Purpose; Literature Review; Methodology; Results; Discussion and Conclusion; Recommendations

Summary: A discovery of the job areas that are most lacking in highly skilled employees and make sure that the curriculum emphasizes these areas needed to be researched. It is hope that the graduates of the program will have a competitive advantage upon graduation thus making them more marketable. In order to compete in this ever-changing industry, the departments and institutions need to look ahead to the future to prepare leaders in the field.

Undergraduate Research in Visual Communication Technology

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Ms. Colrain Zuppo
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Need: This presentation is needed to identify and discuss current and future topics for research in visual communication technology and the involvement of undergraduate students. Research topics in the industry range from the technical, aesthetic to process issues. Involving undergraduate students in systematic research is essential to their future careers in order that they may apply good research practices in technology management including such topics as technology forecasting and assessment.

Overview: This presentation will present a rationale for teaching a research course within a visual communication technology program. Data gathered from over 60 undergraduate students will identify topics that both interest them and are reflective of their vision of print, photography, video and interactive media. Data gathered from industry professionals about their expectations regarding a graduate's ability to conduct and apply systematic research will also be discussed. A suggested topic outline for a course will be shared and examples of student research will be presented.

Major Points:

- Areas of research undergraduate students have identified and studied
- Research being conducted and documented in the visual media literature
- Industry expectations for ability to conduct research in future employees
- Outline of topics and content for an undergraduate research course
- Highlight Research Poster Fair for articulation of research ideas

Summary: The ability of alumni from programs related to print, photography, video, and interactive media to conduct research is increasingly important. Conducting systematic research to solve visual media problems is a very attractive addition to students' knowledge and skills in designing, producing, implementing and evaluating visual communication media. Utilizing a successful course plan will make teaching research both effective and enjoyable.

Sustainability for Printing and Packaging

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Need: The topic of sustainability is both timely and an important component of the printing and packaging industry. Whether this topic is integrated into current courses or taught separately, it is required content that students must have when entering the industry. The topic is quite broad and extensive and it is important to identify the most relevant aspects including economic impacts, certifications, company culture, design and future research for graduates.

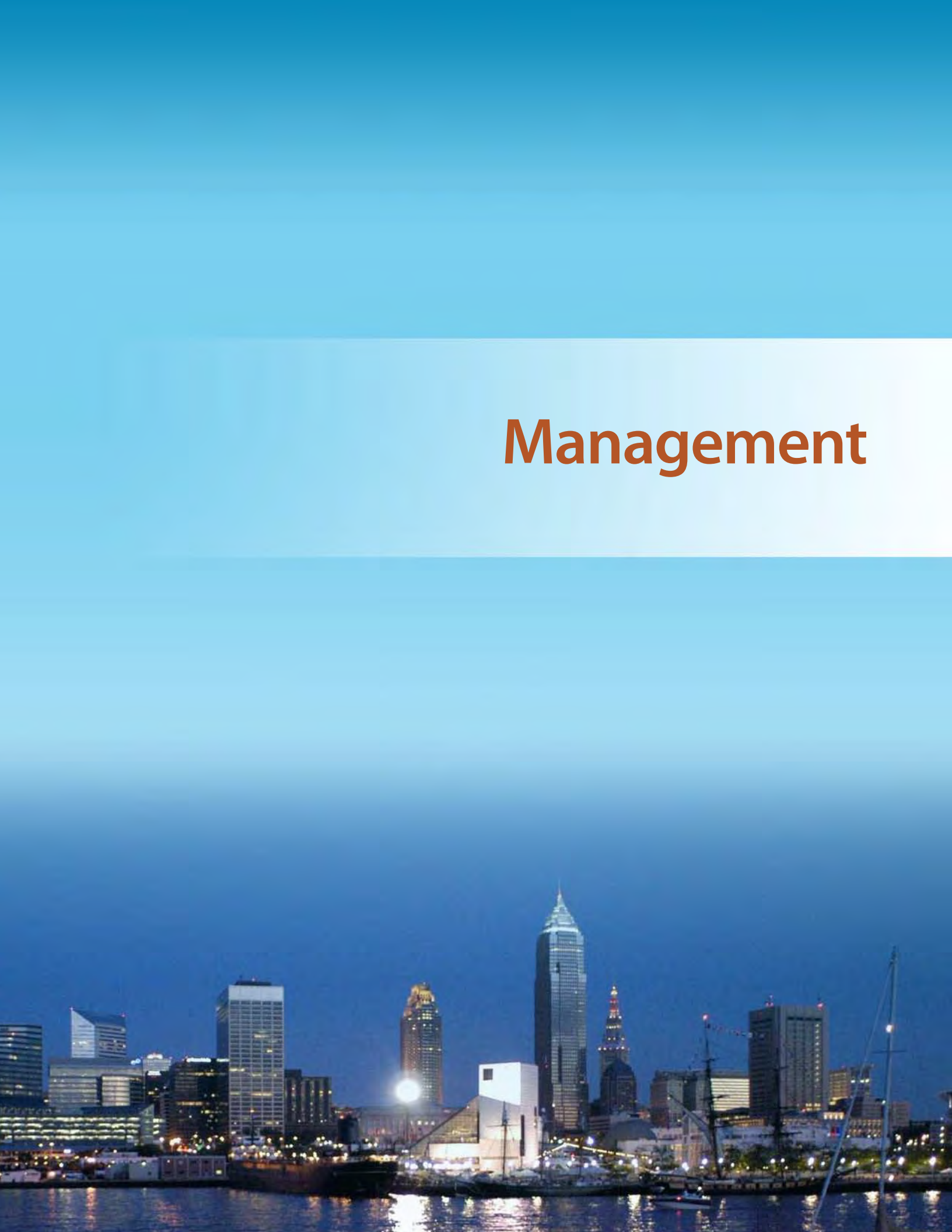
Overview: This presentation will propose a suggested topic outline for an advanced course in Sustainability in Printing and Packaging. Examples of reverse engineering sustainable packaging projects will be presented and discussed. Data from graphics industry professionals as to requirements for new employee knowledge regarding sustainable practices will be addressed. Involving industry professionals, environmental studies faculty, recycling managers and other technology faculty is a key to a successful, effective course.

Major Points:

- To define the scope of sustainability in printing and publishing
- Discuss certifications of sustainable printing and packaging
- Discuss trends and industry challenges of sustainable practices
- Demonstrate examples of reverse engineered sustainable packaging projects
- Present data from industry professionals' perspectives

Summary: The ability of alumni, from programs related to print, to understand and lead organizations in the sustainability area is increasingly important. Faculty must be able to address the integration of sustainability into the curriculum to help students become relevant to the industry from which they will be seeking employment. Graduates will be integral to the successful management and implementation of sustainable practices and ultimately result in economic impact.

Management



Why Productivity Matters? An Overview for Productivity Concepts and Measurements

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Need: Productivity is a required tool in evaluating and monitoring the performance of all business sectors. Productivity is an overall measure of the ability to produce a good or service. Productivity measures provide a means to managers to ascertain, plan control and improve efficiency at different levels of organization. This helps manager set improvement targets and goals for organization's long term strategic plans, and in developing suitable competitive strategy. Managers are also concerned with how productivity measures relate to competitiveness which also facilitates comparison of performance of different companies within a market or manufacturing. Productivity is usually expressed in one of three forms: partial factor productivity, multifactor productivity, and total productivity.

Overview: Productivity is used to assess the extent to which certain outputs can be extracted from a given input. We can measure productivity for a single input resource such as manpower used, or for numerous resources. There can be many different types of productivity measurement depending on the type of resources considered. Some of the most common types of productivity measurements include labor productivity, capital productivity, and material productivity.

Major Points:

- Productivity is a measure of output from a production process, per unit of input.
- Productivity of an organization is defined as the ratio of outputs produced by the organization and the resources consumed in the process.
- Companies can increase productivity in a variety of ways. The most obvious methods involve automation and computerization.
- Productivity measures are key indicators of economic performance and there is strong interest in comparing them internationally.
- Efficiency improves when the cost of inputs used is reduced relative the value of output.

Summary: Productivity is not just important for good performance in all organizations – they are essential. No organization can continue to operate for long without using some productivity measures, and their performance is influence by the nature of productivity measures used. Productivity measures are also vital for motivating employees through payment of incentive for great productivity. The authors of this paper are seeking to make clear on how productivity is an objective concept that not only can be measured, ideally against a common standard but can be used for strategic reasons such as project control or controlling performance to budget.

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Toward a Technology Management Core: Defining What the Technology Manager Needs to Know

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Need: The Association of Technology, Management, and Applied Engineering (ATMAE) sets standards for academic program accreditation, personal certification, and professional development for educators and industry professionals involved in integrating technology, leadership and design. However, ATMAE accrediting standards do not specify a management core; only a range of required hours. In addition, the content for the Certified Technology Manager exam is not well-defined or aligned with accrediting standards. What is the relationship between accrediting standards, CTM certification, and recognized management principles?

Overview: Management courses are what distinguish 4-year programs from 2-year programs across ATMAE accredited programs. It also distinguishes the discipline from pure engineering programs (i.e., mechanical, electrical, civil, etc.). The presentation will discuss current research on technology management and explain the ATMAE technical management core as defined by the Management Division. The Division membership recommends technical management standards for accreditation and certification. The standards answer the questions:

- What do technology managers need to know in their day-to-day activities?
- What are the competencies that all entry-level technology managers should possess?
- The management core model includes entry-level generic competencies within a category of knowledge for a specific managerial context. The competencies are applicable to systems, operations, processes, or projects and linked throughout by accepted leadership principles.

Major Points:

- Published research on technology management principles and skill sets
- The ATMAE Management core
- The management core, accrediting standards, and the CTM exam
- Future plans and challenges

Summary: What is the relationship between accrediting standards, CTM certification, and recognized management principles? Attendees will review and discuss the alignment of research with a core set of management principles. The principles will be compared to current ATMAE accreditation standards and CTM certification.

Teaching Sustainability as a Technology System

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Need: All industries including the construction industry is requiring critical thinking, leadership skills and knowledge of green/sustainable practices. These areas are challenging to teach, but we must also be able to teach our students how to manage these issues after they graduate, similar to how they will manage other technology systems such as safety and quality. The basic steps in safety and quality management also pertain to sustainability management, it is just a matter of degree- how to identify and quantify what the clients/owners want, and how the designers, contractors and suppliers will achieve these criteria or goals.

Overview: How faculty can incorporate safety and quality management teaching techniques into sustainability management program course.

Major Points:

- Technology systems and what is involved, including why safety, quality and sustainability can be managed similarly.
- Basic green and sustainability issues and how they can be managed and taught in a management course.
- Examples of Sustainability forms and procedures
- Options and materials for general sustainability courses, with a focus on construction as an example.

Summary: This presentation will introduce the newest technology system and summarize "Sustainability Management" and how it can be taught similar to Safety and Quality Management. It will also discuss appropriate courses where sustainability management discussions can be included, and the instructional materials and options available for faculty.

Application of System Dynamics and Agent-Based Modeling to Supply Chain Simulation

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Need: Supply chain management is a complex task due to the involvement of many different players at various levels. Because of their broad scope, modern day supply chains are difficult to model using any one single modeling approach. There is a need to combine the strengths of various modeling approaches including system dynamics and agentbase modeling in a hybrid approach that can capture the complexity of today's supply chain networks.

Overview: In this paper, we present a hybrid modeling approach to supply chain simulation. The hybrid approach is based on the integration of system dynamics (SD) and agent- based modeling (ABM) paradigms. SD modeling simulates dynamic behavior of complex systems through their feedback structure. On the other hand, ABM simulates individual agents and their interactions with the goal of examining their effect on the system as a whole. In the hybrid modeling approach, supply chains can be modeled with a macro-level and a micro-level of aggregation. At the macro level, ABM is used to model interactions between individual companies in the supply chain. At the micro level, SD modeling is used to model the internal structure of individual companies. Anylogic multi-method simulation modeling tool is used for the hybrid modeling. Applications of the new approach are demonstrated using a prototype supply chain model. The strengths and limitations of this integrated approach are also discussed.

Major Points:

- Discussion on ABM and SD modeling paradigms.
- Overview of AnyLogic simulation modeling tool.
- Modeling of a prototype supply chain.
- Visual demonstration of the simulated model.
- Discussion of simulation results.

Summary: The focus of this paper and the presentation is on the integration of system dynamics and agent-based modeling for supply chain simulation using AnyLogic modeling tool. The presentation will be of interest to industrial engineers and supply chain managers, who manage complex supply chain management tasks in their respective organizations.

Lean Health Care: It's an Emergency!

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Need: Manufacturing has been applying lean and Six Sigma principles, and many other management decision making tools for a number of years. The Institute for Healthcare Improvement believes that lean principles can be — indeed, already are being — successfully applied to the delivery of health care. One such example is how Essentia West Region Health Care (Essentia West) , Fargo, ND, a local provider of health care services applied lean six sigma principles to their Emergency Room Hospital Admission Process. Essentia West provides standard health care services through 5 hospitals and 21 clinics in North Dakota and Minnesota. As Essentia West and health care in general, prepares for an unknown future, many of the principles applied in Industrial Technology are helping them create a lean, efficient, cost effective business model/work environment. Because of this upsurge in process improvement in the health care industry, this also provides an opportunity for Technical Management and Operations Management 4-Year programs to expand their manufacturing based curriculum to include the health care industry.

Overview: By applying solid leadership principles, lean and six sigma principles, and various other process improvement tools, Essentia West changed their emergency room hospital admissions wait time from 1hr 43 mn (Industry Standard is 1hr 40 mn) to 43 minutes. A patient that normally would lie in an emergency room cart up to 1hr43mn after the doctor made the decision to admit to the hospital is now comfortably in his/her room in less than 45 minutes. This not only improved patient satisfaction; it increased revenue by increasing the number of open beds and patients seen. This is all occurring in an industry that is speckled with many unknowns—unknown government legislation, changing patient demands, ever increasing competitive landscape, and staffing shortages. In addition, because of the need for the right talent with the right technical management and process competencies, Essentia West and MSU-Moorhead ATMAE accredited Bachelor's of Science Operations Management program have worked together to match MSU-Moorhead's Operations Management curriculum to Essentia West's hiring needs.

Major Points:

- Essentia West will share best practices, lessons learned, tools used, desired employee competencies during the planning and implementation of their Emergency Department Hospital Admissions Process Improvement Project
- MSU-Moorhead Operations Management Program Coordinator will share how they are partnering with Essentia West to map their Bachelors of Science in Operations Management curriculum to create graduates with the talent desired and hired by health care

Summary: Attend this presentation to learn about: a) Lessons learned, best practices, and tools utilized when Essentia West applies to process improvement initiatives, b) Competencies desired by Health Care in Technical Management and Operations Management graduates, and c) How MSU-Moorhead's Operation Management program is partnering with Essentia West to apply the guidelines from the ATMAE accreditation curriculum foundation requirements to create graduates that are in high demand in the health care industry.

Organizing Organizations, Products and People

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Need: Businesses that are aiming to become world-class organizations need to organize themselves well to get the benefit of synergy and innovation from its workforce. Not only do organizations need to give deep thought as to how they organize their products and personnel, but they also need to show logic and innovation in how they organize their departments and divisions. This applies equally well to for-profit and not-for-profit business entities. New businesses that keep adding personnel, products or divisions without a system-wide perspective, tend to allow their organizational structures to evolve rather than be designed. Evolution without intelligent design of the structure, leads the organization into chaos and confusion due to the redundancy, duplication and ambiguity that results from the evolution.

Overview: The mathematical principle of "mutually exclusive and collectively exhaustive (MECE)," that is a key element in the mathematical field of probability can be utilized to help organizations organize products, personnel, departments and divisions. Using MECE, an organization can assure that any new entity added to an existing list consisting of products, personnel or divisions is mutually exclusive and collectively exhaustive. In classification or analysis, the ME part of MECE avoids the risk of double counting and the CE part of MECE avoids the risk of overlooking. Doing so maintains the sanctity of the entire classification scheme utilized for structuring, and can reduce the need to cater to off-rule requests for special or sub-grouping. Utilizing case studies the concept of MECE will be explained and how organizing can utilize it to organize themselves, products, and people will be demonstrated.

Major Points:

- Avoiding chaos in classification
- The concept of Mutually Exclusive and Collectively Exhaustive (MECE)
- Applying MECE to products
- Applying MECE to organizational structures

Summary: Attendees will understand how the concept of MECE can be utilized to structure and partition databases consisting of products, personnel or divisions, so that a holistic overall view is always maintained when adding new entities to the old order of things.

The CTM Exam: Revised, Restructured, and Rejuvenated

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Need: The ATMAE Certified Technology Manager (CTM) exam was developed over a decade ago and during this period of time it has only undergone a few minor updates. As an association changes its name, purpose, and vision to be more reflective of the demands of a global society so must its professional certifications. A certification exam must stay abreast of its content area to maintain its validity and reliability as a means of assessment.

Overview: This presentation will focus on the extensive revision process that was performed on the Certified Technology Manager exam. A detailed explanation will be presented on how and why this process was conducted as well as a quick overview of additional content covered by the exam.

Major Points:

- Purpose of exam revisions
- Method used for revising exam
- Process for validating exam revisions
- Overview of revised exam content

Summary: After more than a decade since its inception, the ATMAE Certified Technology Manager exam underwent an extensive revision to realign its assessment goals with the current needs of industry. This presentation will highlight the revision process and how this certification can be generalized to a larger number of programs presently accredited by ATMAE.

Measuring the Relationship Between Employee Trust and Quality Decision-Making

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Need: Quality is one of several workplace goals and several factors influence the quality climate of an organization. One factor believed to play a role in quality climate is trust. Although limited research has examined the relationship between trust and quality climate, no previous inquiry has examined the role worker trust levels play in quality-related decision-making in a workplace setting. Because workplace quality outcomes depend heavily on the decisions made by employees, an understanding of the factors which influence the decision-making process of employees is an important component of workplace quality initiatives.

Overview: This presentation will discuss the interactions between trust and workplace quality climate. In addition, the methodology used by researchers to measure the relationship between employee trust and the quality-related decisions made by employees in a workplace environment. Data findings will be shared along with implications for managers, policy-makers, and researchers as they relate to the development of workplace quality initiatives.

Major Points:

- Relationship between trust and quality climate
- Quality decision-making as defined by this study
- Measuring the relationship between trust and quality decision-making
- Summary of data findings
- Implications for managers, policy-makers, and researchers

Summary: The audience will learn the role of trust in quality related decision-making as measured in a workplace environment. Information from this presentation may assist managers, policy-makers, and researchers as they develop quality initiatives for the workplace.

Development of a New Graduate Course in Supply Chain Sustainability and Security

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Need: Rapid change in the global economy and environment have necessitated new priorities, processes, and standards for industry and government in dealing with domestic and international supply chain sustainability and security. Supply chain management (SCM) may be defined as "all activities associated with the flow and transformation of goods from the raw materials stage, through to the end user, as well as the associated information flows. Materials and information flow both up and down the supply chain. SCM is the integration of these activities through improved supply chain relationship, to achieve a sustainable competitive advantage" (Handfield & Nichols, 1999). There is a high need for graduate students in technology to stay abreast of the advanced approaches to supply chain sustainability and security.

Overview: This presentation will outline a new course that presents new industry and government approaches to supply chain sustainability and security. Course content, instructional strategy, and expected learning outcomes will be covered.

Major Points:

- Need for graduate education in supply chain sustainability and security
- Key definitions used to develop curriculum and design instruction
- Sustainability concepts may be applied to the supply chain by considering the need for "triple bottom line" performance (Elkington, 1998); the relationships between economic, social, and environmental responsibilities.
- Supply chain security must also consider triple bottom line performance while considering the security of infrastructure, facilities, carriers, people, cargo and information used in supply chain management.
- Graduate level instruction based on problem-solving instructional strategy.

Summary: This course will cover all three areas of sustainability and the metrics for measuring sustainable practices in industry. Students will discover how to transform an organization into a long-term profit institution through case studies, current events, and structured reading materials. The importance to educate our future leaders on practices and metrics of sustainability is critical for industry. This course will serve as a starting point for students to dive farther into their research studies on the different ways to secure and sustain a firm's supply chain.

Engineers Are Needed, Yeah! But What Kind?

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Need: Frequently it is portrayed in the media that the US is not producing as many engineers as the rest of the world. Statistical studies show that compared to other nations the US is falling behind in the development of engineering professionals. What is the truth behind those numbers? Are foreign engineers as good as or even better than those produced in America? What does this mean for US productivity and our competitiveness in a global economy?

Overview: Industries around the country state that they cannot find the right "people" to develop and manage complex high-tech processes in their plants. Every year thousands of engineers graduate in the around the world; but, are they all the same? Are we creating dynamic or transactional engineers? Why are the terms business savvy and entrepreneurship so unrelated to engineering education, but frequently considered needed in this discipline? How do we make our engineers capable not only of developing "critical thinking", but also entrepreneurial skills?

Major Points:

- Why global statistics in engineering graduation rates are not trustworthy
- Understanding the need of creating the "right" engineers
- Global competition requires skills beyond the typical engineering curriculum
- Entrepreneurial engineers that create job opportunities have higher impact

Summary: Understanding the needs of our society will help us create the "right" type of engineers. Comparing domestic and global engineering graduate numbers may not give a fair picture of the US competitiveness in this field. One thing is certain; our future engineers will need to become potential entrepreneurs in order to better align their skills with the needs of society.

Theory X vs. Theory Y Management Styles and Continuous Improvement

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Need: Numerous organizations have implemented continuous improvement initiatives and haven't realized benefits similar to those documented by other organizations who implemented the same initiatives. This paper will examine how the behaviors and perspectives of the managers and the characteristics of the entire organization play a major role in the success of continuous improvement efforts. It will analyze the continuous improvement success from the perspective of Theory X or Theory Y organizational characteristics.

Overview: In his book, "The Human Side of Enterprise," Douglas McGregor described the human behavior models that were coined Theory X and Theory Y. From these theories, management practices and organizational behaviors were categorized. This paper discusses the results of a survey of managers of companies in northeastern and southeastern United States. The paper will discuss an analysis of the relationship of organizational characteristics and organizational perspectives with continuous improvement efforts.

Major Points:

- The characteristics of Theory X and Theory Y organizations
- The characteristics of Theory X and Theory Y management styles
- Correlation of Theory X and Theory Y organizational characteristics and behavior with continuous improvement success

Summary: Attendees will understand the impact of management styles on the success of any continuous improvement initiative. This paper will discuss the analysis of data from a survey of managers to determine if there is correlation between the Theory X or Theory Y management style and the success of continuous improvement efforts.

A Reliability Analysis of an Automotive Suspension Component Line

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Need: Understanding the reliability of automotive related assembly lines is important for several reasons. The competitive nature of the automotive industry extends to the productivity of the manufacturing processes. Poor reliability can lead to the added cost of overtime production, or in the worst case, an OEM may be shut down resulting in very expensive line shut down penalties.

Overview: This analysis covers reliability of an automotive assembly line producing suspension components. Operating times between failures are collected and analyzed using descriptive statistics. The Mean Time between Failure (MTBF) is calculated as well as is the failure rate utilizing several confidence intervals. Such analysis enables manufacturers to calculate the risks related to breakdowns, as well as to establish a baseline against which continuous improvement activity can be measured. In addition to assessing the reliability for the multi-station assembly line, this study graphically calculated the MTBF for one particularly troublesome assembly station. Continuous improvement efforts are more successful when focused on the most troublesome areas, a form of employing the pareto effect.

Major Points:

- Analysis of automotive manufacturing processes is important
- Distribution of time between failures are typically skewed
- MTBF and failure rates are important reliability parameters for assessing compound assembly lines
- Graphical assessments using exponential plots and Weibull plots are useful for assessing individual assembly stations where the failure modes are likely the same
- Infant failure modes and typical operating failure modes can coexist in a single station requiring a separation before analysis

Summary: Attendees will be exposed to an example of a reliability study conducted in an automotive component assembly line which might be used as a benchmark approach in similar assembly lines.

Manufacturing

Increasing Technology in Higher Education Leads to a Resurgence of Manufacturing in the US

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Need: In the last several years manufacturing system integrators have been playing different roles not only at local level, but also regional and national to become global players in the different markets. Due to the globalization, and technical advances in automation technology, manufacturers need to integrate and utilize production equipment from different vendors, nationalities and continents in order to remain competitive. In order to do this the organizations are going to need highly trained individuals that are comfortable working with systems that are not "off the shelf" systems. The use of flexible manufacturing systems that allow the organizations to grow with their customers' needs requires skills in integration, automation technology, and cutting edge manufacturing, including fluid power, robotics, sensor technology, PLC controls and network communications.

Overview: The Ogden College of Science and Engineering Consortium for Automation, Robotics, Simulation, and Animation at Western Kentucky University (WKU) was designed to be the region's premiere facility for offering cutting edge education, research, and workforce development opportunities in automation, robotics, simulation, and animation. As such the facility is crucial in the development of student learning outcomes that will benefit local companies, regional industries, and US manufacturing.

Major Points:

- Applications of robotics in manufacturing;
- Applications of automation in Computer Integrated Manufacturing (CIM);
- Applications of simulation and animation related to product design, systems design and integration, and manufacturing operations;
- Engineering and foundational design of robots.

Summary: In order to ensure that modern manufacturing can be competitive in the global workplace will require persons from several disciplines to work together in teams. The consortium will recreate this working environment as it educates students to become globally competitive in each of thematic areas of computer science, engineering and manufacturing technology.

Reverse Engineering Using 3D Scanning and Direct Data Input from Digitizing Arms Directly into Solid Modeling Software

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Need: Reverse Engineering has traditionally been a time consuming, laborious proposition with as much effort spent using measuring tools to capture size, shape and location as re-engineering the part and preparing the drawings. 3D scanning produces point clouds that have to be manipulated to be converted into mesh data that has to be "cleaned-up" before being used. New software allows data captured directly from a portable coordinate measurement machine to be used to automatically create 2D and 3D parametric features from within the solid modeling software.

Overview: Reverse Engineering is the practice of measuring and recreating the geometry of a physical object. The collected geometry is used to create copies of the originals, as the basis for the development of alternate configurations of the object, or to develop new objects that interface with the reverse engineered object. New software allows the user to simply digitize critical information directly into parametric software where the digitized data is used to "build" 3D parametric parts that can be easily modified.

Major Points:

- Data from 3D part scans require a lot of "post-processing"
- New software allows for the direct capture interactive editing and creation of sketch entities where data can be easily added or subtracted
- The software converts the digitized data to geometric elements that are parametric, fully editable, and conform to the feature-based intelligence of the modeling software being used

Summary: Participants will see how to use software and hardware to directly capture part geometry and simplify the process of reverse engineering. In the past a drafter would have spent an enormous amount of time manually measuring the part and its' features to produce working drawings. Now as you use the software and coordinate arm to capture the size and location data, a fully parametric 3D model is built. That 3D parametric model is very easy to modify and extremely easy to extract drawings. Finally the 3D virtual model can be used by the quality department to compare manufactured parts to the intended design.

Explore the Benefits of Virtual Reality Technology Supported by Industry Partner for Manufacturing Technology Education

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Need: Virtual Reality (VR) uses immersive technologies such as head-mounted display or CAVE systems so that the user can visualize and interact with objects in a simulated 3D environment. Due to the technological advances in the recent decade, VR has become an important tool for many applications. For example Virtual Reality can be used in manufacturing as a virtual tool to simulate production process in a virtual environment so as to reduce prototype cost and product lead time. VR is also associated with education purposes to assist students' learning process. One of the advantages of VR is that meaningful knowledge can be acquired through interaction which will increase students' participation and performance on projects and assignments. Therefore, VR is a promising technology that technologist should be aware of.

Overview: In this presentation, the general trend of VR technology and its industrial applications particularly associated with Virtual Manufacturing will be discussed. And also the impact of VR on education and learning process of students will be analyzed through an assigned project to a group of undergraduate students in the Industrial Technology Department at University of Northern Iowa (UNI). The students will be assigned a prototype modeling project using CAD software. The generated CAD model will be loaded into a VR lab owned by a Midwestern manufacturing company in the community. Student participants will review their design in VR environment and report their experience and thoughts on how VR affect their learning process.

Major Points:

- Trend and applications of Virtual Reality with the focus on Virtual Manufacturing
- Hardware and software used in Virtual Manufacturing today
- Case Study: undergraduate VR project supported by a local industry and impacts of VR technology on students' learning effectiveness.

Summary: Integrating VR technology to manufacturing and education is a very important strategy in today's business and education environment. Analyzing manufacturing processes in simulated environment has provided tremendous benefits to manufacturing companies. Also schools, colleges and universities can be benefitted from using this technology. Attendees will understand current developments and advantages of VR technology and its application in manufacturing with the supportive case study.

An Energy Systems and Sustainability Course for Manufacturing and Construction Engineering Technology Students

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Need: Energy sustainability is fast becoming an integral part of many academic disciplines, including Manufacturing and Construction Engineering Technology. The U.S federal government, state, and local agencies are establishing new policies aimed at reducing dependence on fossil fuels as well as net energy consumption by communities, businesses, offices, schools, homes, and other facilities. Even at current levels, today's energy systems pose harmful effects on human health and the environment. It has been predicted that in the next ten years, up to five million "green" jobs will be created in the energy sustainability industry, particularly in manufacturing, construction, and operations. Thus, there is a pressing need for engineering technology students, particularly those majoring in manufacturing and construction, to be trained in a course aimed at preparing them to be future leaders in a workforce where they will contribute toward potential solutions for energy efficient technologies.

Overview: There is a growing number of emerging renewable energy technologies that can play a beneficial role in modern and long-term energy systems. A course in Energy Systems and Sustainability will be based on a combination of lectures, laboratory experiences, computer simulations, and field testing that cover these technologies. Topics to be covered include Energy and Sustainable Development, Energy Storage, Building Systems (Green Buildings), Photovoltaic Devices and Systems, Solar Thermal Applications, Wind Energy, Geothermal Systems, Net Metering and Electricity Network, Installation, Testing and Maintenance.

Major Points:

- Develop a strong understanding of Energy Systems for a Sustainable Future
- Design and install renewable energy systems, such as photovoltaic devices
- Future role in policy-making for improvement of commercial, industrial, and residential facilities.
- Implementation of advanced technologies for increasing U.S energy sustainability.

Summary: Engineering Technology has a key role to play in energy and environmental sustainability in the U.S economy. A course in Energy Systems and Sustainability will focus on current and future energy needs of society. Engineering Technology students who complete the course will be adequately prepared to enter the energy and sustainability workforce where they will be expected to introduce new and relevant skills necessary to deploy environmentally-friendly technologies while maintaining or retrofitting aging infrastructure. It is expected that students who complete this course will have the necessary background to create new jobs and thereby contribute to the U.S economy.

Quality Integrated Manufacturing Systems Planning for Satisfying Global Market Requirements

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Need: Manufacturing is the most crucial business unit of a supply chain (SC) for transforming inputs into outputs as expected by the customers. Manufacturing creates difference in the marketplace by developing products of right quality, required features and competitive pricing, ensuring delivery lead time. In today's globalized business process, cost criterion comes only after a customer agrees to buy based on product quality, if the product includes the entire desired feature. Although the final selling transaction is cost-based, this fact is overshadowed by quality-based decisions and the mindset of the customer. As such, manufacturing system for a product should be designed integrating quality metrics as desired by the market. The SC managers should identify manufacturing operation attributes that are responsible for the desired product quality metrics. The SC should then evaluate the capability of the manufacturing plants by considering all relevant attributes and metrics. Based on this evaluation, the SC should assign production only to a quality-capable plant in order to ensure quality products, as expected by the market.

Overview: The research will outline importance of products and services quality in the customer satisfaction and decision-forming process in today's globalized market. It will also define manufacturing operations attributes and relevant performance metrics that are responsible for ensuring product and services quality in the marketplace. Based on multidimensional quality attributes metrics and their desired performance set by a company, the research will develop a plant capability criterion. This quality-integrated plant capability criterion will facilitate SC managers in respect to assigning production exclusively to plants capable of ensuring quality products to the market. It will also assist plants and SC mangers in pinpointing quality attributes relevant to specific plant operations, when appropriate measures are called for improving performance. This research will clearly establish a mathematical model-based methodology for evaluating plant capability, considering the quality-based plant operation attributes. It will include a systematic procedure for defining attributes, relevant metrics and setting desired performance criteria for the entire set of these attributes.

Major Points:

- Importance of products and services quality in the current global market.
- Defining manufacturing operation attributes responsible for assuring product quality.
- Methodology and model for evaluating quality-based plant capability index.
- Quality system-integrated manufacturing system planning model.
- Carrying out if-what analysis to pinpoint factors requiring improvement

Summary: The research will present a new approach of defining and evaluating quality-based manufacturing plant capability criteria that can be integrated into the manufacturing system planning to ensure quality product in the global marketplace. It will facilitate SCs to be confident on their product quality and thus taking steps for overall business growth. The research will provide step by step procedure for applying the method in a generic manufacturing setting.

An Experimental Study on Reducing the Formation of Dross When Cutting 1018HR Steel Using a CNC Plasma Cutter

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Need: Maximizing productivity and minimizing material waste are essential for any manufacturer today. Plasma arc cutting is an excellent process to demonstrate how to improve the quality of the parts produced through the use of a statistical study. In this presentation I will explain the procedure used to improve plasma arc cutting to maximize the quality of parts produced with this process.

Overview: Modern CNC plasma cutters can produce very accurate parts for a relatively low cost. Large manufacturing companies, universities, job shops, prototype shops, and others have realized the benefits of cutting flat parts using the plasma arc cutting process. One of the biggest quality issues with plasma arc cutting is the formation of dross (re-solidified metal) on the cut edge. There are numerous operating parameters that are critical to maximizing the machine performance. This study examines those variables and identifies the critical machine settings that minimize the formation of dross on plasma cut parts.

Major Points:

- Defining the variables to examine
- Designing the experiment
- Statistical analysis of the data
- Results and conclusions of the study

Summary: Plasma arc cutting has many uses in industry today. Like many manufacturing processes, careful control of the operating parameters is required to optimize its performance. This presentation will demonstrate a study completed to improve this process.

Apply Lean Concepts to a Local Start-Up Business to Enhance Flexibility to Respond to Growth

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Need: Lean manufacturing is widely accepted and applied in well established manufacturing industries. The tools of lean, such as 5S and Value Stream Mapping can also be effectively used in a start-up processing business. This paper introduces a student project in which the principles of lean and several tools were used to improve service and production of a local start-up business in our community. This project not only helped students to acquire a deeper perceptive in lean manufacturing, but also verified the application potential of lean concepts in a start-up company.

Overview: The core of lean is founded on the concept of continuous product and process improvement and the elimination of waste. Lean is about doing more with less waste. Lean is the set of tools that assist in the identification and steady elimination of waste. Examples of such tools are Value Stream Mapping, Five S, and mistake-proofing. In short, lean manufacturing is an undertaking to eliminate waste, provide useful measures and balancing production with demand.

Major Points:

- Start-up companies do not have well established process flows.
- By clearly defining value for a specific product or service from the customer's perspective, all non- value added activities can be targeted for study.
- Lean is about eliminating waste and balancing production with demand
- Regularity of work station patterns reduces uncertainty, increase learning and improvement potential, and permits better planning and actions towards customer demands.
- Provide broad visibility to all employees of the Lean concepts in action.
- Foster employees' involvement and buy-in to improve the performance

Summary: Lean manufacturing concepts develop the process efficiency. The completion of lean manufacturing concepts at the College of Technology not only illustrated how lean concepts were introduced in the local business area, helping the students obtain a deeper understanding in lean manufacturing, but also demonstrated great application potentials of lean concepts in start-up companies. The authors of this paper are seeking to apply lean principles to all areas of organizations and validate the value of this approach for local start-ups in developing a successful strategy for success.

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Wangping Sun, Todd Yanagawa (2006) "Implementing Lean Manufacturing Concepts in Non-manufacturing Areas" Journal of Technology Interface. From http://technologyinterface.nmsu.edu/Spring06/

Manufacturing Mississippi's Graduates: An Assessment of Employability Skills as Perceived by Faculty & Final Year Students of Four-Year Manufacturing Related Degree Programs

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Need: Numerous research studies highlight a "skills gap" between the demands of employers and the level of workforce preparedness of university graduates. Despite current high unemployment rates, employers continually report an inability to find qualified workers. Today's workplace requires highly skilled professionals prepared to meet the challenges of increased global competition. Research studies indicate that new employees lack needed employability skills such as teamwork, decision making, and communication – just to name a few. Similarly, recent national and local findings suggest that graduates of Mississippi's manufacturing related degree programs may not be fully prepared to meet the needs of state manufacturers. Hence, this study seeks to determine the degree to which Mississippi's manufacturing related degree programs are adequately preparing students for the workforce by integrating employability skills in major coursework.

Overview: This quantitative study employs the "Survey of Employability Skills" instrument to obtain the perceptions of faculty and final year students of Mississippi's undergraduate manufacturing related degree programs. Data gathered is used to assess the integration of employability skills including teamwork, leadership, project management, and change readiness. Survey results assist in determining the following factors: 1) the level of importance for identified employability skills; 2) the competence level of students in performing the identified employability skills; and 3) existing strategies used to integrate employability skills into major coursework.

Major Points:

- Importance of Employability Skills
- Impact on the Manufacturing Industry
- "Survey of Employability Skills" results
- Strategies to Integrate Employability Skills in the Manufacturing Curriculum

Summary: The presenter will share survey results, experiences, challenges, and strategies to implement employability skills within manufacturing course work.

3D Parametric Design and Production Simulation in Manufacturing Technology Course

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Need: The application of advanced technology is not only limited to verifying and simulating the manufacturing system, but is also applied to product and process design, pilot model development, quality assurance, and cost analysis. This paper demonstrates how the manufacturing technology courses were modified to incorporate recent trends in 3D parametric design (solid modeling) and assembly simulation applications in the industry.

Overview: The manufacturing industry implemented 3D parametric design and assembly simulation as one of the vital tools for improving the manufacturing system, in order to produce higher quality products at a reasonable cost and within a reasonable time. This practice was extended after the industry recognized that the capability of the advanced technology is much greater than was previously thought. This paper shows how these aspects of visualization and simulation tools have been successfully implemented into manufacturing technology courses.

Major Points:

- Different aspects of 3D parametric design and assembly simulation
- Recent trend in the aerospace and automotive industry
- Modification of curriculum and lab activities: Hands-on and real life projects
- Work accomplished
- Feedback from the industry

Summary: The demand for technologists who are knowledgeable in and capable of using 3d parametric modeling and assembly simulation as a whole is growing rapidly. Our responsibility is to prepare our students with hands-on experience in advanced technology, coinciding with what the industry wants.

Virtual Manufacturing Simulation and Rapid Prototyping in Production Technology Courses: A Real Life Experience

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Need: The use of combination of virtual manufacturing simulation and rapid prototyping as a method of improving a production system has been a growing trend within the industry. The application of advanced technology is not only limited to verifying and simulating the production system, but is also applied to product and process design, pilot model development, quality assurance, and cost analysis. This paper demonstrates how the production technology courses were modified to incorporate recent trends in the industry.

Overview: The manufacturing industry implemented virtual manufacturing simulation and rapid prototyping as one of the vital tools for improving the production system. This practice was extended after the industry recognized that the capability of the advanced technology is much greater than was previously thought. The aerospace, automotive and shipbuilding industries have begun using virtual simulation in robotics, ergonomics, facility and process design, and product lifecycle management (PLM). This paper shows how these aspects of virtual simulation and rapid prototyping have been successfully implemented into a production technology courses.

Major Points:

- Different aspects of virtual manufacturing simulation and rapid prototyping: Parts Design, Parts Assembly, Robotics, Ergonomics, Facility Design, and PLM
- Recent trend in the aerospace and automotive industry
- Modification of curriculum and lab activities: Hands-on and real life projects
- Work accomplished
- Feedback from the industry

Summary: The demand for technologists who are knowledgeable in and capable of using virtual simulation and rapid prototyping as a whole is growing rapidly. Our responsibility is to prepare our students with hands-on experience in advanced technology, coinciding with what the industry wants.

Design, Manufacture and Utilization of a Low Cost CNC Router

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Need: In manufacturing concentration areas in technology, updated lab equipment is a high priority and difficult to acquire without large company sponsorships or alumni endowments. For universities located in nonindustrial rural areas, even exposure to modern manufacturing equipment via field trips is a challenge. In a slow economy, companies are hesitant to donate their resources of time or money for university undergraduate education needs. In manufacturing programs there is also a need for students to test CNC programs generated from CAD 3D modeling software to create prototypes or finished products using less inexpensive materials. The design, manufacture and utilization of a low cost CNC router is one solution to this dilemma.

Overview: Students in a senior project course have designed, manufactured and fabricated a CNC router with 36"x, 36"y, 8"z travel for less than $1,500.00 material costs compared to a similar commercial unit costing $4,000.00 or more. The CNC router was designed using the operating software called Mach3 that can run machining code post processed from tool paths generated in most CAD/CAM programs such as Mastercam or NX5. The CNC router operates a gantry for the x and y axis movement and a belt driven acme screw and nut for the z axis using 425oz.in. stepper motors and the Mach3 stepper motor driver board. The gantry travels on v-rollers and rails which are positioned using rack and pinion gears located on each side of the table.

Major Points:

- CNC Routers offer a low cost solution for teaching CNC technology.
- Machine code generated from 3D CAD/CAM software will produce accurate parts within .005" that can be used for visualization only or as final products.
- Router is constructed of aluminum plate, MDF and 8020 extruded aluminum.
- Safety precautions on the machine include (2) E-stops and (6) limit switches and 3/8" clear Plexiglas shield

Summary: Attendees will understand what is required to design, manufacture and utilize a CNC router for producing low cost prototype parts modeled using 3D CAD/CAM programs. Rapid prototyping or machining metal prototypes in a machining center can be prohibitive due to cost or equipment availability. So, a CNC router can be an inexpensive alternative for manufacturing programs to consider for part realization and/or a teaching tool for generating and operating CNC equipment.

Incorporating Sustainability in a Manufacturing Engineering Technology Program

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Need: Sustainability is becoming increasingly important in the industry and academe. Many employers now require their new employees/graduates to be knowledgeable about the subject. To make our graduates socially and environmentally responsible citizens, and more marketable to potential employers, the manufacturing engineering technology program at Ball State University is introducing sustainability into some of its courses such as plastics processing and fluid power.

Overview: There seems to be a strong perception in many quarters that global economic activities are not sustainable given the rate of consumption of non-renewable natural resources such as hydrocarbons, in particular, fossil fuel. For example, since land-based fossil fuel findings/wells are rapidly being depleted, there is a need to explore the deep seas for fossil fuel. Given this scenario, there seems to be a desire to promote sustainability in industry and academe. Along this line, Ball State University (BSU) has undertaken the installation of the largest geothermal energy project in the US. In the same light, aspects of sustainability are being incorporated in many of the Manufacturing Engineering Technology (MET) courses at BSU so that students can better appreciate the concept of sustainability. Specifically, in a junior level plastics course, students are working with a biopolymer, polylactic acid (PLA) and clay nanoparticles to make plastics products. The impact of these activities on the students understanding of sustainability will be shared with conference participants.

Major Points:

- Introduce students to the concept of sustainability by using hands-on activities.
- Teach students social and environmental responsibilities.
- Students gain valuable experience with polymer/clay nanocomposites.

Summary: This presentation will show that the concept of sustainability is viable in a manufacturing engineering technology program. Students are motivated to become active learners when motivated to become social and environmental responsible. Data supporting this claim will be presented at the conference. In addition, students with a good understanding of the concept and practice of sustainability are more marketable to potential employers.

Using Design of Experiment to Identify Material and Processing Variables that Impact Part Warpage in Injection Molding

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Need: The cooling process in injection molding of thermoplastics make up about 75% of the entire injection molding process. Consequently, identifying the material and processing variables and/or their interactions that significantly influence the cooling process is of utmost importance in understanding and optimizing the cooling process and in preventing part warpage. Many studies have investigated many aspects of the cooling process in injection molding, but none have incorporated the thermal diffusivity of the material in their studies. Thermal diffusivity measure how fast thermal energy travels through the plastics materials and thus affects the rate of thermal energy (heat) removal during the cooling process. Therefore in this study, the impact of coolant flow regimes, coolant temperature, injection back pressure, injection filling rate and material thermal diffusivity on the cooling process and part warpage have been investigated. The interactions among these variables on part warpage were also studied.

Overview: The injection molding of plastics parts consists of a series of events that include mold closing, injection of molten plastics into closed mold, cooling of molten plastics, mold opening, and ejecting of molded parts. Of these events, the cooling processes comprise 75% of the injection molding cycle time. Hence, optimizing the cooling process increases productivity of injection molding by reducing processing time while reducing or eliminating scraps caused by part warpage. To achieve this goal, design of experiment (DOE) has been used to identify the materials and processing variables that significantly impact the cooling process. This study is novel in the sense that it includes materials properties such as thermal diffusivity and amorphous/semi-crystallinity while considering process variables such as coolant flow regimes, coolant temperature, injection back pressure and injection filling rate. The impact of the interactions of the variables the cooling process was also investigated.

Major Points:

- Identity the impact materials properties play in the cooling process of injection molding.
- Use of DOE to study injection molding cooling process.
- Identify the process parameters and their interactions in prevention of scraps generation by part warpage

Summary: This presentation will show role materials properties and process variables play in the cooling process of the injection molding process. In most studies, the materials properties are often omitted even though they are integral part of the cooling process. This study seeks to identify the significant variables and to elucidate their influence on part warpage.

Re-Shoring: Returning Manufacturing to America

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Need: American manufacturing has been moving off shore for decades. Manufacturing remains a huge portion of the US economy and many believe our standard of living cannot be maintained if this trend continues. Specifically our loss of jobs to China has had a devastating effect on many industries as well as many towns and families. There are organizations studying the true costs of manufacturing in China compared to the US. One such group is Polymer Ohio Inc. whose mission is to grow Ohio's polymer industry. One area of study is to bring manufacturing back to Ohio from China known as re-shoring.

Overview: This presentation will discuss efforts being made in Ohio to re-shore manufacturing that has been off-shored to China. Many companies have already made this decision and others are considering this action. Issues being studied include: rising Chinese wages, increasing shipping costs, long supply chains and lead times, increasing material costs, technical support costs, change management and delays, intellectual property, etc.

Major Points:

- Overview of re-shoring study.
- Reasons companies are re-shoring manufacturing from China.
- Examples of organizations and products coming back to America.
- Future of re-shoring.

Summary: This presentation focuses specifically on re-shoring activities in the polymer industry in Ohio. However, these activities may be applicable across many industries and states. The manufacturing industry overall must increase in the US if our standard of living is to be maintained for our future generations.

Mass Customization: A Pathway to Agility

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Need: With the globalization and advancements in information technology the world has come much closer than ever before. Manufacturers are facing new challenges as competition has become global. Companies are waiting for opportunities to acquire market shares of their competitors. Consumers are demanding customized products with exceptional quality and high performances at prices which they consider is value for their money. Manufacturing companies are looking for winning strategies which would help them gain an edge over their competitors and are trying to achieve capabilities that would make them unique and difficult to copy. Companies are considering how to change their practices and competencies to be effective world-class competitors. To become agile or nimbleness to adapt to changing market demands has evolved as one of the key pathways to success.

Overview: Paul T. Kidd, renowned author in the agile manufacturing arena, defines agile manufacturing as the ability to thrive and prosper in an environment of constant and unpredictable change by bringing technology, knowledge, skills, resources and people around clearly identified market opportunities. Agility is all about quickly responding to changing market and customer demands. With significantly short product life cycles manufacturers can no longer compete if they produce goods in large volumes. One of the key competencies to achieve agility is the ability to mass customize an organizations products. This presentation is focused on mass customization manufacturing (MCM) and its implementation strategies.

Major Points:

- Overview and definition of Agile Manufacturing.
- Definition of mass customization manufacturing (MCM).
- Need for MCM and its benefits.
- Product design for mass customization (DFMC)
- Mass customized products and implementation strategy.
- How MCM relates to lean?
- The new buzzword "reconfigureability".
- Conclusions.

Summary: The presentation is aimed at educating the audience on underlying principles of agile manufacturing and how the concept of mass customization manufacturing (MCM) in specific could play an important role in achieving agility.

Evaluation of Artificial Neural Networks Learning Algorithms for Tool Condition Monitoring Systems

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Need: Computer Integrated Manufacturing (CIM) system has been referred as an ideal system to meet the current industry demands, diverse and customized design with the cost benefit of mass production. Among the many requirements for successful incorporation of CIM system, especially in metal cutting industry, monitoring the condition of manufacturing system is essential to achieve uninterrupted operation of system. Among the many conditions to monitor, the tool condition is one of the most important requisite to achieve the dimensional accuracy and surface condition of the product. Through the last decades, a number of studies were conducted in Tool Condition Monitoring (TCM) systems utilizing Artificial Neural Networks (ANN) and various sensor technologies. Many studies explored different ANN learning algorithms to predict or evaluate the tool condition by utilizing a range of sensor signals and machining conditions. However, there was no significant study to evaluate the learning algorithms that can provide an optimized performance in TCM system. This presentation provides results of a study comparing the performance of various ANN learning algorithms in TCM system.

Overview: This presentation provides overview of the experiment conducted and a comparison of various ANN learning algorithms for TCM system. The performance of each algorithm was measured based on ANN structure development time, the amount of residuals with limited iterations, and accuracy of tool condition prediction.

Major Points:

- Tool Condition Monitoring System
- Artificial Neural Networks
- Sensor and Signal Processing Technologies
- Learning Algorithms
- Multilayer ANN structures
- Iteration and Convergence of ANN System
- ANN Performance Measurement

Summary: Attendees will understand the need of TCM system, different ANN learning algorithms, the process of ANN structure development, and the new performance measuring method for ANN in TCM system.

Predicting an Optimal Die Shape Design in Bimetal Extrusion using Finite Element Analysis

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Need: In bimetal extrusion, the process variables seriously affecting core fracture include die semi-cone angle, volume fraction of the core, ratio of the flow stress of the core to the flow stress of the sleeve, friction factor, and the reduction in area. Among these variables, die shape optimization is one of the most important aspects in process design, since the rest of the variables may often serve as the constraints imposed by the customers' and manufacturers' need. This research focuses on a finite element-based approach for optimizing the die shape to produce uniform velocity distributions in the extruded material during extrusion of a cylindrical, two-layered rod made by explosive cladding of aluminum rod (1050A) and copper pipe (M1E).

Overview: Bimetals are materials composed of two separate metallic components which are usually intimately bonded at the interface by processes like explosive cladding. The usefulness of bimetal rode, wire or strip stems from the possibility of combination of properties of dissimilar metals. Optimizing the die design for bimetal extrusion to reduce the strain rate and shear stresses by producing uniform velocity distributions during extrusion is a very critical factor to reduce the chance of fracture. Aluminum – Copper bimetal rods are widely used in the industry and an optimization study of its mechanical properties during bimetal extrusion holds paramount importance in die design for a process designer. This study focuses on various die shapes and an investigation into the various process parameters influenced by it. The goal is to achieve an ideal die shape based on reduced stresses and strain rate, and uniform velocity distribution. Abaqus® will be used as the finite element analysis tool towards the optimization process.

Major Points:

- Design various die shapes for bimetal extrusion of Al-Copper system
- Optimizing the die shape for this bimetal extrusion
- Investigate the mechanical properties of the optimized die shapes

Summary: Finite element Analysis using Abaqus® is employed for the die shape optimization study of Al-Cu bimetal alloy cylindrical rod. Process and output variables are affected by the die shape optimization. Effect of the optimization process parameters on the mechanical properties of the bimetal is investigated.

Improve the Quality of Precision Products Utilizing On-Target Design and Bilateral Manufacturing Tolerances

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Need: Products which have a functional requirement to have sliding, rolling or turning members are designed utilizing the hole-based system. In a hole-based system, the strength requirement for the member determines the nominal diameter of the hole. The nominal diameter is taken as the minimum dimension for the hole. The ideal clearance between the rolling or sliding members is then subtracted from the minimum dimension of the hole to get the maximum dimension for the shaft. Manufacturing tolerances are provided for the shaft and the hole based on the process capability of the operations used to make the components. The other tolerance limit for the shaft and the hole is taken as 'six times the standard deviation for the process' away from the target dimensions. Doing this results in the hole tolerance being a positive tolerance and the shaft tolerance being a negative tolerance to the nominal dimensions. Hence, for precision assemblies the ideal is always to have unilateral tolerances for the shaft and the hole.

Overview: This presentation will show why manufacturing personnel should be inhibited from ignoring unilateral tolerances and target dimensions, and not be allowed to convert unilateral tolerances into limits or goal-post tolerances for producing parts. How this results in sloppy fits, sub-standard parts and higher warranty costs will be discussed. Also, participants will be shown the need for unilateral tolerancing from a design engineer's viewpoint, and how to induce manufacturing people to produce high-quality parts by changing their tolerances to bilateral tolerances so as to achieve on-target tolerances will also be shown.

Major Points:

- Designing parts for best fits
- Need for unilateral tolerancing
- Providing bi-lateral tolerances to mimic unilateral tolerances on the manufacturing floor

Summary: Attendees will understand how design engineers provide tolerancing on mating parts to get optimum functionality. Also, how manufacturing personnel can be provided with goal-post tolerancing that they have been accustomed to, to mimic target tolerance requirements of the design engineer will be demonstrated.

Survey of Manufacturing Company Expectations from Manufacturing Technology Programs

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Need: As companies replenish their managerial ranks it is essential that schools in our discipline provide graduates with the skills and expertise required for these organizations to achieve and maintain competitive operations. ATMAE academic members must monitor these needs, and continuously evaluate their programs to ensure they are being met.

Overview: During the past year we have completed two surveys of manufacturing company managers and graduates of our manufacturing technology program. The following companies were personally interviewed: DELMIA Corp. (simulation software provider); Ford-Engine Plant; Ford-Dearborn Engineering Group; GROB Systems (global machine tool builder and automation systems integrator); Honda-Manufacturing Design Group; Honda-Engineering Group; KTH Industries (tier one Honda supplier), and TechniGraphics, Inc. (global engineering services provider). A third survey is planned for completion in the near future which lists and ranks topics taught in our program's manufacturing operations management and production courses; the purpose being to maintain our focus on the areas of greatest significance to the companies. This presentation summarizes and analyzes the results of these surveys, and indicates appropriate curriculum revisions to best satisfy the current and anticipated needs of our manufacturing company 'customers.'

Major Points:

- Brief description of our manufacturing technology program
- Explanation of the surveys, objectives of each, and methodologies used to gather data
- Documentation of data received, summary and analysis of results, and listing of significant comments by respondents
- Implications of the results for adjustments in subject matter topics, applications and technologies for our curriculum and similar programs

Summary: Attendees will learn these manufacturing company priorities, and may consider their programs' effectiveness to fulfill these expectations to enhance the job-readiness of students to better serve these 'customers' of our academic programs.

Integrating Sustainable Practices in Design and Manufacturing – Role of Unified Sustainability Frameworks and Metrics for the Industry and Academic Curriculums

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Need: Sustainability is now considered an essential, if not the essential, criteria in any design and manufacturing activity. However, adaptation of sustainable design and manufacturing practices are not easy, specifically since there is no unified metric that can be followed by all to measure their own efforts of sustainable practices as well as methods to incorporate sustainability in their design and manufacturing process. A review of the current state as well as approaches to incorporate ideas of eco-innovation, lean manufacturing and product lifecycle management in the sustainability metric both for the manufacturing industry as well as for the academia (manufacturing technology curriculums) is desirable.

Overview: In an effort to encompass all major factors that can affect sustainability in specific sectors, many different frameworks and metrics have been developed (and are being developed) by researchers and authorities throughout the world. However, since this process is still in progress each set has its own limitations, for example, some of them may be too complicated for use by non-experts. In this presentation, some of the major frameworks/metrics are reviewed from the manufacturers' internal decision making point of view as well as for adaptation in manufacturing technology curriculums.

Major Points:

- Sustainable manufacturing – current state of available frameworks and metrics
- Review suitability of these metrics for various design and manufacturing process
- Need for the standardization for comparison and evaluations
- Incorporating sustainability metrics in manufacturing curriculum

Summary: The proposed presentation would focus on the current state of development of sustainability metrics and how those ideas could be integrated in design and manufacturing activities. Issues and challenges in introducing sustainable design and manufacturing criteria in manufacturing technology curriculums are also discussed.

Changing the Future of Manufacturing with Additive Manufacturing

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Need: Additive Manufacturing is changing the way people are manufacturing today and will play a large part in the evolution of manufacturing in the future. This presentation will showcase companies using 3D Printers and Production Systems in their product design, product development and manufacturing processes. These companies are saving thousands of dollars and precious time with the help of their 3D printing systems.

Overview: This presentation will bring to light how Additive Manufacturing is changing manufacturing by streamlining the processes and radically reducing costs. From concept models to functional prototypes to manufacturing fixtures and end use parts, manufacturers have a distinct advantage when a 3D printing system is a part of their team. Stratasys is the world leader in 3D Printers and Production Systems. Its proprietary technology, Fused Deposition Modeling, creates functional prototypes and manufactured goods directly from any 3D CAD program, using high-performance industrial thermoplastics. Stratasys 3D Printers and Production Systems are used in the aerospace, defense, automotive, medical, business & industrial equipment, education, architecture, and consumer-product industries.

Major Points:

- 3D Printing Industry History
- Primary Solution Options
- Typical Applications
- Customer Success Story – Thogus

Summary: Additive Manufacturing is changing the way people are manufacturing today and will play a large part in the evolution of manufacturing in the future. Stratasys is heavily involved in this changing process today.

New Practice for Machine Design Hierarchy

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Need: Over the past several years, major technological innovations in control circuits for automated manufacturing environments have evolved. These innovations have resulted in the development of a new practice for Machine Design Hierarchy. This practice is aimed at assessing and reducing risk potential in automated manufacturing environments through the integration of sensors and programmable systems in manufacturing controls. Initially Machine Design Hierarchy standards were introduced and utilized in Europe. However, in June of 2010, the American Society of Testing & Materials (ASTM) formed a new Subcommittee E34.75 specifically relating to a "New Practice for Machine Design Hierarchy". Consequently, this topic will soon become a technological standard in the United States and educational programs in manufacturing technology will need to integrate this emerging technology into their curriculums to meet the needs of students preparing to enter the field of automated manufacturing.

Overview: This presentation will provide an overview of: a) Machine Design Hierarchy, b) associated control circuit technological developments utilized in this hierarchy and c) potential curriculum and equipment needs for preparing students to enter the field of manufacturing.

Major Points:

- The first component part of this presentation will involve an introduction to Machine Design Hierarchy
- The second component part of this presentation will discuss risk assessment and risk reduction modeling
- The third component part of this presentation will present how to integrate control circuit design based upon machine design hierarchy
- The fourth component part will introduce innovations in sensors and programmable systems for machinery protection
- The last component part of this presentation will present laboratory equipment that can be developed and used to teach this technology along with associated curriculum needs.

Summary: Emerging technologies relating to Machine Design Hierarchy are evolving at a much great pace than textbook coverage of this subject area. Consequently, it is important for manufacturing technology programs to begin developing curriculum objectives and materials necessary for preparing students to meet the needs of these new emerging technologies and standards.

Laboratory-Based Manufacturing Execution System for Teaching

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Need: The manufacturing environment is currently evolving: it is now characterized by globalization, variety, and time-based competition. Enterprise information systems make it possible for information to be able to flow freely to where it is useful so that their processes will be open and capable of reaching across functions and hierarchies. Teaching students to learn these systems is critical for their career success.

Overview: The manufacturing environment is currently evolving due to globalization and development of new technologies. Enterprise information systems make it possible for information to be able to flow freely to where it is useful so that industrial processes will be open and capable of reaching across functions and hierarchies. Enterprise Resource Planning system (ERP) is an integrated computer-based system used to manage internal and external resources, including tangible assets, financial resources, materials, and human resources. Manufacturing Execution Systems (MES) have evolved to fill the communication gap between the manufacturing planning systems and the control systems used to run equipment on the plant floor. Manufacturing industries need our graduates to operate ERP and MES systems. A MES lab is initiated in the Department of Applied Engineering Technology to implement a functional MES system capable of providing high level visualization, administration of data, monitoring and controlling of the computer integrated manufacturing cells, processing equipment and enterprise wide resources. This lab is utilized in teaching students in various areas of manufacturing and industrial management.

Major Points:

- What is ERP system?
- What is MES system?
- Why we need them?
- How we teach them for our students?

Summary: Manufacturing Execution Systems are systems that supply information allowing for optimization of production activities from the initial request to the final product. Making use of accurate and up-to-date data, MES's guide, start, report and answer to activities in plant as they occur. The resulting fast response to operational conditions variations allied to focus on the reduction of activities that do not aggregate value to the product results in the efficient operation of processes in the plant. MES make better return for the operational resources as well as allow an improvement of performance of deadlines, materials management, raw margin and cash flow. MES supply critic information to the company about production activities throughout the plant and the supply chain, using bi-directional communication. A two-tier approach was undertaken during the building of the laboratory environment. The desired tiers were to have a physical system and a virtual one. The first phase had the objective of creating a physical environment composed of various field devices, information technology components, and flexible/scalable controls. The second phase, a virtual one, was developed for simulation of the physical system's attributes and for student skill development.

Mapping of Superficial Residual Stresses in Both Machined and Cast Components

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Need: Measurement of residual stresses is a complex, time consuming, and expensive business. A low-cost method has been developed at MSU and has been applied to both cast and machined components and compared to both X-ray diffraction and cutting of the sample. This new method can be employed by small shops for predetermining the stress levels of a new component or, by schools who are trying to show students the effects of manufacturing operations on the residual stresses that can be induced into components via manufacturing processes without the purchase of expensive equipment.

Overview: This presentation will show how residual stresses are currently measured and the strengths and weaknesses of them when compared to each other. A new method will then be introduced that can be easily employed by a small shop or school that relies on the change in spacing of previously applied pairs of micro-hardness indentations which occurs after stress relief. Results will then be given that show how well this method compares to other methods of residual stress measurement and the effects of manufacturing processes such as, machining and casting have on the generation of residual stresses.

Major Points:

- An overview of residual stress and the methods employed to measure them
- The methodology employed in the new method.
- The effects of residual stresses on machined and cast components.
- Comparison of the new method to X-ray diffraction.

Summary: This paper will demonstrate that a low cost technique is a viable alternative to expensive residual stress measuring techniques to pinpoint areas of interest on a component. It will also, show that how we manufacture items will have a dramatic effect on the residual stress patterns induced on the surface of a component and that the altering of manufacturing parameters can have a detrimental effect on the subsequent in-service/fatigue life of a component. It will also demonstrate that this can be employed as a teaching tool for students.

An Online Manufacturing Information System for Robotic Systems

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Need: Manufacturing systems are becoming more autonomous, requiring less operator intervention in daily operations. This is a consequence of today's market conditions, characterized by global competition, a strong pressure for better quality at lower prices, and products defined in part by the end-user. Industrial robots are good examples of flexible manufacturing systems. Manufacturing engineers need to integrate other technologies with the objective of extracting from robots the flexibility they can offer. This project developed an online manufacturing information system to provide real-time management for automated work cells with robotic systems.

Overview: This purpose of the project is to establish an online manufacturing information system to manage programs and real-time data of robotic systems over a Local Area Network (LAN). In this project, a LAN network is established connecting all the industrial robots on a factory floor to higher level computers. A database server and a Human-Machine Interface (HMI) are developed to provide real-time program and data management over the LAN network. It provides a solution in system integration for flexible and efficient manufacturing systems. The hardware and software components of the system, programming techniques, and the system performance will be demonstrated in the presentation.

Major points:

- Literature review of the research
- Introduce the procedure and system integration
- Analyze the system performance
- Discuss of further improvement and study

Summary: This project is a collaborated project with a manufacturing factory. The purpose of the project is to implement a more efficient and productive manufacturing information system to manage the data and programs of their robotic systems. The presentation examines the technologies applied in establishing the system, introduces the procedure, and analyzes the performance of the online manufacturing information system.

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Development of Green Manufacturing Teaching Module by Embedding Research Components for a Senior Level Manufacturing Technology Course

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Need: In recent decades, growing economic development has been accompanied by growing concerns about global climate change, consumption of natural resources. With the pressure from environmental protection, natural resource conservation and increasingly stringent governmental regulations, green manufacturing gradually becomes a philosophy. Showing great interests in sustainable production, industries are taking initiatives to reduce the impact of manufacturing on environment. This emerging trend raises a need for future generation of technologists to understand and apply green strategies in manufacturing practice.

Overview: With full consideration of energy usage, resources consumption and environmental impact, green manufacturing is a method in which products will be produced using manufacturing processes that are environment-friendly, conservative in consuming energy and natural resources, and safe for employees, consumers and society. Converting green manufacturing from a slogan to a real practice confronts pressing challenges. On one hand, technological innovations from up-to-date research must be incorporated. On the other hand, education and training programs are very important for preparing the human workforce needed for future green manufacturing jobs. This paper will present a green manufacturing teaching module that includes both research accomplishments and open-ended questions and how the teaching module is embedded in an existing senior level manufacturing class.

Major Points:

- Introduction to green manufacturing
- Sustainable consumption
- Aspects considered for decision making based upon green manufacturing, from product design & evaluation, material selection, machine tool selection, manufacturing process planning and implementation, actual production process and waste management
- Research components that are integrated in the green manufacturing module
- How students are motivated by the research related learning

Summary: Technology, innovation and education are essential to social and economic growth. Lean Manufacturing, green manufacturing processes and green thinking for the complete life cycle of the product will go a long way in ushering green manufacturing. As major players, industrial and academic institutions should synchronize their strengths to promote green manufacturing. Illustrative examples included will provide some insights of how research and teaching can be tied with green manufacturing towards sustainability.

Nanotechnology

Developing a Nanotechnology Program for the Community College Environment

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Need: Many technical schools and community colleges are exploring nanotechnology as a program offering. Where does one start? Where does assistance come from? What equipment is necessary at the beginning? What are the employment opportunities? These questions and more are asked and must be answered. Ivy Tech Community College South Bend will be teaching its first nanotechnology classes in August, 2011 and has received state approval to provide the degree, the first in the state of Indiana.

Overview: The presenter will share his experiences during the process: program approval, university partnerships, faculty search, equipment purchase, space and clean room requirements, taking of nanotechnology classes by students by other majors, and other considerations.

Major Points:

- Finding a university partner
- Gaining support from the local Chamber of Commerce
- Ascertaining a market for program graduates
- Developing a curriculum
- Creating tentative course content
- Obtaining state approval to offer the program (if needed)
- Creating a "buzz" about the program
- Finding qualified faculty
- Purchasing equipment needed
- Finding a home for the program in your facility
- Determining appropriate loading for faculty during the course development and marketing phase

Sumary: The presentation described does not answer the great technical problems, but does something often more important – answering questions for others embarking on this path. The author has experienced this effort first hand and is sharing his experience.

Locating/Understanding the "Technology" In Nanotechnology - Insights from Case Studies in Applying Lean Principles to Nanotechnology

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Need: Scholars tend to focus on the nano aspects of the Nanotechnology and often tend to overlook the technological aspects associated with developing applications, products, material at nano scales. There is a need to address the gap in scholarship which discusses the practical difficulties in scaling Nanotechnology research for commercially viable applications. Technology professionals and researchers have the potential to make substantive contribution in this regard.

Overview: Nanotechnology is a generic term referring diverse research contexts, technologies and application domains. We present two case studies illustrating the diversity of research as well as the technological issues associated with scaling pilot/lab based operations to industrial/commercial levels. We demonstrate the utility of lean principles such as the Six-Sigma methodology in addressing technological issues pertaining to diverse Nanotechnology related contexts by discussing the applicability of lean principles to the two cases discussed.

Major points

- Explain dominant constructions of Nanotechnology in the public domain.
- Describe the diversity of technologies, products, and applications which rely on Nanotechnology related research.
- Demonstrate the applicability of lean principles to advance manufacturing processes based on Nano-Technology.
- Discuss the importance of locating research question at the intersection of advance manufacturing, Nanotechnology and lean principles.

Summary: The audience will learn to recognize the relevance of technology to discussion on Nano-Technology. Furthermore they will become aware of versatility of lean manufacturing principles in addressing core issues related to commercializing Nanotechnology based research.

Lateral Diffusion of Nanotechnology Safety Education: Preparing Nanotechnology Workers to Handle Nanoparticles

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Need: Nanotechnology is a new area of science and engineering involving the creation and control of novel substances at the nanometer (billionth of a meter) length scale. The number of manufacturer-identified consumer products that incorporate Engineered Nanomaterials (ENMs) – chemical substances with one or more dimension between 1 nm-100 nm – is estimated to have grown from 50 in 2005 to more than 1,000 in 2009.1 Today, the growing workforce faces potential exposures, yet lacks reliable information about the specific nature of the risks posed by ENMs, or about how to work safely with ENMs. Risk management tools that permit the safe handling of many hazardous materials are built upon a strong foundation of data and experience collected over years or even decades of use. Especially critical is the need to train workers to manage risk in the absence of quantitative exposure limits and in light of evolving standards for risk and hazard communication, including the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). ENM health and safety knowledge is a rapidly evolving landscape that many safety professionals and other workers cannot currently map.

Overview: The OSHA funded training program consists of a day-long course for safety professionals and trainers and will cover ENM occupational health and safety and will emphasize human exposure. Each of seven topics is developed into a one-hour module which will also be taught using web-based instruction. Due to the participants' geographic location, using a web-based instruction provides flexibility to the participants.

Major Points:

- Purpose of training program
- Training curriculum (Modules developed)
- Delivery of training content
- Assessment of training
- Participants' perception of training
- Year 1-impact of training

Summary: This is the first federally funded OSHA -Susan Harwood grant for nanotechnology safety education. The project team has developed tools to deliver innovative content to bring awareness of properly handling nanomaterials. The project is the first step in broadening the scope of training in safety education. In addition, the results of the grant may be an avenue to expand the target population beyond workers to include trainees (students). Results will be presented at the conference.

An Innovative Approach to Scaling Advanced Technological Education

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Need: As the demand for Micro and Nano technology technicians continues to increase, there is a critical need for standardized/readily available sets of Microsystems learning modules to facilitate rapid dissemination (scale) and adaptation (shift) into contemporary and evolving programs. The lessons presented by the Southwest Center for Microsystems Education (SCME) can be applied to other advanced technological education programs.

Overview: In an effort to lay the foundation for Microsystems education, the National Science Foundation (NSF) funded the creation of the SCME. The proposed presentation describes how SCME has embraced industry methodologies to improve instructional materials design, delivery and dissemination which has reduced time to market, and increased penetration. Since the SCME has developed dozens of Learning Modules and several hands-on kits, it has become apparent that there is a need to improve the promulgation of these materials to educational organizations nationally in order to impact a larger segment of the student population. Utilizing lessons from the "Research, Practice and Transformation through Synergy Project" and "lean" manufacturing methodologies, SCME has developed successful scaling strategies that can be leveraged by your organization.

Major Points:

- Modular design of educational offerings
- Utilization of lean rules and principles to eliminate waste in educational offerings
- Scaling strategies to enhance materials utilization

Summary: Attendees will have the opportunity to "rethink their future" based on SCME's story. These lessons and methods may prove valuable in your quest to disseminate your offerings to others, thus continuously improving America's ability to compete in emerging technologies.

Rethinking the Future Toward Increased Polymer Nanocomposites Usage

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Need: It is important for individuals involved in the management of people, processes, and materials to be aware of emerging technological developments. Not only are many in society unaware of the existence of nanotechnology, but many are unaware of the specific development involving the use of polymer and nanoclay toward applications and uses in the marketplace.

Overview: This presentation will not only inform the audience of the parameters used to define nano-materials, but it will inform it of the types of nano-clay used to develop commodity, and environmentally-friendly, polymer and nanoclay composites. Furthermore it will discuss the past, current, and potential applications for polymer-clay nanocomposites (PCN) usage in the marketplace.

Major Points:

- Nanoclays, as nano-materials, are defined by specific attributes, molecular formations and mechanical parameters.
- Certain types of both naturally occurring and organically modified clay, with specific attributes, mechanical parameters, structures, and chemical properties, are commonly used to produce PCNs.
- Commodity-polymer made PCN's have been developed and used for limited applications over the past twenty years and starting with, and branching from, usage in the automobile industry.
- Past research focused on the use of commodity polymers intercalated with nano-clay.
- Recent research utilizing environmentally-friendly polymers intercalated with nano-clay suggests increased application and usage.

Summary: Attendees will understand not only the characteristics that separate nanoclays from other nano-materials, but they will become aware of the types of nanoclays used to develop polymer clay nanocomposites. Moreover, attendees will become aware of past, current, and potential future PCN applications, using not only commodity-based, but environmentally-friendly, polymers intercalated with nano-clay, suggesting increased marketplace application and usage.

Where Does Nanotechnology Fit Into a General Technology Program's Curricula?

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Need: Nanomaterials are being integrated into most of the products we purchase routinely for our daily lives. Sunscreen, wrinkle free clothes, disinfectants, and golf balls all contain nanomaterials and are manufactured in factories similar to the one's that currently hire many technology program graduates. Because the demand for nanotechnology-related products has escalated at an unprecedented rate, the need for more highly trained technology managers continues to grow proportionally.

Overview: This presentation will focus on what type of nanotechnology content should be integrated into a general technology program's curricula. More specifically, the steps involved with successfully integrating nanotechnology curriculum content into a program's current curricula with existing faculty and resources.

Major Points:

- Brief overview of nanotechnology
- Barriers preventing the integration of nanotechnology into general technology program curricula
- Overview of nanotechnology content relevant to existing general technology program curricula
- Preparing and educating faculty to teach nanotechnology

Summary: As nanotechnology related products continue to integrate into more and more products, manufacturers and suppliers of these products seek more highly trained professionals to manage their workforce. This presentation focuses on how ATMAE accredited programs can properly prepare graduates for careers pertaining to nanotechnology.

Nanotechnology Education - What it Takes to Make it Work

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Need: Many colleges are considering the creation of a nanoscience program or for some it is consideration of how to integrate nanotechnology concepts into existing courses or other technical programs. For these colleges there are many unanswered questions or uncertainty in which path to follow. To begin to consider the questions and walk the path which is independent of the desired role for nanoscience at your college you must consider multiple contributing elements. These elements are administration, faculty, industry and facilities. Each of these elements must be considered and present when determining how your college may implement nanotechnology concepts.

Overview: This presentation will look at all four of the necessary elements which must be in place prior to insertion of nanotechnology concepts into programs or courses (or setting up a new nanotechnology degree program). Based on over 6 years of "lessons learned" we will discuss the necessity of each component, how to assess the strength for your college (the questions to ask) and how to create the needed strength and support of all four elements.

Major Points:

- Four elements are required for a successful nanotechnology program or course: Administration, Faculty, Industry and Facilities
- Each element must be present and of a certain strength
- The four elements are inter-related and interdependent
- Questions to ask to assess the strength of each element
- Methods to strengthen each of the elements

Summary: This session will help you determine the steps required to assess the feasibility of nanotechnology as a part of your college curricula and how to make it happen.

The Many Faces of Nanotechnology: Concepts for Many Disciplines

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Need: Nanotechnology at its very core draws upon all of the traditional sciences and therefore the concepts of nanoscience are applicable in physics, chemistry, biology and engineering courses. Similarly, nanotechnology finds applications ion hundreds of markets and industries. The matching of emerging concepts as a result of nanotechnology cannot be integrated to education or industry in a random fashion but instead requires a coordinated and intentional effort. . Therefore there is often a need to correlate nanoscience concepts with specific segments of traditional science and/or with specific applications to various industries.

Overview: This presentation will look at several of the major concepts of nanotechnology and map them into traditional science and engineering content. We will also map the nanoconcepts onto specific applications and industries. We will use activities and examples from nanomaterials, nanobiotech, and sensors to illustrate the correlation and leverage the multi-disciplinary aspect of nanoscience.

Major Points:

- Primary concepts of nanotechnology draw from and feed into segments of traditional science and engineering course content
- Nanotechnology concepts (skills, knowledge and abilities) support needs of many market segments
- There is a strong correlation between nanotechnology concepts, traditional science and company skills
- Learn about these correlations
- Take away examples, activities and applications to integrate nanotechnology concepts into courses
- State of the art applications of nanoscience (i.e. sensor technology, photonics) will be used in the examples

Summary: This session will guide you through the process of using nanotechnology in many classes at many different levels by using practical examples and applications.

Microsystems Fabrication - Making Tiny Devices

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Need: Microsystems are fabricated with many of the same tools and technologies used in nano fabrication. In order to understand nano fabrication and make your students more marketable, educators should expose students to the basic process principals and technologies found in microsystems fabrication.

Overview: This presentation provides an overview of three widely used micromachining processes for microsystems: Bulk micromachining, surface micromachining and LIGA.

Major Points:

- Three major fabrication methods discussed:
  - Surface Micromachining
  - Bulk Micromachining
  - LIGA – "Lithography Galvanoforumung und Abformung"
- Extensive SCME Educational Materials on these topics will be described (free access for participants).

Summary: Micro devices enable nanotechnology and visa versa. This presentation will present an overview of LIGA, Surface and Bulk micromachining processes. The Southwest Center for Microsystems Education (SCME) is an NSF funded Advanced Technological Education (ATE) regional center of excellence and has developed the educational materials to enable you to teach microsystems in your STEM classes.

Dynamic Cantilever - Macro Model of a Micro Nano Device

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Need: Students need to make the connection between the macro, micro and nano world in a hands-on approaches. These fields are interdisciplinary and this topic enables educators to tie physics, mathematics, engineering, materials science, and chemistry to the micro and nano technology used to create their favorite consumer products.

Overview: This session will describe how to use a cantilever (diving board) to enable students to learn about one of the cornerstone micro/nano devices in a hands-on environment. Cantilevers are used to probe surface at the atomic level (AFM's), as RF mechanical switches, flow sensing elements and nano-enable chemical sensor arrays.

Major Points:

- What is a cantilever?
- Discovery – Length, Width, Thickness, Mass and material Vs Frequency
- Data acquisition – using a video and quicktime to determine resonance frequency in the macro world. Real data to match the observations.
- Connecting to the mathematics and engineering
- Taking it down to the nano – application to atomic force microscopes and chemical sensor arrays. What happens when scaling?
- What can you, the educator, do with this? Survey of SCME materials, activities and kits available for this topic.

Summary: This presentation will give the participants a path to follow in order to teach students a myriad of concepts with one simple device, the cantilever. By allowing hands-on interaction, students can see and feel the concept of natural, resonance frequency and how this parameter is affected as a function of length, thickness, width, material and mass added.

Enriching Engineering Technology Curriculum through the Introduction of Nanotechnology

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Need: The importance of Nanotechnology has grown in recent times because of the large scale developments in the technologies that aid in its utilization. It is already present in many of the electronic products that are being used today. Although many of us are not directing our attentions seriously towards nanotechnology, we cannot deny the fact that it is going to be the main ingredient in most of the objects that we are likely to come across in the future. Therefore it is imperative that all engineers and technologists should be aware of what nanotechnology has to offer.

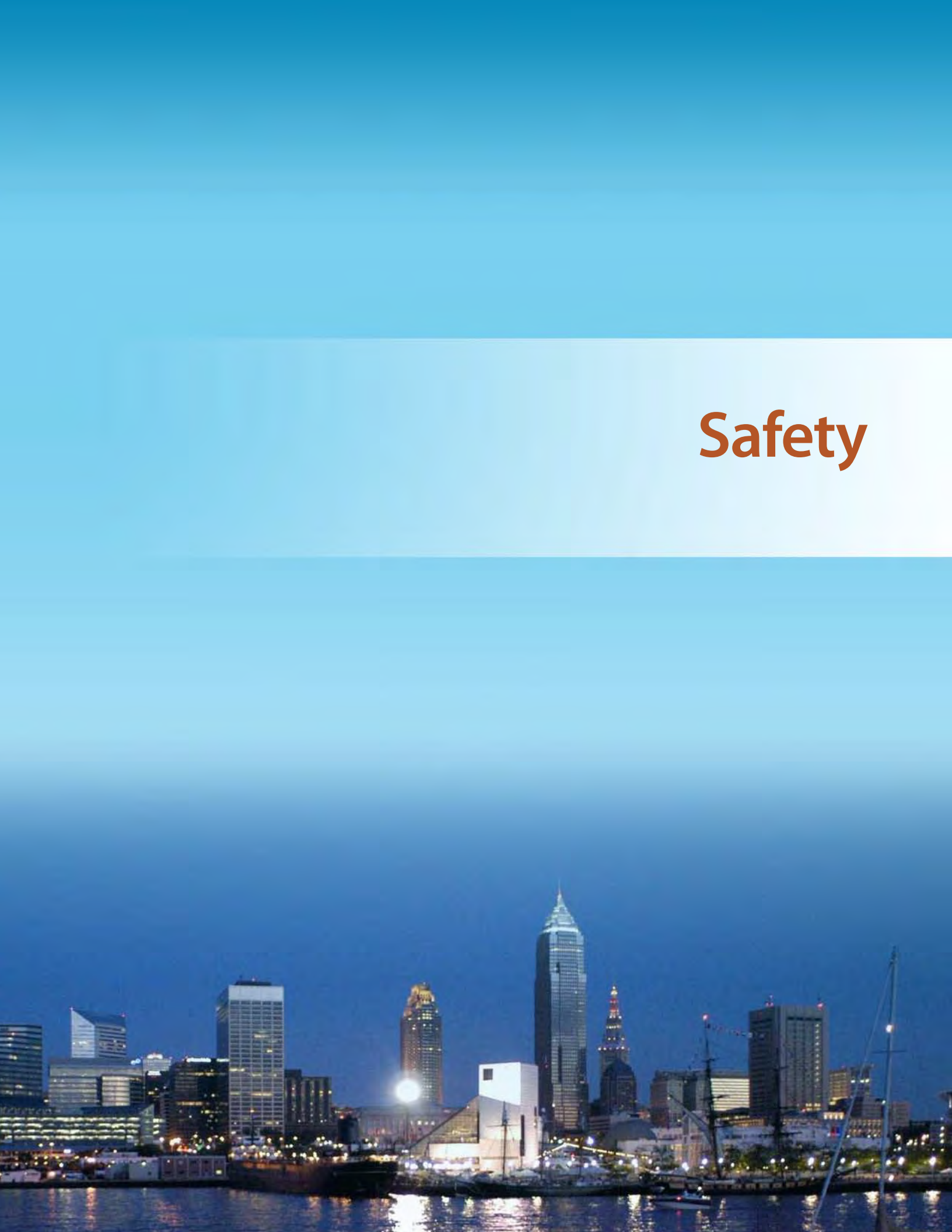
Overview: A number of applications are already utilizing nanotechnology in day to day life. We may not be aware but they are already there. A few examples are: Solar Cells, Clothing, Batteries, Automobiles, Food and Beverages, Environment and Drug Delivery Systems. It is estimated that by 2015 we may require about 2 million nanotechnology personnel at various levels. A good number of them are going to be in the design and manufacturing of various devices that incorporate nanotechnology. This paper will present a case for including nanotechnology into the curriculum of most ETD (Engineering Technology Department) groups, so that enough trained personnel can be available that have the minimum training and understanding of the subject to be included in the nanotechnology job market.

Major Points:

- Historical development and definitions of Nanotechnology
- Major advantages that can be gained by the use of nanotechnology
- Major current applications of Nanotechnology
- Typical knowledge inputs required for successful understanding of nanotechnology
- Suggestions for the adoption of nanotechnology into the engineering technology curricula.

Summary: The essence of nanotechnology is size and control. The properties of matter change drastically when they are reduced in size. With these special properties it is possible to obtain many new products which are not otherwise possible. The inclusion of nanotechnology in ETD curricula will benefit these programs. Also included in the paper are the challenges and opportunities with the development and presentation of the nanotechnology curriculum to the ETD groups.

Safety



Applications of Combined Micro Technologies and Unmanned Systems in Support of Public Safety and Homeland Security

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Need: Previously, the military establishment has been the primary developer and user of micro technologies associated with unmanned systems. As these technologies become available commercially, a need exists to integrate the use of the technology into local or regional public safety and homeland security incidents. The purpose of this presentation is to explain several key factors to consider when using micro technologies and unmanned systems in support of public safety and homeland security officials. Real time information is critical to the decision making process for public safety and homeland security officials to make assessments and quickly resolve crisis situations. Unmanned micro-vehicles and micro technologies are well suited to remotely observe, gather essential information, and immediately relay it to incident responders.

Overview: The research team aims to show the benefits of using micro technologies and related unmanned systems in gathering information for public safety and homeland security officials. The use of micro technologies is well suited for hostage situations, hazardous environments, search and rescue, natural disasters, border patrol and many others. The true benefit is having remote resources providing real time support to incident responders. The research team will demonstrate the use of several different types of micro-vehicle platforms in a public safety scenario. In addition, they will show the associated technologies such as GPS, autopilot, communication, and sensor devices.

Major Points:

- Using micro-vehicles as essential tools in the response to threats/disasters, both man-made and natural
- Acquisition of information to increase incident commanders' situation awareness
- Understanding applications, benefits, and obstacles to the use of micro-systems
- Providing an understanding of the complexity and interfacing needed in the micro-devices
- Providing training for assessment and certification of operators, analysts, and decision makers

Summary: The conference participants will gain an understanding of the micro technologies associated with unmanned systems and their application in aiding homeland security and public safety officials while dealing with natural and man-made disasters. In addition, the team will demonstrate methods of improved information acquisition and dissemination by integrating the different micro technology platform capabilities.

Bio-Safety: Nano Particles with Macro Problems

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Need: Biological agents, such as viruses, bacteria, fungi, parasites, prions, are of the nano size yet cause tremendous harm and scare. Although these hazards are more common in laboratories, they affect all of us when we come in contact with an infected person. Cases of Ebola Plague, SARS, Malaria, Small Pox, Cholera and such have caused many panicky days. There is even talk of terrorists attempting to get hold of biological agents for their attacks. Anthrax is a well-publicized scare.

Overview: Biological agents, such as bacteria, virus, fungi, and parasites in the work place, especially laboratories, healthcare facilities and in the environment affect the general public and employees in the work place. The "Occupationally Acquired Infections" (OAI) results in severe illness and/or death. This presentation will discuss some common OAIs and how they can be prevented by simple engineering controls and work practices.

Major Points:

- What are the biological agents
- How the agents transmit diseases to humans
- Some work practices and engineering controls to prevent infection
- Some current rules and regulations as they apply to bio agents
- What to do after the "violence" occurs

Summary: At the end of the presentations the audience will understand how biological agents transmit diseases to workers, signs and symptoms of some of the common diseases and conditions, and steps and measures which can be taken to prevent/minimize exposure to these agents in the workplace.

Personal Protective Equipment for Eyes and Hearing: Proper Selection, Use, Maintenance, and Common Errors

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Need: Many workers and supervisors in a variety of occupational situations do not properly understand how to select, use, or maintain personal protective equipment (PPE) relative to tasks or situations at a worksite, especially relative to eye and hearing protection. Often proper PPE is not even available in some work environments because of this lack of understanding or appreciation of typical hazards. Improper selection of eye protective devices and lack of use of hearing devices when needed are both common issues at typical worksites in most industrial scenarios, both in manufacturing and construction.

Overview: Workers and safety supervisors should be fully aware of potential situations at a worksite and how to determine which PPE is most appropriate in a wide variety of situations. Understanding the nature of typical hazards is an essential part of selecting and using proper PPE. The nature of many typical hazards and the design/purpose of eye and hearing protective equipment will be explored to better equip attendees for selecting, using, and maintaining PPE, as well as how to incorporate them into supervision and training programs. A number of common scenarios for misuse or lacking use of PPE will be explored to raise the awareness level of attendees.

Major Points:

- Design features and functions of typical eye and hearing protective equipment
- Matching design to scenarios in the workplace
- Proper use of eye and hearing personal protective equipment
- Maintenance of eye and hearing personal protective equipment
- Common improper practices in the workplace and solutions
- Supervision implications
- Training issues

Summary: Attendees will understand how to select, use, and maintain personal protective equipment (PPE) for eye and hearing protection for a variety of situations. Supervision and training issues are also covered for safety professionals and educators.

Learning through Skits: A Pilot Study Using Contextual Learning to Achieve Learning Outcomes in Safety Education

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Need: To better prepare safety majors, post-secondary educators need to brainstorm different methods of delivering safety content. According to CORD (2010), a research center for learning indicated, "the majority of students… are unable to make connections between what they are learning and how that knowledge will be used" (p.1). Educators are facing unique challenges to teach Millennial or Generation "Y" students. One of the learning methods used on students to achieve learning outcomes is the use of contextual learning using skits/short play to demonstrate what students learned. Furthermore, this form of learning can help retain more information than memorization. Even more, students will be better prepared to function in a safety supervisor/manager capacity.

Overview: Skits were used as a final exam for a pilot study in the Behavioral Safety course in the fall semester of 2010 at The University of Texas at Tyler. A final exam rubric was used to assess the course content. Students in groups created their skits based on the criteria specified by the instructor. In addition after the final was complete, a short survey was dispersed to students to assess if they felt that they learned more using skits than a paper test. Results will be disclosed during the ATMAE conference presentation.

Major Points:

- The rationale for using contextual learning for safety education
- The design of the final exam rubric
- Examples of students' skits
- Reveal survey findings
- Lateral diffusion of the pilot study to other safety programs

Summary: This instructional model is an attempt to introduce an innovative approach to meet the Millennial or Generation "Y" students' learning needs when engaged in safety education. Wide spread use of the instructional model can better prepare safety majors to be more competitive in industry.

Shaping Mexican Occupational Health and Safety Conditions by Utilizing United States Occupational Health and Safety Techniques

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Need: Because of the passage of NAFTA and CAFTA, occupational safety and health issues have become increasingly significant in Mexico. To decrease the rate of accidents and injuries, appropriate occupational safety and health techniques must be implemented in the workplace. The best approach would be to utilize a model similar to OSHA which is utilized in the United States.

Overview: The presentation will focus on how to implement an effective safety and health program in Mexico in order to improve workplace conditions. The occupational safety and health approach that Mexico has employed in the past years has proven to be inadequate. Mexican industries need to model and implement a successful occupational safety and health program close to what U.S. industries utilize. Due to the high rate of occupational accidents and illnesses a large amount of money is spent in Mexico on accidents and injuries in different industrial sectors every year. In order to reduce this trend, appropriate occupational safety and health techniques must be implemented.

Major Points:

- Analyze and describe the current situation of Mexico's occupational safety and health practices.
- Apply the American occupational safety and health rules and regulations to the corresponding Mexican industries.
- Propose a plan for an effective occupational safety and health program in Mexico to reduce the number of accidents and injuries.

Summary: The important role that occupational safety and health will play in Mexico's future economic prosperity is evident and realized by authorities. As a result the mindset and opportunity to implement an appropriate occupational safety and health programs in Mexico is at hand.

Measuring Safety Performance: Integrating Key Metrics with Six Sigma

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Need: Today's economic conditions and the resulting impact on scarce budget resources and safety improvement create an increased risk to workers in the manufacturing work environment. Clear, well understood and consistent approaches for deploying relevant safety performance measures together with Six Sigma can minimize unforeseen risks, deviations, or errors; thereby, reducing the prevalence of accidents, injuries, and other deficiencies in the safety management system or workplace. The cumulative effect of such deficiencies in most manufacturing work environment can be significant. Moreover, the combined lack of understanding, tools, and performance measurement data poses increasingly daunting challenges for safety professionals in small and mid-size firms. However, many of these challenges can be resolved by effectively integrating safety metrics with Six Sigma principles and tools for measuring and controlling safety performance.

Overview: Safety performance measurement and Six Sigma principles are integral parts of proactive safety initiatives designed to positively impact safety improvement and culture. This presentation will highlight performance measurement approaches and techniques, incorporating key safety metrics with Six Sigma to verify safety outcomes via analyzing processes for improvement. Relevant issues, safety measurement techniques and examples will be addressed in the presentation.

Major Points:

- Measurement and safety process definitions
- Rationale for integrating safety metrics with six sigma
- Key safety metrics
- Six sigma methods and tools used
- DMAIC model for problem solving process improvement
- Examples of executing safety process control techniques

Summary: Ensuring safety effectiveness requires reducing the risk of incidents, deviations, errors, and failures that can disrupt normal operations. This presentation will provide attendees insight regarding the integration of safety metrics with Six Sigma to sustain and improve safety processes.

Nanotechnology Materials: Potential Hazards and Risks to Workers in the Manufacturing Workplace

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Need: Nanotechnology has emerged as an important scientific and technological innovation in terms of its application to diverse manufacturing sectors. However, in recent years engineered nanomaterials have attracted a great deal of attention due to some inherent, harmful properties at the nano-scale. Exposure to engineered nanomaterials in the manufacturing work environment poses safety and health hazard risks to employees in both short-term and long-term injury and illness effects. Clearly, there is a need to understand the behavior, effects and mechanisms of action regarding engineered nanomaterials. There is also an urgent need to evaluate the safety of these diverse materials and to rapidly develop an effective risk management process for known hazards and risks, as well as for those unknown/uncertainty.

Overview: Although nanotechnology research is still evolving, numerous workers currently are exposed to engineered nanomaterials in manufacturing operations. This presentation will provide attendees insight on the potential dangers of nanotechnology; and incorporate a strategy on how to protect workers from potentially harmful materials. Relevant issues, strategy techniques, and examples will be shared in the presentation.

Major Points:

- Nanotechnology hazard risk definitions
- Trends in nanotechnology and how it is used in manufacturing
- Hazardous nanomaterials and their effects on workers
- OSHA applicable safety standards
- Precautionary approaches to minimize hazards and worker risk of exposure

Summary: In highly competitive and fast-changing manufacturing industrial sectors, worker safety and health are vital concerns. This presentation will provide attendees insight on protecting workers from potentially harmful engineered nanomaterials.

Predicting and Identifying the Causal Factors for Non-Junction Accidents in Jamaica

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Need: Road accidents are random events throughout a road network which have reached epidemic proportions. On a daily basis the lives of people across the globe interact with transportation systems; these systems are complex and dangerous. Since 2001 the Jamaican Government has registered 108 pediatricians and 38 pedal cyclist deaths each year. According to the World Health Organization, road traffic accidents will increase its ranking to sixth place as a major cause of death worldwide by 2020. In this presentation, the focus will be on the validation of non-junction accident look-up tables which can be used in the prediction of accident frequency along specific carriageways, causal factors that contribute to road accidents and setbacks in the thinking of Road Administrations, in developing countries, as seek to provide safe road networks.

Overview: Road Accidents are random within a given road network. However, their frequency can be predicted and mitigated by considering all road users, i.e. motorized and non-motorized (pedestrians, cyclists, animal-pulled carts, wheelchairs, etc.), during the design and construction of the infrastructure. This presentation will be divided in three sections. Section one will focus on the Jamaican context in terms of accident rates and driver behavior. Then proceed to introduce a tool that uses observed information to predict future accident frequencies, and the interventions (or sensitivity analysis) that can influence future outcome. The presentation will end with policy recommendations based on the results generated by the tool.

Major Points:

- Road accident frequencies and causal factors. Causal factors for road accidents include road user error and misjudgment, deficiencies in the road environment, obscurity of pedestrians by parked vehicles, and anti-social behavior of road users.
- Traffic and pedestrian flow surveys and traffic calming schemes
- Accident prediction look-up tables based on TRL Report 183; Summersgill and Layfield full-accident-flow-geometry model
- Model validation; using Jamaican data in predicting the frequency of non-junction road accidents.

Summary: Attendees will be able to identify key variables affecting the frequency of accidents on a road network before or after a junction. The information presented will also inform road users of their contribution to road accidents; especially pedestrians on their usage of crossing facilities

Developing an Effective Laboratory Safety Program for Academic Environments

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Need: There is a need for educational institutions to understand that safety programs are required to be updated for today's student. Academic environments of today are vastly different than they were 20 years ago let alone the differences from industry. Understanding the pedagogy of an 18-24 year old student is different from adult learners. Realizing these differences will assist in developing effective safety programs for academic environments.

Overview: This presentation deals with the requirements for an effective laboratory safety program in academia. In an academic environment there are individuals using laboratory space that are inexperienced, added to that federal guidelines usually do not cover colleges and universities. Safety guidelines need to be viewed as engaging and inventive by the students. We cannot reinvent the wheel for today's students, with pedagogy and technology that has been used in the past. Students today will not sit down and read manual after manual to find the correct answer. Technology must be used as a way to engage students about safety in laboratories. Lastly lessons have been learned that will make it easier to develop future safety programs in academia.

Major Points:

- Federal compliance when federal compliance is not required
- Reinventing the Wheel
- Pedagogy of students
- Technology for students
- Lessons learned

Summary: Attendees will understand some of the requirements for developing an effective safety programs in academic environments; due to the differences in compliance, student's pedagogy and use of technology. While passing along lessons learned.

Analysis of Safety Decision-Making Data Using Event Tree Analysis

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Need: Predicting and analyzing employee safety decision-making is an important component of managing safety in the workplace. This presentation will discuss the process of transforming existing safety decision-making data into an event tree pathway. Event tree analysis methodology is utilized to identify contributing factors in complex systems, illustrate interrelationships of the causes of specified events, and to quantify probabilities of occurrence for each pathway of events. Once pathways are constructed and probabilities for each are estimated, safety decision paths with the highest probabilities can be targeted for educational intervention. Thus, the use of safety decision-making data with event tree analysis has great potential for use in the discipline of safety management.

Overview: This presentation will discuss the use of safety decision-making data in event tree pathway development and its potential benefit in managing workplace safety. A case study using existing safety decision-making data will be shared. Discussion of the event tree analysis methodology will be discussed from a safety prospective. Implications for educational intervention in the field of safety will also be shared.

Major Points:

- Event tree analysis methodology as used in the field of safety
- Presentation of a case study utilizing existing safety decision-making data to develop an event tree • pathway
- Benefits of using event tree analysis for managing workplace safety
- Event tree analysis as a basis for educational intervention in the field of safety

Summary: The audience will learn about the development of event tree pathways using existing safety decision-making data in a case study format. Event tree analysis methodology will be discussed from a safety perspective and implications for educational intervention in the field of safety management will be shared.

Develop a Safety Program for Your Classroom Or How to Liability-Proof Your Self in A Lawsuit

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Need: Teachers are living in a very litigious society where individuals think they have a right to sue another person over any minor action. Teachers in the Technology Education and Career Technology programs are very vulnerable to being sued. Many laboratory teachers do not realize the importance of developing a comprehensive safety program that would be defendable in a courtroom. Many teachers believe a one page pledge and release sheet would be sufficient documentation for a liability release. The trend of alternative certification of teachers has allowed many untrained people to certify as a technology teacher. These teachers have completed their certification through regional service centers, proprietary business that advertise certification through passing a state examination, and through regular teacher education programs. The alternative certified teachers receive very little instructions in how to establish a safety program. Instructors with alternative certification indicate there is very little understand of how teacher liability is determined much less how liability can be avoided. Teachers must understand how liability, immunity, negligence, comparative negligence, contributory negligence, assumption of risk, proximate cause, and government immunity laws affect the laboratory teachers.

Overview: Developing a Safety Program for Your Classroom are how to Immunity Proof Yourself in a Lawsuit will introduce topics in a lawsuit that are considered in determining a teacher's liability. This program will present a complete safety program that has been tested in a major lawsuit as a result of a student accident in the classroom laboratory. The safety program will teach participants the necessity and how to develop documents to include in a safety program. The presentation will present why teachers become liable, the steps in teaching safety, and how to develop forms to document the student is continually monitored in safety education in the laboratory. Participants will understand how to write a safety pledge, waiver/ purchase insurance, authorize consent of medical care, consent to use equipment, eye safety rules, eye safety pledge, failure to follow safety report, selection of safety glasses, cognitive and psychomotor safety exams, accident reports, and how to deal with lawsuits. Teachers that sponsor "Skills U.S.A. Clubs" are responsible for supervising students on field trips to local, state, and national contest. Participants will learn how to write/ develop a safety guide form to document an accident and the repercussions of an accident while away from the school.

Major Points:

- Need to protect yourself from a possible lawsuit resulting from and accident in your classroom
- Identify and provide examples of forms/actions that should be included in a safety program
- Identify and provide examples of how to write and administer psychomotor safety test
- How to deal with a lawsuit

Summary: Participants will understand the concepts that determine how and why a teacher can be found negligent and liable in a student accident. Participants will understand the value and importance of developing and implementing a comprehensive safety plan. Industrial Educators will receive examples of all the forms necessary to develop, teach and measure student safety knowledge of safety. Forms will be provided to teacher educators to use when teaching safety related courses.

Methodology for the Correlation between Workplace Assigned Mobile Communication Devices and Increased Employee Stress

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Need: Workplace stress can cause numerous mental and physical health problems. These problems can range from mild anxiety to serious problems that could cause death. There are other factors involved with many health problems but, most can be linked to and accelerated by stress. Stress can also have an adverse effect on the productivity and morale of employees. With the rapid advance in communications technology, mobile communication devices are new possible stressors that have become prevalent over the past few years.

Overview: Two surveys were created to study the correlation between workplace assigned mobile communication devices and workplace stress. The surveys were completed by employees in various companies and careers. The surveys included questions about the employee's background, stress levels, workplace stress, and their workplace assigned mobile communication device. The reliability of the second survey was evaluated using the Cronbach Alpha test and was determined to have a reliability of 0.943.

Major Points:

- Stress is a serious issue in the workplace
- Surveys were created to determine a link between stress and workplace assigned mobile communication devices
- Survey results were discussed and analyzed using statistical analysis
- There appears to be a correlation between stress and workplace assigned mobile communication devices.

Summary: The results showed that most employees have workplace stress. Most employees are aware of their workplace stress and use stress reduction techniques. More than half the respondents have workplace assigned mobile communication devices. The respondents were required to use their workplace devices after work hours and take them on vacation. The results of the second survey were analyzed using Analysis of Variation (ANOVA). The ANOVA showed a resulting F > Fcritical with F equal to 2.6278 and Fcritical equal to 2.61. This implies that p equals .0486.

World Class Environmental Health & Safety

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Need: Methods for containing accidents and injuries, minimizing risks and exposures are needed along with cost containment in all workplace environments. Work culture and safety effectiveness are byproducts of management ownership and leadership. Tools are needed to assist workers with key elements for success.

Overview: World-class environmental health and safety involves strategic planning for optimal organizational performance improvement. An analysis of how people working together to achieve the common purpose of health and safety with a specific set of objectives can achieve world-class performance. The entire organization, including internal and external stakeholders, can be committed to and involved in the process. It looks at three levels: organization, process, and job/performer and considers three variables: goals, design and promotions.

Major Points:

- Financial forecasting. If we can predict safety, we can predict future trends, events, and outcomes with business perspectives in mind, which is, profit, interest, supply, demand, and similar issues
- Recipes for Success include management leadership and commitment
- Benchmarking other institutions utilizing best known methods
- Listening to employees: Ensuring feedback mechanisms are in place
- Driving employee engagement in planning
- Developing core values. Rewarding and recognizing championship behavior
- Continuous improvement, looking at an ongoing, systematic process to assure, maintain, and improve

Summary: Attendees will understand the world-class performance model used in heavy manufacturing to pursue zero lost time injuries. The world-class performance model can be used to improve any workplace environment exposed to occupational hazards.

Teaching Innovations

Challenges in Teaching Engineering Statics to Non-Engineers

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Need: Engineering Statics is traditionally taught lecture-based with a large concentration on the application of Mathematics to solve statics problems. This course demands high levels of competency in difference areas of Mathematics. In addition, problem solving and spatial visualization skills are paramount when solving engineering problems. To adopt and teach Engineering Statics to Industrial Technology (ITEC) students, a different teaching strategy should be developed along with many hands on activities that distinguishes ITEC from engineering programs.

Overview: This study describes in detail the challenges in teaching Engineering Statics to Industrial Technology (ITEC) students. This study also provides a proper model in teaching Statics that is suited to ITEC students' backgrounds and their program objectives. Historically, the curriculum designed for ITEC programs are focused more on applied engineering sciences that entails less analytical but more hands-on skills. ITEC program is described by the U.S. Department of Education as "a program that prepares individuals to apply basic engineering principles and technical skills in support of industrial engineers and managers1". Normally, students who do not have strong interest or background in math and sciences but have interest in applying certain technologies, choose ITEC program. Recently, NAIT's name change to ATMAE was to address changes in the skill-set required for ITEC graduates. Many ITEC programs nationwide adopting the name change and soon, we will see many Applied Engineering Departments with a revised curriculum. Engineering Statics, in part, was introduced to the current ITEC students to address this change. In this descriptive study, the challenges of teaching Engineering Statics to ITEC students will be presented. The teaching methods, assessing techniques, and hands-on and group activities that are adopted to properly deliver the course material suitable to ITEC students will also be presented. Moreover, RISA 2D, an engineering design and analysis software, that was used for students' tower design project will be discussed. Student evaluations are used to assess teaching strategies and to draw potential changes to the course. Prospective improvement in the prerequisites, teaching strategies, assessing techniques, project-based learning, and using RISA 2D will be discussed.

Major Points

- Challenges and new strategies in teaching engineering statics to ITEC students
- ITEC students' mathematics background, spatial visualization and problem solving skills
- Project-based learning of Statics
- Analysis of design problems using RISA 2D and AutoCAD Mechanical

Summary: Attendees will understand the potential challenges in teaching Engineering Statics to non-engineers. A successful strategy of teaching Statics to ITEC students will be discussed. In addition, project-based learning of statics will be emphasized. Examples of Engineering Statics problems that are solved using RISA 2D and AutoCAD Mechanical software will be presented. A tower design, analysis, and construction project that was used to assist understanding the Engineering Statics concepts will be discussed.

1 http://nces.ed.gov/pubs2002/cip2000/occupationallookup6d.ASP?CIP=15.0612

Rock On! Teaching STEM Using Electric Guitars

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Need: According to both the United States National Research Council and the National Science Foundation, STEM fields are collectively considered core technological underpinnings of an advanced society. It is commonly understood that the strength of the STEM workforce is viewed as an indicator of a nation's ability to sustain itself. The project being presented here is one effort to strengthen STEM education in our schools by providing an innovative and exciting way to engage students and educators.

Overview: The presentation will outline the NSF project: Faculty Professional Development in Design, Construction, Assembly and Analysis of a solid body electric guitar. The goal of the project is to provide professional development to high school and community college faculty in STEM concepts through the design, construction and analysis of a solid body electric guitar. The team of educators participating in the NSF project has been presenting the staff development workshops throughout the US and has seen many successful implementations of the guitar project. There is no denying that electric guitars are simply "cool" and students of all types, including nontraditional, clamor to participate in the STEM classes. This presentation will describe the project successes, lessons learned, and explain how more teachers can join the STEM guitar revolution. The NSF grant provides stipends, tools, and guitar kits to help you get started. See more about the project at www.guitarbuilding.org

Major Points:

- Overview of the NSF project activities and objectives
- Successes and lessons learned
- A typical workshop agenda
- How you can get involved

Summary: Attendees will learn how electric guitars are being used to engage students in STEM like never before. Find out how you can become involved in this innovative and exciting project.

Service Learning as Experiential Learning: A Method Used to Simulate Learning and Serve as a Recruitment Tool for Technology Disciplines

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Need: Experiential learning is the process of making meaning from direct experience. Experiential learning is learning through reflection on doing. Since service learning, a form of experiential learning, incorporates teaching, learning, and reflection, this allows students opportunities to participate in projects that serve the community and develop academic competencies. In building on John Dewey's views that advocated active student involvement in learning as an essential element in effective education, the community is an integral component of educational experiences for both enhancing a student's education and for developing future societies. However, there is an additional component that helps fill a void in the academic community. As students (especially college students), make a positive presence in the community by participating in technology-based service learning projects, this helps promote the field of Technology to secondary students. Such a method of exchange helps to minimize the decline of the Technology student population.

Overview: Service learning is an educational strategy that allows classroom skills and knowledge to be place into practice while fulfilling a societal need. It combines civic involvement with academic coursework in a manner that benefits both the student and the community. However, technology- based projects will add to students' experiences as they are being developed as practitioners. As technology students are serving the community, they become change agents with a positive presence. This, in turn, ignites or heightens secondary students' interests in Technology; thus, this may service as an influential recruitment tool.

Major Points:

- Indicate how service learning in a form of experiential learning
- Discuss the implementation of technology in experiential learning and how this develops meaningful class projects
- Discuss the decline in technology student population and efforts to increase student interest
- Identify how service learning may be used in developing experiences for students and how it may be used to recruit future technology students

Summary: Service (experiential) learning is distinguished in the following ways: curricular connections, student voice, reflection, community partnerships, authentic community needs, and assessment. Curricular connection is integrating learning into a service project, which is essential in gaining experience. Student voice is beyond being actively engaged in the project itself, students have the opportunity to select, design, implement, and evaluate their service activity, encouraging relevancy and sustained interest. Reflection is structured opportunities are created to think talk, and write about the service experience. Nevertheless, technology-based projects, when partnered with secondary school or entities, will increase awareness of technology academic programs and careers, and it will aid to increase the technology student population.

Using "Question Clouds" for Focusing Student Attention on the Core Concepts or Ideas of a Topic

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Need: Technology and management courses typically develop specialized knowledge, skills, and attitudes in students using structured lectures, laboratory session, and projects. Wading through all the information and prioritizing what is most important can be difficult for students. There is a need for focusing student attention towards the fundamental or core ideas related to the topic under discussion. Rather than provide students with the answers, these core ideas can be posed as discussion questions, "question clouds," or "thought bubbles" as are common in art and cartoons. The perceived informality of the format can be helpful in sparking conversation around the essential ideas related to the topic, drawing students to the core ideas linked with it.

Overview: Courses are organized around a limited set of key concepts and terms. The top-level organization of the course may consist of different units, and each unit in turn includes topics that are discussed in individual lecture and lab session. While topics are often presented in a linear fashion as part of lecture, certain ideas "bubble" up to the top. These can be posed as introductory questions for initiating discussion and as concluding thoughts. Using a technique reminiscent of mind-maps the instructor can then introduce and interconnect key terms and concepts within each lecture or laboratory session.

Major Points:

- Development of critical thinking skills and prioritization of information.
- Emphasizing essential content, skills, and attitudes relevant to the course unit or topic.
- Using "question clouds" for sparking discussion around key, need-to-know content about a topic
- Introducing core questions at the start of the lecture, and revisiting these at the conclusion.
- Samples of key questions drawn from technology and management course lectures.
- Motivating students to organize their learning in courses around key terms and concepts.

Summary: Learning to think deeply about a subject or topic requires students to focus on the primary concepts, ideas, terms, skills, and attitudes linked with it. Other content of the course can usually be expressed in terms of this primary content. Using "question clouds" students' attention can be directed to consider the important concepts. This activity requires students to use critical thinking and communication while discussing the implications and interconnections between key terms and concepts linked to a topic.

Developing Visual Rubrics for Evaluating Student Competencies

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Need: Assessment of multi-faceted student learning outcomes in technology, applied engineering, or management areas often rely on rubrics. The implementation of these rubrics to measure the different facets can be challenging for faculty. In many cases this process has to be done in real time, as is the case with live presentations or demonstrations. Therefore, there is a need for developing visual rubrics that are intuitive, easy to maintain, while providing valid and reliable measures of student competencies.

Overview: Evaluation of student competencies found in course and capstone projects related to critical thinking, creativity, and communication often rely on rubrics. These rubrics can be cumbersome to use, being organized in a tabular format, with multiple categories, each containing several levels of student performance. Graphical rubrics offer the advantage of depicting different dimensions of learning visually. These rubrics can be easily understood and internalized when used across the curriculum by students.

Major Points:

- Role of rubrics in evaluating complex student learning outcomes and competencies
- Challenges in developing, implementing, and updating traditional rubrics for use in technology, applied engineering and management classes
- Representing competency levels in multiple areas simultaneously using graphical rubrics as compared to tabular rubrics
- Alternate formats for graphical rubrics
- Encouraging students to self-evaluate the knowledge, skills, and attitudes relevant to their profession development using rubrics
- Improving intra-group interaction using visual rubrics as a rapid feedback mechanism
- Determining the effectiveness of visual rubrics for measuring student learning outcomes

Summary: Determining the appropriate level of performance while evaluating project reports, presentations, and problem solving activities using a tabular rubric can be time consuming for the instructor, and difficult to interpret by the student. Graphical representations of rubrics linked to more detailed tables as needed, can provide the student with appropriate and timely feedback. Participants of the session will learn about techniques for converting or linking tabular rubrics to equivalent graphical rubrics.

Vertically Integrated Project: New Approach to Involving Undergraduates in Research

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Need: Many benchmarks and metrics found in major universities today are intended to encourage undergraduate students to engage in research. Unfortunately, that is a difficult task in today's environment. Students are often not interested in conducting research, and may not have the skill sets needed to capably participate. Likewise, faculty who are pressed with many competing responsibilities may not have the time to work with and develop research opportunities for undergraduate students. A result of all of these problems is that the amount of graduate student recruiting that can be achieved by engaging undergraduate students in research is limited. There is a need for a new approach to getting undergraduate students involved in research that helps to overcome such barriers, and that assists in creating a "pipeline" of undergraduate students that can move into graduate school with some research and laboratory experience.

Overview: The Biometrics, Standards and Performance Assurance Lab in the College of Technology at Purdue University announced an opportunity for undergraduates to engage in research. They established a vertically integrated project (VIP) with a group of volunteers that was structured to run for 3 consecutive semesters. The group included a mix of students in both Industrial Technology and Industrial Distribution degree programs, and also utilized graduate student mentors in the project. This paper discusses the highly successful outcome of the VIP, as well as the lessons learned that will be incorporated to improve future projects.

Major Points:

- The need for VIPs for undergraduate students; rationale for faculty to engage in.
- Structure of VIP used in Purdue University's Biometrics, Standards and Performance Assurance Lab.
- Support for VIP garnered from industry partners and service-learning grant from Purdue University.
- Outcomes of the VIP in terms of benefits and costs for faculty and students; includes impacts related to student performance, student publications, learning outcomes for accreditation activities, student resume enhancement, and conference participation, and need for structure and mentoring skills for faculty and graduate students.
- Lessons learned; plans for future VIPs

Summary: The project ran to a successful completion, with undergraduate students achieving multiple scholarly publications as well as academic conference participation as a result of the project. One of the students is also planning to enter the M.S. program upon graduation; a prized outcome. A prime conclusion regarding effectiveness of the VIP is that undergraduate students can successfully conduct, and excel, at scholarly research, in spite of the fact they often underestimate the magnitude of their work and their ability to write and publish scholarly articles. It is an excellent way to get undergraduate students involved in research with many benefits for students and faculty.

Student Sustainability Projects in Information Technology

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Need: Information technology has been a catalyst for economic development. However, the continued increase in demand information technology products and services has had a significant negative impact on the environment at a global scale. Across society; individuals, businesses, and governments are calling for the information technology field to adopt sustainable practices. This is evident in the number of Green IT articles found in both trade and non-trade publications. Students need to gain an appreciation of the impact information technology has on the environment. This awareness should encompass the entire product lifecycle of information technology hardware. That is, students should investigate the environmental impact of the manufacturing, usage, and disposal of information technology hardware.

Overview: This presentation will identify several key areas within a typical information technology curriculum can incorporate sustainability concepts and practices. The environmental issues related to these key points will be discussed. Having established the need to address the key areas, immersive learning student projects will be presented. The projects are designed to engage the student in research, discovery, and critical thinking related to determining sustainable solutions in information technology. Projects will cover topics related to the design, manufacturing, use, and disposal of information technology hardware. It will be shown how the projects can be replicated at other institutions with little to no additional resources.

Major Points:

- Students need to be aware of sustainable practices in information technology.
- Student projects designed to raise awareness of how sustainability relates to information technology will be presented.
- Strategies for incorporating sustainability projects into an existing information technology curriculum for little to no cost will be offered.

Summary: Despite the tremendous advances that have been enabled through information technology, the manufacturing, use, and disposal of such hardware has resulted in significant environmental problems. This presentation will present a series of projects designed to increase student awareness; promote research skills; and foster critical thinking as they try to find solutions sustainability issues related to information technology.

Interdisciplinary Service Opportunities for Technology Students

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Need: In the Mechanical Engineering Technology (MET) Program manufacturing concentration, each student will complete a two semester capstone project sequence required for graduation. For universities located in nonindustrial rural areas, implementing these capstone projects in conjunction with industry partners is a challenge. An additional barrier is a slow economy that does not allow for companies to donate resources for sponsoring a student run project. Experiencing first hand projects initiated by industry that have ground to an abrupt halt as soon as priorities have shifted within the firm has necessitated a more reliable source of capstone experiences for product design and development projects. Reuse of university equipment that may exist in departments that has fallen into disrepair, been donated to the university, or that needs to be retrofitted to serve a new purpose serves a sustainability need as well as an educational need.

Overview: Interdisciplinary service projects allow students the opportunity to research customer requirements, develop solutions and solve problems with faculty and students from units outside their own department. While the educational benefits for the technology student are obvious, interdisciplinary service projects also benefit students from other departments. Examples of projects that have been implemented include designing, manufacturing, and/or developing processes for; Material Sciences Engineering test equipment, Civil Engineering concrete sample accelerated environmental simulation tests, and realization of Biomedical Engineering products.

Major Points:

- Interdisciplinary service projects fulfill a university sustainability strategic goal.
- Equipment retrofit projects require integration of electromechanical skill set.
- Job growth area: To develop procedures for, utilize, and service test equipment.
- Biomedical product development requires innovative manufacturing production methods.
- Communication skills are necessary for creation of operations and safety manuals.

Summary: Attendees will understand the advantages and challenges of implementing interdisciplinary service projects for manufacturing concentration graduates from a technology program. Data will be presented that indicates the costs and benefits of projects including troubleshooting, retrofitting, designing and manufacturing components for a donated die cast machine and environmental simulation test chamber among others.

Implementing a New and Innovative Teaching and Assessment Strategy Using Jing Software Technology in the Classroom

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Need: To attain teaching excellence, university and public school faculty need new and innovative ways to provide meaningful instruction and assessment. Typing a detailed example for instructional purposes is slow and tedious. Typing detailed feedback is also slow and tedious and it is not always meaningful for students. Free software called Jing can make instruction and assessment more meaningful. Jing acts like a video camera and captures narrated videos on an instructor's screen as he/she provides instruction or feedback in any software program selected by the instructor. According to Rosenblum (2007), "We don't live in a print driven culture anymore. We live in a video driven culture. But we are not educating our people in video literacy, and we should" (Para. 9).

Overview: During the presentation, a free online software program called Jing will be demonstrated. It can assist university and public school faculty with providing innovative and meaningful instruction and assessment. The presenters will demonstrate how to use Jing to capture video and sound for instruction and assessment purposes. The presenters will also show how to quickly and easily distribute recorded video instruction and assessment via e-mail or in e-learning platforms. The presenters will share real-world results relating to the recent implementation of this technology in a university classroom.

Major Points:

- Accessing, downloading, and setting up free Jing instructional and assessment software
- Pedagogy relating to using Jing software to provide innovative and meaningful instruction and assessment
- Demonstration of Jing software to capture video and sound for instruction and assessment purposes
- Distributing recorded video instruction and assessment via e-mail or in e-learning platforms
- Presentation of real-world results relating to the recent implementation of this technology in a university classroom

Summary Participants will leave the presentation with a firm understanding of how to use Jing software to provide innovative and meaningful instruction and assessment. The participants will have an understanding of how to distribute recorded video instruction and assessment via e-mail and in e-learning platforms. Participants should be prepared to implement this technology in their own classroom upon leaving the presentation.

Reinventing the Electric Car: Providing Students "Alternative" Education through Undergraduate Research Projects

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Need: The "simple" production of an electric vehicle is neither new nor inventive. With vehicles like the Toyota Prius, Honda Insight, Chevrolet Volt, and Nissan Lead already in prevalent production, one may question why such a venture would be worthy of study? Students graduating from colleges and universities nationwide are entering a world where these production vehicles and their hybrid cousins are becoming more reality than concept. Students leaving campuses must be prepared for that reality; whether entering graduate study, industry, or simply functioning as a consumer. This undergraduate research project planned for the summer of 2011 is just one example for how educational institutions may provide opportunities that build upon and extend beyond the traditional classroom experience. Future employers are looking for students with skills that extend beyond basic degree requirements.

Nearly 88% of employers agree that the challenges their employees face within their organization are more complex today than they were before, and a similar proportion say that to succeed in their organization, employees need higher levels of learning and knowledge today than they did in the past. (Association of American Colleges and Universities, [AACU], 2010, p. 5)

This undergraduate research project will provide students an opportunity to explore interests that could alter course, major, and career choices prior to graduation. This opportunity will also equip students with the interdisciplinary skills that are both challenging and highly sought after in a modern job market.

Overview: This presentation intends to share the experience of this particular undergraduate research project as it attempts to guide interested students through the development, design, and production of an electric vehicle. The presentation will share the pertinent details of the undergraduate research project as well as the crucial student perspectives collected throughout the process. It is anticipated that sharing the particulars of this undergraduate research project may foster collaboration with other institutions interested in exploring similar research experiences. It is equally anticipated that those same institutions may provide vital commentary as to how we may improve our own efforts to prepare our students for their roles in a modern world.

Major Points:

- Project overview including research, design, and production
- Participating student majors (plan of study), skills, and attitudes prior to research project commencement
- Student reflections and observations throughout the creative research project
- Comparison of attitudes, skills, and plans of study collected at the commencement and the completion of the research project
- Successes and challenges of the creative research project experience
- Potential creative research projects utilizing the electric vehicle

Summary: Attendees will come to understand the undergraduate research project recently explored at Berea College. The project intended to take four students through the development, design, and production of an electric vehicle. It was hoped that this effort would better prepare students for the various demands and expectations of the post college world.

Engineering and Technology Summer Camp, Designing Young Students Future

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Need: Engineering and technology are professional disciplines that suffer from the lack of recognition among K-12 students. Additionally, K12 teachers introduce very little engineering and technology concepts into the classroom. However, engineering and technology are consistently listed by almost every career potential ranking system as top choices for both salary and opportunities. Clearly, educational programs targeted at showing potential engineering and technology students the very exciting aspects of these fields are needed to potentially increase the number of high school students entering these fields.

Overview: The UL Lafayette College of Engineering will design a camp entitled "Engineering and Technology Discovery Camp" that will provide GEAR UP students with eight days of an exciting educational experience that will include a mix of theory lecture, hands-on experiences, and tours of actual engineered systems within the Lafayette Area. The camp will be designed toward discovering "really cool" aspects of the engineering and technology fields.

Major Points:

- Provide a better understanding and appreciation on what engineers and technologists actually do along.
- Give important insight into the vast career potential for those students entering either engineering or technology.
- Allow the students to experience some of the more exciting aspects of engineered design and technology operations.

Summary: GEAR UP measurable objectives were to increase the academic performance and preparation for post-secondary education for GEAR UP students as well as increase the rate of high school graduation and participation. Preliminary results show from student and parents of participants show increase knowledge of postsecondary education options and educational expectations and preparation.

Use of 3-D Printing Model to Enhance the Classroom Learning Concepts of a Metal Casting

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Need: In the study of metal casting, students learn about certain guidelines and design principles pertaining to casting a component. In this presentation, we will present a project done by students and show how it was used to further enhance their learning concept of a metal casting

.

Overview: The use of CAD software to design a casting pattern and the mold, followed by printing these components using a 3-D printer resulted in the student been able to see, touch and feel the design that they had created. By pouring molten metal into the 3-D printed mold, students were able to observe some of the defects in their casting mold design. This project allows the students to print the parts that are usually too costly and time consuming to produce using traditional methods and at the same time provides a good hands-on learning experience in understanding some of the fundamental concepts of casting design.

Major Points:

- General design consideration for casting.
- Need to bring together previously learned skills (CAD) and knowledge (Metallurgy) into practice.
- Use of 3-D printers to emulate the look, feel and functionality of the metal casting.

Summary: Attendees will understand that this project involving the use of CAD software, 3-D printer and basic metallurgy practices can help the student understand some of the fundamental concepts of casting design.

Taking the Learning Center into the Classroom

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Need: Students learn at different rates and in different ways. By leveraging the skills of our Learning Center tutors, we are able to assign tutors to specific classes and give instructors great flexibility in how the tutors can help them during class meetings.

Overview: At Clermont College, The Learning Center provides walk-in tutoring for core subjects across the entire campus. TLC staff also organizes workshops, study groups to support the needs of the students. Our paper focuses on bringing specialized assistance to students during class meetings rather than after the fact. Specially trained tutors who work in The Learning Center are assigned to work in technology classes at the discretion and direction of professors who are actually teaching the classes. The tutors are used in different ways by the professors based on their needs and the needs of the students in the class. We provide descriptions of successful and less than successful techniques based on the first-hand experience of a tutor, a professor, and the Director of The Learning Center.

Major Points:

- The genesis of The Learning Center and the innovative in-class tutoring program
- The identification and training of the student tutors
- The assignment of tutors to classes
- The negotiation process between tutors and professors.
- The unique ways that tutors are used throughout the class meetings.
- The results of in-class tutoring from the perspective of the tutors, the professors, and the students.

Summary: Taking our Learning Center tutors into active classrooms has proven to be a great success at Clermont College. Our paper describes in general and specific terms how the program has been developed, deployed, and evaluated. The program has been a great success and the education community at large can benefit from our experiences.

Facilitate Learning by Video Capturing Your Lectures with Free Software Tools

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Need: Teaching and creating education content through the use of tablet PCs have gained popularity among the engineering faculty. When screen capturing video tools are combined with tablet PC features, it becomes a much more promising technology to increase teaching and learning performance in both traditional and online courses. Advantages of using tablet PCs running Windows operating system and commercial screen capturing software have been reported by many educators in the last few years. However, the availability and use of free open-source screen capturing video tools have not received much attention. Recent developments in user friendly open-source applications offer quite appealing alternatives to tablet PC users in recording lectures and making the video files available for students' use. This subject offers a review of free open-source software tools available for Tablet PCs running Linux operating system, and a summary of lessons learned from the teaching experience of four industrial and engineering technology related courses in a traditional classroom with a tablet PC and free screen capturing video tools.

Overview: Tablet PCs make it possible to write on pdf or word files during the lecture and save them in desired file formats. The file that has instructor's inscriptions can be made available to students after the lecture. Recent advances in software and computer technology also let instructors to record both the screen and sound in a video file. The most important aspect of teaching the course with the Tablet PC was that students have the option to replay the movie times as many times as they need to clarify concepts they missed in the classroom. It is this feature that was used and appreciated by the students most often, and has made the most positive impact in students' mind about the use of Tablet PC in the classroom.

Major Points:

- Share survey results
- Introduce tablet PC and Linux environment
- Study media formats
- Describe open source software
- Investigate compatibility of integrated systems

Summary: This subject summarizes the authors' experience in teaching four courses using a tablet PC that runs Linux operating system and free screen capture software tools. Students indicated that they like the Tablet PC style lecture delivery, and found the availability of video files very useful. Details will be shared with academia and industry.

YouTube, It's Not Just for Kids

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Need: Students at every level need to be engaged in their learning. Over 2 billion people a day view YouTube. As educators, we should learn how to take advantage of this popular, free, timely technology in the classroom.

Overview: Presentation will include several YouTube applications throughout the area of technology. A variety of programs/areas of emphasis within the School of Technology (Industrial Technology, Advanced Manufacturing, Design Technology) utilize YouTube in the classroom to demonstrate safety techniques, principles of electricity, features of new design software upgrades, etc.

Major points:

- YouTube background (what is it, how long has it been around, who uses it, why do they use it)
- Classroom applications of YouTube (interviewing, safety, design, etc.)
- How to load YouTube into Power Point and Blackboard
- Fears regarding YouTube (is it safe to use, what if the movie is not there when I need to use it)
- Student reactions to YouTube in the classroom

Summary: Attendees will know how and why to use YouTube in the classroom. Straight lecture format, while sometimes necessary, can be too traditional. The mere fact that you are using YouTube in the classroom will evoke curiosity. Amateurs as well as professional technical organizations author movies on YouTube. Students can watch movies of actual events that are difficult if not impossible to recreate in the classroom. Engaged students will be able to better retain and apply the learning objectives of the class.

Simulating a Biofuel Production Internship in an On-Campus Environment

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Need: The Chemical Technology and Sustainable Energy programs at Ivy Tech Community College – Lafayette have collaborated to develop a course in the fundamentals of biofuel production. The course is directed at individuals who have little or no prerequisite knowledge in chemistry or production systems. The need for the course stems from local interest in small- and medium-scale production systems such as biodiesel, ethanol, and biogas. Since many potential employers are small businesses, they are unable to take on supervised interns.

Overview: This presentation outlines the steps that were taken to provide students with an internship opportunity. The corresponding course, Fundamentals of Biofuel Production, implements relevant apparati, and introduced critical skills required for small- and medium-scale biofuel production. Previously reported efforts by Ivy Tech Lafayette faculty have demonstrated the capability to provide a closed-loop environment for biofuel production and utilization. As students seek internships in this area, Ivy Tech has provided them with meaningful internship experience that take a biofuel production process from design to application.

Major Points:

- The nature of small- and medium-scale biofuel production often precludes the availability of internship opportunities for students
- Ivy Tech Lafayette has developed and implemented a closed-loop biofuel process
- Students interns are engaged in this process from set-up to full production
- Students are provided with application opportunities that may not otherwise have been available

Summary: Students interested in the operation of small- and medium-scale biofuel systems are unable to find internships with small businesses implementing such production. Ivy Tech Community College – Lafayette provides an internship opportunity through their existing closed-loop biofuel process for those students.

Using Technology to Educate the "Facebook" Generation

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Need: Higher education is faced with the task of educating a generation that has grown up with technology, the "Facebook" generation. Students use technology on a daily basis. Many university courses use websites, chats, clickers, and social media to reach students. Many college students report that they like the different types of classes that technology allows. What are the technologies that higher education can use to teach students? Research has found that the effective use of technology in the classroom can engage the student and improve learning. With increasing the number of students in the classroom, technology may also help faculty in their workloads.

Overview: Technology can help make the classroom more about learning and less about information gathering. Appropriate technologies can enhance student engagement. Because this generation thrives on the use of technology, effective use of technology in the classroom can enrich the learning experience. Education is seeing the advantages of offering different strategies and technologies in classroom. This presentation provides techniques for using various technologies in the classroom.

Major Points:

- Reasons for using appropriate technologies in the classroom
- Challenges of technology in the classroom
- Using technology to help with faculty workloads
- Techniques for achieving student engagement with technology

Summary: Attendees will understand the different technologies that can be used in the classroom to engage students and increase learning. This presentation provides techniques for using technologies in the classroom for effective instruction. In addition, this presentation will give ideas on using technology to help with faculty workloads.

Optimizing FDM Rapid Prototyping Technology to Enhance Conceptual Visualization of Design Project Models in Architectural/Construction Graphics Courses

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Need: Production of architectural/construction project design models that accurately convey designers' intentions or clients' requirements frequently pose challenges to model makers as a result of the unavoidable scaling factors. Design detail is often lost as a result of size differences between project and model. In this presentation, we will demonstrate a systematic approach using one of the Fused Deposition Modeling (FDM) RP technologies to optimize fabrication of conceptual design models using different thermoplastics and compatible support materials.

Overview: The resources required producing model prototypes that efficiently and effectively satisfy designers/client purposes vary dramatically when using FDM machines. Pre-determining the most appropriate thermoplastic model making and compatible support materials and the amounts required before actual model making processes are carried out enables one to make data based decisions. Accurate available modeler configuration setting options available together with the correct material selections helps to produce desired model finishes/strengths and above all, ultimately determines model building estimate times. This information greatly assists model makers to monitor the building process as some machine settings and material choices require replenishments of building/support material canisters on the modelers.

Major Points:

- The fundamental applications of different types of models on architectural/construction projects designs
- Model making using rapid prototyping technology
- A discussion on available fused deposition modeling technologies available
- Optimizing the FDM Vantage SE modeler to produce sought architectural/construction project design models
- Comparison of model making/support material consumptions depending on thermoplastic types used, modeler machine settings, and prototype building times. (The costs involved and model finish styles)

Summary: The audience will experience an approach that can be used to optimize the production of appropriate architectural/construction project design models using the FDM Vantage SE rapid prototyping machine. The approach can also be used on other design modeling in addition to architectural and construction.

An Activity-Based Approach to Teaching Building Codes in Academic Programs

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Need: Building codes function collectively as a mechanism to ensure safety in built environments. It is imperative for academic programs, such as architecture, interior design, construction management, facilities operation, etc., to offer courses on building codes in order to better prepare students majoring in relevant fields to gain necessary knowledge for his/her future professional career, as well as to apprehend the health, safety, and welfare criteria that serve as the basis of professional licensure. In this presentation, an activity-based approach to teaching building codes will be introduced, reviewed, and assessed based on student learning outcomes. This novel pedagogical delivery method was formulated as a result of curriculum development, and implemented in interior design program at Eastern Michigan University.

Overview: Having been recognized as a crucial part of the body of knowledge for fields pertaining to building design, construction, and operation, building codes have been adopted as a component for professional licensure examinations, such as ARE (Architectural Registration Examinations) and NCIDQ (National Council of Interior Design Qualification). Yet, due to the regulatory nature of provisions, learning building codes has been considered by students as one of the least interesting tasks in comparison with other design-oriented courses that nourish creativity and celebrate innovation to derive project solutions. To effectively convey the key contents of building codes and achieve the teaching objectives through a more appealing way, the format of the class was reformed to shift from traditional form of lecturing in the classroom to an activity-based pedagogy, which places emphasis on such activities as observation, comparison, measurement, and documentation to be conducted in actual built environments.

Major Points:

- Building codes and the safety of occupants in the built environments
- The intent of code and the logic underpinning code provisions
- Observation of code implementation in physical building environments
- Learning through measurement and documentation to verify code compliance
- A review on student learning outcomes

Summary: Teams consisting of two students were formed; each team was required to select a target building on campus for observation, documentation, and verification of code compliance. Through the physical involvement in actual buildings, students demonstrated enthusiasm in the learning process, while student project reports and presentations indicate teaching effectiveness.

Managing a High-Risk Laboratory as a Learning Opportunity for Students

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Need: Many students in the Ivy Tech Community College – Lafayette Sustainable Energy program are preparing to enter the wind technology field. Work on utility scale wind turbines is laden with hazards, including those surrounding fall protection, climbing, and rescue. These specific subjects are best taught with hands-on activities. The use of the facilities to do this is potentially lethal if used incorrectly. The preparation and documentation necessary in the classroom applies directly to the workplace. These should be used as learning opportunities to better prepare students for their careers

Overview: This presentation will outline the experiences of the Sustainable Energy program at Ivy Tech Community College – Lafayette in managing the Sustainable Energy Tower. As a part of the curriculum, students participate in climbing and rescue exercises on the 80-foot, outdoor tower. Where liability and documentation may appear to be a barrier to the use of such a facility, this presentation outlines how they are developed into learning activities that increase student interest in the topics, improve students' familiarity with the protocol, and better prepare them for their careers as wind technicians.

Major Points:

- Students participate in high-risk activities as a part of the wind turbine technician program
- Documentation of release, inspection, and safety documentation is used as a learning activity
- Student interest in and familiarity with the high risk nature of the exercises is improved through these activities making them better prepared for their careers

Summary: Students operate more safely in the laboratory when they are better prepared for the activities. Additionally, their interest in learning more about climbing, fall protection, and rescue increases after these activities.

Using Jing Software Technology as an Innovative Tool to Assist In Academic Advising

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Need: While Academic Advising is a rewarding experience, it can often become challenging to the point of frustration. At times we offer advice and instruction, over and over often to the same students that have forgotten, failed to follow instructions, or were not interested until they need the material. This results in repeat appointments answering the same questions or arranging a group session to address issues. It is often addressed by developing instruction sheets and distributing them electronically or directly by hand. The sheets can instruct students how to access information, develop graduation plans, or similar advising related functions. While this method is effective, it often ends in copy being thrown away, lost, or totally disregarded. A free software application called Jing can make instruction and advising more meaningful. Jing acts like a video camera and captures narrated videos on an instructor's screen as he/she provides instruction or advice in any software program selected by the instructor. This may have a greater impact on the student advisee, as suggested by Rosenblum (2007), "We don't live in a print driven culture anymore. We live in a video driven culture. But we are not educating our people in video literacy, and we should" (Para. 9).

Overview: The presentation will provide demonstration/instruction on using a free online software program called Jing. This software may be used to assist advisors and faculty with disseminating instruction and advice. The presenters will not only demonstrate how to use Jing to capture video and sound for advising/instruction purposes, but will allow members of viewing group try it also. A discussion will be undertaken to share ideas and suggestions on using this method in advising and other innovative ways this may be applied to advising.

Major Points:

- How to start using free Jing software in academic advising
- How to distribute recorded video advising material
- Demonstration of Jing software to capture video and sound for advising purposes
- Sharing of applications and ideas for using Jing in academic advising

Summary: Audience participants will have the opportunity to try the software so they will be able to implement it in their situation once returning to their university. New ideas and applications for academic advising may be generated during the instructions, enabling participants to try and develop new innovative techniques on their own.

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Rosenblum, M. (2007). The Case for Video Literacy, Retrieved from http://rosenblumtv.wordpress.com/2007/06/05/three-rsand-a-v/

Designing Assessment Instruments for Evaluating Student Attitudes Needed by Future Technology and Management Professionals

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Need: Success in the highly competitive technology-driven workplace depends in large measure on the knowledge, skills, and professional attitudes of the individual. Discussions with departmental advisory committee members along with data from national surveys indicate that an often overlooked but essential aspect of success is the professional attitude graduates exhibit. Assessment instruments are needed for recording and subsequently evaluating these crucial skills in students.

Overview: Formalizing a way to measure soft skills as part of course activities in technology and management oriented classes will enable students to know, do, and be more professional. By incorporating assessment of attitudes in various activities students have the opportunity to strengthen these skills. Using assessment instruments for this important area are often overlooked. In addition, providing feedback regarding this to students can be difficult, owing to personal and subjective nature of the information. The presentation will provide information about designing and integrating attitude assessment tools.

Major Points:

- The importance of assessing attitude as part of grading in technology, applied engineering and management graduates.
- Using advisory committee feedback regarding attitudes of successful professionals.
- Sample measuring instruments for assessing professional attitudes as part of course activities.
- Determining the relative weighing of professional attitudes within a given activity as compared to the knowledge- and skill-based components
- Providing feedback judiciously to students for improving professional attitudes.

Conclusion: Professional attitudes conducive to success in the workplace cannot be learned in one course and must be developed as well as evaluated across the technical and management oriented program. These include factors such as a maintaining a constant awareness of personnel and equipment safety, focusing on quality, sharing responsibilities as part of a team, communicating effectively using integrated media sources, scheduling time and project activities. In the era of instant global communication and growing social media use, maintaining these professional attitudes is essential. The presentation will include sample measuring instruments that that can be readily adapted for use in various courses.

Understanding Energy Conservation through Curriculum-Based Service Learning Projects

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Need: Energy is now listed along with health care and education as critical to the nation's economic future. With a hike in energy prices, investing in communities through improved energy efficiency in public and private buildings is a win-win opportunity for local, state, and federal governments. For private home-owners, energy efficient buildings are one of the best ways to reduce energy costs, increase available capital, spur economic growth, and improve working and living environments. An energy audit is often the first step in making buildings more efficient. Therefore, there will be a high demand for more energy auditors in the near future.

Overview: An energy audit assesses how much energy a building uses and evaluates what measures can be taken to improve efficiency. An enhancement of the engineering and technology curriculum to include student-led conservation projects, including energy assessment will help learners to better understand the energy field, which is one of the most dynamic and fastest growing areas. Moreover, the new methodology will provide a way to equip students to pursue employment or graduate degrees in the STEM fields related to energy as well as broaden the curriculum to include topics related to current community issues.

Major Points:

- Need for student-led energy conservation projects to the curriculum
- Students in engineering and technology to gain access to the energy management field
- Provide an innovative approach in designing an energy management based curriculum providing competencies on energy concepts, changes, management, and conservation
- Find ways to equip students to pursue employment or graduate degrees in STEM fields
- Broaden the curriculum to include topics related to community emphasis
- Students to be aware of green energy opportunities and challenges

Summary: Attendees will learn about an innovative approach used at Virginia State University to conceive and infuse energy dimensions into a core foundation course to reflect the nation's new requirements. The curriculum enhancement model can be used to improve most technology courses.

Assessing and Improving Integrated Software Literacy: Bridging the Gap between Perceived Student Skill Sets and Applied Skills in Microsoft Office

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Need: Students entering university courses are expected to have a base level of literacy in standard Integrated Software packages. Experience in the classroom reveals that students have a wide range of applied software skills that often don't appear to meet the minimum levels required for basic literacy. If these basic skills deficiencies are not addressed early in their college career, the lacking skills of the collective diminish the ability to cover material at higher level courses due to the need for remediation to achieve basic skills levels. In this presentation, we will present data from a pilot study that utilizes a Microsoft Office skills assessment and improvement program.

Overview: A perceived gap between expectations and student skill levels in applying skills related to Integrated Software Packages led to a desire for a process to objectively assess and remediate skills deficiencies in college freshmen at the University of Wisconsin-Stout. A pilot program was begun in the spring of 2011 as the first phase in a longitudinal study utilizing an assessment and tutorial system to determine and improve skill levels. A survey tool was also utilized to ascertain prior exposure to learning experiences aimed at developing software literacy. This presentation will discuss what we have learned from this pilot.

Major Points:

- Students entering the university may not have adequate software skills
- Need assessment tool to identify and provide remediation for software skills deficiencies
- Objective assessment needed to verify / disprove belief that students lacked skills
- This process should minimize the need for literacy remediation in higher level courses

Summary: Attendees will see the results of a pilot program aimed at identifying and addressing software literacy issues related to Microsoft Office. Also discussed will be lessons learned and revision of the project as it goes from pilot to longitudinal study.

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Administration

Associations of Instructors' Behavior on Students' Attitude Toward Classes in Technology and Engineering Programs

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Abstract
Administrators in technology and engineering programs emphasize methods and techniques by which instructors can attract the attention of students and get them engaged in course content. However, a major aspect of defining the students' attitude towards educational materials and classes in general is the instructors' behavior at different stages of the semester. Furthermore, the students' perceptions of the instructional material affect the ability of the instructor to effectively deliver the course content in classes. This interaction between the instructors and the students in a class room can set both of them on a path to success if done thoughtfully and properly. A review of literature suggests plausible methods and techniques on how to get students involved in class. However, little research is available on how the attitude of the instructor in first class affects the students' perspectives on the material. In addition, the variation in instructors' attitude also has an association with student learning outcomes. Drawing from the viewpoints of existing and new technology and engineering faculty in different ranks, including full, associate, and assistant professors as well as contracted faculty, this paper summarizes the experiences of others in an attempt to help administrators and instructors identify and develop a thoughtful process of integrating students in the class room to maximize dissemination of knowledge. In addition, it provides a robust methodology through Machine Learning (ML) for predicting the best means to be adopted in dealing with new classes.

Introduction
Education plays an important role in the development and improvement of societies. However, teaching endeavors are described as complex and diverse undertakings that tackle nonstandard challenges. Instructors plan, design, and develop materials that are essential to help students achieve the highest potentials and knowledge from their educational experiences. In an attempt to mitigate these obstacles, researchers and educators have focused on developing and identifying techniques and methodologies to engage students in class rooms such as active learning, experiential learning and problem based learning (Gijbels, Dochy, Van den Bossche, & Segers, 2005; Kolb & Fry, 1975; Lycke, Grottum, & Stromoso, 2006; Piercy, 2011; Hawtrey, 2007; Graeff, 2010). However, fewer studies examined the factors that promote academic success among students whose demographic characteristics and school circumstances affect their attitudes towards class rooms and educational materials (Akey 2006). As stated by Curran and Rosen (2006) "The first and most obvious answer is the instructor." The instructor's behavior and teaching practices in the class room outline a student's attitude toward a class that he or she may take. This perspective is congruent with social learning theory, which draws from the perspective that learning takes place through social interaction within the environment, including the instructor as well as other learners (Bandura, 1977).

In an endeavor to further examine this cause and effect phenomenon, this paper provides a summary of a number of experienced educators in technology and engineering programs in reputable universities in the United States of America and other courtiers. It further provides a Machine Learning (ML) model through Support Vector Machines (SVM) to predict the best practices to be adopted to achieve a positive attitude towards classes. To that end, the adopted research methodology (1) interviewed full, associate, and assistant professors as well as contracted faculty; (2) compared and analyzed the outcomes of the interviews; (3) identified stages of behavioral change and their effects on students' attitudes in class rooms; and (4) developed and compared the outputs of 4 SVM prediction models. The outcome of the aforementioned research methodology identified three stages of attitudinal shifts: initial, remedial, and final. In addition, the outcome highlighted the methods adopted by the instructors to adjust or control the situation.

Research Methodology

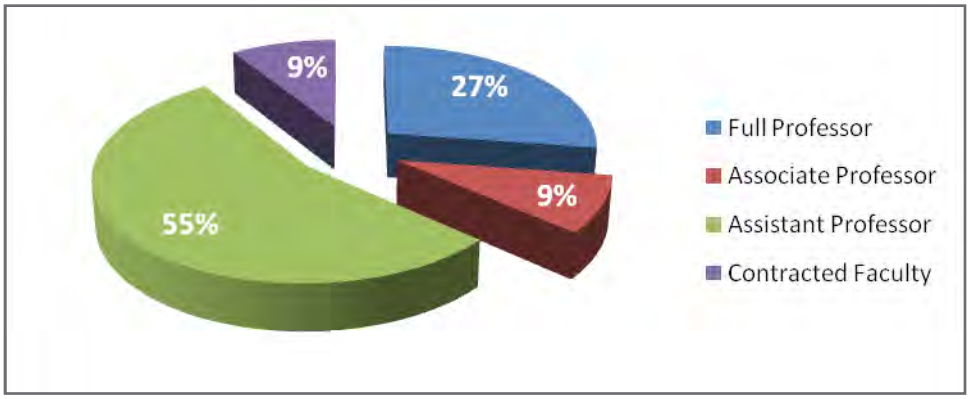
The current paper aims at defining associations between instructors' actions and their effects on students' attitudes through lessons learned. To achieve this goal, the research team performed informal interviews with 22 faculty members at different universities in the United States of America (USA), Arab Republic of Egypt (ARE), United Arab Emirates (UAE), and Kuwait. Table 1 provides the distribution of the faculty in relation to their geographic locations. In addition, Figure 1 illustrates the percentage distribution of the interviewed faculty per academic rank.

The gathered notes from all interviews were analyzed and key concepts were manually highlighted. These concepts in combination with class information were utilized to develop a Machine Learning (ML) model through Support Vector Machines (SVM) to provide instructors with best techniques and their expected success rates in newly encountered cases.

Table 1. Geographic distribution of faculty

Faculty Count	Program	Country
3	Technology	USA
3	Engineering	USA
4	Engineering	Kuwait
2	Technology	Kuwait
6	Engineering	ARE
2	Technology	UAE
2	Engineering	UAE

Figure 1. Faculty percentage disctribution per academic rank



Results and Discussion

This section provides the outcome of the implementation of the aforementioned research methodology. To that end, it constitutes of 3 sections, namely Stages and Practices Identification, Success Rates Identification, and Machine Learning (ML) Model Development.

Stages and Practices Identification

The analysis of the gathered notes from the different faculty members identified three main stages in the life cycle of classes at which shifts in the instructors' behavior affect students' attitudes. The first of which is classified as the *initiation stage*. All interviewed faculty mentioned this stage as the most crucial one, for it defines the first impression of students towards the class. The most prominent practices affecting this stage are discussing the class syllabus, emphasizing the required background information, and highlighting the teaching style.

For more elaboration, the syllabus represents laying the ground rules for managing a class. It defines the rights, obligations, and expectations from both parties (instructor and students). Consequently, discussing the syllabus content in the first class increases the awareness and attention of students about class requirements. As mentioned by some faculty, stating to students that the syllabus represents the contractual agreement between the instructor and students as well as asking

them to read it and provide feedback about its contents boosts their seriousness about the class. In addition, it was noticed that two of the most important parameters of laying the rules are the discussion of the attendance and assignments policies. Three examples were highlighted within the interviews related to this issue. It was identified that in class where the attendance policy was not highlighted in the first class or not required by the syllabus, students usually drop class attendance after the first month. However, if the policy was emphasized and clearly stated in the syllabus, students' attendance was found to be high throughout the semester. In an extreme example, one instructor included a statement in the syllabus that 5 unjustified absences would automatically lead to failing the class. This statement led to that professor's highest attendance rates.

Emphasizing the required background information and highlighting the teaching style were defined as equally important in the initiation stage. As stated by some faculty, students' attitudes are directly related to the time gap between a current class and its pre-requisites. In other words, the greater the time interval, the more negative impression towards the new material. Within the same context, defining the instructors teaching style affects students' attitudes. In one of the cases, the instructor illustrated to his students that the teaching style adopted for a certain class is going to be math intensive. He clearly illustrated that he will not be reviewing the required background material within this class. As a consequence, a noticeable number of drops within the first week took place.

The second defined stage is the *remedial stage*. The time identified for this stage varied by instructor. Some identified it to be after a month from starting the course, while others illustrated it to be after the first exam. However, all faculty members agreed that changing the teaching style to accommodate the learning requirements and expectations of students is one of the most effective means of achieving positive attitude towards the class material. In one of the interviews, an instructor in a technology program stated that it was noticed that students understood the materials more when it was taught within a practicable context. As a result, changing his teaching style from emphasizing the scientific concepts and backgrounds to focusing on practicable applications through real life examples enhanced the students' attitude. Among other means within this stage were performing revision sessions in the form of games and group competitions, as well as using one minute papers.

The last recognized stage is the *final stage*. Although the majority of the faculty did not put emphasis on this stage, some identified it as the last resort. Some of the means adopted to change students' attitude within this stage are discussing incentives to enhanced performances, offering extra work for bonus grades, and having one to one discussions with students. A number of faculty stated that having an opened discussion with the class regarding their opinion about the material and offering bonus grades for performance advancement especially in the final exam had a major impact on the students' attitude. Students who have not been performing well within the semester usually look at this as a second chance or a method of adjusting their grades. As a result, they tend to spare no effort in understanding the material towards the end of the semester. On other occasions, faculty highlighted that providing extra bonus homework serves the same purpose. A common theme that emerged out of the discussion with the interviewed faculties was the importance of face-to-face discussion with students. Interpersonal discussion between the instructor and the student help to overcome perceived faculty-student barriers. In addition, such discussion has proved to be instrumental in alleviating student's dissatisfaction regarding instructor's attitude, material, or student's personal life.

Success Rates Identification

Within the interviews, each faculty was asked to provide his/her estimate of the success rate of each of these means as well as any combinations adopted. In addition, information about the different classes was gathered. Table 2 illustrates the collected class information and their ranges. Table 3 includes the reported success rates of the individual adopted means in each stage. The rate is defined as the average success rate per all interviewed faculty.

Table 2. Factor Description

Item #	Factor Description	Factor Range
1	Number of Students	>15, <15 - > 20, >20 - <25, >25 - <30, and >30
2	Gender of Students	Male, Female, and Mix
3	Class Age	Freshman, Sophomore, Junior, and Senior
4	Campus Location	USA, Kuwait, UAE, and ARE
5	Academic Rank of the Instructor	Full Professor, Associate Professor, Assistant Professor, and Contract
6	Program	Technology, and Engineering

Table 3. Average Success Rates

Stage	Adopted Mean	Average Success Rate
Initiation	Class syllabus	60%
	Emphasizing the required background information	45%
	Highlighting the teaching style	30%
Remedial	Adaptive Teaching Style	75%
	Revisions	40%
	Group Competitions	35%
Final	Incentives	55%
	Extra work for bonus grades	25%
	One to One discussion	50%

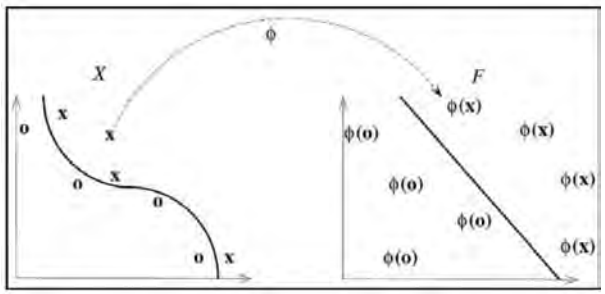
Machine Learning (ML) Model Development and Implementation

This sub-task focuses on the development of a ML model, through Support Vector Machines (SVM), for the prediction of the best practices to be adopted in newly encountered classes. The following is a descriptive background of the Support Vector Machines concept. SVM classification aims to find a surface that best separates a set of training data points into classes in a high dimensional space. In the current research, it aims at defining the best practice to be adopted by an instructor to positively affect students' attitudes in a specific class. In its simplest linear form, a SVM finds a hyper-plane that separates a set of positive examples (a situation belonging to a specific adopted mean) from the set of negative examples (a situation not belonging to the same adopted mean) with a maximum margin. Binary classification is performed by using a real valued hypothesis function, Equation 1, where input x (class characteristics) is assigned to the positive class (specific mean) if $f(x) \geq 0$; otherwise, it is assigned to the negative class.

$$Y = \langle w.x \rangle + b \qquad (1)$$

For a binary linear separation problem a hyper-plane is assigned to be $f(x) = 0$. With respect to Equation 1, the vector w (weight vector) and b (functional bias) are the parameters that control the function of the separation hyper-plan (refer to Figure 2). In addition, x is the feature vector which may have different representations based on the nature of problem. Within the context of the current research, the input feature space X constitutes of the training cases (class characteristics) that are defined by the vectors x and o in Figure 2.

Figure 2. SVM Kernel Transformation and Classification



In the development of the proposed SVM models a problem emerges if the data are not linearly separable. Defining the best means to be adopted by an instructor for a new class cannot be represented by a simple linear combination of class factors identified in Table 2. Consequently, a more sophisticated higher dimension space is needed for the representation of the current problem in order for it to be linearly separable. As the literature in this field suggests, Kernel representations provides a solution to this problem by transforming the data into a higher dimensional feature space to enhance the computational power of linear machine learning (Mangasarian and Musicant, 1999). As shown in Equation 1, the representation of a case in the feature space for linear machine learning is achieved as a dot product of the factors vector (x) and the weight vector (w). By introducing the appropriate Kernel function, cases are mapped to higher feature space (Equation 2 and Figure 1) transforming the prediction problem from a linearly inseparable to a linearly separable one. In this manner, the input space X is mapped into a new higher feature space F={Ø(x)|x where Ø is the kernel transformation function.

$$x=(X_1, \ldots, X_n) \rightarrow \Phi(X)=(\Phi_1 X_1, \ldots, \Phi_n X_n) \qquad (2)$$

To that end, this step includes (1) Factors definition; (2) Feature Space Development; and (3) SVM Model Design and Implementation.

Factor Definition

The current task utilized (1) the factors illustrated in Table 2, (2) the success rates defined in Table 3, and (3) the averaged success rates calculated for the different combinations identified by the interviewed faculty for the development of the model. A total of 110 cases were defined. Within the context of the current task, each case represents a class situation defined by an interviewed faculty and identified by the factors mentioned above.

Feature Space Development

Under the current research, a feature space is developed to represent the different cases in a usable manner for the model. The output of this sub-task is matrix "**X**" representation of all cases, refer to Figure 3, where each row represents a specific case mentioned by a faculty and each column represents an identified factor. Each element $x_{i,j}$ in the matrix represents the value of a specific factor *j* in case *i*.

*Figure 3. Feature Space Matrix "**X**"*

$$(d_j) \downarrow \qquad (t_i^T) \rightarrow \begin{bmatrix} x_{1,1} & \cdots & x_{1,n} \\ \vdots & \ddots & \vdots \\ x_{m,1} & \cdots & x_{m,n} \end{bmatrix}$$

SVM Model Design and Implementation

The proposed research methodology developed and compared the outputs of 4 SVM models as follows (1) 1st degree polynomial kernel SVM models; (2) 2nd degree polynomial kernel SVM models; (3) 3rd degree polynomial kernel SVM models; and (4) Radial Base Function (RBF) SVM models. Validation of the best developed model was based on prediction accuracy. The learning process is performed on a 10 fold cross validation mechanism. For more elaboration, the set of training data is divided into 10% and 90% portions in each fold. The model is trained on the 90% and tested on the other 10% cases. The process is done in an iterative manner until the model is trained and tested over the whole set of cases. The prediction accuracy of the model is developed as the average accuracy attained among all folds.

The outcomes of the model development are illustrated in Table 4. Further examination of the results illustrates that:

- All models attained prediction accuracy above 60%.
- The highest prediction accuracy was achieved using 2nd degree polynomial kernel SVM. It attained an advancement of 14%, 9%, and 22% over 1st degree, 3rd degree polynomial kernel SVM, and RBF respectively.

Table 1: Prediction Accuracy of SVM Models

Model Type	Average Prediction Accuracy
1st Degree Poly. Kernel SVM	69%
2nd Degree Poly. Kernel SVM	83%
3rd Degree Poly. Kernel SVM	74%
Radial Base Function (RBF)	61%

This outcome is attributed to the computational capacity of SVM classifiers. Support Vector Machine (SVM) is a state-of-the-art classification and regression algorithm, which implements strong regularization techniques, that is, the optimization procedure maximizes predictive accuracy while automatically avoiding over-fitting of the training data (Cannon et al. 2007). Furthermore, the transformation of the data into a higher dimension space through Kernel estimation provides the strength of the SVM model in solving this complex problem.

Conclusion

This paper provides a summarized experience of a 22 faculty members at different academic ranks in different universities in USA, Kuwait, ARE, and UAE. It identified three stages in the life cycle of a class as well as commonly adopted methodology to achieve a positive attitude from students towards class materials. Finally, the paper proposed a robust methodology to implement best practices in newly encountered cases through SVM. The findings of this study will help administrators and instructors to develop a thoughtful process of engaging students in the proceedings of the class room thus maximizing knowledge dissemination.

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Evaluation of Faculty Teaching and Course Content by Students: Effects of Changing the System

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Abstract
Administrators in technology programs recognize that the evaluation of faculty members' teaching in the classroom and course content are critical metrics and are often used in personnel decisions affecting tenure, promotion, and salary. One common method for administering these evaluations is through an end-of-course instrument completed by the students. As research has revealed that many factors can affect students' ratings, administrators need to be aware of potential biases and how changes to the evaluation system may affect outcomes. Although there is no shortage of complaints about student evaluation of faculty and course content, little research and information is available to assist program administrators in fairly overseeing the process. The result is that administrators and faculty alike are often unaware of the effect any changes to the system might have. Drawing from the authors' experiences as they underwent a change from a paper-and-pencil system to one that was completely online, this paper helps administrators understand potential differences in participation and other factors that affect student evaluation of faculty and program courses and offers a potential solution to boost participation.

Introduction
One of the primary administrative tools for faculty review is the teaching evaluation. While there are myriad ways of evaluating teaching, common evaluation approaches include those conducted by administrators, peers, and students. Student reviews of faculty teaching, initiated more than 90 years ago at the University of Washington, have become used across universities in the United States, Canada, Australia, and throughout the world (Bembenutty, 2009; Bernold, 2007; Smith, 2008).

These evaluations are used in a number of important decisions regarding faculty: hiring, tenure, promotion, salary, awards, honors, and course assignment, as well as accreditation and other uses (Kulik, 2001; Read, Rama, and Raghunandan, 2001). However, a number of concerns have been raised regarding faculty evaluation by students, ranging from reliability and validity to the effects of the instrument used. As Knapper (2001) stated, "Student ratings of university teachers have been common for at least thirty years, but it is a rare campus where they are accepted with equanimity" (p. 3). Faculty and administrators alike have a vested interest in insuring that these evaluations are accurate and effective.

This paper provides an overview of existing research on student evaluation of faculty and courses, advantages and challenges of student evaluation methods, sample instruments used in the authors' department previously and currently, an analysis of student ratings of faculty, and practices that have been demonstrated to increase student participation.

Literature Review and Background of Study
Evaluation of faculty by students and the proper use of these evaluations have been questioned virtually since their introduction. In their seminal paper on student ratings of college instructors, Brandenberg and Remmers (1927) stated:

> We do not know how much the validity the composite judgment of an instructor's students possesses as a true measure of the instructor's ability. We should certainly hesitate to accept the undergraduate's judgment of the value of an instructor as a whole to the university and to society in general. . . . While heads of departments and other executives might make considerable use of students' ratings in forming judgments of instructors, still the wisdom of forcing any instructor to submit to such procedures is extremely doubtful. (p. 400-401)

Despite these cautions, 84 years later student evaluation of faculty is now the most common form of teaching evaluation and is widely accepted by students, faculty, and administrators alike (Wolfer and Johnson, 2003). Changes in teaching evaluation have been driven by student desires for accountability in the 1960s, developmental reasons in the 1970s, and administrative issues in the 1980s and 1990s (Ory, 2000). These administrative uses continue to drive both purpose and method of evaluation.

Despite such importance for faculty placed on these evaluations, research has revealed many concerns with the process. For example, Worthington (2002) found that anticipated grade, ethnicity, age, and gender were all significant influences on student ratings, and that perceptions and characteristics of students impacted potential bias of teaching performance dimensions. Munz and Fallert (1998) discovered a correlation between student mood in the classroom and evaluation of faculty and courses. Brown (2008) reported that students believed that they were able to accurately evaluate instructor's teaching, but still had doubts about their validity and utility. Similarly, Spencer and Scmelkin (2002) found that students were willing enough to participate in the evaluative process, yet had little belief that the evaluations would be of any use. In a study examining more than 2,000 professors, Freng and Webber (2009) even found that "hotness" (i.e. physical attractiveness) accounted for more than 8% of the variation in faculty teaching evaluations by students. Lindahl and Unger (2010) posited that the anonymous evaluation instrument "allows students to write cruel remarks and morally disengage from the consequences of their actions" (p. 71).

These evaluations have been typically conducted with students completing an anonymous, paper-and-pencil instrument during class time, although online evaluation is becoming more widely used. Investigations of the impact of changing the method of administering the evaluation instrument have also been revealing. Dommeyer, Baum, and Hanna (2002) found that students were less likely to complete online teaching evaluations than those conducted in class, and they had concerns about anonymity and login procedures. In a later study, online response rates were still found to be lower than in-class methods, although a grade incentive boosted online participation comparable to traditional methods (Dommeyer, Baum, Hanna, and Chapman, 2004). Faculty have also been found to prefer the traditional, in-class methods almost 2-to-1 over online evaluations due to anticipated higher response rates and accuracy (Dommeyer, Baum, Chapman, and Hanna, 2002). These perceptions have been confirmed in other studies; as Gamliel and Davidovitz (2005) stated, "Mode can matter" (p. 581). Institutions that have adopted online evaluations have acknowledged concerns over low response rates and other issues (University of Michigan, 2007).

The setting of this study is a department of technology in a public, Midwestern university. The instrument and method of evaluation have evolved over the years, with the latest three versions being discussed here. For some time previous and through the spring semester of 2007, a paper-and-pencil version was administered to students in class. This instrument, referred to as *Version A*, asked students to anonymously respond to 8 items regarding the course, 9 items regarding the instructor, and provided a space for students to write in any additional comments (see Appendix A). Starting in the fall semester of 2007, a new form was used that had been developed with faculty input and focused only on instructor evaluation. This instrument, *Version B*, was still administered in class in the traditional manner and had 10 items plus space for written comments (see Appendix B). While expectations varied across campus, in the department under examination, every course was expected (required) to be evaluated (with the exception of overload courses); other departments were free to use different sampling approaches.

In the spring of 2010, the university administration announced that all teaching evaluations would be administered online. The stated reasons for the change were cost savings, reduction of environmental impact (paper use), reduce employee processing time and costs, and "increase class time available for other priorities in the last week of the term" (T. King, university communication, May 21, 2010). A change to online grade submission was implemented concurrently.

A "core set" of questions were initially implemented in for the summer 2010 semester. This set included 6 items on the instructor and 5 on the course, plus sections for comments on each. Starting in the Fall 2010 semester, departments were given the option of adding (but not deleting) items to the core set. In a faculty vote, the department under examination did not elect to add any additional questions to the core set. This last version, *Version C*, may be found in Appendix C. Students were notified by e-mails to their university accounts that the online survey was available during the last two weeks of the semester. Follow-up messages were also sent periodically, and it was reported in the student newspaper (Kidd, 2010). Faculty members were made aware when the evaluation was made available to students and were requested to encourage student participation.

Research Methodology

Two faculty members' (the authors') student evaluation data was analyzed for this study. Both are currently tenure-line assistant professors in the same program within the department of technology, and have been evaluated under the paper-and-pencil, traditional methods and online. Faculty member A has been teaching in the program since the fall semester of 2005 and has been evaluated by students under Versions A, B, and C of the evaluative instruments. Faculty member B has been teaching since the fall of 2009 and has been evaluated with Versions B and C.

Data were collected on all courses that were offered repeatedly (i.e., more than once), with one-off, overload, and independent study courses not considered. Although not conducted as an experiment, Faculty A was teaching in a computer lab during initial implementation of the online method and asked the students to complete the evaluations on the first day available while the faculty member stepped out of the room. This was similar to how the evaluations were conducted traditionally, with the students instead logging in to the survey and not having to have a proctor. When the students were complete, Faculty A returned to the room and class resumed normally. During the next semester (Spring 2011), Faculty A made arrangements to bring students to the computer lab again, using an open lab in one case and utilizing another classes space with the voluntary (and gracious) permission of another faculty member in the other. Faculty B mentioned the evaluations being available in class, but did not reserve computer lab space.

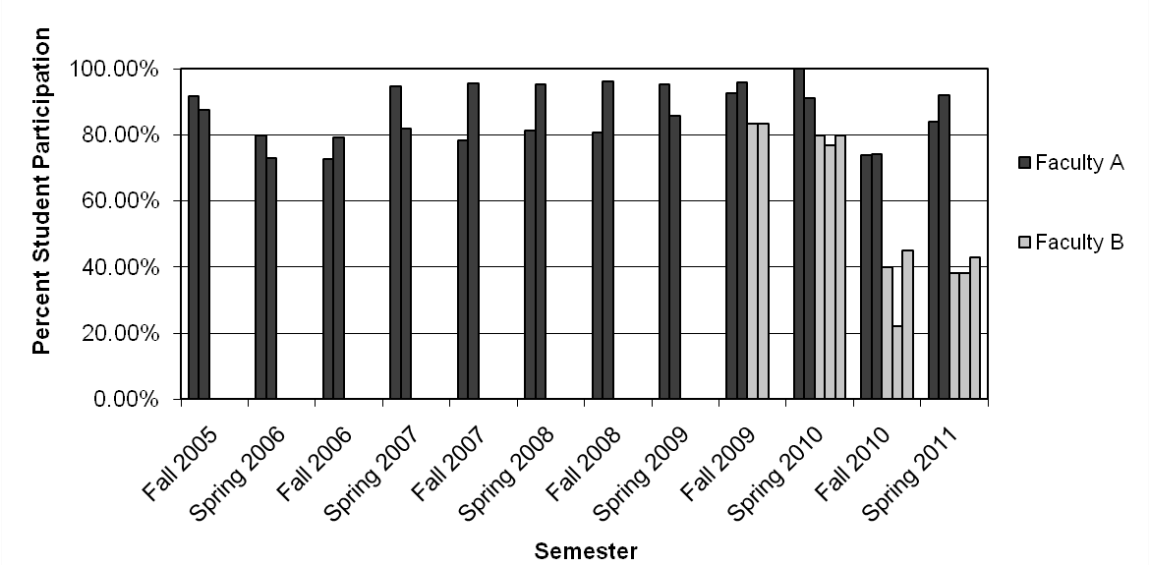
Data were collected on student participation and number of comments offered through the review of the online reports (for Version C) and the hard copy results of the traditional evaluations (Versions A and B). Any written comment was considered for the traditional evaluations; only comments provided in the "instructor" section were considered for the online version.

Results and Discussion

Evaluation results from 635 students who participated out of 812 enrolled in 35 sections were analyzed. Tables D-1 and D-2 (Appendix D) show the data for each faculty member by format (paper/online), version (A-C), semester/year, number of students responding, number of students enrolled, participation (responding/enrolled), number of students providing written comments, and the percentage commenting (commenting/responding).

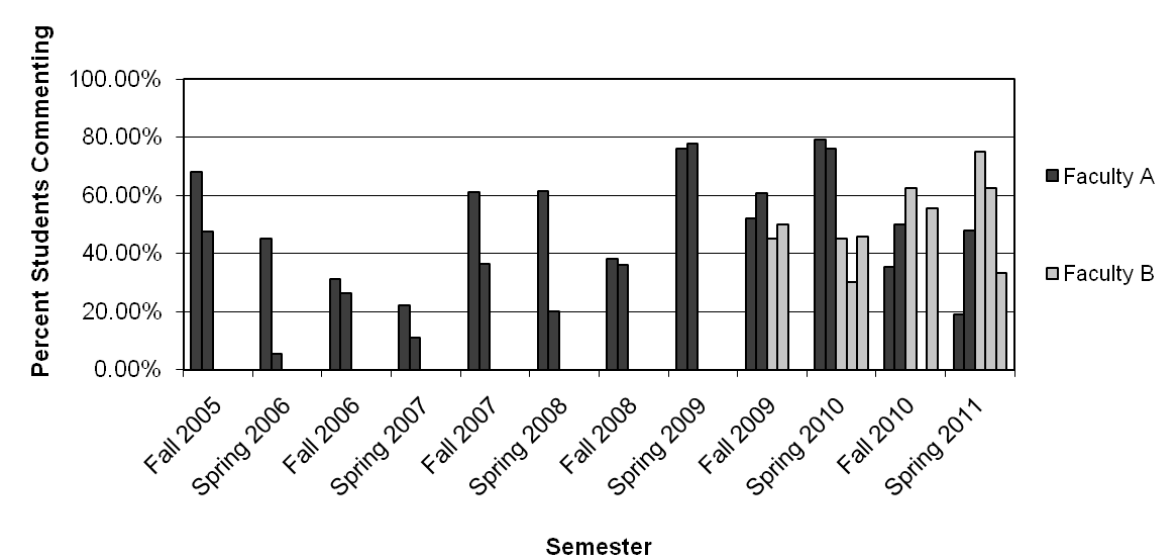
Participation, as measured by the number of students responding divided by the number of students enrolled, decreased for both faculty members with the change from paper to online. On average, participation dropped from 85.96% with the paper-and-pencil versions (A and B) to 57.47% with the online version, a reduction of more than 28%. However, there was a notable difference between the two faculty members' results. Faculty A, who had arranged for students to be in the computer lab and requested that they complete the evaluation in class, saw a reduction in participation from 87.45% to 81.00% (6.45% reduction). Faculty B, who had requested students complete the evaluation but had taken the classes to a computer lab, saw participation drop by more than half, from 80.62% to 38.02% (42.60% reduction). These results are shown graphically in Figure 1.

Figure 1. Percentage of Responding Students Participating



A reduction in the average number of students providing comments was not found with the change from paper to online evaluations. The percentage of students commenting varied widely across both paper and online versions. With the change from paper to online, Faculty A's comment percentage reduced from 47.28% to 38.27 (reduction of 9.01%), but Faculty B's comment percentage went up from 43.27% to 52.17 (increase of 8.90%). Figure 2 shows these results graphically.

Figure 2. Percentage of Responding Students Commenting



The reduction in student participation in evaluations with the change from traditional to online modes was confirmed university-wide, dropping from 80% in the fall semester of 2009 to just over 55% in the fall semester of 2010 (Ball State University, 2011b; Boswell, 2011). The university is examining options to potentially boost participation, including incentives, specialized communication, information system issues, and cultural change (Ball State University, 2011a).

Conclusion

This study has confirmed that changing the mode of evaluation can impact student participation in faculty teaching evaluation. However, it was seen that leading the students to participate in the process through the use of reserving computer facilities during the review period and requesting that they complete the evaluations had a notable impact on participation over relying solely on the university-wide system of e-mail communication. Although contrary to the expectation of having more time available at the end of the semester with online evaluation, administrators and faculty alike should consider making full use of computer facilities and class time in an effort to boost student participation.

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Appendix A

Paper-and-pencil version completed in-class; used previously through Spring 2007.
Students asked to provide major, class (Freshman-Senior), expected grade (A+ through F, not sure), and average out-of-class hours/week devoted to this class (1-2 through >12). Responses recorded on a scale of 5 (Excellent) to 1 (Poor) or N/A.

Course Items

1. Organization of course.
2. Administration of course.
3. Supplemental course materials/handouts.
4. Homework assignments.
5. Exams.
6. Lab activities.
7. Problem-solving.
8. Overall assessment of course.

Instructor Items

1. Preparation for class.
2. Clarity of presentation.
3. General instructional technique.
4. Availability outside of class.
5. Student involvement.
6. Effectiveness in answering questions.
7. Prompt feedback.
8. Concern for students.
9. Overall assessment of instructor.

Space provided for written comments.

Appendix B

Paper-and-pencil version completed in-class; used to Fall 2007 through Spring 2010.
Students asked to provide major and class (Freshman-Senior). Responses recorded on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree)

1. My instructor actively engages students in learning.
2. My instructor is effective at clarifying difficult concepts.
3. My instructor communicates effectively.
4, My instructor deals with me fairly.
5. My instructor uses a variety of teaching methods to support learning.
6. My instructor demonstrates a clear understanding of the content.
7. My instructor uses appropriate techniques to assess learning.
8. My instructor is organized.
9. My instructor provides helpful feedback.
10. My instructor demonstrates respect for students.

Space provided for written comments.

Appendix C

Online version completed by students; used Summer 2010-present.

Instructor Items

1. My instructor explains the course objectives clearly.
2. My instructor explains course content clearly.
3. My instructor uses effective examples and illustrations.
4. My instructor is respectful when I have a question or comment.
5. My instructor provides feedback that helps me improve my performance in the class.
6. My instructor is available for consultation (e.g., after class, email, office, or by appointment)
7. Please provide any additional written comments on the instructor's strengths and weaknesses.

Course Items

1. This course has clear objectives.
2. This course is effective in meeting its objectives.
3. This course has assignments related to the objectives of the course.
4. This course has a clear grading system.
5. This course broadens my perspective and/or knowledge.

Please provide any additional written comments on the strengths and weaknesses of the course. You may comment on such things as the use of assignments, text(s), exercises, exams, etc.

Appendix D

Table D-1. Faculty Member A Evaluation Data

Format	Ver.	Sem/Yr	Resp.	Enroll.	Part.	Comm.	% Comm.
Paper	A	F05	22	24	91.67%	15	68.18%
Paper	A	F05	21	24	87.50%	10	47.62%
Paper	A	S06	20	25	80.00%	9	45.00%
Paper	A	S06	19	26	73.08%	1	5.26%
Paper	A	F06	16	22	72.73%	5	31.25%
Paper	A	F06	19	24	79.17%	5	26.32%
Paper	A	S07	18	19	94.74%	4	22.22%
Paper	A	S07	18	22	81.82%	2	11.11%
Paper	B	F07	18	23	78.26%	11	61.11%
Paper	B	F07	22	23	95.65%	8	36.36%
Paper	B	S08	13	16	81.25%	8	61.54%
Paper	B	S08	20	21	95.24%	4	20.00%
Paper	B	F08	21	26	80.77%	8	38.10%
Paper	B	F08	25	26	96.15%	9	36.00%
Paper	B	S09	21	22	95.45%	16	76.19%
Paper	B	S09	18	21	85.71%	14	77.78%
Paper	B	F09	25	27	92.59%	13	52.00%
Paper	B	F09	23	24	95.83%	14	60.87%
Paper	B	S10	24	24	100.00%	19	79.17%
Paper	B	S10	21	23	91.30%	16	76.19%
Online	C	F10	17	23	73.91%	6	35.29%
Online	C	F10	20	27	74.07%	10	50.00%
Online	C	S11	21	25	84.00%	4	19.05%
Online	C	S11	23	25	92.00%	11	47.83%

Table D-2. Faculty Member B Evaluation Data

Format	Ver.	Sem/Yr	Resp.	Enroll.	Part.	Comm.	% Comm.
Paper	B	F09	20	24	83.33%	9	45.00%
Paper	B	F09	20	24	83.33%	10	50.00%
Paper	B	S10	20	25	80.00%	9	45.00%
Paper	B	S10	20	26	76.92%	6	30.00%
Paper	B	S10	24	30	80.00%	11	45.83%
Online	C	F10	8	20	40.00%	5	62.50%
Online	C	F10	4	18	22.22%	0	0.00%
Online	C	F10	9	20	45.00%	5	55.56%
Online	C	S11	8	21	38.10%	6	75.00%
Online	C	S11	8	21	38.10%	5	62.50%
Online	C	S11	9	21	42.86%	3	33.33%

Graduate Faculty Workloads: Recognizing Scholarship and Student Engagement at the Comprehensive Regional Institution

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The character of graduate work is one of scholarly endeavor with highly qualified graduate faculty that work with students to culminate their experience through the completion of a graduate project, thesis, or dissertation. Inherent in this activity is the expectation that faculty will devote themselves to produce scholarly works of their own, spend the time needed to counsel and guide students through the process, and serve as members or chairs of various thesis/project/dissertation committees. Additionally, an increasingly accepted perspective of scholarly activity is the generation of external support for programs, research, and regional economic development, of which faculty and graduate students frequently participate.

Starting in 2008, the Association of Technology, Management, and Applied Engineering (ATMAE) began accrediting master's level programs. Since that time, three graduate degree programs have been accredited with the expectation of more programs forthcoming. In order to maintain a high standard of excellence and good teaching practice, it is in the best interests of ATMAE accredited higher education institutions to establish policy guidelines for graduate faculty graduate committee workloads as the number and size of graduate programs increases. In 2008, of the approximately 80 technology-related graduate programs, 706 technology master's degrees were awarded (ATMAE, 2009). Graduate enrollment is expected to increase as industrial/engineering and technology faculty retire over the next 10 years (Zargari & Sutton, 2010).

The purpose of this paper is to establish the need and propose the development of policy guidelines for graduate faculty workloads with regard to thesis and graduate project committees.

Current Practice

At present, ATMAE accreditation does not have a policy for serving or chairing thesis/graduate project committees. Workloads are typically negotiated based on university, college, or departmental guidelines. While this provides a great deal of flexibility, it also creates the possibility of inequity between graduate programs with regard to graduate student expectations and thesis/project quality. In addition, the workload is often beyond the faculty member's assigned teaching load. For smaller departments, teaching loads often consist of both graduate and undergraduate courses. In this environment, faculty may choose to limit their participation on graduate thesis/project committees or not apply for graduate faculty status due to the increased workload/and or scholarly expectations. The supervision of a thesis or graduate project represents a significant teaching/scholarship activity for the graduate faculty member. Recognition of these duties as a value adding activity within the academe is important.

Benefits

An established set of policies or guidelines for thesis/graduate project committee workloads would provide the following:

- Identify workload expectations for graduate faculty
- Assure equity in committee load distributions
- Promote faculty scholarship and graduate committee service
- Identify areas of opportunity for potential research
- Increase consistency of thesis/project quality
- Further delineate the status of graduate faculty as valued members of the academe

Current Practice at Higher Education Institutions

Organizations often benchmark their practices against similar institutions to establish norm references and targets for improvement. Twenty institutions of higher education were selected based their listing as comprehensive regional universities of similar size and scope. These institutions address graduate faculty committee work through specific policy or as part of the assigned general workload. Workload policies are set at the department, college, or university level. Institutional polices for graduate committees can be summarized as follows:

- Assigned as credit hours or teaching units
- Additional compensation or a reduced load
- Negotiated by the individual faculty member

These universities allow faculty workloads to vary, but some universities count graduate committee work as assigned credit hours while others count it as part of expected research and service load. The most liberal policies provide for both credit hours and added compensation while the most conservative policies consider graduate committee work as part of unassigned workload. Table 1 shows a summary of current workload policies and practices by the selected comprehensive regional universities.

Table 1. Graduate Faculty Thesis/Dissertation Workload Policies at Benchmark Institutions

Benchmark Institution	Policy
Ball State University	Considered part of faculty member's scholarly, creative, and teaching responsibilities. May be assigned 3-4 credit hrs per semester as defined by the college.
California State Univ. - Chico	Four percent of teaching load for each chaired committee.
California State Univ. - Fresno	Four percent of teaching load for each chaired committee.
University of Central Missouri	No specific policy for graduate committees. As negotiated with department.
Eastern Illinois University	No specific policy for graduate committees. Compensation for credit hours above assigned teaching workload.
Eastern Michigan University	No specific policy for graduate committees. As negotiated with department head and dean of the college.
Florida Atlantic University - Boca Raton	No specific policy for graduate committees. Compensation is negotiated with department head in excess of 1 full time equivalent (FTE).
Indiana State University	No specific policy for graduate committees. Compensation is negotiated with department chair in excess of 1 FTE or course load reduction the following semester.
Middle Tennessee State University	No specific policy for graduate committees. Compensation for teaching load in excess of normal.
Montclair State University	4 students = 1 teaching credit hour Thesis supervision paid $100 per individual student
Northern Arizona University	Policy established by each academic unit.
Oakland University	Policy established by each academic unit.
Missouri State University	Graduate faculty members receive reassigned teaching loads for graduate program advisement, research advisement, or thesis supervision as negotiated with the academic unit.
Stephen F. Austin State University	Considered part of regular workload. Overloads may qualify a faculty member either for additional compensation or for a teaching load reduction in a subsequent semester.
Towson University	Individual plan negotiated with academic unit.
University Of Northern Iowa	Workload established by academic unit.
Western Illinois University	Policy established by each academic unit. Faculty may receive additional consideration by department.
Western Kentucky University	Individual plan negotiated with academic unit.
Wichita State University	Policy appears to be set at the college or department level.
Youngstown State University	Policy established by each academic unit. Can receive 1 teaching hour per student per semester up to 3 teaching hours per student

Other Institutional Models

Institutions other than comprehensive regional universities also have policies with regard to service on graduate thesis and dissertation committees. A few are summarized here for comparative purposes.

Texas A & M-Texarkana: A semester credit hour equivalency is established ranging from .25-.75 credit hours for committee membership or .75-1 credit hours for a committee chair per student. Faculty receive a reduction of teaching load during the semester accumulated or in the next immediate semester term (Faculty Academic Workload and Reporting Requirements).

University of Hawaii at Manoa; College of Education: Graduate faculty receive a one course reduction for one semester after they have accumulated 30 points. Points accrue for service as a member or chair of thesis/dissertation committees (Faculty Workload Policy).

University of Houston-Downtown: Service as chair of four thesis committees is credited for a graduate course release. Thesis committee members serve as part of their regular workload (Faculty Teaching Workload memo).

University of Delaware; College of Marine Studies: A scheduled master's thesis counts for one credit hour. A scheduled dissertation counts for two credit hours. Participation on a graduate committee is counted at 1% per student committee. Credit hours are received in the semester in which the student defends (Policy Statement F/2/03).

Spalding University, Louisville; College of Education and School of Professional Psychology: Faculty members who chair more than three completed dissertations in an academic year are compensated $500 per dissertation beyond the initial three. Membership on four completed dissertations is equivalent to chairing one dissertation. Chairing more than five dissertations requires approval of the dean/department chair. The maximum number of active dissertations chaired per year is nine (Dissertation Workload Supervision Standards for Graduate Faculty).

Recommendation

If the expectation of ATMAE graduate faculty is for technical/managerial currency and scholarly endeavor; and if the supervision of advanced graduate work is valued, then association membership should establish or recommend policy for graduate faculty workload with regard to thesis or graduate projects (and dissertations). The policy should, at a minimum, recommend guidelines for maximum graduate committee workloads. A preferred policy would establish credit hour equivalents or some type of overload compensation.

What does it mean to be a graduate faculty member? If the answer includes some expectation of engagement with students in the production of quality scholarly work then the academe should provide an incentive for those faculty. An increasing number of graduate students in the discipline will have expectations that graduate faculty will be available and capable to serve as mentors for their capstone experience. The ATMAE accrediting body can assert their influence to ensure graduate faculty are recognized and valued.

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Persistence Factors of Women in Information Technology

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Introduction

A high demand for information technology (IT) professionals blossomed as the use of IT became pervasive throughout society. The knowledge, skills, and abilities needed to design, implement, and maintain the complex technology that drives our economy is in high demand. Despite this opportunity, very few females enter into and remain in the field. Despite the scarcity of female IT professionals, there has always been a small percentage of women who have persevered in the IT industry. The insights into their experiences, motivations, and coping strategies, are significant to successful recruitment and professional staffing of the IT field.

By recognizing and understanding the factors for entry, retention, and promotion of women in the IT field, policy makers can make better-informed decisions regarding the creation of programs and policies to reach out to females potentially suited for IT careers. Thus, the probability of recruiting, training, and then retaining qualified IT professionals will rise to meet the economic demand.

Barriers

Swanson and Woitke (1997) described career barriers and challenges as "events or conditions, either within the person or in his or her environment, that make career progress difficult" (p.434). Past research has found that the lack of role models, sex-role stereotyping, perceptions of IT, self-confidence and the lack of career guidance and academic preparation negatively influences the female pursuit of careers in IT.

One of the primary barriers identified is the lack of female role models (ITAA, 2003). Without the presence of a female role model to identify with, young women do not see IT as an appropriate career path.

Kekelis, Ancheta, and Heber(2005) found that parents of females maintained a laissez-faire attitude and provided little to no career guidance. Parents were more likely to suggest technology as a career path to boys.

Newmarch, Talyor-Steele, and Cumpston (2000), characterized the stereotypical IT professional as "a nerdy male dressed in a short sleeved shirt and tie who completely lacks social skills" (p. 7) or that they were "lonely and dull with little human interaction" (p. 8). This image is reinforced in all forms of media (Barker & Aspray, 2006). Media frequently portrays females as the helpless users of technology, while the males are presented as technological intellectuals rescuing the damsels in distress.

The negative attitudes towards careers in IT has been exacerbated by the perception that the industry promotes a philosophy that it is necessary to sacrifice your personal and family life in order to succeed (von Hellens, Nielsen, & Trauth, 2001).

Boys tend to be socialized towards an affinity for technology, whereas girls have been directed towards the use of technology (Bush, et al., 2002). Newmarch, Talyor-Steele, and Cumpston (2000) stated, "parents were more likely to buy computers for boys than girls because they are more likely to believe that male children will have a future career in [information technology]" (p. 6). Additionally, fathers were more likely to engage their sons in activities that involved experimenting with computers than they were with daughters (Barker & Aspray, 2006).

Eccles (1987) noted that "student, teacher, and parental attitudes discourage girls from pursuing science and math despite the fact that females, in general, get better grades in math and science than males" (p. 30). Gender stereotyping increased the likelihood of parents underestimating the potential of girls' capabilities in the areas of math and science.

Programs to Increase Female Representation

Ramnanan (2001) developed and implemented an after school program for young women (ages 14 to 18) in Miami-Dade county in Florida. The program focused on development of skills and mentoring impacts by providing girls with a female only environment supported by female role models.

Denner, Werner, Bean, and Campe (2005) developed an after-school and summer program for girls (grades 6-8) to break down the barriers of entry into technology. The underlying concept of the program was to have girls develop their own computer games using Flash technology.

The Girl Scouts of the USA (2007) has been involved with the movement to promote an interest in science, technology, engineering and mathematics (STEM) among its members. They have developed STEM awareness programs that local chapters can present to their members. Currently available on the Girl Scouts of the USA website is a resource guide that was developed in conjunction with the Optical Society of America Foundation. Through the efforts of the Girl Scouts of the U.S.A., many of the aforementioned barriers are being addressed at an early age.

Research Design

This study was designed as a qualitative multiple case study, that sought to discover the factors that contribute to the career persistence of in women in the field of IT. The research design was based on Stake's (2006) model of studying the quintain through multiple case study analysis. Stake defined the quintain as the overarching research question for which the individual cases are trying to enlighten. Stake's model of multiple case study analysis contained two distinct phases: individual case analysis and cross-case analysis.

Each subject agreed to a series of two interviews. The first interview used an interview guide in a semi-structured format. Each interview was transcribed and analyzed individually for themes related to the research question. Once the individual analyses were completed, a cross-case analysis was performed to determine common themes across all of the subjects. Based on the individual and cross-case analyses, subjects were interviewed using an unstructured format to clarify comments made in the first interview and to explore themes discovered in the first interview cross-case analysis. Subjects were women who have worked in the IT field for a minimum of five years. A snowball approach was used to identify potential subjects for the study.

Reliability Measures

In order to increase the reliability of the study, a qualified indigenous-insider (Banks, 1998) was asked to review various aspects of the study. To fill this role, a female academician in the field of IT volunteered to be the insider for the study. Throughout the study, the insider was asked to review the design and analysis for any oversights or biases that may have resulted from the primary investigator being male. The insider reviewed the interview guide for the first interview for its appropriateness based on the research questions and for language that would introduce a male bias. After data collection was complete, the insider reviewed one of the transcripts in which the personally identifying references had been removed. Her purpose was not to conduct any of the analysis, but to ensure that the primary investigator did not impose a male perspective on the findings.

The second reliability measure was member-checking (Bromley et al., 2003). With member-checking, the subjects were asked to review their individual case analysis for accuracy. The concern with member-checking is that subjects may choose to change their story if what they have said does not present them in a positive light. To avoid this, subjects were given the opportunity to clarify or expand on what was said in the first interview, but were not able to retract any of the comments.

Results

In the final analysis, the individual cases were assessed on the degree to which they provided insight into the quintain. The results of the study were not a retelling of the individual case analyses, but a presentation of the findings associated with the overarching research question.

Personal Traits

There were personal traits that were common amongst the subjects. The identified traits should not be construed as requirements for women to be successful in the field of IT. The subjects possessed traits to varying degrees

Aptitude

All of the women in the study expressed having an aptitude for IT. The subjects found that learning technology did not present any difficulties. One subject mentioned that she always thought that she "had a knack for it". She felt that this ability to learn technology easily has been a key factor in continued professional growth and perseverance in the field of IT. This ability to understand technology was credited for their continued success in IT.

Ambitious

All of the women interviewed were ambitions and noted that ambition keeps them going, even in the face of conflict. Subjects talked of how being "go-getters" have provided internal motivation to take steps to move forward in their careers. One subject stated, "I've just always been a person that if I have something to do, I just put my head down and get it done. Another subject added, "I'm just not one to quit."

Self-Confidence

Closely related to ambition is self-confidence. It may be true that those who display high levels of ambition are also highly self-confident. Each subject was asked to describe her level of self-confidence when she first entered the IT field. Most of the women expressed a high level of confidence in their ability to fulfill the responsibilities of an IT professional. A subject stated that if you are going to be a woman in IT, "you have to develop confidence." A woman has to have faith in her own abilities and decisions; and that she must find confidence in herself if she does not have it when entering the field to be successful.

Character

For the purpose of this study, character refers to the moral and ethical traits that define an individual. There are recurring character related traits of the subjects that have been identified as factors that contribute to career persistence.

True to yourself

Most of the subjects made statements indicating the need for women to stay true to themselves. Women need to maintain their integrity when they encounter ethical dilemmas in their careers. A subject explained, "I've never done anything for someone that I knew was dishonest. And, I wouldn't. And, I think that a lot of people get compromised in a workplace, even in an IT shop." Another subjected added, "I can't do some of the things that are dishonest that some people do to get ahead."

While it may be easier to engage in questionable activities to get ahead, women in IT need to resist this temptation. The women of this study pointed out that these acts are especially risky for women. It was noted that women are under greater scrutiny than men are in the IT workplace. While the dominant male culture in IT is likely to overlook or forgive the actions of men, they would use the opportunity to drive a woman out of the job.

Role Model

All of the women in the study expressed the importance of having female role models in IT. While it is easy to state these needs, it takes a special character to choose to be the role model for future generations of women in IT. Almost all of the women mentioned the hope that they are leading by example to show other females that women can be successful in IT. These women hoped to provide others with a plan on how to attain a successful career in technology.

Activism

Along with offering up themselves as role models, several of these women would take actions to actively affect the well-being of other women in IT. One strategy used by the subjects was to engage in hiring practices that favored women. One subject observed that in areas where there are more women in technology, "they're pushing their tech coordinators, who are generally men, to make changes, to let loose some of the tights reins there holding onto".

Another form of activism presented by the subjects is to actively address acts of discrimination against women. A subject observed that on hiring committees, her male coworkers were discriminating against female job applicants. They were making assumptions that the female applicant did not know enough about technology. Her activism came through when she confronted the men about their actions.

For other subjects, their activism came through in their defense of other women in the workplace. It should be noted that these actions were not always welcome. One subject "had initiated a group called Women in Technology at my company for the purpose of having a dialogue group for women that were working in technology positions in my company". In response to this group, her male supervisor ordered her to disband the group. His argument was that it was inappropriate to have such a group for women within the organization.

Effective Career Strategies

To successfully navigate through the male-dominated culture of IT, women have to develop effective career strategies, as demonstrated by the women in this study. As a group, they provided examples and recommendations of actions a woman can take to improve her likelihood of having a sustained career in IT.

Prove Yourself

One of the recurring hurdles that the subjects shared is the lack of credibility or respect they received due to being a woman in IT. It was especially so at the start of their careers. It was stated that people "don't expect a woman to have any kind of [technical] knowledge." Since these women are defying societal expectations, they do not start their careers with the same level of credibility as their male coworkers. Nor do they get the initial respect or credibility from both male and female users in their organizations. Overwhelmingly, the women in this study reinforced the belief that a woman is going to have to prove herself in order to earn the respect and credibility from others. These women have indicated that, unlike their male counterparts, their actions, decisions, and very presence were questioned by others in their places of employment when they started their careers. They pointed out that since a man will be given the benefit of the doubt, his actions or recommendations are not as likely to be scrutinized.

Know What You Want and Get It

All of the women interviewed agreed that they wanted respect and creditability for the work they do. Compensation for their hard work was another required factor to job satisfaction. Asking for appropriate pay and raises was encouraged along with flexible schedules, especially by those women with children at home. Also, it is imperative that women get access to whatever resources are needed to be successful within the organization. That is, there are those that will withhold information or physical resources that the female needs to do her job effectively.

Coping Strategies

Instead of wondering ***if*** a woman will encounter various barriers as they try to enter and progress in their careers in IT, it is a question of ***when***. Of vital importance is an awareness of the coping strategies utilized by these women to help them get past those barriers and continue with their careers.

Thick-Skinned

The most frequently expressed coping strategy was the need to develop a "thick skin". Having a thick skin was described as the ability to accept that others may act inappropriately and not take it personally. There was consensus among the women that the successful female IT professional will endure unwanted and unfair comments and behaviors from male co-workers and others. It was recommended that women need to build a barrier through which the words and actions of others cannot penetrate. This is not something that is an inherent trait; it is a survival skill that develops over time.

Avoidance

A few of the women interviewed for this study indicated that they felt that they had experienced little or no barriers, of such. They credited a supportive work environment for the lack of barriers. However, there appears to be some discrepancies in their stories. Despite their claims, these women would occasionally make statements indicating that they had in fact, experienced some of the same barriers as the others. One woman qualified her experiences by saying that the only time she noticed any discriminatory behavior was when she interacted with those outside of her department. She was also the same person who described how her male coworkers engaged in discriminatory practices while serving on hiring committees.

There appears to be ambiguity of tolerated behavior. Examples of avoidance behaviors included statements that they did not "perceive" that there was discrimination occurring at the workplace. There were also statements that subjects felt "sheltered" in their work environment or that their workplace was not part of the "real world industry". One of the women did acknowledge this avoidance behavior when she indicated, "it could just be me choosing not to see it". Other women simply did not see certain classical discriminatory behaviors as such.

Embrace the Positive

The subjects in this study were unanimous about taking the positive approach to dealing with pressures and stressors at work. One subject described how she "liked IT. I understood how it worked and so that's what I drew on." Another subject agreed when she stated that the reason "I've stayed in IT is because it is challenging." This challenge to solve problems or to keep up on the constant changes within the field is what drives these women to persevere.

Humor

While most of the women expressed some form of humor during the interviews, the three most senior participants specifically identified humor as a prominent contributor to their longevity in the field. These professionals used humor as a way of building rapport with the users in the organization, and as a stress reliever.

For almost all of the women in this study, the most important contributor to a sustained career in IT was the support of family. Ellen talked about how her husband has always been in favor of her pursuing her career. When there were times when she had to stay at work after hours or go out of town for training, he was always prepared to care for the children. Unfortunately, women are placed into a situation where they are forced to choose between family and work.

For certain jobs within IT there are time commitments that are unsympathetic to the needs of family. Iris explained that a woman choosing that type of career path needs to work with her children to develop an understanding. Without it, there can be resentment and other negative repercussions. Iris spoke of her children having school problems, which she attributed to her not being available at home as much.

Mentor

The majority of the subjects put some importance on having a mentor, especially at the beginning of their careers. They need to find someone with whom they can build a "good faith" relationship. One subject recalled that her mentor once told her, "if you want to just stay the same the rest of your life, you'll never catch any flack. But if you want to go ahead and improve your career, you're going to get a lot of sour grapes from other people and you're going to need to be able to accept that and let it roll off your back. That's the price you pay for moving ahead."

One subject expressed a commitment to mentoring the females under her supervision, and she has been equally generous to the men that have worked for her. She described a response from a young man she had mentored who had started with the bank as a high school intern. "He literally almost cried when he left because he said, 'you took a kid straight out of school who really didn't know anything. You taught me how to behave every day. I don't even know all the lessons that I've learned from you, but I know that I've just landed this wonderful job with so many opportunities and I could not have done it if it hadn't been for you.'"

Conclusion

This study investigated the persistence factors of women that have had sustained careers in IT. The personal traits shared by the women allowed them to move forward despite the barriers that they may experience. The most important career strategy suggested by the findings is the need to develop a "thick skin" in the face of adversity. Close behind is the need for female IT professionals to prove their ability and value. This will entail working harder, smarter, and more efficiently than their male counterparts. Further research is suggested to explore the extent to which these factors contribute to career persistence of women in information technology.

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Construction

Building Information Modeling: A Software Review for Curriculum Development

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Abstract
Traditionally, construction documents have been individual two-dimensional drawings. This approach makes coordination between the design team and construction team difficult and error prone. Architects and contractors are moving rapidly toward Building Information Modeling (BIM). BIM programs generate easy to understand, three-dimensional models. With BIM a single project file contains the database for plans, elevations, details, and schedules. Changes are updated throughout the project automatically. Three-dimensional models enable better visualization of how a building goes together and thus understanding of the designer's intent. Several BIM software packages are now available, including Revit Architecture, Revit Structure, Revit MEP, and Navisworks, which provide for accurate and fast planning, estimating, scheduling, and collision detection. A review of these programs is provided to understand how, where, and to what extent these programs may to be incorporated into the technology program curriculum.

Introduction
The need to quickly and accurately create construction documents that depict a structure in an easily understood format has always been a challenge. This task has become more daunting with the complexity of today's construction projects. Architects and contractors are now moving rapidly toward utilization of the latest technology, Building Information Modeling (BIM). McGraw-Hill/ Young, Jones, Bernstein, and Gudgel, (2009) found that approximately 71% of contractors report the obvious benefits of BIM and contractors are adopting BIM faster than any other group in the construction industry. It is the task of the Construction Management curriculum in technology and applied engineering programs to ensure that students are prepared to utilize the latest technology when they enter the workplace. Sabongi and Arch (2009) state that approximately 10% of construction management programs address BIM, and in their survey, less than 1% of respondents offered a stand-alone BIM course.

In ancient times plans were carved in stone in great detail and to scale. Then came paper and plans were hand drawn on drafting tables with T-squares and triangles. This technical artwork generated two-dimensional (2D) and isometric views and each drawing was an independent work. Interpreting this work required considerable skill. This process continued until about 1982.

Computer aided design (CAD) software appeared in 1982 and its use continues today. Drafting boards disappeared and the CAD software generated digital drawings in both two and three dimensions. Still, each drawing was an independent work, and the data generated by CAD software is not computable.

Construction documents generated with today's CAD software are primarily 2D drawings that depict plan views, sections, elevations, and detail views. There is no link between these drawings, and this makes coordination within the design team and between the construction team difficult and error prone. A change to the length of a building would require changes to plan views, sections, elevations, and coordination with the structural engineer so their drawings could be changed. Interpreting these CAD generated 2D drawings can prove to be difficult. We live in a three-dimensional (3D) world, and it is difficult to visualize a 3D object from a 2D reference.

In 2000, Building Information Modeling made its appearance. BIM software generates a three dimensional model with all information contained in a single relational database. Parametric modeling is derived from the database. This database of building objects generates 2D, 3D, 4D (time), and 5D (time and cost) drawings and data. All drawings and views are part of the database, and a change in one drawing is automatically updated throughout the project. Removing a door in a BIM project removes the door throughout all of the drawings and views and updates the door schedule. Coordination within the design team is automatic as everyone is working in the same database. Drawing foundations, walls, floors and roofs is all done in 3D, which makes it easy to visualize the project. 3D views can be created anywhere, which provides a wonderful tool for helping contractors see how things are put together.

BIM Software

While there are several BIM software programs on the market, this paper deals with Autodesk products, because the authors' institution has a site license for Autodesk products, and students can download fully functional versions at no cost. AutoCAD is one of the most widely used programs and details and drawings created with AutoCAD can be imported into Revit.

Revit Architecture is the foundation Autodesk BIM program. Drawings, 2D and 3D views, and schedules are generated from a single database. Thus changes in one view are updated throughout the project. This eliminates the process of having to search through each drawing to make sure changes are consistent. Schedules are quickly generated as all of the doors, windows, finishes, and foundation elements are part of the database. There is no need to search through the drawings to count windows and doors. Revit Architecture is a parametric building modeler, which means that you can assign relationships between components and constraints. For example, the latch side of a door should be 12" from the wall. By establishing a relationship between these two elements moving the wall results in the door going with it. Of tremendous benefit to the construction manager is the ability to takeoff material quantities by building a schedule. There is no need to search through documents and measure distances. Autodesk Revit is also capable of interference checking. The program will check for clashes or interference between two categories such as stairs and floor systems. The ability to check for clashes between building elements is of tremendous value as problems can be detected and solved before construction begins. This process can greatly reduce the traditional "request for information" (RFI) process.

Revit Structure deals with the structural engineering side. Revit Structure and Revit Architecture share many of the same features, and the file formats are the same, which greatly improves collaboration as everyone is working out of the same database. There are analytical tools for evaluating loads and boundary conditions. Of primary use to the construction manager is the ability to visualize details of concrete reinforcement, steel connections, and details. Schedules of structural steel including type, length, and number can be quickly generated without sorting through drawings. Being able to view the structural assembly in 3D greatly enhances the understanding of the building and process. Revit Structure is capable of the same interference checking as Revit Architecture. Detecting problems between structural elements before construction begins can result in significant savings in time and money when compared to the traditional RFI method during construction.

Revit MEP addresses the mechanical, electrical, and plumbing aspects of the project. This program shares the same file format and many of the same features as Revit Architecture. When the architect and structural engineer have added their components and systems the mechanical, electrical, and plumbing engineers add their systems to the same database model file. This makes for effective collaboration and minimizes design coordination errors. Spaces and zones are easily added to the model, and these are used in calculations for lighting, heating, and cooling requirements. Mechanical equipment such as air terminals, ductwork, VAV's, (variable air volume boxes) and air handling units are part of the library and include information on sizing, air flow, and electrical requirements. Ductwork can be placed manually or there are tools that generate solutions and automatically route ductwork and connect all systems within a zone. This is all done in three-dimensions. Electrical panels, transformers, switchgear, lights, receptacles, and switches are all part of the Revit library, which can be modified and added to. After placing equipment a distribution system is created by associating equipment with panels. Circuits for lights and devices are created by associating them with panels and switches. Wiring is automatically placed. Information on panel names, loads, wire size, and wire length are all part of the properties for defined circuits. Conduit and cable tray are easily placed at specific elevations and can then be viewed in 3D to confirm locations. There are tools to check circuits and balance loads, and all of the information is easily displayed in schedules that are quickly created without sorting through drawings. The final part of Revit MEP is plumbing, piping, and fire protection. After placing plumbing fixtures system relationships are defined for hot and cold water supply and sanitary. Piping for these systems can

be automatically generated or manually drawn. Piping systems can also be defined for sprinkler systems and connection geometry is automatically generated. Pumps, sprinkler piping, sprinkler heads, and valves are all part of the Revit MEP library. For HVAC, piping system relations are defined for hydronic supply and return and solutions for routing the piping are automatically generated. There is also a tool that verifies that all defined piping systems are properly connected. Revit MEP checks for interference between elements such as lights and air terminals or piping and ductwork. Interference conditions can be viewed, corrected, and coordinated with the design team. To be able to see equipment, ductwork, piping, cable trays, and conduit in three dimensions is a valuable tool for construction managers and subcontractors. This certainly gives one an appreciation for how crowded the plenum space can be and the importance of proper coordination of trades.

Navisworks invites collaboration between team members by importing a variety of file formats to create a composite model. For example, Revit Structural, Revit Mechanical, and Revit Electrical models can be imported into Navisworks and combined into a single model. Navisworks is all about planning, scheduling, and detecting problems before construction begins. Clash detection identifies potential conflicts between disciplines. Does the ductwork or sprinkler piping clear the structural steel? Finding and correcting such problems before construction begins saves time and money when compared to the traditional method of issuing a request for information when a problem is encountered during construction. Navisworks enhances Pre-construction planning and scheduling by linking schedules with the model. As a result 4D simulations can be created that show the building elements going up in sync with the timeline of the schedule. Other tools provide for creating animations and section views. In some cases construction teams are modeling all of the mechanical, electrical, and plumbing components then checking for clashes and building from that model.

BIM and the Construction Management Curriculum

BIM provides many benefits to architects and engineers. Working out of a single database encourages collaboration within the design team and changes are updated instantly throughout the project. The 3D model helps visualize the design and provides a greater understanding of the intent of the architect. Much of the tedious work of creating schedules and drawing sections and elevations is eliminated.

Construction management students are not designers or engineers, so why should BIM be included in the CM curriculum? Taiebet and KiHong, (2010) state that four out of twenty-three construction companies that responded to their survey require knowledge of BIM. Contractors have also discovered the advantages of using BIM. By virtually constructing a 3D model of a building, problems can be detected and corrected before construction begins. Navisworks is a powerful tool for clash detection and visualizing animations of the construction process by linking schedules. Being able to show a contractor how their work should be completed in a 3D model is much more intuitive than trying to explain a 2D drawing. Material lists and schedules of components are easily generated, and the construction manager can create the lists and schedules that they need. Taylor, Liu, and Hein, (2008) stated that the benefits of BIM are such that contractors are creating their own 3D models even when provided with 2D construction drawings. In particular modeling of complex MEP systems can help locate clashes and determine how best to route duct and piping before construction begins. Once these models are complete the contractors build from the model and the model becomes the record drawings.

BIM extends into every part of the construction process and thus could extend into every course in the CM curriculum. Revit Architecture is the core program used to create the building model. This software would be best addressed in a standalone BIM course. Students could create 3D models from 2D drawings and learn how to view the model and create schedules and quantity takeoffs. The models could feed into scheduling, estimating, and project management courses. Revit Structure would naturally fit with a structural mechanics course. Revit MEP would be a great tool to use in the course addressing mechanical and electrical systems. Navisworks is a unique program that could be a part of construction planning, site utilization, scheduling, and project management. All of these programs are wonderful tools for demonstrating to students what systems look like and how they should be sequenced.

Extending BIM into the existing course structure would certainly enhance the learning experience and introduce the latest technology to estimating, scheduling, project management, and other subjects. However, there are drawbacks as faculty members would be required to learn and apply new software. Clevenger, Mehmet, Glick, and Porter, (2010) stated that learning and applying new software presents an unattractive responsibility for faculty. This is confirmed by the author's conversations with faculty members. Clevenger, Mehmet, Glick, and Porter, (2010) also stated that one way around this problem is to develop learning modules using Adobe Captivate (Adobe, 2010). These modules can then be utilized in other classes with no knowledge of the BIM software, and it looks like the actual BIM software is being used. Taylor, Liu, and Hein,

(2008) believe that BIM can be the central focus of a capstone course. As the culmination of the construction education experience BIM should be a part of the Capstone Course. Students could explore the advantages of BIM in a competitive environment, and the experience would be fresh in their minds for their first real world position.

BIM could be integrated throughout the curriculum or there could a standalone BIM course or a combination of the two. Taylor, Liu, and Hein, (2008) stated that their study indicated that a standalone course could be offered along with integrating BIM throughout the program. At this point in time the authors' program is pursuing a standalone BIM course. Once this course is developed we will have a better understanding of how to integrate BIM into other CM courses.

Conclusion

Based on the associated research and the authors' experience, BIM is being fully utilized by many construction companies, and the CM curriculum must include BIM in order to meet the demands of the industry. BIM software offers powerful tools to the construction manager. Buildings can be virtually constructed and problems detected before construction begins. Construction managers with knowledge of BIM can develop their own models without having to rely on design professionals. This offers tremendous advantage in planning, scheduling, site utilization, and estimating. Several aspects, such as whether to teach BIM as a standalone course or integrate it throughout the curriculum, were discussed that must be considered by programs while tailoring their distinct curricula. The how and to what extent BIM is included in the CM curriculum requires further research.

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Developing Experiential Learning in the Construction Management Classroom

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Abstract
Construction projects demand a wide knowledge base for potential construction managers and within that framework, experience plays a huge role in developing a solid background to accomplish projects from start to finish. Most times, in higher education, experiential learning is limited to coop or internship opportunities garnered during the summer months and those experiences can be limited in nature due to the short amount of time available on the project. Through this paper, the audience will understand how experiential learning can be implemented within one course curriculum using emerging technologies and volunteer companies throughout a semester course. The curriculum helps to establish a working relationship in the construction industry and affords those valuable experiences that are necessary on a construction project.

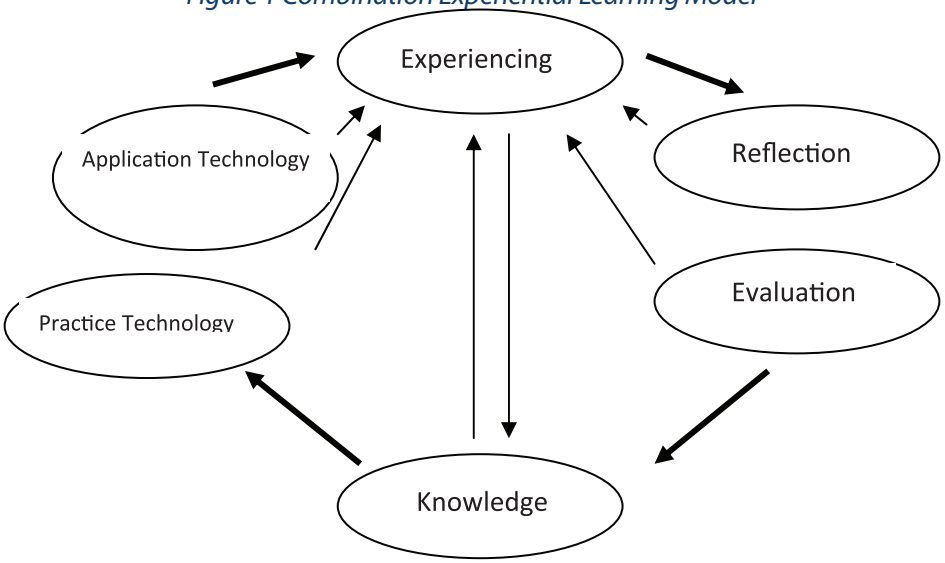
Introduction
Borzak, in his 1981 book " A Sourcebook for Experiential Learning", makes the statement that, "Experiential learning thus involves a direct encounter with the phenomena beings studied rather than merely thinking about the encounter, or only considering the possibility of doing something about it" (1981). This is especially true in the construction industry, as a vast knowledge base is needed in order to function properly as a construction manager on a project. While much of the information and knowledge is discussed and garnered in a classroom setting, as Borzak states, it is incumbent of experiential learning to develop skills by application and utilization of knowledge in practice (Borzak, 1981).

With the introduction of advanced technological techniques, experiential learning can be used to further develop those concepts and applications that are introduced and used in the classroom while reinforcing those metrics on the project site with those industry professionals. The most instrumental tool in this development role is the creation and application of a curriculum that strengthens learning applications and increases a student's ability to garner that valuable experiential experience while attending coursework.

The incorporation of this model will allow programs flexibility for experiential learning while forging relationships with industry by utilizing techniques that allow students to interact with those participating companies. While every program has different requirements and objectives, the integration of additional learning opportunities help to reinforce techniques and knowledge gained in the classroom.

Educational Model
According to David Kolb, experiential learning is about creating an experience where learning can be facilitated by use of a model that matriculates knowledge at all levels (Kolb, 1995). In the construction industry, that experience is accomplished by interactions within the project or industry itself. It is not realistic for a recent graduate to have that professional experience that has been accumulated through years on the job. However, there is a way for that experience to be handed down to those young professionals through those experiences. In higher education, it is paramount to the success of our students to accommodate a changing environment by injecting these opportunities into our curriculum to build relationships while elevating the breath of our program. In order to accomplish this, we as the facilitator, must set up our courses to optimize success. The basis for type of learning tears down those classroom walls that have been, for so many years, acceptable and becomes an interactive, real world test lab where actual applications have a dynamic impact on the company and learning. The ability of a student to interact and learn in this manner may well increase their abilities and expertise as a connection to the actions, reactions, and understanding of business operations and management (Schon, 1983). In an experiential learning outcome, it becomes circular in nature and is culminated when connections can be attained from concrete knowledge to application and vice-versa.

Figure 1 Combination Experiential Learning Model



The model, Figure 1, above is a combination of Dewey, (1933), Kolb, (1975), and Fry (1981). In this model, you can see that the circular nature of experiential learning starts with the attainment of basic or introductory knowledge that is expanded by use of practical application and practice within the classroom. From there, normal progression would carry to evaluation and assessment but in the experiential model, the progression goes toward real-world experience where knowledge, practice, and application are infused into actual business situations. In the end, the learner then has an opportunity to reflect and evaluate that experience against the end result of the application. In order for this model to be truly effective, additional parameters must be employed from goal setting, to experimenting, observing, and planning (Itin, 1999).

Course Identification and Parameters

As a construction management program, the importance of estimating and scheduling is at the forefront for future successful project and construction management, but is two areas where technology has continued to develop. Thus, the course, TECH 452, selected for this experiential experience is a senior level course for students in the construction management discipline and is being delivered at a small private university in Ohio. The main focus of the course is for students to gain knowledge in both estimating and scheduling while using state of the art software programs to facilitate the current upgrades in the industry. Students use a myriad of software programs, (Primavera, On-Center, Microsoft Office Project, Quick Bid, and Oracle), to build knowledge in these areas. Final projects have been limited to constructed projects in and around the area and are judged by a panel of construction professionals during a structured presentation.

Course Technology

Since the industry is moving slowly to electronic software packages for design, estimating and scheduling, the mastery of leading edge technology such as BIM, (Building Information Modeling), and mastery of such programs are required for aspiring professionals. The current curriculum incorporates those new innovative packages to estimate and schedule but sometimes falls short based on the level of mastery by the student. The different technologies are used on various smaller projects during the semester but final projects are completed using the software and technology that is chosen by the student.

Industry Interaction

While final projects are graded by construction professionals, there is still a disjoint between the student and industry. For final projects, students choose a project that was constructed by a regional contractor and has very little interaction with the company in the compilation of the project. The various changes that occurred in estimating or on the project are normally not known and create voids in the final presentation.

New Experiential Course

As David Kolb states, "It is imperative that experiential learning develop a circular model of learning by (1) concrete experience followed by (2) observation, followed by (3) forming abstract concepts, and finishing with (4) testing in new situations (Kolb, 1995). To accomplish this, the course is going to be organized to infuse students into the company by use of new technologies that will allow students to work virtually with the company over the semester on current and future projects. Within this construction management program, students are required to complete a number of field hours, a 15-week internship or two separate co-ops during their undergraduate program. This new inclusion of experiential learning within the classroom will allow students to record documented field hours toward fulfillment of their coops or internships. According to Bruner, computers and technology are more than pedagogical tools, they represent and create meaning from the environment from which the student is centered (Bruner, 1996). The use of these emerging technologies for conferencing, web interaction, and discussions will allow for flexibility in this transformative classroom project.
Studies have shown that active experiential learning in a higher education setting is stimulated based on the social and cognitive activation incurred by outside interaction, problem solving, and self regulation activities to complete tasks and projects (Kester, 2004). This new type of learning will elevate student involvement and participation in the industry while elevating his or her own sense of accountability as a future professional.

Curriculum

Since this is a senior level course, students are expected to draw on their past course experiences in the construction management program to complete the course. Much of the coursework is directed to an outcomes based class that is steeped deep in project and hands-on based applications that develop mastery of skills in estimating/bidding and scheduling. Students are expected to develop their skills with new technology in and out of the classroom, especially when they become attached to a volunteer construction company. The course is broken down into three 5-week modules where students are attached with those companies that are participating in the course.

Week 1 - 5

During the first five-week block, students learn and apply knowledge obtained in estimating by performing small projects the company has identified. During this time, students are learning the programs but at the same time interacting with the companies by use of multi-media means. While there is a number of different conferencing and web-based programs available, for this first time course delivery, students and companies will be using Skype, Windows Live, Elluminate, Microsoft Office Live, First Life, WebCt, Blackboard and Whiteboard. Also during this time, students are building relationships with the company while working with those company professionals that are responsible for estimating. In order to mitigate situations where estimating programs are being used by the company that is foreign to the CM program, the companies that are participating have been chosen because they are currently using the same programs or those that are closely related to On-Center, Quick Bid or Timberline. Additionally, students are responsible for a face-to-face meeting with the company to get acquainted with those professionals and also to learn some of the intricacies of their processes and procedures. From week three to week five, students must have at least four different virtual meetings with their chosen company.

Week 6 – 10

During this period, students are moving forward with estimating abilities and knowledge but also including scheduling as an additional learning module. Students are still completing estimating projects, but are starting to use scheduling software in order to understand the close connection between the two applications. There are, at least, two projects that are required complete during these weeks. Again, students are introduced to software programs such as Primavera, Microsoft Office Project, Oracle Contractor, Navisworks (conversion software for BIM projects), and continue their relationship with their chosen company. During this time period, students begin to have virtual weekly meetings with the company but no site visitation is required.

Week 11 – 15

At this time, students begin to work on their final projects, which are actual projects from the company, and work closely with the different elements of the estimating and scheduling teams from the company. During this time, students are required to have daily contact with the company by virtual meetings, company visitation, or submission of daily reports and status reports or a combination of the three. Students will be completing a full estimate and schedule for a project that the

company is currently working on for future consideration. In this module, students finish any project that is outstanding or any scheduling project that has not been completed. In the end, all professionals from each company will participate in the final presentations during finals week.

Assessment

There are a number of different assessment metrics included in the course that range from quizzes, projects, professional evaluations, and final presentations. Quizzes are structured to assist students and can be retaken until mastery is obtained. Students are required to complete two estimating projects, two scheduling projects, and one final project. Each will be evaluated by the course instructor and company professional but the final project will be evaluated by all the participating company professionals during finals week. Students will also receive weekly evaluations from the instructor and company professional based on different facets of the experiential learning experience. Finally, students evaluate their own performance and substantiate their evaluation by their daily progress book that they are required to keep during the course.

Conferencing and Technology

Students are required to use different multimedia to communicate with the company that they are attached to and must ensure that set up is complete for the company. Some of the different multimedia tools that will be used are Skype, Windows Live, and Elluminate. These programs will be used to create the virtual conferencing between the student and company. Additional technologies that will be used are Blackboard, WebCT, Whiteboard, and in some cases Face book (Chat). To ensure that privacy is maintained, security measures have been set up with the companies and the university. Any information that is used or transmitted over the web will be done using a secure or login method.

Participating Companies

For this trial course, there are five companies that will be involved in the experiential learning experience. They are located regionally to the university and are small to medium size commercial construction organizations that are actively involved in internship and coop opportunities for students of the program. Each company has agreed to participate in the course and incorporate the necessary technology for virtual meetings and transmission of documents from the university to the company and vice-versa. All students that will be attached to each company must sign a confidentiality agreement before the course starts as required by each company.

Conclusion

Aspiring professionals in the construction industry must have a diverse knowledge of the processes, procedures, applications, and guidelines to ensure success in the building industry. An ability to incorporate experiential learning within the classroom allows for flexibility in learning from the classroom while gaining valuable experience in the field. This course is designed to take advantage of real world experiences and industry professionals to gain insight and knowledge in a changing discipline. The ability to branch our classrooms into transformative learning environments is essential to the success of our future graduates in the construction industry.

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Presence of BIM in Construction Management Program Curriculum

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Abstract
Building Information Modeling (BIM) is argued to be effective in reducing the construction industry's fragmentation and inadequate interoperability, and improving its efficiency. To prepare the construction students for future professional success, the construction programs should make them familiar with BIM authoring and various construction management functions of BIM. The primary objective of this study was to examine the baccalaureate and graduate curricula for courses on BIM offered by the construction programs in the United States. A systematic search of the curricula of construction programs offered by the ASC (Associated Schools of Construction) member universities was conducted to identify the courses on BIM or its variants. Results show that less than one fourth of the member universities offered individual courses on BIM and there was significant variation in course objective, level the courses were offered, and prerequisite for the courses. Common themes of learning objectives of the courses are summarized to help educators fill in the voids to provide a more holistic education of BIM to the construction students.

Introduction
Building Information Modeling (BIM) has been widely adopted by the Architectural, Engineering and Construction (A/E/C) industry in the recent past due to its ability to create an accurate virtual model of the built facilities, bringing productivity gains and long term benefits over prevailing practices (Eastman, Teicholz, Sacks, & Liston, 2008; Goedert & Meadati, 2008). Paired with the increasing popularity of BIM, the demand from the A/E/C industry to produce individuals trained in BIM is also increasing (Morse, 2009). To cater this demand, more and more educational institutions have started incorporating courses on BIM in their curricula. Although many institutions are providing courses on BIM, there is no general consensus on the content of the courses and the delivery methods (Morse, 2009). The courses offer students the opportunity to learn BIM authoring as well as other specialty applications of BIM in varying degrees. In addition, the courses also differ in their approach and overall learning objectives.

The goal of this study was to examine the current state of BIM education offered by universities in the United States. The study focused on BIM courses offered by the construction programs with emphasis on the following factors: (1) course level, (2) required prerequisite, (3) course description, and (4) learning outcome.

Defining Building Information Modeling
Building Information Modeling (BIM), in the most generic sense, is defined as the process of development and use of computer generated model to assist in the process of design, planning, construction, operation, and maintenance of a built facility. A BIM model is a data –populated, object oriented, parametric digital representation of a facility (Azhar, Hein, & Sketo, 2008). Various stakeholders involved in different phases throughout the lifecycle of the facility can view and extract data from the model to make proper decisions regarding the development and improvement of the facility (AGC, 2005). In other words, BIM is the process of creating a parametric model, which facilitates decision making during the design phase, prediction of building performance, cost estimation, construction planning, and also preparation of precise construction documents (Krygiel & Nies, 2008). The BIM model with all the physical and functional characteristics of a facility "is intended to be a repository of information for the facility owner/operator to use and maintain throughout the life-cycle of a facility" (NIBS, 2011).

A typical BIM model carries all the necessary information related to a building, which ranges from the physical and functional characteristics to the lifecycle information (CRC, 2007). The model includes information about the geometry, spatial relationship, geographic information, quantities, and properties of the facility. The model can also be used to perform quantity takeoff, prepare project schedule, and demonstrate the entire lifecycle of the facility (Bazjanac, 2004). As a result, scopes of work can be easily defined and isolated from the entire model. In addition, assemblies and sequences can be easily extracted from the model. As all the physical and functional information is stored in one single model, the construction documents such as drawings, procurement details, submittal process and other specifications can easily by interrelated (Azhar, et al., 2008).

The parametric nature of the model allows different stakeholders to modify and make changes to it, maintaining the geometric consistency and the integrity of the model. Thus, the key to understand BIM and its difference from two-dimensional (2D) design is to have a proper understanding of the concept of parametric objects. Eastman (2008) defines parametric object as a series of concisely integrated geometric definitions and its associated data.

Evolution of BIM

From the earliest stage of inception when Graphisoft introduced their first "Virtual Building Solution" (also known as ArchiCAD) in 1986, the concept of BIM is presently more than two decades old (Morse, 2009). ArchiCAD helped architects and engineers to create virtual three-dimensional (3D) models. The revolutionary new software allowed architects to digitally construct virtual 3D model of their project, instead of relying on the conventional computer aided design (CAD) programs of the time to produce 2D drawings. In addition, to be able to construct an accurate model, the architects and designers could also add an array of information to the building model. The information ranged from the geometry, spatial relationship, and geographic information to the quantities of the components used in the design. This concept was in sharp contrast to the prevailing practice of producing numerous specification documents using conventional CAD programs to convey required information pertinent to the project.

In other words, BIM can be considered as the successor of computer aided design (CAD) (Wong, Wong, & Nadeem, 2011). The primary advantage of BIM over its predecessor is its consistency, which enables automatic update of information in all the view if one view is modified (Azhar, et al., 2008). BIM models are represented as parametric models generated through the different building elements such as walls, beams, floors, doors etc. in comparison to CAD drawings, which are represented as graphical objects such as lines, rectangles, arcs, circles etc (CRC, 2007). In addition, within the BIM environment each object instance is defined only once.

BIM and Construction Education

Recently, BIM has become more popular in the Architectural, Engineering and Construction (A/E/C) industry. This significant rise in popularity of BIM in the A/E/C industry created a demand for trained individuals (Morse, 2009). To meet this demand various educational institutions have started incorporating courses on BIM in their construction curricula. For instance, a one week tutorial on BIM was initially offered by Auburn University, which was followed by a one-semester introductory course on BIM (Taylor, Liu, & Hein, 2008). The Architecture Department at The New Jersey Institute of Technology has been offering BIM for many years in multiple upper level classes, which were later, combined into an individual course on BIM, taught as the main tool in a design studio (Autodesk, 2007). The incorporation of BIM in construction curriculum will not only provide the A/E/C industry with skilled professionals but will also improve the students' ability to deal with new occupational challenges and achieve higher efficiency in their professional career (Wong, et al., 2011). Several education institutions have adopted different types of approaches to introduce BIM in their curricula (Burr, 2009; Haynes, 2009; Sacks & Barak, 2010; Woo, 2007). Two main options by which BIM can be introduced in the curricula are combining it with an existing course, or offering an individual course. For example, BIM is introduced to the students of Building Construction Program at Virginia Tech by addressing some elements of BIM as part of the Integrated Construction Leadership Studio course (CNST 5124). Considering the various courses offered in the construction programs of different educational institutions with varying focus on BIM authoring, students also have opportunities to learn other specialty applications and construction management functions of BIM. These courses vary in their approach as well as the intended learning objectives for the students, which entails a comprehensive review of the BIM courses offered in the various institutions across the nation.

Research Scope and Procedure

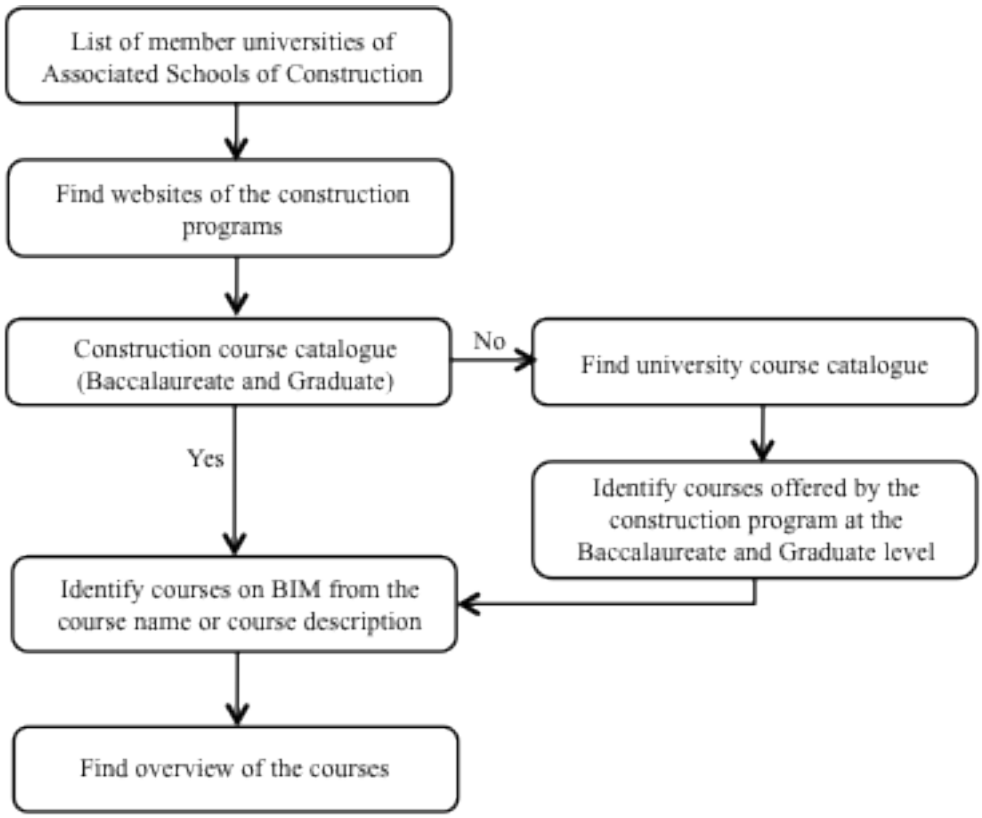
The goal of this study was to document the state of BIM education offered by the construction programs in the United States. Many universities across the nation offer individual courses on BIM both at the baccalaureate level and graduate level in their construction programs. The specific objectives of the study were:

1. To compare the levels at which the courses are offered, and the required prerequisite(s) for the courses
2. To analyze the descriptions and learning outcomes of the courses

For the purpose of this study, a web based research method was adopted. A systematic review of the curricula of the construction programs available online was conducted. The member universities of Associated Schools of Construction (ASC) were selected as the sample for the review. The consideration of ASC for the study was due to the fact that it is the largest construction-specific professional organization for universities. As of May 2011, a total of 137 universities in the United States were registered with ASC as members (n=137). These member universities were divided into seven regions according to their geographical locations. The eighth region comprises of the universities located outside the United States and was not included in this study.

It was assumed that the curricula of the construction programs available online were up to date at the time the review was conducted, and were comprehensive representations of the courses offered by each of the programs. The overall methodology of the study involved the following steps: (1) retrieving list of member universities from ASC website; (2) examining curricula of the construction programs of selected universities; (3) identifying courses offered on BIM; (4) collecting data of interest to this study (course level, prerequisite, course description, and learning outcomes); and (5) analyzing the data. The synopsis of the procedure followed for this study is illustrated in Figure 1.

Figure 1: Overview of the search process



Curricula for the four-year baccalaureate degree as well as graduate degree were selected for this study. Presence of course(s) on BIM in the curricula was searched using one or more of the following keywords: 'BIM', 'building information modeling', 'visualization', 'integration, 'graphics', and 'CAD'. Only individual courses on BIM were considered for this study. Subsequently, descriptive summaries and content analysis were used for data analysis.

Descriptive summaries

Review of the curricula showed that less than one fourth of the member universities of ASC (n=32) in the United States offer one or more courses on BIM in their construction programs at the baccalaureate and graduate level. Though the number of member universities listed under each of the regions varied widely from 15 to 27 (a minimum of 15 members in the North Central Region to a maximum of 27 members in the Great Lakes Region), number of member universities offering course(s) on BIM under each region showed less variation with a maximum of 7 (both the Great Lakes Region and the Rocky Mountain Region) and a minimum of 2 (North Central Region). Table 1 shows the number of member universities within each region, and the number of universities within each region offering courses on BIM.

Table 1: Member universities of ASC offering course(s) on BIM

Regions	Number of member universities N (%)	Number of universities offering courses on BIM N (%)
Region 1 – North East Region	22 (16.1)	4 (18.2)
Region 2 – South East Region	17 (12.4)	5 (29.4)
Region 3 – Great Lakes Region	27 (19.7)	7 (25.9)
Region 4 – North Central Region	15 (10.9)	2 (13.3)
Region 5 – South Central Region	18 (13.1)	7 (38.9)
Region 6&7 – Rocky Mountain Region	19 (13.9)	3 (15.8)
Region 6&7 – Far West Region	19 (13.9)	4 (21.1)
Total	137 (100)	32 (23.4)

The systematic review of the curricula identified 51 individual courses on BIM offered across all the member universities. Table 2 shows that the universities of the South Central Region (25.5%) offered maximum number of courses, while universities of the Rocky Mountain Region (5.9%) offered the least number of courses. Although both the South Central Region and the Great Lakes Region had maximum number of universities offering courses on BIM, number of courses offered by the South Central Region was distinctly higher. In terms of levels at which the courses were offered, majority (74.5%) of the courses were offered at the baccalaureate level. Universities in all the regions except the Rocky Mountain Region offered one or more than one courses on BIM at the graduate level.

In the baccalaureate curricula, courses on BIM were offered across all the four levels. However, number of courses offered at the senior (400/4000) level was highest (34.2%) followed by freshman level (26.3%), sophomore level (23.7%), and junior level (15.8%). The trend of offering courses on BIM throughout all the years of the baccalaureate degree suggests the emphasis given to the subject. The students get an opportunity to be introduced to the concept of BIM at the very beginning of their degree, and gradually gain expertise and more exposure to the subject as they progress through the curricula.

Table 2: Number of courses on BIM offered according to class level

Regions	Freshman	Sophomore	Junior	Senior	Under Graduate	Graduate	Total
	N	N	N	N	N (%)	N (%)	N (%)
Region 1 – North East Region	0	2	0	3	5 (9.8)	2 (4.1)	7 (13.7)
Region 2 – South East Region	1	0	1	2	4 (7.8)	2 (4.1)	6 (11.8)
Region 3 – Great Lakes Region	1	2	2	1	6 (11.8)	3 (6.1)	9 (17.6)
Region 4 – North Central Region	2	0	1	0	3 (5.9)	2 (4.1)	5 (9.8)
Region 5 – South Central Region	2	3	1	4	10 (19.6)	3 (6.1)	13 (25.5)
Region 6&7 – Rocky Mountain Region	1	1	1	0	3 (5.9)	0 (0)	3 (5.9)
Region 6&7 – Far West Region	3	1	0	3	7 (13.7)	1 (2.0)	8 (15.7)
Total	10	9	6	13	38 (74.5)	13 (26.5)	51 (100)

To ensure that students come to the BIM courses with a basic knowledge about computer aided design (CAD) and construction graphics, some of the construction programs have prerequisites for their courses on BIM. The prerequisites are not always made mandatory, but are recommended for improving students' comprehension and application. A list of the common prerequisite courses as found in the curricula of the member universities of ASC is rank ordered in Table 3. As evident from the table, some of the advanced courses on BIM had introductory courses on BIM as the prerequisites.

Table 3: List of prerequisite courses

Rank	Prerequisite subjects	Percentage
1	Construction drawings/graphics	21.57
2	Introduction to BIM	7.84
3	Construction materials	5.88
3	CAD for Architecture & Construction management and technology	5.88
4	Statics and strength of materials	3.92
5	Introduction to construction	1.96
5	Fundamentals of architectural problem solving and design	1.96
5	College algebra	1.96
5	Survey of accounting	1.96
5	Project management and control	1.96
5	Residential architecture	1.96
5	Construction estimation	1.96
5	Design build, facilities management, and green building	1.96
5	Mechanics and deformable bodies	1.96

Note: 35.29% of the courses on BIM did not have any prerequisite

Findings

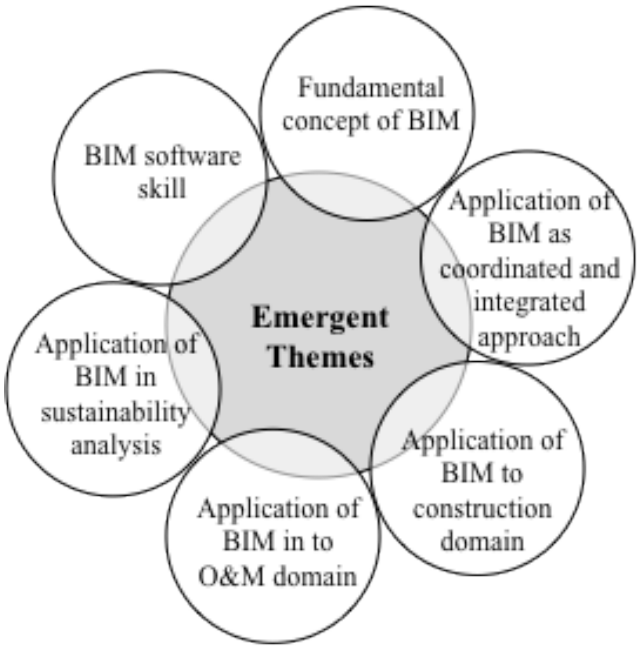
To gain an insight in the learning objectives of the courses on BIM, the individual course objectives were analyzed. The primary type of data analysis for this research study was content analysis. The authors examined the course descriptions (n=51) to see what categories emerged and how those categories were related. Subsequently, these categories became the themes of the study. Data analysis began with the coding of each individual course description available online. Authors reviewed the course descriptions to identify key terms or phrases that summarized the learning objectives of the course as related to BIM. As an additional level of credibility through triangulation, all the authors reviewed the course descriptions separately and identified key terms. After the second iteration, a table of all open codes was created.

Following coding, the authors collaborated to identify patterns within the open codes. These patterns were developed into categories of common learning objectives among all the courses (Table 4). These categories were further narrowed into themes, which framed the emergent themes of the learning objectives of the courses on BIM (Figure 2).

Table 4: Categories of common learning objectives

Fundamental concept of BIM
Theory of BIM
Advantage of BIM over traditional design and construction practices
Application of BIM as a coordinated and integrated approach
Integration of structural, architectural, MEP plans
Coordination of site work
Interdisciplinary team approach to problem solving
Integrated design, construction within advanced digital environments
Application of BIM to construction domain
Role of BIM in residential and commercial construction
Create virtual model of building for quantity take offs, design decisions, interference checking, construction document generation, rendering and presentation
Manage model and extract data useful for construction management
Interference issues and interference resolution
Construction communication tools
Application of BIM to operation and maintenance domain
Role of BIM throughout the lifecycle of a facility
Application of BIM to the construction, operation, and maintenance of a facility
Application of BIM in sustainability analysis
Energy compliance
BIM software skill
Prepare construction drawings using CAD
Parametric modeling
Use of software to develop CAD tools for analytical interpretation of construction projects

Figure 2: Emergent themes of learning objectives of the courses on BIM



Conclusion

The study developed an understanding about the current status of BIM education in the construction programs of the United States. Based on the baccalaureate and the graduate curricula available online, this study quantified the number of member universities of ASC offering individual courses on BIM. Moreover, the level at which these courses were offered and the prerequisites were identified. The emergent themes presented in this paper summarize the common learning objectives, which were usually addressed in the BIM courses. The themes illustrate the learning objectives of the courses currently offered and can help educators to fill in the voids to provide a more holistic education to the construction students.

While the search process adopted in this study was delimitated by a number of constraints, it is evident that in spite of the growing demand for construction professionals knowledgeable about BIM practices and techniques, a consensus on what constitutes the body of knowledge for BIM is still in the developing phase. Organizations such as Association of Technology, Management, and Applied Engineering (ATMAE) and Associated Schools of Construction (ASC) can act as platforms to exchange ideas and help the member universities reach agreement on the content and delivery method of BIM education system.

Future research will overcome the limitations of this study by including the courses addressing some elements of BIM within the search sample. To conduct an exhaustive search, surveys will be sent to the contacts of the member universities in which no BIM courses are found by searching online.

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A Time to Draw: Old-Fashioned Architectural Drafting, An Experiment in Basics

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Abstract
Through this paper the audience will understand the relevance and need for manual drawing work in lower level architectural drafting classes as an instructional strategy for improved 3D spatial cognition. The paper presents a term long architectural drawing project in the construction technology program at a midwestern university. Manual drafting is presented as a pedagogical tool and the potentials and pitfalls of such strategy are examined in the light of existing scholarly research on the subject. The paper includes students' feedback on the project, which can be used as a benchmarking tool to further assess and refine this strategy.

Introduction
The seismic shift from traditional drafting to CAD applications is irreversible. Arguably even a discussion about the relevance of manual drafting today, is highly questionable. What if anything, do students stand to gain from old world drawing boards, and archaic instruments? Are we not engaging in a re-run of the slide-rule versus the calculator debate? However, it can also be argued that some basic drawing and visualization skills are being lost in translation. We don't want to throw out the baby with the bathwater so to speak. The premise of this paper relates to the *instructional* relevance of manual drafting. Doubtless CAD rules all workplaces today, and for good reason. Here we will not get into the obvious positives of machine drafting, but instead explore ways that manual drafting can still be useful in lower level architectural drawing classes for visualization of shapes, solids, dimensions, and drafting conventions.

This paper is based on an existing lower level drafting class curriculum, where an instructional experiment with manual drafting was carried out over the course of a term as a pedagogical strategy to reinforce drafting fundamentals. The project is described in terms of the various tasks the students were expected to accomplish; the relevant gains to drafting instruction are discussed; and finally the students' feedback on the project is brought in to examine the perceived relevance or the lack of it from their perspective.

Drawing as a Pedagogical Tool
The relevance of manual drafting in the age of CAD is not a Luddite argument. An architectural or mechanical drawing is a *product*, as well as a *process*. It is in the latter sense that the instructional value of manual drawing can be better appreciated. The act of drawing a shape or a form for instance, informs its comprehension. Significant scholarly research can be cited for consensus on this issue. For instance, according to a study conducted on the perceived value and relevance of teaching students the use of traditional drawing instruments, several key themes have emerged (McLaren, 2008). Professional CAD users including engineers and architects pointed to skills such as problem solving, visualization, and accuracy. Competencies in coordination, use of standard conventions, personal discipline, and even artistry were reported to be enhanced due to manual drafting instruction. It was found that the students in fact appreciate the experience of traditional drafting (McLaren, 2008).

Fundamentals of CAD must be founded on basic understanding of geometric construction, and drafting conventions. Literature suggests that poor standards in students' CAD work may often be the result of the lack of such basic underpinning (Reid-Gray, 2009; Olkun, 2003; Raudebaugh, 1996; Romaniuk, n.d.). It has been suggested that physical and mental manipulation and 2D-3D representations are necessary not only to solve spatial relation problems, but also for more complex spatial visualization tasks (p2). Thus the act of manual drafting affords the learner the means to develop cognitively. A student must be able to fully integrate, and disassemble 2-D diagrams in order to accurately represent their 3-D counterparts. The language of graphical conventions gets strengthened; fundamental assumptions in drafting are reinforced; and most importantly, students can mentally rotate, visualize, translate, and manipulate spatial objects without the need to resort to a computer.

According to McCardle, (2002), the value of manual technical drawing lies in the development of visualization and manipulation of views 2D and 3D, issues of cognitive modeling and transposing images; line quality, accuracy, basic geometry involved in constructing shapes and clarity through application of accepted conventions. An interesting, although admittedly older study compared the quality of the 'end product' between manual and computer aided drafting systems reported some thought provoking findings. Bhavani and John (1996) note the emphasis on the haptic, physicality of feedback from pencil and paper to eyes and brain. The use of the wrong procedure or strategy results in a low quality drawing, which is easily recognized as low quality drafting, and inaccurate solution. They argue that since 'there is such a strong causal relationship between technique and quality, and because the flaws are publicly visible, drafters tend to be highly motivated to improve technique' (p. 336). They argue that this causal relationship is absent in CAD. A CAD drawing is clean and *looks* accurate. There is no visible indication that the drawing was produced by a sub-optimal strategy, As a consequence there is little motivation to look critically either at the outcome or at the process of creating the drawing.

Lastly some anecdotal evidence in response to a web poll question: "How important is it to you to teach hand drafting?" Of the statistically insignificant number of respondents (19), more than half expressed their willingness to teach some form of manual drafting before moving on to CAD (CNCZone, n.d.).

Extremely! I teach it extensively	3
Very! We cover it before we move to CAD	10
Somewhat. We touch on it briefly	2
I don't really use it. It is a waste of time	2
You mean, like, with a pencil and stuff?	2

Research Design

The project outlined below was based on the theoretical work on the comparative merits and relevance of manual drafting. A lower level class in architectural drafting and blueprint reading was assigned a term long manual drawing project at a Midwestern university. The project resulted in the production of a set of blueprints for students' designs, and served to reinforce the theoretical principles of architectural drawing. The students were given a hypothetical site plan, with 8 possible locations for a 2-bedroom house design that they could select from. They could assess the possible entryways, proximity to local kindergarten, park, etc.; they could also evaluate potential noise sources, traffic issues, parking access etc., while making their selection.

Working in groups of two, the students worked through the various site-planning issues. Once selected, each site had to be examined for orientation issues, so that they could determine the best options for room layout. The students began by creating sketch designs for a two-bedroom house on their selected site. They proceeded to make decisions on access, parking, orientation, basic layout, etc. in order to develop their designs. Relative placement of the various rooms, utility versus the living areas, parking, and even the landscaping, were analyzed.

It must be pointed out that architectural design is not the intent of the class in question. The brief foray into the design process was introduced in order to give the students a fundamental understanding of the decisions involved in what they were about to draft. The process also allowed them to 'own' their project, and thus become involved more viscerally than would have been possible otherwise. They also understood that drafting and design are not entirely distinct exercises, or don't have to be. In the process of working through their drafting, many times the students felt the need to modify, and redesign sections of their work. The process of drafting was never completely devoid of designing itself. Table 1 given below illustrates the expected timeline for the various project deliverables throughout the term:

Table 1. Project deliverables timeline

Time	Drafting goal	Tasks to be accomplished	Dwg. Scale
Weeks 1-2	Initial sketch design	Basic layout decisions	Freehand
Weeks 3-4	Site Plan	Orientation, set-backs, access roads, parking, initial landscaping decisions	1:20
Weeks 5-6-7	Floor Plan/s	Detail layout, openings, wall thickness, dimensions, labeling, furniture, notes, etc.	1:1/4
Weeks 8-9	Elevations: Front/ Side	Material finishes, openings, roof form	1:3/4
Weeks 10-11	Interior elevations/ Section	Self selected to illustrate the most interesting interior view/ level differences/ staircase/ mezzanine/ basement etc.	1:3/4 1:3/8
Weeks 12-13	Details	Three self-selected details: e.g. footing/foundation, flooring, sill, jamb, roofing, insulation etc.	3:1
Week 14	Completion	Revising all drawings to reflect final design	

Although the students were given a rough timeline of project deliverables, they were not required to turn in their work throughout the term. Instead, they were encouraged to work back and forth through their drawings. It was underscored time and again that all drawings represented a single object, and therefore a change on one sheet needed to be reflected on all related drawings. Final project week was set aside for making any and all such revisions.

The design and drawing lab-work was aligned and supplemented as far as possible, with lectures on related topics. One of the key student feedbacks was their appreciation of the hands-on nature of the assignment. They also expressed a renewed respect for the complexity involved in putting together a project of this magnitude.

Discussion

At the culmination of the project student feedback was recorded in order to investigate their reactions on the perceived usefulness, relevance, and learning value of the entire exercise. A complete response listing is included in the appendix; however, some broad observations are discussed here. The responses are overwhelmingly positive; although prior to the survey it had been made clear that this was purely an opinion gathering exercise. The students were free to express opinions in any way they chose. Following are some key themes that emerged from the survey responses.

For instance, one student stated: "Learning how to think when you design a house and what you need to think about before you even start the design" (See appendix). This comment is significant from pedagogical perspective, as it steps up the exercise to the higher order Bloom's Taxonomy learning goals. The project is acknowledged to move beyond mere description, and understanding, to analysis and evaluation skills. Furthermore there was an acknowledgement of the inherent complexity involved in the drafting exercise. The students seemed to go beyond the manual task of drafting, to the innards of building design, and appreciate design complexity by virtue of having engaged in the drafting exercise. They reported learning that "a line drawn on any plan has a purpose, so you have to pay attention to the thickness.." (App). The comments reported not only a drafting know-how, but also a deeper understanding of design itself: "I learned why houses are built a certain way to match their surroundings" (App).

A potential disadvantage of manual drafting as noted by students was the inability to identify the author, especially in a group work situation. The students pointed to the capacity of CAD where individual contributors could be identified, and therefore recognized. On the whole though, the reaction was mostly positive. The hands-on nature of work was much appreciated. Students not only reported learning how to read drawings, and scales, but also acknowledged the inherent complexity involved in the exercise. Interestingly, not one of their responses questioned the relevance of manual drafting instruction in today's CAD age. The exercise of manual drafting, on the other hand seemed to engage them, and sharpen the awareness of fundamental designing and drawing skills: "It takes a lot of patience and a whole lot of imagination to design a structure with the qualities you want.." (App).

From the perspective of the instructor the drafting exercise created a hands-on engagement of the students with the design and drawing process. It generated active interest among the students, and allowed them to 'own' their designs. It must be pointed out though, that such project work must be accompanied by utmost clarity regarding the *role* of manual drawing in today's CAD driven professional world. It is above all a pedagogical exercise, its role being spatial cognition at a fundamental level. Within the framework of a hands-on learning exercise, it continues to remain meaningful in lower level drafting classrooms.

Conclusion

The relevance, and suitability of manual drafting has been discussed in this paper as an instructional device. The scholarly literature debate on the subject was introduced as a backdrop to the drafting project assigned in a lower level architectural drafting classroom. Students' feedback has been presented at the end of the term long exercise. The instructional experiment points to a meaningful role for introducing manual drawing in the overall drafting curricula. Critical visualization skills, and cognitive capacity development for 3-dimensional spatial comprehension are key proficiencies served by such an exercise. The need for manual drafting is doubtless no longer a professional requirement. It remains nonetheless an effective tool for teaching spatial comprehension in three dimensions.

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Appendix: Student feedback

Students' responses to the following question were recorded verbatim: *What did you learn from the Drawing Project? Was it a useful learning experience? Did you enjoy working as a team?*

1. I learned how to think when you design a house and what you need to think about before you even start the design. I learned a lot of symbols and how they are used. Also learned how to read a blueprint better.
2. I learned the different symbols and what they mean. Also how to setup a section and detail drawings. This was useful because I plan to teach architecture at a high school level. Working as a team was nice because we both could be working on a drawing or be pointing out what we messed up on to be able to fix it.
3. I thought it was very helpful. Working as a team really helped because you had someone to collaborate ideas with plus that would have been a lot of work to do alone
4. It was kind of a repeat for me. I'd done the same thing in high school. As for partners I didn't care for it because hand drawings are not like CAD where you can't tell what one person did and the other didn't
5. Learned what scales drawings were supposed to be in, how many different drawings there were and how each shall be laid out. I think I learned a lot and it was very useful and I did also enjoy it at the same time
6. I learned that creating these complex drawings are very complicated & time consuming. It takes a lot of patience and a whole lot of imagination to design a structure with the qualities you want, as well as energy efficiency. I also learned that partners on drawings it is not always fun when their level of detail is not very good. I would have liked to be on my own. Overall my skills were improved.
7. I learned about the different types of blueprints and scales that are used. It was an educating experience.
8. I learned more on the project than I have in any class. I learned how to read the scales, scale different drawings & how to read and create a floor plan & so much more. It was definitely a useful learning experience. Hands on is the best experience. I enjoyed working as a team because it made it less stressful.
9. The drawing project taught me a lot about blueprint reading/ drawing. I knew nothing about the process coming into the project and came out with a lot of information on how to use scales and draw proper lines. Also I enjoyed the lettering part of the project. I enjoyed my partner because we really worked well together. I also learned how to draw a section drawing which is very interesting to me
10. Yes, it was very helpful. It gave me a better understanding of scale usage. It put in perspective everything we learned previously in the class, by the actual drawing of each drawing. It was good to work as a team, because that would have been too much work for just one person.
11. I enjoyed the drawing project a lot. I learn primarily by doing and the drawing project allowed me the opportunity to apply what I learned in class. I enjoyed working as a team to divide the rather large work load of the project
12. I learned that a line drawn on any plan has a purpose, so you have to pay attention to the thickness & what must be drawing with straight edges. I believe it was a very useful experience. I really hated working as a team because my group member never showed up to class and was very lazy in getting his work done
13. I learned how to actually draw blueprints. It showed how much time and work are put into this. I learned what is needed to build a house. I learned why houses are built a certain way to match their surroundings. It was a useful learning experience because I learned a lot of things I never knew before. I liked working in a team because there were different ideas thrown out
14. The thing that I learned from the project was how to better understand the process of making up drawings to a certain area. I did like working as a team and the project was useful on the thought process of how to make the house into a drawing
15. I learned very little. However, I think it did help my drawing skills. I am glad we did it as a team or else it would have been even more time consuming.
16. I learned how to draw blueprints using the engineer scales & the architect scale. The project also reinforced what I learned from the lectures., for example room placement, location of the house, etc. It was a good experience drawing the blueprints. I enjoyed working as a team. I found it was a difficult project to complete, but in the end it was useful. I found the project difficult because it was hard to just draw a elevation/section drawing without any good examples to look off of.
17. I learned how to draw a house using a site plan, floor plan, detail drawing, and elevation. It was a good experience and will help greatly in the future. I did enjoy working as a team because I will work as a team on the job site the rest of my life
18. From the drawing project I learned about different types of drawings and scale. It was a useful experience because of learning about different types of drawings and scale. Also I learned about different types of lettering. It was especially useful because I can put this experience towards my future career as a construction manager. I did enjoy working as a team because of the exchange of ideas and so we could correct others mistakes.
19. I have learned a lot about where I would place rooms in a house depending on which direction the house faces. It was definitely useful for if I ever design houses. I did not enjoy working as a team because we split the work up and I didn't get to first-hand deal with all aspects of the drawings

Distance & Online Learning

Evaluating Face-To-Face Industry Training for Online Delivery: An Action Research Collaboration and Learning Transformation

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Introduction

In an increasingly complex global economy, cultivating talent and improving business processes remain a major concern for most businesses. The knowledge and skills needed by current industry professionals are changing. Educators and industry professionals agree that process improvement skills are critically important for meeting the challenges of the 21st century. However, gaps exist between the critical skills needed in industry and with what Universities offer (Jones, Smith, & Callahan, 2010).

Lean Six Sigma (LSS) is a widely accepted process improvement methodology that aims to reduce variation, eliminate waste, and improve quality and customer satisfaction (Salah, Rahim, & Carretero, 2010). Chakrabarty and Tan (2007) affirm that most service industries are now implementing LSS, while the manufacturing industry, where LSS has its roots, is still steadily adopting LSS methods and principles. Industry experts claim there is ample demand for professionals who are educated in Six Sigma (Antony, 2008). Academics are calling for greater attention to demand for skilled workers, especially professionals trained in process improvement, and for greater consideration of curricular modifications to meet industry needs (Anderson-Cook, Patterson, & Hoerl, 2005; Callahan, Jones, & Smith, 2008; Goffnett, 2004; Miller, 2011).

Although spending on training has declined recently in several learner categories (e.g., clerical), professionals have been least affected (Carliner & Bakir, 2009). Callahan et al. (2008) said, "Training and assisting with formal education are expensive activities for employers. [Employers] are willing to absorb these expenses realizing that an even bigger reward will be realized through improved performance and efficiency" (p. 6). Tharenou, Saks, and Moore (2007) completed a meta-analysis of 67 studies investigating relationships between training and performance. The researchers found positive relationships between investment in training and organizational performance and human resource outcomes. In a recent study of manufacturing professionals, more than 50% of respondents believe time spent on training will increase over the next decade and that employers will emphasize Lean and Six Sigma most in this period (Callahan et al., 2008). This is consistent with growing evidence that Lean and Six Sigma can improve performance and efficiency as well as enhance knowledge creation and organizational learning (Foster, 2007; Shah & Ward, 2003; Sin, Zailani & Ramayah, 2010).

Training is one way that employers can provide workers with appropriate skills to fill needed roles. However, training is an expensive proposition and usually a function that organizations look to cut during economic hardship as training can be a costly activity. According to the American Society for Training & Development (ASTD) (Patel, 2010), in 2009, employers spent a collective $126 billion on employee learning and development, with more than one-third of the outlay ($47 billion) going to external services. Nearly one-third, or 27.7%, of all formal learning hours were administered online, which is a significant increase from 23.1% in 2008. Online now represents over 75% of all technology-based learning that is available (27.7% / 36.5%). Learning cost per employee did not increase significantly from 2008 to 2009, with the average cost per employee in 2009 coming in at $1,081. There is indication that trainers are more productive, seeing that over the last decade learning hours have increased from nearly 25 hours to more than 36 hours per employee, with little increase in cost. This may explain some of the leveling in expenditure on training. However, increased access and use of e-learning applications provides

further explanation (Carliner & Bakir, 2010). The average percentage of formal learning hours available via technology-based delivery, including online, has increased 137%, from 15.4% in 2002 to 36.5% in 2009 (Patel, 2010).

Instead of cutting training, organizations are exploring other solutions to reduce costs associated with the process, namely cost of facilitators, training materials, and collocation of facilitators and participants where necessary. If designed and implemented correctly, online training programs can reduce the amount of employee productivity lost as well as reduce the cost of delivering the training without diminishing the quality of learning (Smith & Mitry, 2008). Organizations, however, need to consider the various benefits and detriments of using technology-based options to meet current training needs and not focus entirely on cost.

Universities are positioned to assist businesses with understanding e-learning alternatives as well as with satisfying employee training needs (skills training, executive development, etc.) (Callahan et al., 2008). The number of online courses offered by Universities has increased dramatically in recent years. Universities – and their students – are overcoming challenges associated with e-learning and at the same time are experiencing benefits that technology-based delivery provides (Hansen, 2008; Eom, Wen, & Ashill, 2006). Smith and Mitry (2008, p. 150) claim that e-learning affords Universities the capability of connecting with more learners in "diverse locations and circumstances." Universities will be in an even better position to meet the needs of learners so long as faculty are trained in the latest technology and in successful techniques for developing and delivering technology-based learning (Cesarini, Sinn, & Armentano, 2006; Dobbs, 2005; Smith & Mitry, 2008). Moreover, it is equally important that learner preferences and skill sets be considered in instructional design and technology-based delivery (Lightner, Doggett, & Whisler, 2010).

Purpose

The purpose of this study is to describe how a University and a Fortune 100 company (client) established an innovative partnership to investigate various e-learning technologies and training options. The collaboration aimed to develop and deliver LSS Green Belt (LSS-GB) training online to their employees worldwide. The main objectives of this study are:

1. To address existing needs to develop and deliver high-level skills training on a global scale
2. To evaluate and implement e-learning capabilities that can facilitate learning
3. To describe a collaborative online training development and delivery process
4. To offer lessons learned from an industry case study and current literature that illustrate design considerations and success factors for technology-based delivery

The following sections provide background about action research and discuss a collaborative e-learning partnership and the steps taken to develop and deliver skills training through online medium. The concluding section discusses a number of design considerations and lessons learned in the process as well as findings in literature that should help others as they consider new course offerings and learning services that address industry's educational needs.

Method & Background

This study uses process improvement methods and action research principles to assist an industry partner with solving a difficult training and education related issue. Action research is a constructive approach where researchers take an active role in an engagement to facilitate change and improvement or to test new methods and frameworks, which can lead to rapid implementation of results or progression of theory (Marshak & Heracleous, 2005; Reason & Bradbury, 2001). Researchers have applied this method in variety of manufacturing and service settings (e.g., Cappelletti & Baker, 2010; Coughlan & Coughlan, 2002; Kotter, 1995; Lewin, 1952; Nair, Malhotra, & Ahire, in press; Schein, 1988).

The team assembled for this collaborative research project consisted of individuals that had subject matter expertise in deployment and training of LSS, extensive experience with classroom and online delivery, and organizational authority. The core team was the right size and composition to coordinate successful development and delivery of the product and service.

Collaborative Opportunity

A client approached Central Michigan University (CMU) for assistance with providing a competitive LSS-GB training program that enables their employees to better contribute to organizational performance. The client saw collaborative improvement of training delivery as an opportunity to utilize expert facilitators, reduce delivery variation, and reduce the Master Black Belt (MBB) training workload. They saw an opportunity to improve training flexibility for the company by delivering it when and where people need it. There was also a perceived opportunity to improve the "bottom line" for the company by eliminating

various travel, entertainment, and facility costs and by significantly reducing time committed to training for MBBs and participants. Lastly, the client saw a clear opportunity to improve the "top line" for the company by freeing up resources to devote more time to working on projects to capture value. The ultimate goal for the client was to have consistent LSS-GB training readily accessible to all of their employees that was both cost and performance effective.

CMU saw an opportunity to establish commercial and academic offerings to educate students worldwide in LSS principles and practices. CMU's objective as an educational enterprise was to develop a LSS-GB learning program for the client through collaboration that enabled technology-based online delivery capability and access to subject matter experts and advanced learning materials. The project offered additional opportunity to develop an area of concentration in an MBA program and a graduate certificate that are aligned with the College's mission, which is to provide innovative, high quality, business-connected education that inspires students to excel in diverse global environments.

The scope of the project, which resulted from a formal needs assessment, was to deliver a blended learning version of existing client LSS-GB content to meet the changing needs of employees across the globe. The assessment indicated a number of important items. For example, the client described the typical training participant as college educated, reasonably motivated to learn new skills, and competent in technology. System parameters included PC compatibility using Windows XP and later, compatible with Internet Explorer 7 and later, and delivered in compressed video format, recognizing potential bandwidth concerns for reaching other regions of the world. CMU was to evaluate and make every attempt to use current client LSS-GB classroom materials, as the company has significant investment and proven success with themed content for the chemical industry. In addition, CMU needed to maintain LSS-GB certification integrity by having minimal changes in content and testing. The client mainly wanted to leverage CMU's distance learning expertise and best practices.

Cost & Capabilities Assessment

The client developed a cost model to determine whether the university could improve the cost/benefit ratio the client had experienced with internal training. Elements of this assessment were established using historic LSS-GB training delivery costs, which were adjusted using expert input regarding probable cost savings activities (e.g., reduced travel for MBBs and participants, reduced materials printing and shipping, reduced meals and facilities costs). CMU defined their costs for the client that include instructional design, faculty facilitation of training development and delivery, IT infrastructure and support, registration, maintenance, and other administrative overhead. The client compared the cost models (current in-class vs. blended/e-learning) and conducted a gross sensitivity analysis to illustrate contrasts. The client investigated other competitive vendor offerings to evaluate industry-leading candidates and cost estimates, which they contrasted with the CMU proposal.

Table 1 Alternative vendor identification and benchmark assessment

Potential Training Vendor (Supplier)	Materials Capability	Facilitation	**Cost Competitive**	**Project Contender**
ASQ	Limited	Limited	No	No
Villanova University	Yes	Blended	No	No
Moresteam.com®	Yes	e-Learning	No	No
The Quality Group	Yes	e-Learning	Yes	**Yes**
BMGI®	No	e-Learning	Yes	No

Table 1 shows partial benchmarking results. The Materials Capability factor describes whether the vendor or supplier would augment the client material with its own. Facilitation refers to the training delivery mode the vendor would provide. The last column is a conclusion by the client whether the vendor was worth further consideration based on benchmarking factors.

The corporate client needed assurances that CMU could deliver a product and service suitable to their requirements and budget. CMU conducted an internal capability assessment and made key improvements where appropriate. For example, CMU considered several technologies and media tools for this project. The main criterion for choosing which technology to employ in the e-learning experience was that it had to address a learning need or client requirement. Other selection criteria include functionality, quality, cost, ease of use, and leveragability to other projects. Table 2 lists the various technologies considered and used in the process.

Table 2 Selected technology and assessment for development capability and uses

Selected Software	Primary Capability and Uses	Alternatives	Additional reasons for selection over alternatives
Articulate® '09 (Presenter, Quiz Maker & Engage), Camtasia Studio®	Publish modules to web content, create quizzes, learning activities (e.g., drag and drop), and allows video and voice-over content	Adobe Presenter & Captivate®, Screenr®	Multiple templates to create learning activities; easy to use quiz making tools
Adobe Soundbooth®, Audacity®	Edit/Record audio; Produce quality voice-over content to engage learner	Adobe Audition®	Audacity: free, easy to use; Soundbooth: vocal enhancer and powerful noise removal
Adobe Premiere®	Edit/Render video; Develop professional and more personal visually stimulating content	Final Cut Pro X	Easy to use
Adobe Photoshop®	Edit pictures and graphics; Create relevant and engaging images	Gimp	Features, industry standard
Microsoft SharePoint®	Store and host development collaboration and production content in secure area	Network-Attached Storage (NAS)	Collaboration, revision history, backups, layer of security
Blackboard Learn™	Host content frontend and provide training facilitation tools (groups, discussion forum, wiki, file share)	Moodle™	Existing infrastructure, support, licensing and implemented university wide
Microsoft Live Meeting®	Provide meeting capabilities for developers and facilitate small group discussion by learners	GoToMeeting® & Wimba™	Standard meeting software of client

Besides being able to deliver training when and where needed, the client defined a capability assessment that consisted of a number of learning requirements such as using their content as the primary learning materials, using a delivery mode that is stimulating and engaging that promotes interaction between MBBs and learners and is capable of tracking progress. The client assessed CMU's capabilities to address their requirements by reviewing a sample of LSS materials that were converted to online format. The sample demonstrated learner engagement using various interactive learning aids, for example, that checked for understanding. Content was presented to the client via temporary access to a sample course in Blackboard Learn™, which is the web-based learning management system used by CMU. The pilot module required two development iterations (revise/resubmit) to demonstrate development capabilities.

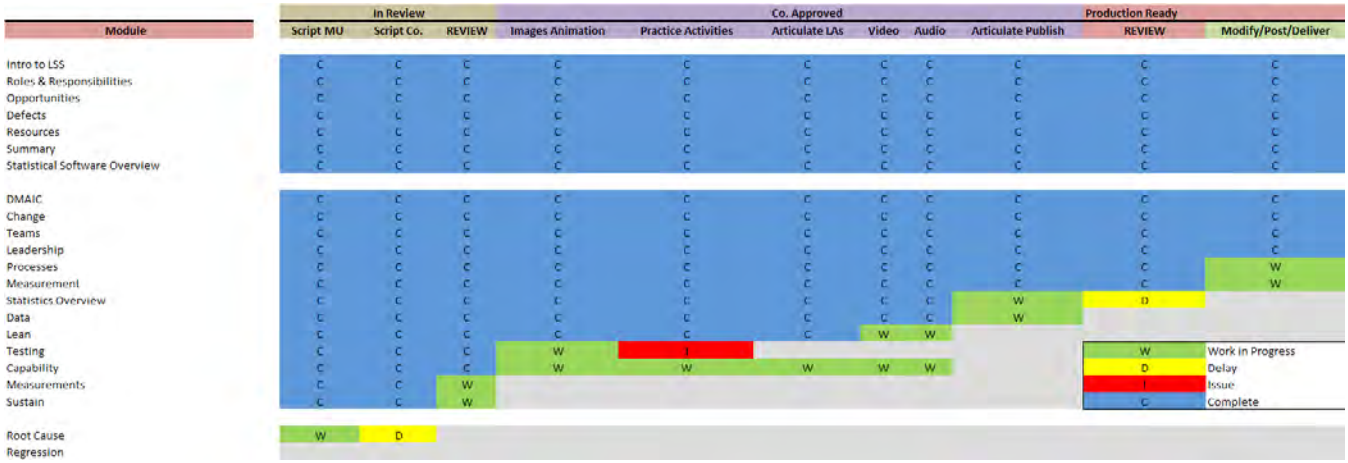
Development & Delivery Process

The development of each learning module (nearly 50 in total) followed the steps shown in Figure 1. The capability assessment followed similar steps. The client provided PowerPoint decks with minimal graphics and notes, CMU reviewed the content and identified areas to enhance learning by incorporating interactive learning aids (LAs), small group activities, simulation, animation, and videos that were presented via Articulate Presenter software that streamed through respective links in Blackboard. Concurrently, CMU created support media (e.g., video, pdf worksheets) as well as wrote script and recorded audio narration for nearly every module. Modules ranged from 15 to 75 pages in length, with run durations of about 10 to 45 minutes. When complete, the client reviewed each module then either accepted it or requested that CMU revise and resubmits the product after addressing their comments and suggestions.

The project team used an Excel® spreadsheet as a development document to track progress. Figure 1 shows a sample status report. The left-most column identifies the specific module or task that needed to be completed. The top two rows list the

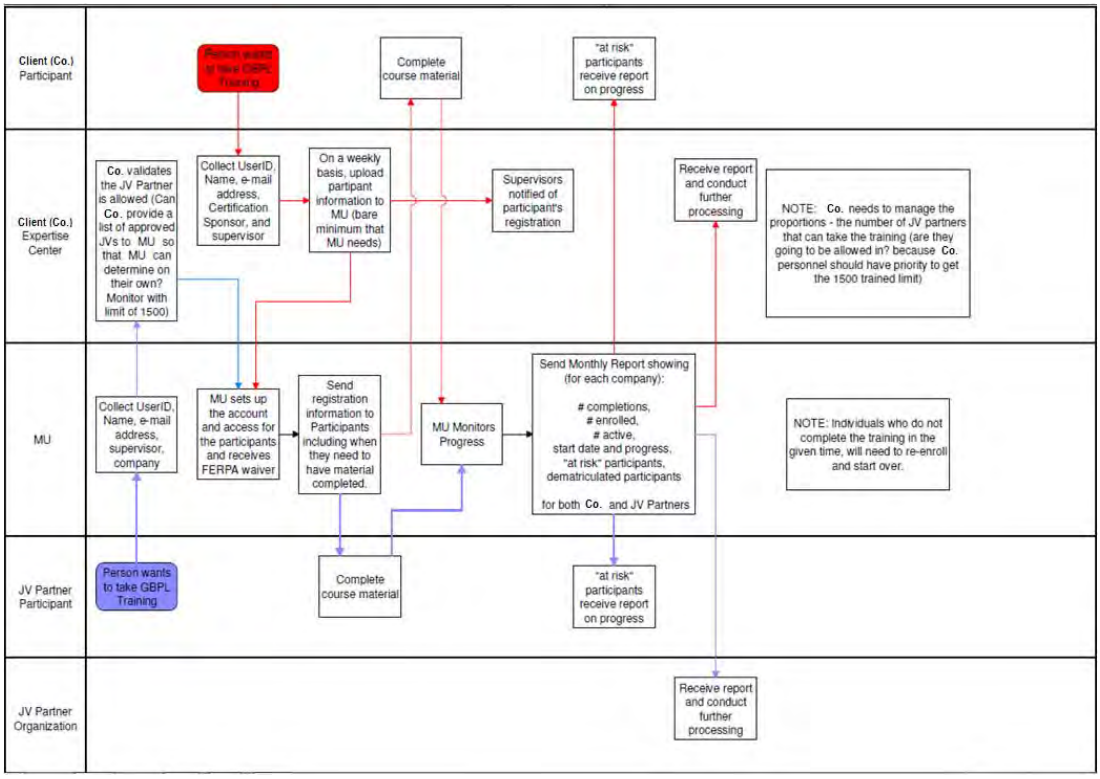
stage of activity for the module or task as well as the party responsible for the stage. The intersecting cell for the task and stage is labeled and color-coded using conditional formatting to indicate the status of each task. This document was useful for communicating and planning work among team members and stakeholders. The project team reviewed and revised the document weekly.

Figure 1. Development document and work schedule status report excerpt.



Both organizations had different methods for registering users for training. CMU used Blackboard Learn™ and Active Directory (AD), while the client used an internal company method to organize and schedule employees for training. The registration process illustrated in Figure 2 shows how the team merged the two systems, which provides for the eventual participation of other ventures. The process map shows responsibilities of groups in "swim lanes" and the flow of information. This document was useful for communication and planning among the various groups to build and administer the registration and training activities.

Figure 2. Lean Six Sigma Green Belt training registration process.



CMU uploaded finished modules to SharePoint® for storage, security, and content hosting purposes. Links to modules were created in Blackboard and accessed through exclusive membership in an AD group that participants were enrolled in during registration. Before participants can access Blackboard or the training materials, they must be included in a registration (CSV) file the client provides to CMU. This file is used to propagate the AD group and enroll users in a Blackboard shell via a special snapshot. The snapshot triggers a welcome email that the process sends to participants with login information and details about the training. Once the Blackboard shell is propagated with users, there is some manual manipulation required to assign participants to small groups and to apply any progress or credit received in previous LSS training. The training allows 17 weeks for completion, is mostly self-paced, and uses a one-question survey to confirm the participant has successfully completed a module. Blackboard logs survey results for progress review and for programmed release of modules in a given sequence.

In the event that the participant is unable to remember their password to log into the training course shell, there is a form on the single sign-on page that allows them to receive a new password via the email address they provided when signing up for the training. The most common incident encountered, besides lost account credentials, is failure to complete the survey that confirms module completion to release the next module. When this happens, the preferred course of action is for the learner to seek assistance from their MBB. Besides communicating with their MBBs in the event of a technical issue, learners work with small groups and their MBBs in Blackboard where they have their own group discussion board and file sharing capability. These groups provide opportunity for timely feedback and exchange of ideas.

Discussion

Literature and experience influenced a number of design factors that the CMU team considered while developing the online training program for the client. Table 3 lists many of the factors used in the e-learning collaboration (cf., Eom et al., 2006). Nathan (2011) states that "when properly designed, developed, and implemented, e-learning is more interactive and believed to be more engaging by the company" (p. 7). Eom et al. (2006), for example, found six factors in online course development and delivery (course structure, self-motivation, learning styles, instructor knowledge and facilitation, interaction, and feedback) that were important in determining positive training outcomes. Literature also suggests that less-than-optimal results are generally from ignoring success factors in design (Eom et al., 2006; Nathan, 2011).

Table 3 Design considerations and success factors for technology-based learning

Factor	Description	Example of Use
Motivation to learn	Interest and behavior toward learning	Provided support and communications to stimulate interest and present instructions, timelines, interactive tools, etc to help facilitate learning and training progress
Learning preferences, skill sets, & structure	Type of learning preferred or performed by each learner (visual, aural, read/write, etc).	Designed a mix of learning experiences and interactions (e.g., activities and quizzes with automatic feedback, small group discussions; access to MBBs, GB training survey; actual LSS projects)
Learning interaction & feedback	Interaction with course materials and peer group	Designed a mix of learning experiences and interactions
Instructor/Facilitator knowledge	How much material instructor knows and contributes to learning	Experienced instructors placed in small groups to mentor participants pursuant of their most knowledgeable topic areas
Instructor facilitation & feedback	Communication and engagement provided by facilitators concerning progress and accomplishments	Instructors facilitate small group activities, monitor progress and discussion boards, and answer questions regarding training
Instructional location & learning availability	Place, setting, and time of learning	Blended learning opportunity; online w/ group interactions
Training transfer	Measureable competence and understanding and application of acquired knowledge and skills	Application via learning aids, activities, simulations, journaling, certification exam, leading actual LSS projects
Language	Patterns of words and syntax	Planned translation of materials
Technology & technical assistance	Available technology and the level of support with technology and technical procedures and issues	Standard corporate technology setup; Access to technology help desk, expert facilitators and project team

The development team also considered a number of benefits and detriments associated with e-learning that are demonstrated in existing research (e.g., Daymont & Blau, 2008; Hansen, 2008; Nathan, 2011; Smallwood & Zargari, 2000). The benefits of online instruction revolve around the fact that it is flexible. Flexible both in terms of how it is administered and how the learner can chose to complete the training. Convenient access, minimal travel, lower cost, less time, and being as effective as face-to-face learning are a few of the beneficial reasons for taking an interest in e-learning. In this case, work schedules and travel to learning sites make it difficult for people to take advantage of important learning opportunities. Using online delivery, the learner can complete the training at his or her own pace in familiar and conducive surroundings, while facilitators gain the flexibility of providing expertise via diverse training medium (audio, visual, interaction). As for the difference in ability to impart knowledge on the learners between online and face-to-face education, several studies show that online instruction is at least as effective as face-to-face (Bernard et al., 2004; Hansen, 2008; Smith & Mitry, 2008).

There are some drawbacks, which are mostly minor (i.e., manageable) and typically associated with the discipline required to complete the course. Since much of this learning is delivered asynchronously, it provides opportunity for learners to mismanage time, but this concern can be mitigated. Due to geographical dispersion, some learners do not feel as connected to their peers or to content and assisting resources. Feedback and communication, for example, may not occur in real-time or in the same language. Lastly, technology can present some challenges, particularly for new users who may require additional assistance to move forward.

This case resulted in a number of lessons learned, as shown in Table 4, regarding what it takes to collaborate with industry to develop and deliver a major online training program. For example, the project benefited from using training material

originally developed and used by the client. This design foundation, and working from an agreed upon charter, helped reduce the time to deliver and maximized acceptance of the material by the client and their employees. Furthermore, it maintained the elements of training needed for certification. Management support and regular communication are essential and cannot be overstated.

Table 4 Lessons learned in collaborating with industry client in e-learning development

What Worked Well	What to Improve
Regular communication meetings to get agreements and keep project on timeline	Negotiating more specific expectations and contract terms
Knowledgeable, experienced, and respected team members with consistent and transparent work styles	Establishing communication plan for all stakeholders and using it
Using client materials as design foundation	Stakeholder input
Charter that all agreed to	Establishing work process and individual roles and responsibilities initially rather than in flow of work
Management support (incl. resources and technology)	
Collaborative process improvement approach	

Conclusion

Traditional approaches to employee education and training, namely face-to-face lectures, can present costly limitations in meeting current and emerging employee development needs. Organizations are searching for alternatives that are flexible, less costly, and effective in delivering skills training. New technology in distance education and collaborative opportunities are available to help satisfy emerging skill needs. This study illustrates how Universities can leverage their expertise in collaboration with industry to design and deliver successful online training programs that address industry's educational needs.

The collaborative development process expressed in this case substantiated many of the findings from previous research regarding e-learning and technology-based delivery. Some major design considerations and lessons learned include creating an interest toward learning, accommodating learning preferences, providing learning interactions and feedback, and offering immediate learning transfer opportunities. A successful development process requires working from a solid design foundation and charter, having management support and regular interaction, and team members with the appropriate skills for contributing to collaboration and innovation.

The project produced nearly 50 learning modules that learners complete in a matter of weeks in preparation for LSS-GB certification. The collaboration offered mutual benefit to the client and CMU by leveraging CMU's expertise in e-learning. The resulting product and service provide an online medium that allows for interaction between learners and instructors using consistent and centrally maintained course materials. This training is now delivered any time and any place with less variability, less coordination, and at less cost than the client's face-to-face delivery model. The project resulted in more than a 30% reduction in learning hours compared to the face-to-face model without any negative effects on learning transfer.

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Electrical, Electronics & Computer Technology

2.4GHz Wireless Communication Project with MRF24JMA and IEEE 802.15.4 on a PIC Training System

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Introduction

Wireless communication technology has become increasingly popular and is widely used in almost every electronic product that we may use in work, educational, and recreational activities. The radio frequency (RF) communication component (FCC, 1997) plays a major role in the design and operation of wireless products. Typically, the RF application is integrated with an embedded system such as a microcontroller to implement various applications such as temperature sensing, data logging, data exchange, actuator activation, and user interaction in a wireless manner.

New rapidly changing technologies create unique teaching and training challenges for engineering technology students and faculty. A project based model can be used as an effective instructional strategy to enhance learning about complex RF concepts and technologies. This project method can lead to improved understanding and create interest by actively engaging students with hands-on experiences coupled with problem solving and critical thinking activities. This project is based on teaching and learning experiences with a previously developed low cost PIC microcontroller training system (Hsiung, 2009). The PIC (Peripheral Interface Controller) (PIC, 2011) training system was coupled with a readily available RF communication module (MRF24J40MA, 2008) that can be used in a variety of real world, hands-on applications in designing senior capstone projects for Electrical, Electronics & Computer Technology (EECT) majors.

In 2008, Microchip Inc. introduced a 2.4 GHz RF transceiver module called the MRF24J40MA that provides several attractive benefits (Lattibeaudiere & Venuturumilli, 2011). These benefits include a compact package design, low-cost, and easy to use product with a small additional parts count that includes all components less the power supply. Integrating Microchip's RF transceiver module with the PIC trainer does not require any extra hardware thus, the software development of Serial Peripheral Interface (SPI) (SPI, 2010) and protocols designs become the focus of the RF learning concept. The IEEE 802.15.4 2003 rules, standards, and software protocols designs with SPI interfacing are the center of the student's project. The student assessment process includes a written report, a live demonstration, and video recording of the functions using three of the RF transceiver modules to control motors on a Rhino XR skeleton with PIC trainers.

The MRF24J40MA Module

The MRF24J40MA module is a 2.4 GHz transceiver product manufactured by Microchip Inc. that complies with the IEEE 802.15.4 standard (IEEE, 2003). The price of the MRF24J40MA is $9.95/module. It has low current consumption – at TX 23mA - RX 19mA - Sleep 2uA, Hardware CSMA-CA Mechanism, Automatic ACK Response, Hardware Security Engine (AES-128), and Automatic Packet Retransmit (MRF24J40MA, 2008). This module includes everything needed to perform 2.4 GHz wireless transmitter and receiver functions with a choice of 16 different channels, such as antenna, resonator, slave SPI interface, interrupt driven power saving mode, and operates on 3.3VDC power source. It is packaged in a 12-pin interface module. All the user needs to do is provide a 3.3-volt supply and address the module with SPI protocols. This paper demonstrates the use of the PIC training system that has a built-in plug for the required power and SPI interface communication (SPI, 2010). The applications are directed toward the software design and IEEE 802.15.4 applications using wireless communication

between one master module and two slave modules on three PIC training systems hosting three PIC16F877As as the main MCUs (MicroController Units) (16F877A, 2004).

The IEEE 802.15.4 2003 Standard

The IEEE 802.15.4 2003 standard (IEEE 802.15, 2003) defines the protocol and interconnection of devices via RF communication in a personal area network (PAN). The standard is for ultra-low complexity, ultra-low cost, ultra-low power consumption, and low data rate wireless connectivity among inexpensive devices. Low-rate wireless personal area networks (LR-WPAN) is a simple, low-cost communication network that allows wireless connectivity in applications with limited power and relaxed throughput requirements. The main objectives of an LR-WPAN are ease of installation, reliable data transfer, short-range operation, extremely low cost, and a reasonable battery life, while maintaining a simple and flexible protocol. An LR-WPAN device comprises a PHY (physical layer of the OSI model), which contains the RF transceiver along with its low-level control mechanism, and a Media Access Control (MAC) sub-layer that provides access to the physical channel for all types of transfer.

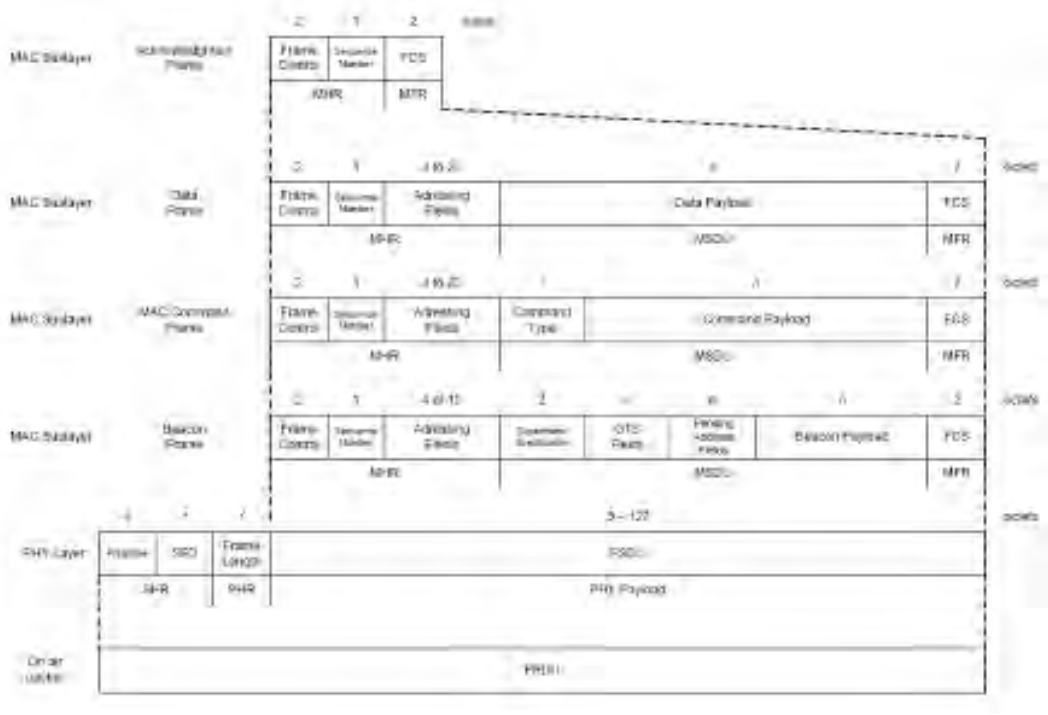
In the star topology, the communication is established between devices and a single central controller, called the PAN coordinator. A device typically has some associated application and is either the initiation point or the termination point for network communications. A PAN coordinator may also have a specific application, but it can be used to initiate, terminate, or route communication around the network. The PAN coordinator is the primary controller of the PAN. Once the PAN identifier is chosen, the PAN coordinator can allow other devices to join its network.

The peer-to-peer topology also has a PAN coordinator. However, it differs from the star topology in that any device can communicate with any other device as long as they are in range of one another. Peer-to-peer topology allows more complex network formations to be implemented such as a mesh networking topology. Applications such as industrial control and monitoring, wireless sensor networks, asset and inventory tracking, intelligent agriculture, and security would benefit from such a network topology.

Beacons are used to synchronize the attached devices to the network to identify the PAN and describe the structure of the super frames. Any device desiring to communicate during the Contention Access Period (CAP) between two beacons competes with other devices using a slotted CSMA-CA (Carrier Sense Multiple Access Collision Avoidance) mechanism. All transactions shall be completed by the time of the next network beacon. In a non-beacon-enabled network, the device can transmit the data at any time. In order to transmit data, the data has to be packaged in a specific format. The IEEE 802.15.4 2003 standard defines four types of frames:

- A Beacon Frame: used by a coordinator to transmit beacons
- A Data Frame: use for all transfers of data
- An Acknowledgement Frame: use for confirming successful frame reception
- A MAC command frame: used for handling all MAC peer entity control transfers
- The physical (PHY) package and frame structure in the standard is presented in Figure 1:

Figure 1. IEEE 802.15.4 Data Frame



The data frame used in this wireless communication project is composed of the header length, the frame length, the header, and the data payload. The payload is comprised of the data that the user desires to be transmitted. The MHR (MAC Header) is composed of several elements: frame control, sequence number, address information, and security related information. The frame control field is 16 bits in length and contains information defining the frame type, addressing fields, and other control flags. All the devices in the network are required to have a unique 64 bits address.

The Design of the Robot Arm Controls

The design uses one master PIC16F877A and two PIC16F877A slaves with each controlling a set of two DC motors that are attached to a Rhino XR skeleton. The data payload communicated between different modules (a Master and multiple Slaves) in this demonstrated project consists of 5 bytes and their declaration and definition are presented in Table 1.

Table 1. Data Payload: Variable Declaration of the Wireless Robot Arm Controls

#	Name	Variable	Bits	Note
1	**Slave Address**	**SLV_ADR**	7 6 5 4 3 2 1 0	**Four Slaves**
2	**Motor Number**	**MOT_NUM**	7 6 5 4 3 2 1 0 x x x x x x x x	**One Motor/Bit**
3	**Motor Direction**	**MOT_DIR**	7 6 5 4 3 2 1 0 x x x x x x	**One Bit / Direction/ Motor-Check Bit**
4	**Motor Duration**	**MOT_DUR**	7 6 5 4 3 2 1 0	**One Byte/Motor**
5	**Motor Speed Timer**	**MOT_SPD_T1** **MOT_SPD_T1**	7 6 5 4 3 2 1 0 7 6 5 4 3 2 1 0	**Two Bytes/Motor: Hi: 0X03, Md: 0X02, Lo: 0X01**

Note: Each Slave controls 2 motors. 3 slaves would be required to control an arm with 6 joints

The Microchip MRF24J40MA transceivers are interfaced through Port C and use the SPI capability of the PIC16F877A via the Master Synchronous Serial Port Module. This allows eight bits of data to be transmitted synchronously. The master initiates the data transfer by sending a serial clock. Data is then shifted from the master Serial Data Out (SDO) to the slave Serial Data In (SDI) one bit at a time until the buffer full flag is set. The slave then sends data from its SDO to the master SDI in the same manner.

DC Motors and Limit Switches

The Rhino XR skeleton has six 24V DC, 600 RPM, motors. Each motor is connected to a minimum of one limit switch to prevent movement of the arm beyond its mechanical limits. The joints that are capable of turning 360 degrees freely, have a single limit switch attached while other joints have an additional limit switch to limit the movement control of the arm. The wrist and claw joints on the system use a single limit switch, while all other joints use two limit switches to prevent extending or rotating sections of the arm beyond its physical limits. An optical encoder is also attached to each motor, but it is not implemented in this project design. The encoders are intended to be integrated into future designs of the arm to provide more accurate positioning and speed control. Every limit switch on the arm is hardware de-bounced with a 7400 NAND chip to provide a clean signal to the inputs of the PIC microcontroller sensing unit.

Hardware Configuration

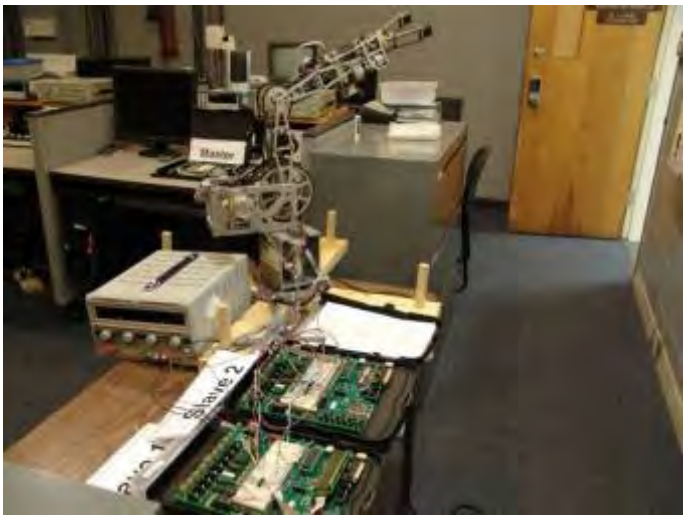
All boards are wired the same to be used in unified 2.4 GHz communication protocols with 5 bytes control of two motors in each slave. The only difference between the Master and multiple Slaves are the H-Bridge configuration in the Slaves and the LCD/keypad user interface in the Master. The actual set up of the hardware of the master control unit is shown in photo 1: A PIC16F877A configured as a master control unit in association with a MRF24J40MA transceiver module, power supply and miscellaneous passive components are assembled and configured on the PIC trainer. An LCD display is also included for displaying data and the keypad is used between the system and user interactions of the transmitted data. The breadboard is used as a patch panel and for designing and constructing circuits. The demonstration included microcontroller trainers that were designed and manufactured for classes at Old Dominion University, the communication system and related instruction strategies may easily be easily reproduced using experimenter breadboard sockets, PIC16F877A, MRF24J40MA module, power supply and miscellaneous passive components.

Photo 1. Master System Board

Photo 2. Slave System Boards

Two additional trainers are used as slave units to communicate with the master control unit. Each of the slave trainers is identically wired; the only differences are the software manipulated long and short addresses. Photo 2 shows the slave units; the one with a LCD module in the photo is just used for testing and verification purposes. The H-Bridge configuration via 8 terminal blocks on the left side of the trainer board is used to activate two DC motors for the robot arm controls. There is no need of a keypad and LCD module on the slave modules because no user input is necessary. However, the master module requires a keypad for user interaction. Photo 3 is the Rhino XR skeleton with 4 DC motors controlled by two slaves that take commands from a master via RF communications.

Photo 3. Robot Arm

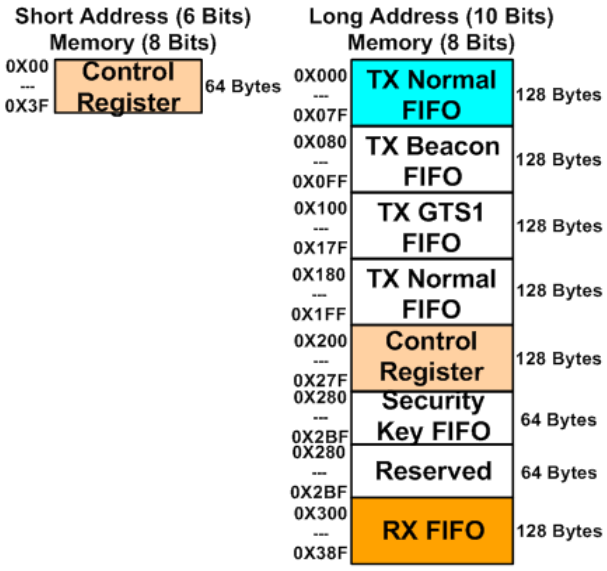


The Implementation of the MRF24J40MA Module

This 2.4 GHz wireless project uses the data frame for communication and is based on a peer-to-peer topology. The master unit is the PAN coordinator. The acknowledgment frame is handled automatically by the hardware of the MRF24J40MA module. This implementation operates in a non-beacon enabled mode that means any device may transmit at any time, so the coordination relies on the software design based on the module's INT signal. The IEEE standard requires that all devices on a network have a unique 64 bit long address (a total of 8 bytes of addresses), a 16 bit (2 bytes) short address, and a common 16 bit (2 bytes) PANID. This data packet contains one byte that defines the length of the total packet, 2 frame control bytes, one sequence byte, 64 bits/8 bytes address are: 2 bytes for the destination PANID, 2 bytes for destination short address, 2 bytes for source PANID, 2 bytes for source short address, and 5 bytes for the data (data payload) for this particular application. They are demonstrated in Data Frame Listing.

A data packet includes a security field, two frame fields, and a sequence field, followed by the destination PAN ID, destination short address, source PAN ID, and source short address. This is followed by the data itself is written to address 0X000 to 0X011 at TX Normal FIFO (First In First Out) buffer control memory in MRF24J40MA module and a transmission command (0X01) is sent to the TXNCON (short address at 0X1B) the packet is transmitted. On the receiving end, when a data package is received the falling edge of the INT signal will be generated by the receiving module and the data is stored at addresses 0X300 to 0X310 at RX FIFO buffer memory available for the receiver microcontroller to display the received information. The data transfer frame has specific requirements for each transmitted data packet that must include the security field, frame fields, sequence number, destination and source address and the data payload. This data packet for TX and RX are presented in the RAM memory map in the MRF24J40MA module as in Figure 2:

Figure 2. An Overview of the MRF24J40MA RAM Memory Map



Designating the chip as a PAN coordinator required writing to the Receive Mac Control Register (RXMCR) at short address 0X00. This same register is also accessed to set the reception modes, such as Normal, Error, or Promiscuous modes (MRF24J40AM, 2008). In Normal mode the screening process for received data is the most stringent, where the transmitted package must meet all the requirements of the IEEE 802.15.4 Specification. In an Error mode, all packets with a good or bad cyclic redundancy check (CRC) (CRC-8, 1999) are accepted, and in Promiscuous mode, all packets with a good CRC are accepted. This project used Normal mode that means a package will only be accepted with good CRC and reject mismatch MAC address or illegal frame type. With one byte of data sent to this register, the particular module was set as the PAN coordinator, disabled automatic acknowledgement response and set the reception mode. Transmission will happen automatically when data package is filled in the TX normal FIFO in the transmitting module RAM followed by a transmit trigger command in the TXCON register. The receiving unit will automatically make the data package available in the RX FIFO RAM in the receiving module followed by a falling signal on INT pin 4 (MRF24J40AM, 2008). The packet format is the IEEE 802.15.4 standard and consists of a length field, two frame fields, a sequence field, and then the destination PANID, destination short address, source PANID, source short address followed by the data payload. The package transmission and its TX Normal FIFO format are shown in Figure 3. The package reception and its RX FIFO format are presented in Figure 4.

Figure 3. TX Normal FIFO Package Format

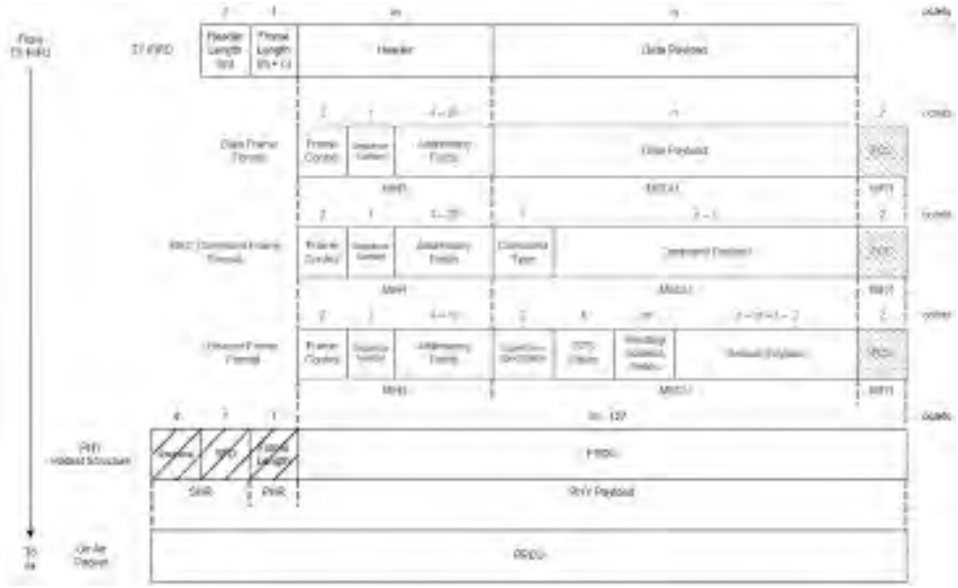
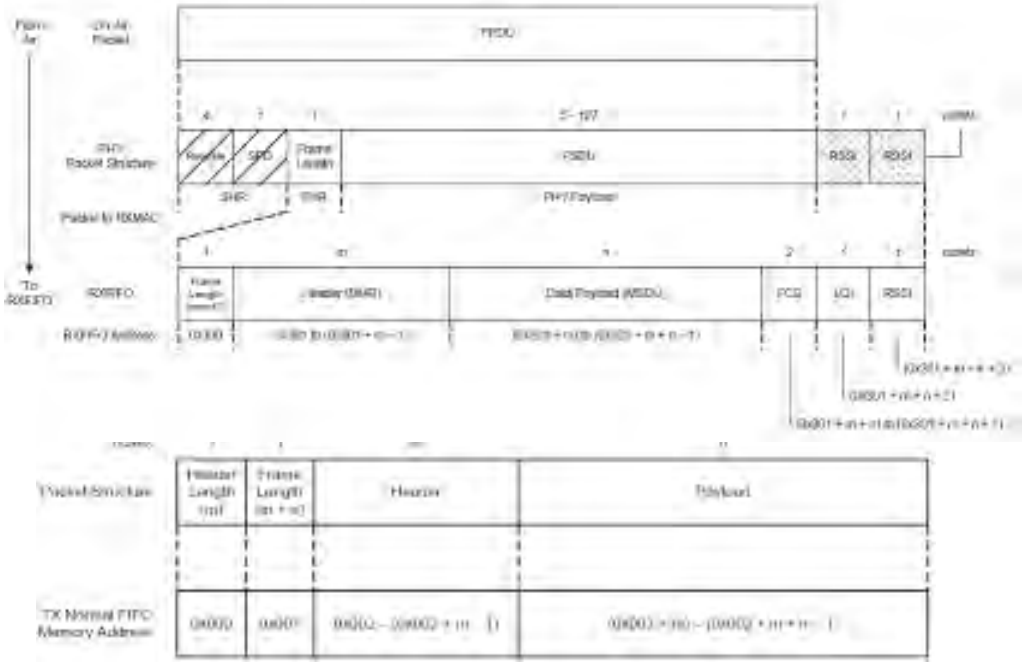


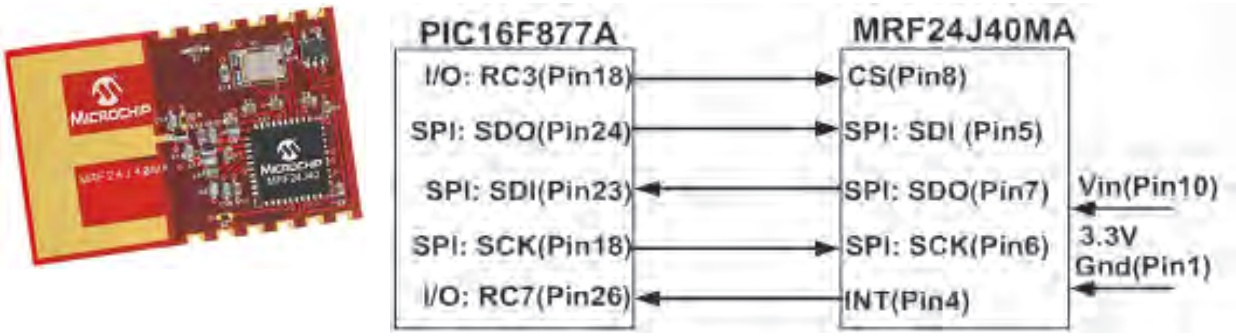
Figure 4. RX FIFO Package Format



The Software Design of MRF24J40MA Applications

The SPI and control interface between the MCU and MRF24J40MA module is demonstrated in Figure 5:

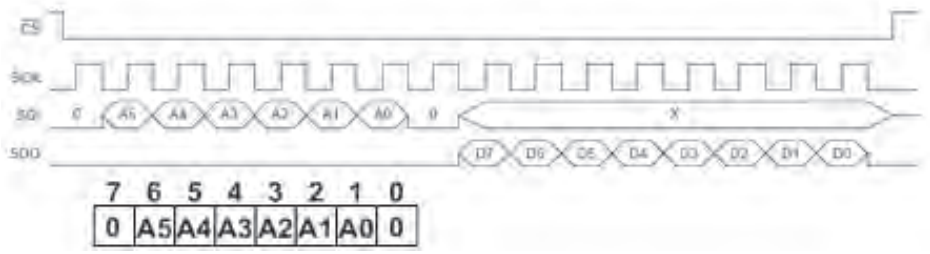
Figure 5. MRF24J40MA Module and Hardware Interface



There are short and long addresses in the static RAM memory organization in the MRF24J40MA module that is accessible via the SPI interface protocol. The diagram shown in Figures 6 and 7 illustrate required communication formats for the short address.

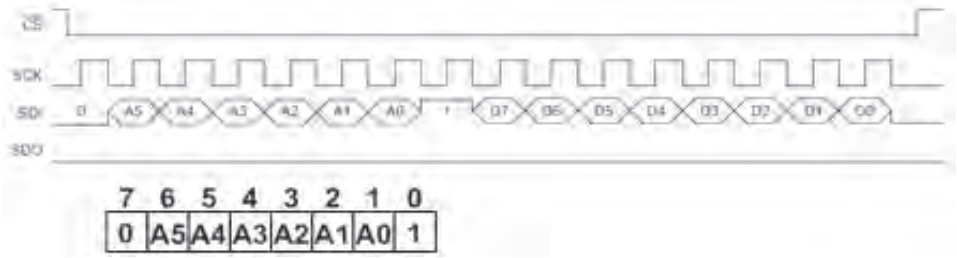
MRF24J40MA Short Address Read

Figure 6. Short Address Read SPI Protocol



MRF24J40MA Short Address Write

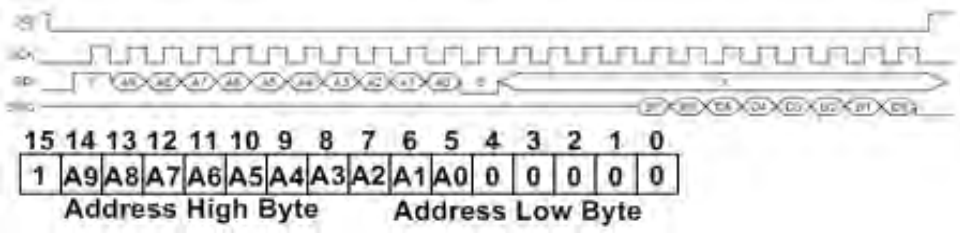
Figure 7. Short Address Write SPI Protocol



There are only 6 bits needed in short address for either read or write to the memory in the MRF24J40MA. It is important to note that the communication with SPI protocols on the short address memory is not lined up. This requires a simple conversion by shifting the bits and package by *zero* or *one* before the address can be sent via SPI. A software design such as shown in Program Listing 1 can simplify the process and make the controls of MRF24J40MA more easily understood.

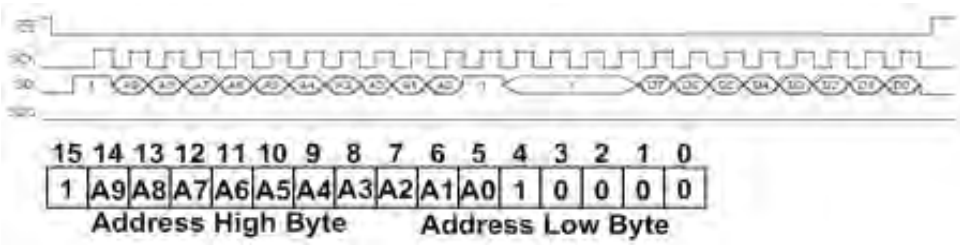
MRF24J40MA Long Address Read

Figure 8. Long Address Read SPI Protocol



MRF24J40MA Long Address Write

Figure 9. Short Address Read SPI Protocol



The long address requires only 10 bits to access the MRD24JMA memory shown in Figures 8 and 9 and yet again they are not aligned and must be divided into high and low byte addresses for the 8-bit SPI communication. Therefore, it is important to note that the repackaging of the bytes must be done before being sent via SPI. Much the same as in working with the short addresses a similar software design in packaging the bits will make the control much easier. Program Listing 2 presents the conversion routines.

The transmitter and receiver must be initialized before they can transmit or receive data (MRF24J40AM, 2008). After the transmitter and receiver are initialized the transmission data package/frame or receiving data package/frame must be established. The receiver will also poll on the INT line until it becomes *low* on the module to gain access of the received data. The initialization steps of the MRF24J40MA that are required by the Microchip's data specifications can be accomplished with short and long addresses *writes* as shown below in Initialization Step Listing. The transmitter package (data frame) should be formulated as in Transmission Step Listing.

Set the transmit frame in the TX normal FIFO bit in TXNCON at short address 0X1B to start the transmission. The module hardware will automatically transmit the data frame to the designated slave receiving module. The TX normal will generate an interrupt to the MCU when it has completed the transmission. A *read* of the INTSTAT is necessary to clear the INT flag (a read action to clear the flag is required by the module hardware) and use it as a signal to precede next action on the master control unit.

The receiver package (data frame) is available after the INT line (pin 4) on the module goes *low*. The receiver should constantly poll until the INT bit on MRF24J40MA pin 4 goes *low* on the module and causes it to wait for the received data frame ready then the package information is available, the Receiving Step Listing presents the needed steps.

The very last action on the receiving side is to do a *read* on the INTSTAT register (short address at 0X31) to clear the INT flag(s) and automatically stop the INT action from the module to the MCU

Conclusion and Recommendations

This paper provides an overview of a capstone demonstration project that is a required senior design project and is an integral part of EET curriculum at Old Dominion University. Students may choose to participate in the microprocessor capstone project with faculty mentors as part of a university research activity or they may elect to prepare and submit

a proposal for an alternative project funded by the student, faculty, or external supporters under faculty direction. This demonstration project is one of the components of an on-going undergraduate research project in the Electrical Engineering Technology department.

The focus of this wireless communication demonstration project is to provide a hands-on-minds-on learning experience for capstone project classes. The project and instructional strategies were built around a 2.4GHz RF module and a PIC trainer. The MRF24J40MA transceiver is easily addressed using only *five* interface lines with the MCU. The design efforts are thus directed toward the software development and make it easier to modify and flexible to explore and develop in different applications. The current application revolves around a master control unit and two slave units. The flexibility of the systems provides an easy path toward adding more slave units to expand the system if needed by a particular application. Additionally, the project implementation on Rhino XR arms demonstrated the potential areas of application. Since the successful completion of this RF demonstration project, it has become apparent by faculty and students that it becomes a building block for expanding the hands-on microprocessor learning experiences. Subsequently, video materials created during the demonstration project are used in other courses to highlight learning experiences and benefits.

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Data Frame Listing

- Length
- Frame Control 1
- Frame Control 2
- Sequence
- Destination PANID Low Byte
- Destination PANID High Byte
- Destination Short Address Low Byte
- Destination Short Address High Byte
- Source PANID Low Byte
- Source PANID High Byte
- Source Short Address Low Byte
- Source Short Address High Byte
- Data Byte 1
- Data Byte 2
- Data Byte 3
- ----------
- Data Byte N (5 in this project)

Program Listing 1. An illustration of a program listing that performs a simple conversion by shifting the bits and package by *zero* or *one* short addressing scheme. This process is completed before sending an address via serial peripheral interface (SPI).

```
ST_ADDR_W                       ;Short Address Write Routine
        MOVWF ST_ADDR
        RLF     ST_ADDR,F       ;Rotate left on address thru C flag
        BSF     ST_ADDR,0       ;Insert Hi  on bit 0 in short address for Write
        MOVF    ST_ADDR,W
        CALL    SUB_SPI
        RETURN

ST_ADDR_R                       ;Short Address Read Routine
        MOVWF ST_ADDR
        RLF     ST_ADDR,F       ;Rotate left on address thru C flag
        BCF     ST_ADDR,0       ;Insert Lo on bit 0 in short address for Read
        MOVF    ST_ADDR,W
        CALL    SUB_SPI
        MOVLW 0XFF
        CALL    SUB_SPI
        RETURN
```

Program Listing 2. An illustration of a program listing that performs a simple conversion by shifting the bits and package by *zero* or *one* for the long addressing scheme. This process is completed before sending an address via serial peripheral interface (SPI).

```
LN_ADDR_R                       ;Long Address READ routine
        BCF     STATUS,C        ; Clear C flag
        RLF     LN_ADDR_LO,F    ; Rotate left on Lo byte address thru C flag
        RLF     LN_ADDR_HI,F    ; Rotate left on Hi byte address thru C flag
        RLF     LN_ADDR_LO,F
        RLF     LN_ADDR_HI,F
        RLF     LN_ADDR_LO,F
        RLF     LN_ADDR_HI,F
        RLF     LN_ADDR_LO,F
        RLF     LN_ADDR_HI,F
        RLF     LN_ADDR_LO,F
        RLF     LN_ADDR_HI,F
        RLF     LN_ADDR_LO,F
        RLF     LN_ADDR_HI,F
        BSF     LN_ADDR_HI,7    ; Insert Hi on MSB bit in long address
        CALL    WR_LN_ADDR
        MOVLW 0XFF
        CALL    SUB_SPI
        RETURN
```

```
LN_ADDR_W                       ;Long Address Write Routine
        BCF     STATUS,C        ; Clear C flag
        RLF     LN_ADDR_LO,F    ; Rotate left on Lo byte address thru C flag
        RLF     LN_ADDR_HI,F    ; Rotate left on Hi byte address thru C flag
        RLF     LN_ADDR_LO,F
        RLF     LN_ADDR_HI,F
        RLF     LN_ADDR_LO,F
        RLF     LN_ADDR_HI,F
        RLF     LN_ADDR_LO,F
        RLF     LN_ADDR_HI,F
        RLF     LN_ADDR_LO,F
        RLF     LN_ADDR_HI,F
        BSF     LN_ADDR_HI,7    ; Insert Hi on MSB bit in long address
        BSF     LN_ADDR_LO,4    ; Insert Hi on Bit 4 in long address for Write
        CALL    WR_LN_ADDR
        RETURN

WR_LN_ADDR
        MOVF    LN_ADDR_HI,W
        CALL    SUB_SPI
        MOVF    LN_ADDR_LO,W
        CALL    SUB_SPI
        RETURN

SUB_SPI
        MOVWF SSPBUF            ;Send data out via SPI
        BSF     STATUS,RP0      ;Bank 1
WAIT    BTFSS   SSPSTAT,BF      ;Poll for BF bit for SPI communication
        GOTO    WAIT
        BCF     STATUS,RP0      ;Bank  0
        MOVF    SSPBUF,W        ;Clear BF bit and read SPI buffer
        RETURN
```

Initialization Step Listing

- Write 0X07 to SOFTRST at short address 0X2A to perform software reset
- Write 0X98 to PACON2 at short address 0X18 to set FIFO and transmission enable
- Write 0X95 to TXSTBL at short address 0X2E to set VCO stabilization period
- Write 0X01 to RFCON1 at long address 0X201 to set VCO optimize control
- Write 0X80 to RFCON2 at long address 0X202 to enable PLL
- Write 0X90 to RFCON6 at long address 0X206 to enable TX filter and recover from sleep for 1ms
- Write 0X80 to RFCON7 at long address 0X207 to choose 100KHz internal oscillator
- Write 0X10 to RFCON8 at long address 0X208 to enable RFVCO bit
- Write 0X21 to SLPCON1 at long address 0X220 to disable clock out and clock divisor to minimum
- Write 0X78 to BBREG2 at short address 0X3A to set CCA recommended value
- Write 0X60 to RSSITHCCA at short address 0X3F to set CCA ED threshold
- Write 0X40 to BBREG6 at short address 0X3E to set calculate RSSI for each package
- Write 0XF6 to INTCON at short address 0X32 to enable RX and TX FIFO interrupts
- Write 0X02 to RFCON0 at long address 0X200 to choose 2.405 GHz communication
- Write 0X98 to PANIDL at short address 0X01 to set PANID Low byte=0X98
- Write 0X76 to PANIDH at short address 0X02 to set PANID High byte=0X76
- Write 0X14 to ADDRL at short address 0X03 to set address Low byte=0X14
- Write 0X58 to ADDRH at short address 0X04 to set address High byte=0X58
- Write 0X68 to EADDR0 at short address 0X05 to set extended address 0=0X68

- Write 0X19 to EADDR1 at short address 0X06 to set extended address 1=0X19
- Write 0X27 to EADDR2 at short address 0X07 to set extended address 2=0X27
- Write 0X11 to EADDR3 at short address 0X08 to set extended address 3=0X11
- Write 0X65 to EADDR4 at short address 0X09 to set extended address 4=0X65
- Write 0X19 to EADDR5 at short address 0X0A to set extended address 5=0X19
- Write 0X29 to EADDR6 at short address 0X0B to set extended address 6=0X29
- Write 0X03 to EADDR7 at short address 0X09 to set extended address 7=0X03
- Write 0X00 to RFCON3 at long address 0X203 to choose max power
- Write 0X01 to RXFLUSH at short address 0X0D to set reset RXFIFO pointer
- Write 0X04 to RFCTL at short address 0X36 to reset RF state machine
- Write 0X00 to RFCTL at short address 0X36 to reset RF state machine
- Delay for 192 µsec

Transmission Step Listing

- Write package length to TX normal FIFO at long address 0X000
- Write frame control 1 to TX normal FIFO at long address 0X001
- Write frame control 2 to TX normal FIFO at long address 0X002
- Write sequence to TX normal FIFO at long address 0X003
- Write destination PANID LSB to TX normal FIFO at long address 0X004
- Write destination PANID MSB to TX normal FIFO at long address 0X005
- Write destination short address LSB to TX normal FIFO at long address 0X006
- Write destination short address MSB to TX normal FIFO at long address 0X007
- Write source PANID LSB to TX normal FIFO at long address 0X008
- Write source PANID MSB to TX normal FIFO at long address 0X009
- Write source short address LSB to TX normal FIFO at long address 0X00A
- Write source short address MSB to TX normal FIFO at long address 0X00B
- Write transmission data to TX normal FIFO at long address 0X00C
- Write transmission data to TX normal FIFO at long address 0X00D
- ----------
- Write transmission data to TX normal FIFO at long address 0X012
- The data write continues depends on its desired length

Receiving Step Listing

- Read package length from RX FIFO at long address 0X300
- Read frame control 1 from RX FIFO at long address 0X301
- Read frame control 2 from RX FIFO at long address 0X302
- Read sequence from RX FIFO at long address 0X303
- Read destination PANID LSB from RX FIFO at long address 0X304
- Read destination PANID MSB from RX FIFO at long address 0X305
- Read destination short address LSB from RX FIFO at long address 0X306
- Read destination short address MSB from RX FIFO at long address 0X307
- Read source PANID LSB from RX FIFO at long address 0X308
- Read source PANID MSB from RX FIFO at long address 0X309
- Read source short address LSB from RX FIFO at long address 0X30A
- Read source short address MSB from RX FIFO at long address 0X30B
- Read transmission data from RX FIFO at long address 0X30C
- Read transmission data from RX FIFO at long address 0X30D
- ----------
- Read transmission data from RX FIFO at long address 0X311
- The data read continues depending on its desired length
- ----------

A Fieldbus Simulator for Controller Area Network

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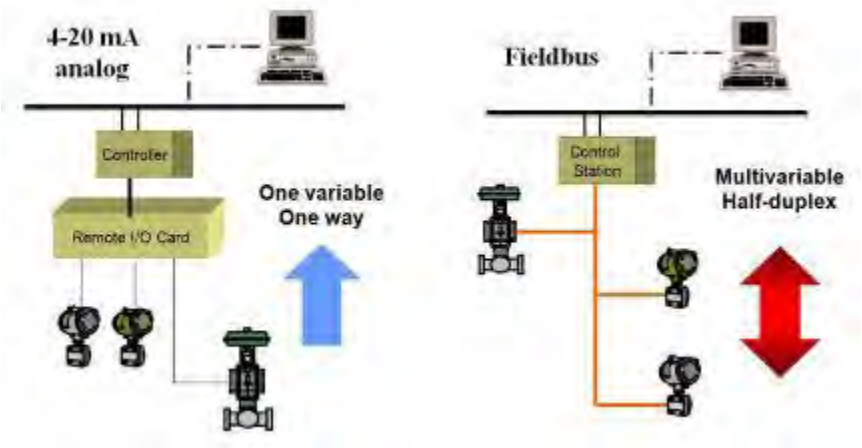
Abstract
Industrial control networks such as Foundation Fieldbus, Profibus, Controller Area Network (CAN), called fieldbuses, are extensively used in recent control system implementations. Though these networks are built in hardware, it is important to study the performance via simulation before implementing them. This paper, therefore, demonstrates the importance of software simulation tools for development, testing and analysis of fieldbus networks using CANoe software for CAN. It also provides a general overview of CAN protocol. A hardware system consisting of stepper motor interface and its communication using CAN protocol in CANoe environment is also discussed.

Introduction
Fieldbus networks are all-digital, two-way, multi-drop communication systems that are used to connect field devices such as sensors and actuators, and controllers in industrial plants. They are gradually replacing 4-20 mA standard instrumentation signals used to transfer measurement and control data between control room and plant floor (Berge, 2002). Figure 1 shows a typical fieldbus network connection and 4-20 mA analog connection in a system. According to Schuessler (2002), the increasing popularity of fieldbus networks in factory automation, power grid management, as well as transportation systems can be attributed to a host of advantages. These include: greater system functionality, simplicity, accuracy, less cost of purchase and expansion, interoperability, and other savings (Berge, 2002). Although, different fieldbus networks such as Foundation Fieldbus and Profibus are available in the control industries, Controller Area Network (CAN) is more accepted in automotive applications. These fieldbus based systems can generally be very complex to implement. Hence, powerful paradigm such as simulation tools can be utilized to study the performance of these complex systems before implementing them in hardware.

Figure 1. Digital Fieldbus and 4-20 mA Analog Standard Connections (Yu, 2007)



A Foundation Fieldbus simulation platform and its remote access interface using LabVIEW software was designed by Mossin et al. (2009). Özçelik et al. (2005) designed a model of a hybrid Profibus network to obtain the performance of the Profibus medium access protocol using CACI Network II.5 software based on discrete event simulation. Rasheed (2007) provided a simulation framework for Wireless Mesh Networks using OMNeT++ software. Pescaru and Dobrescu (2010) used OPnet simulation tool to study various factors such as ring, mesh, star and bus topologies that affect the design of fieldbus

networks. Chen et al. (2008) simulated transmission of data flows in a fieldbus used for a ship power station by designing a set of CAN bus models by OPnet simulator. Though the literature indicated use of general purpose simulation tools such as OPnet, OMNeT++, Network II, LabVIEW and others, there are simulation tools designed specifically to address a particular type of fieldbus such as CAN due to its importance in the automobile field.

This paper uses such a simulation tool called CANoe developed by Vector CANTech for development, testing and analysis of CAN based fieldbus networks. Section II gives a general overview of CAN fieldbus. Section III outlines CANoe software and describes its use through automobile system simulations. A hardware interface called CANStart module is described in Section IV. A stepper motor interface to CANStart and its communication using CAN protocol in CANoe environment is also discussed in that section. Section V offers some concluding remarks.

Controller Area Network

CAN was developed by Robert Bosch GmbH for automotive applications (Evaluation Engineering, 2011). The CAN specification initially became an ISO 11898 standard in 1993, and extended in 1995 to permit longer device identifiers as CAN 2.0B. The CAN protocol is based on the Open Systems Interconnection/International Organization for Standardization (OSI/ISO) 7- layer reference model (Strang and Röckl, 2009) of digital communication, shown in Figure 2. Each layer in this model is responsible for providing its "services" almost simultaneously. CAN implements only Physical and Data Link layers as shown in Figure 2.

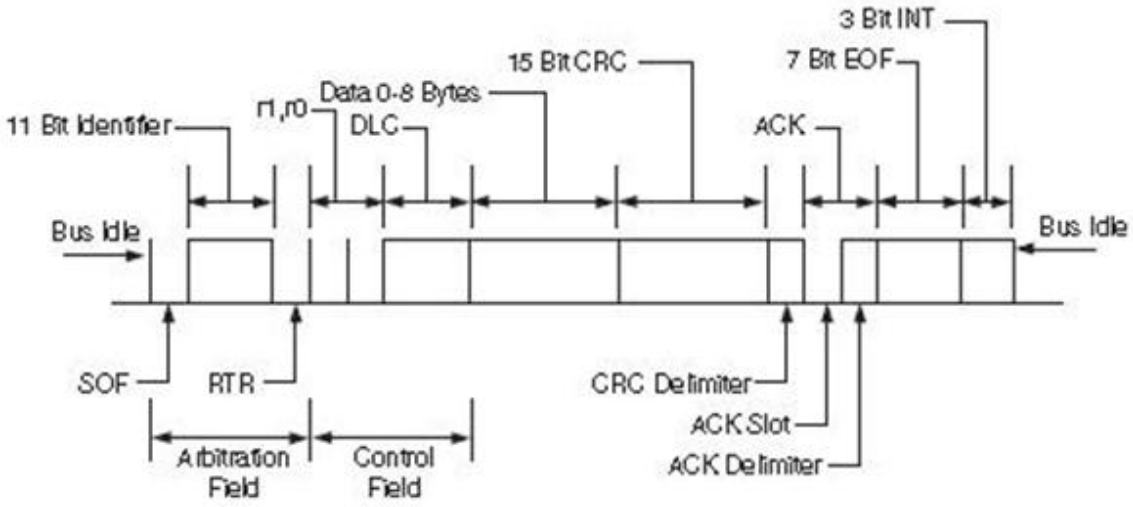
Figure 2. ISO/OSI Reference Model and CAN Protocol

No. of Layer	ISO/OSI Reference Model	CAN Protocol Specification
7	*Application*	Application Specific
6	*Presentation*	Optimal: Higher Layer Protocol (HLP)
5	*Session*	
4	*Transport*	
3	*Network*	
2	*Data Link*	CAN protocol (with free choice of medium)
1	*Physical*	

CAN utilizes twisted pair cable wires as physical medium to interconnect network nodes. It is a serial, multi-master, multi-cast protocol. CAN messages are assigned static priorities, and a transmitting node will remain a transmitter until the bus becomes idle or it is superseded by a node with a higher priority message through arbitration. Bit rates up to 1 Mbit/s are possible in short networks that are below 40 m length. Also, longer network distances reduce the available bit rate to 125 kbit/s at 500 m.

There are four categories of CAN frames. These include Data Frame, Remote Frame, Error Frame and Overload Frame. The CAN data frame is shown in Figures 3 (Bosch, 1991). It consists of seven fields: start of frame (SOF), arbitration, control, data, cyclical redundancy check (CRC), acknowledge (ACK) and end of frame (EOF). CAN message bits are referred to as "dominant" (0) or "recessive" (1). CAN 2.0B support both 11 bit (standard) and 29 bit (extended) identifiers (CiA, 2011). A typical CAN message may contain up to 8 bytes of data. A message identifier describes the data content and is used by receiving nodes to determine the destination on the network. As a result of its popularity, some higher layer protocols have been developed on top of CAN in recent years. These include CAN Kingdom, CANopen, DeviceNet, Local Interconnect Network (LIN), Media Oriented Systems Transport (MOST), FlexRay, and J1587 (Keskin, 2009). Also tools to simulate CAN systems have been developed. In the next section one such simulation tool is discussed.

Figure 3. CAN Data Frame



Simulation Using CANoe Software

CAN open environment (CANoe) software provides a universal development, testing, and analysis environment for CAN bus systems. It was created by Vector Informatik GmbH, and permits simultaneous network development of systems in the CAN, LIN, MOST, FlexRay, J1587 and many other CAN-based protocols. It was designed primarily to model both electronic control unit (ECU) nodes on a network as well as the network that integrates them (Vector[CANoe], 2011). CANoe provides two major windows: "measurement setup" and "simulation setup". The former is used to configure data and statistics that are needed to be monitored while the latter is used to configure and run the entire simulation. The "measurement setup" has several sub windows, such as: "trace window", "data window", "graphics window", "statistics window", and "write window". A typical CANoe system model can be created in the "simulation setup" using the following steps:

1. Create the database with messages, signals and environment variables. CANdb++ editor is used to create these databases.
2. Create the network node periphery, which includes control panels. Panel Editor is used to create these panels.
3. Create the network node model in C-like language called Communication Application Programming Language (CAPL).

The database provides the environmental variables for describing the I/O interface among the nodes and their peripheries. Each periphery element is then "wired" to an environmental variable. It is also connected to the CAPL program for the network node. CANoe differentiates between discrete and continuous variables. Switch positions can be represented as discrete environment variables, temperature, engine RPM, etc. can be described as continuous environment variables. The control panels, created by Panel Editor, provide a user-friendly interface to the environment variables. During the simulation run, values of environment variables can be displayed (lamps, counters) and interactively modified (switches, potentiometers). These three-steps of CANoe simulation creation and its running to display various measurements are detailed below through examples.

Temperature Control Process Example

A temperature control process in an automobile with sensor, actuator and controller communicating on the CAN bus is shown as a simulation panel in Figure 4. The temperature sensor is simulated by a slider and its value is displayed. The controller compares the temperature with a set-point. If the temperature is above the set-point a fan actuator is turned-on, otherwise it is turned-off. This is a simple CANoe configuration with two network node model shown in Figure 5. The simulation steps for this example are:

Step1: In this example there are exactly three peripheral elements: Temperature slider and a display unit at the first node and a fan as the second node shown in Figure 5. The three environmental variables for these elements are represented in the database as evDisplay, evFan and evTemperature.

Step 2: Using the panel editor, Temperature slider, Display unit and Fan, shown in Figure 4, are created. The panels are then integrated into the CANoe configuration.

Step 3: The two network nodes for this example, shown in Figure 5, are created in Simulation Setup. The CAPL programs for each node, shown in Figure 6, simulate the functionalities of these nodes. The CAPL program for the temperature slider and the display unit node gets the new temperature value when the slider position changes and immediately outputs it on the CAN bus and also displays it on the indicator. The second network node's CAPL program then compares the signal generated for the new temperature with the set point of 70 degrees. The program turns on a Fan, when the input temperature is greater than the set point as shown in Figure 7. The Fan goes to the off mode when the signal or temperature value received on the bus is less than the value of the set point.

Figure 4. Panels in CANoe

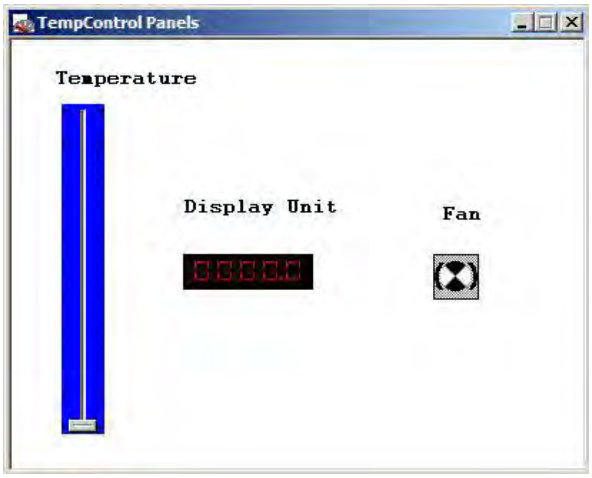


Figure 5. Network Nodes in the Simulation Setup

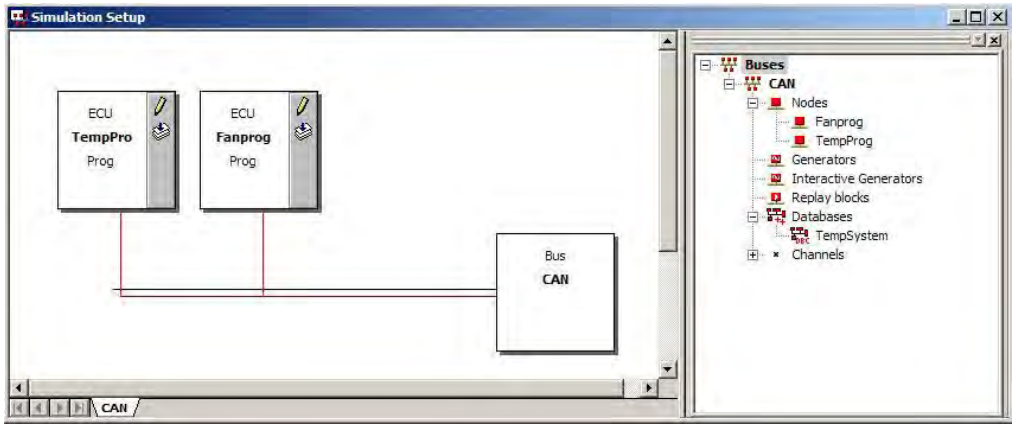
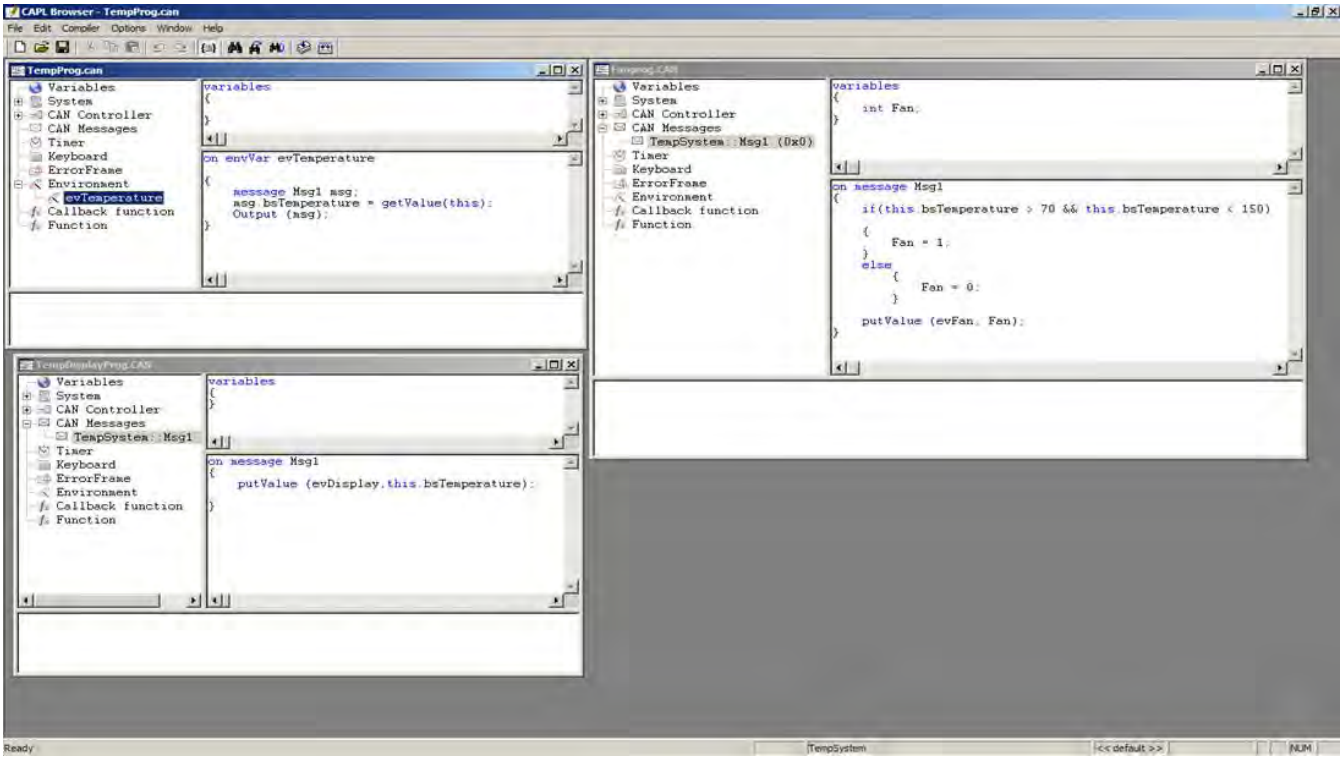
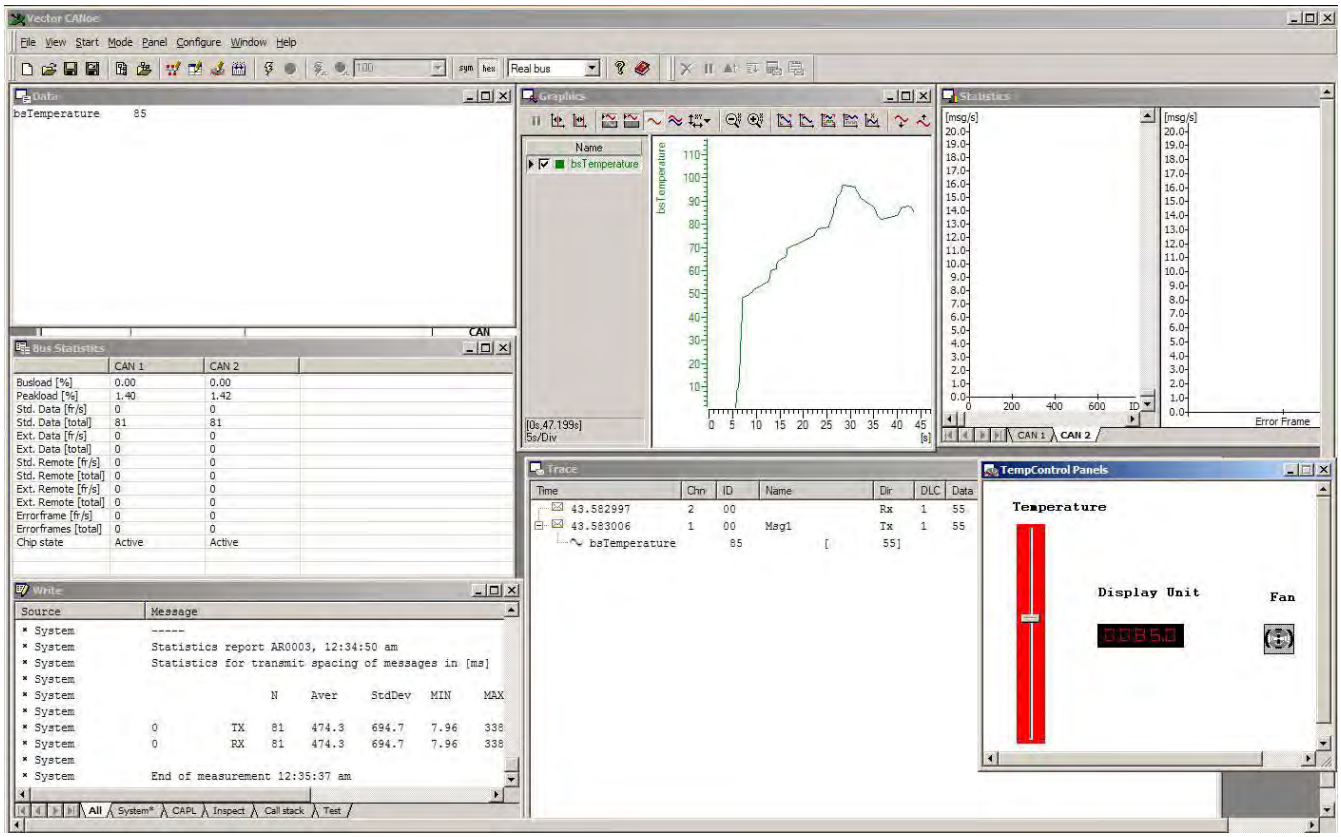


Figure 6. CAPL Program



Once the system is created, the users can simulate the network behavior, observe the bus load, and determine the required performance of the hardware being developed using the "measurement setup" windows shown in Figure 7. The trace window displays CAN messages in bus oriented format. The "statistics window," gives the transmitted messages per second coded by identifiers. A statistics report is also generated for at least one acquisition range which is output to the "write window" at the end of each measurement. The write window shows the total number of messages for each identifier, the mean value, standard deviation, and the minimum and maximum for the recorded transmit interval. The "bus statistics window" also provides an overview of the bus data traffic. The total frequencies of data, remote, error as well as overload frames, bus loading and the status of CAN controller are displayed on this window.

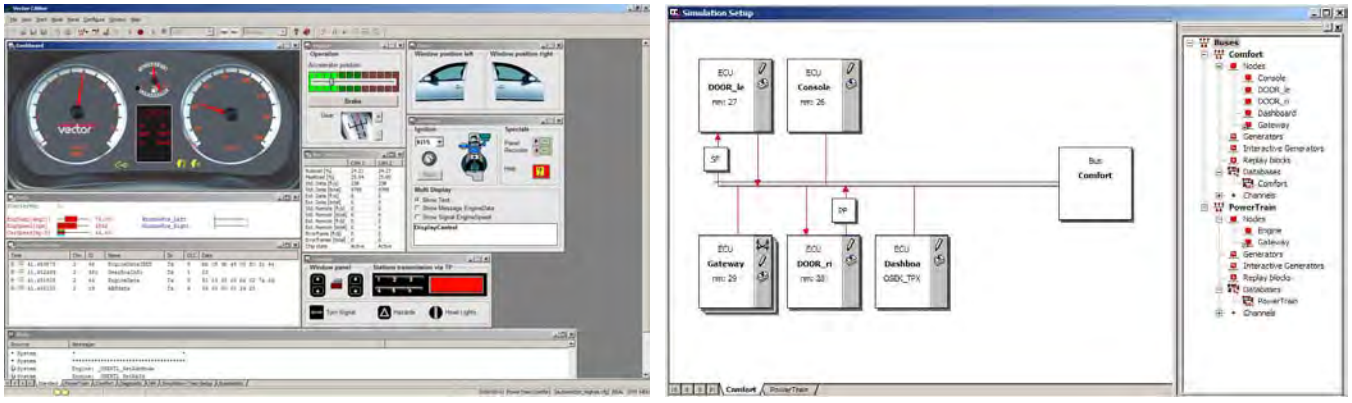
Figure 7. Various Panels and System Windows in CANoe for Temperature Control Example



Automobile Example

A more involved automobile system simulation created with CANoe is shown in Figure 8 (Vector[CANoe], 2011). The panels of the automobile dashboard and various other consoles are shown in a) and part of the network nodes in the simulation setup are shown in b). Though the creation of this system is involved, the above three step process is still followed to simulate this system. The software simulations described so far should finally lead to implementing these systems in hardware. The next sections deal with the hardware integration with CANoe software simulation for further development of the CAN fieldbus systems.

Figure 8. Automobile Simulation Example



a) Simulated Panels *b) Network Nodes*

CAN Hardware Implementation in CANoe

There are several embedded CAN controller chips available and experimental systems were built with them (McKean, 1998) and (Hanzelek, 2006). However, CANoe provides an environment to integrate both hardware and software simulations. Such an environment will allow faster development and better diagnostics features of the actual hardware system. In this section a hardware ECU module called CANStart is described, and a stepper motor interface to this module, designed to communicate using CAN protocol in CANoe environment, is discussed.

CANstart Module

CANstart is a CAN-based electronic module (CANstart, 2006). It has a pre-programmed Microchip PIC18F458 microcomputer that controls all onboard functions, interfaces to user input/output circuits, and handles CAN communications interfaces. A basic block diagram of the CANstart module showing the important interfaces is given in Figure 9. The available input/outputs on the module are: 4 input pushbutton switches, 4 user-controlled LED indicators, 4 digital inputs, 4 digital outputs, and 4 analog inputs. The basic CANstart dialog structure is shown in Figure 10. All information that passed to and from the CANstart board is accomplished with three types of CAN messages. Two messages are periodically transmitted every 100 milliseconds by the CANstart board and contain data sampled by the various CANstart hardware inputs. A single message is used to send command data to the CANstart board and contain output function. A CAN tool such as CANoe software, capable of transmitting a specific command message, is required for the operation of CANstart module. Using a simple CANoe program various inputs and outputs of CANstart module can be activated and their responses can be displayed both on the hardware and simulated panels. While these inputs/outputs can be independently used, a device such as stepper motor can illustrate their integrated operation.

Figure 9. A Block Diagram of the CANstart Module

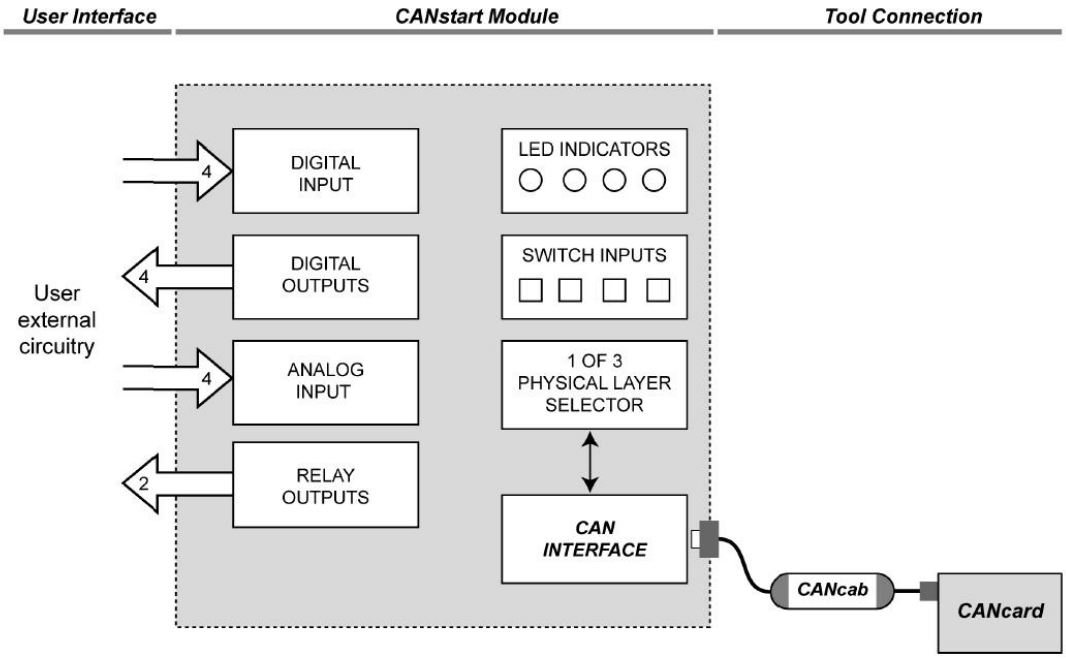
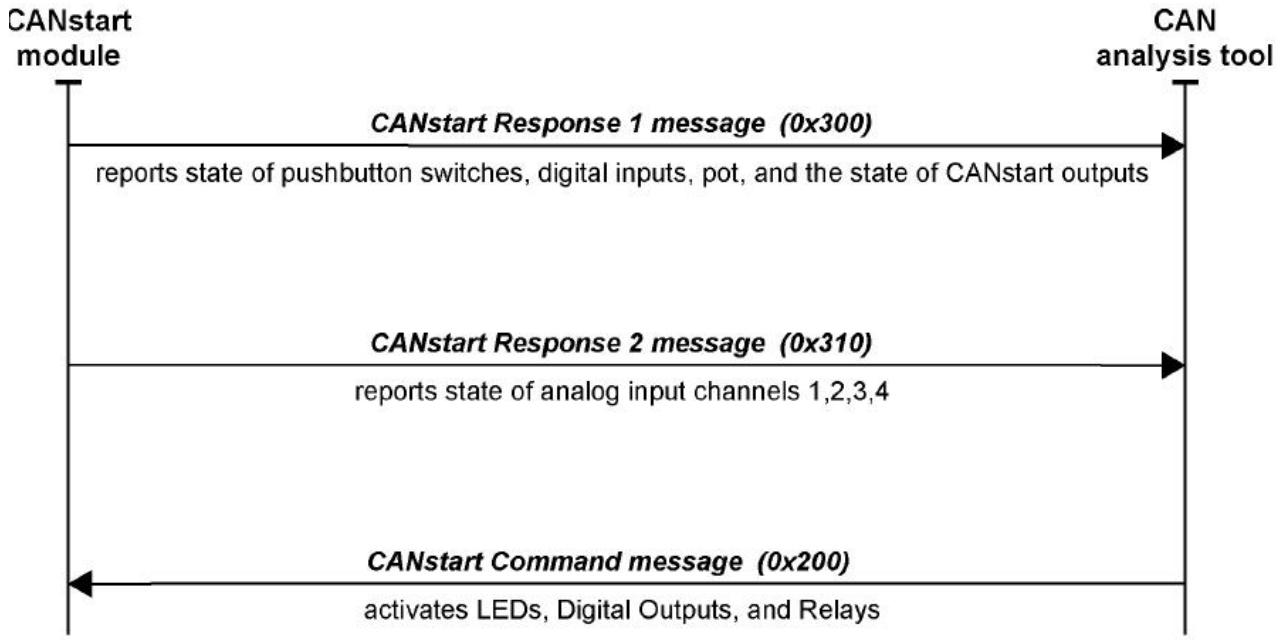


Figure 10. Basic CANstart Dialog Structure



Stepper Motor Interface to CANstart Module

A small 100 steps/revolution unipolar stepper motor is used in this study. It is mounted on a base with a dial pointer and numeric faceplate to emulate a speedometer in an automobile, as shown in Figure 11. The motor is connected to the CANstart module which is then connected to CAN controllers of the PC CAN card. This serves as the CAN node. The motor rotates in discrete step increments when electrical command pulses are applied to it in the appropriate sequence. The sequence of the applied pulses determines the direction of the rotation of the motor. The speed of the motor is directly related to the frequency of the input pulses (Athani, 1997). In this study, the motor control is accomplished through CANoe using the interrupt timer for controlling the motor step sequence at a regular rate as shown in the CAPL program in Figure 12. The program is written so that when the red push button on the CANstart board is pressed, resulting in a digital input of E0 Hex in CAN message, the pointer moves clockwise by sending the required step sequence to digital output lines, and the pointer moves counter clockwise when yellow push button, resulting in a digital input of D0 Hex in CAN message, is pressed again by sending the required step sequence to digital output line. The program shows step sequences of 55, 99, AA, 66 Hex corresponding to the bit pattern sent to the digital output lines and LEDs as CAN data for clockwise and counter clockwise rotation. Figure 13 shows the measurement setup windows of various performance characteristics when the CANoe program for the stepper motor is executed. The "statistics window," gives the transmitted messages per second coded by identifiers 200, 300 and 310. The actual 8-byte CAN message data is displayed on the "trace window". A statistics report is output to the "write window" at the end of each execution. This window shows the total number of messages for each identifier, the mean value, standard deviation, and the minimum and maximum for the recorded transmit interval.

Figure 11. Stepper Motor Interface to CANstart Module

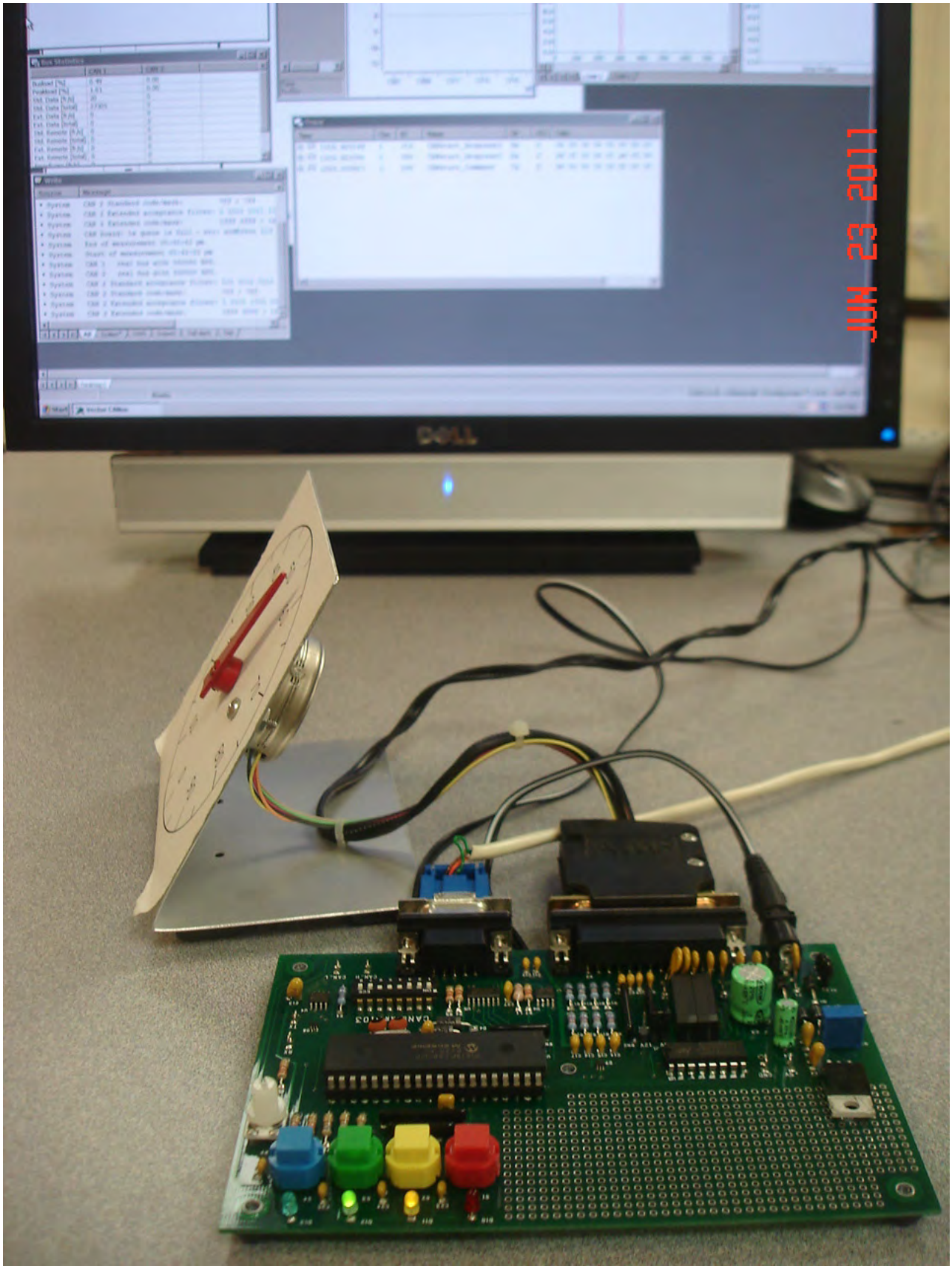
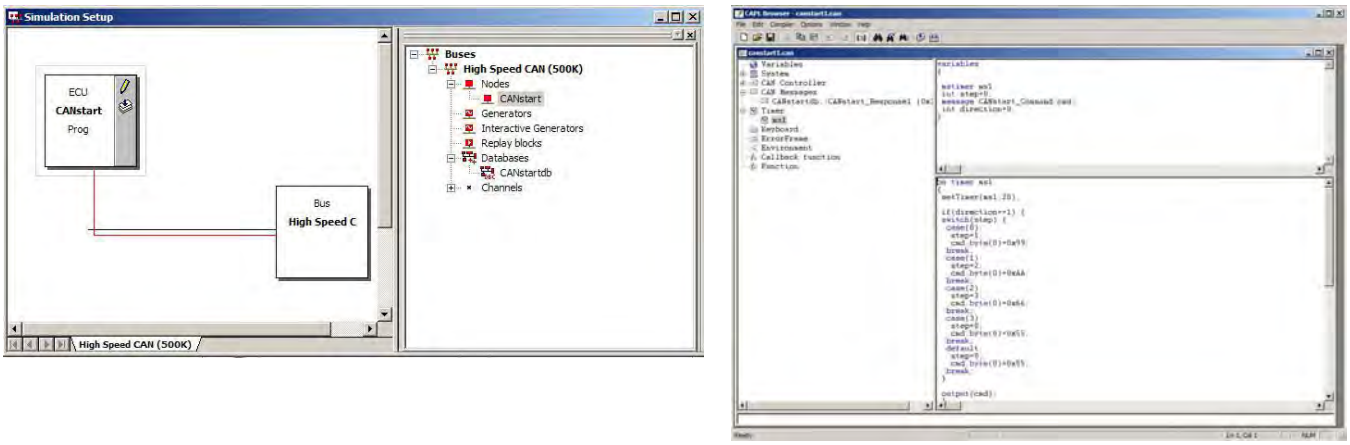
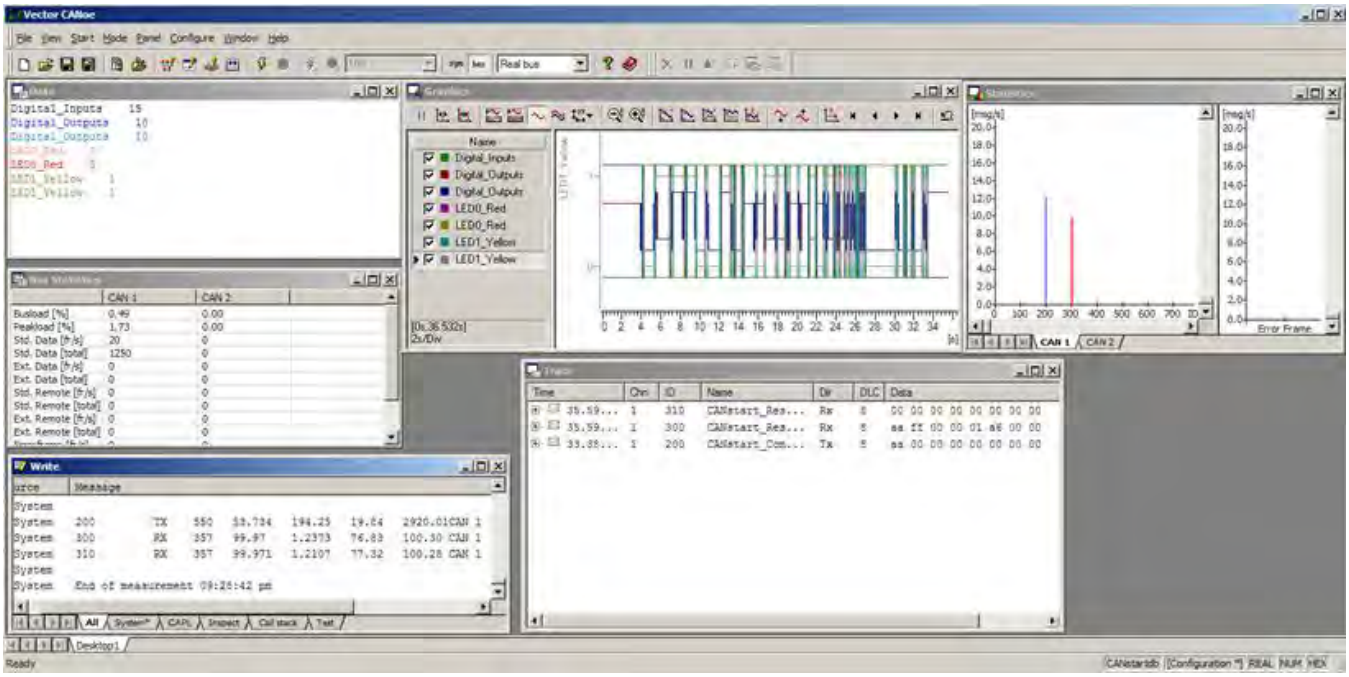


Figure 12. CANoe Simulation Setup and its CAPL Program for Stepper Motor and CANstart



For identifiers 300 and 310, the shown mean transmit interval of 99.97 ms corresponds to the set value of 100 ms. The "bus statistics window" provides an overview of the bus data traffic. The total frequencies of data, remote, error as well as overload frames, bus loading and the status of CAN controller are displayed on this window. The "graphics window" shows the actual digital signals of various inputs/outputs.

Figure 13. CANoe Measurement Windows for Stepper Motor and CANstart



Conclusion

The purpose of this paper was to present software simulation techniques for CAN fieldbus. An overview of the CAN protocol and its operation with respect to the ISO/OSI 7-layer model were initially discussed. CANoe simulation software for CAN was explained in detail with a temperature control example, and an automobile simulation example was also introduced. The statistical communication information obtained through these simulations is useful to evaluate the performance of the systems. The physical signals displayed on various graphs are helpful to operators to monitor these systems. A general purpose PIC microcontroller based CANstart module was introduced, and a stepper motor interface to that module was

described. Communication features of the motor control using CAN protocol through CANoe software was explained. The simulation information obtained in various windows for this software and hardware interaction will help in the eventual physical system implementation.

Acknowledgements

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Integrative Learning on Biomass Renewable Energy

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Abstract
To accomplish global sustainability, we must develop policies and technologies that embrace a diverse range of energy solutions, especially renewable energy. This paper introduces campus-wide efforts on biomass renewable energy at our institution. The construction of a new biomass energy plant exemplifies the university's leadership and commitment to a sustainable energy practice. In addition, the university has established a new Center for Clean Energy Research and Education (CENCERE). CENCERE promotes interdisciplinary collaborations across the campus, including academic departments and schools, facility planning and management, and student body.

Introduction
It has been widely observed that humans have been living unsustainably, as evidenced by our ever-increasing consumption of natural resources such as fossil fuels (World almanac & book of facts, 2008) and alarming emissions of greenhouse gas (Inventory of US greenhouse gas emissions and sinks: 1990-2007, 2009). For example, since 1850, carbon dioxide in the atmosphere has increased more than 30% due to the fact that its release from oil and coal has quadrupled. The increase in carbon dioxide is believed to account for 60% of global warming observed (Blatt, 2005).

In order for the Earth to continuously support human lives, we must achieve sustainability for the global social, economic, and environmental systems that meet "the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987). To reach the global sustainability, we must develop policies and technologies that embrace a diverse range of energy solutions, especially renewable energy (Wetterlund & Söderström, September 2010) (Advanced Research Project Agency, 2009) (Center for Energy and Environmental Security, 2010). Renewable energy offers great potentials for the world to reduce dependency on fossil fuels, which can lead to a cleaner environment, better preservation of natural resources, and more economic opportunities to the communities (Biomass Research, 2010). Among different sources of renewable energy, biomass, which refers to a mass of organisms (mainly plants) that can be used as an energy source, is a major source available in the world (Ngo & Natowitz, 2009).

The reminder of this paper is organized as follows. Section 2 introduces the leadership and commitment on renewable energy at our institution. We focus on the construction of a new biomass energy plant and a new research and education center. The process of biomass energy generation is discussed in Sections 3 and 4. In particular, Section 3 examines biomass resources, and Section 4 explains the process of biomass gasification. We introduce the integrative learning on biomass renewable energy at our institution in Section 5. Section 6 concludes the paper.

Renewable Energy Plant and Research & Education Center at Our Institution
Our university has been a leader in initiating environmentally friendly projects. Since 1995, the university has reduced its consumption of electricity, fuels, and water by more than 30 percent. In 2003, our institution was recognized as the university with the lowest energy cost per square foot among all public universities in the State of Illinois. In response to the challenges of energy and sustainability, our university has decided to move forward with the use, research, and education

of renewable energy. In the following, we will introduce our two major efforts: a new renewable energy plant, Renewable Energy Center (REC), and a new research and education center, Center for Clean Energy Research and Education (CENCERE).

In 2008, the university decided to construct the REC on the east side of campus. The REC will replace the university's current coal-fired power plant built in 1925. The result will be an economically and ecologically friendly answer to the university's critical steam and power needs. The new REC uses biomass gasification technology, which converts biomass such as wood chips into combustible gas, known as syngas. The syngas will then be combusted in boilers that will supply steam for the university's heating and cooling needs. The university will be permitted to utilize two-inch virgin, or non-treated, wood chips obtained as by-products from the lumber industry. The wood chips being delivered will be much more "clean burning" than the coal, and will significantly reduce the overall air emissions released into the environment.

The groundbreaking took place in Spring 2009, and the plant will be operating by Fall 2011 (Figure 1). The projected cost of the REC represents approximately half of the roughly $80 million the institution intends to spend on renovations and new energy conservation projects. In addition to the power plant, the institution examines electrical upgrades, upgrades to the electrical grid connection, and possibilities for wind energy generation. The new REC exemplifies the institution's leadership and commitment to a sustainable energy practice. It will also offer students the first-hand opportunity to learn how renewable energy is utilized to support the needs of a campus or community.

Figure 1: The new Renewable Energy Center (REC) at our institution.

In order to fully integrate student learning with opportunities brought with the REC, the university has established a new Center for Clean Energy Research and Education (CENCERE). CENCERE promotes interdisciplinary collaborations across the campus, including academic departments and schools, facility management, and student body. As a result of the presidential fund raising priority, CENCERE has received a grant to acquire equipment including a laboratory biomass gasifier, an internal combustion engine, a battery bank, and an 110v AC inverter. The gasifier will enable students to test various biomass resources available in the region, such as tree trims, yard waste, and corn stover. A gas chromatography (GC) system will be used to analyze the syngas from the gasifier. Figure 2 shows the gasifier and the GC. New graduate level courses on renewable energy are being offered. We are currently developing a new Master of Science program in Renewable Energy at our institution. More details about the CENCERE and the gasification process will be discussed in the following sections.

Figure 2: Biomass gasifier (gekgasifier.com) and gas chromatography system (chem.agilent.com).

Biomass Resources

Biomass refers to a mass of organisms, mainly plants, which can be used as an energy source. Through photosynthesis, plants and algae convert the energy of the Sun and carbon dioxide into chemical energy stored in biomass. Using biomass as a renewable energy source does not result in net CO_2 emissions, because it will release only the amount of CO_2 that plants have absorbed during their growth (Allin, 2010). It is estimated that there will be a total of one billion dry tons of biomass resource available annually from forest and agricultural land in US. This resource can help the country to replace 30% of the current US petroleum consumption by 2030, the *Billion Ton Vision* set by the Biomass R&D Technical Advisory Committee, a panel established by the Congress (Perlack, Wright, Turhollow, Graham, Stokes, & Erbach, 2005).

Renewable energy practices and biomass resources are highly dependent upon the local conditions including soil, biodiversity, agriculture practices, and many other factors (Tao & Aden, 2009). Ericsson and Nilsson analyzed the potential biomass supply in 15 European Union countries (Ericsson & Nilsson, 2006). Their study was based upon the residue harvest, energy-crop yield and surplus agricultural land. They stated that there was no resource limitation to reach the biomass target of 5.6 EJy^{-1}, a goal set by the European Commission on renewable energy sources. Marginal lands in Asia-Pacific Economic Cooperation (APEC) countries were studied in terms of their potential for biomass energy production (Milbrandt & Overend, 2009). It was reported that economies with the largest marginal lands include Australia (13.5% of total land area), the United States (13%), China (5%), Canada (4%), and Russia (2%).

A wide variety of biomass has been investigated for renewable energy potentials. Switchgrass was selected as a dedicated energy crop for further study in the US following the screening trials in 1980's. By the early 2000s, a total of 30 papers reporting unduplicated yield from switchgrass investigations were identified (Wright, et al., 2009). Canada has actively pursued the option of making switchgrass pellets for applications in home heating stoves, gasifiers, and co-firing with coal. In the US, switchgrass has been tested for co-firing and has been included as a feedstock in several proposals to develop biofuels and to generate electricity using dedicated energy crops.

Miscanthus was extensively studied in Europe as a low-input ligno-cellulosic biomass crop. Its production is characterized by low fertilizer and pesticide requirement, making it an environmental benign crop. The combustion characteristics of miscanthus are similar to woody biomass, except its higher mineral content including chlorine than willow and poplar. It was believed that late spring harvest is a key to nutrient management of the crop (Lewandowski, Clifton-Brown, Scurlock, & Huisman, 2000). University of Illinois at Urbana-Champaign has successfully planted miscanthus in its university South Farm for several years as shown in Figure 3 (Frank G. Dohleman, 2008). Argonne National Laboratory of US Department of Energy in Chicago has also maintained an experimental field of miscanthus. Both institutions have made their crops available for our experiments through Illinois Biomass Working Group.

Figure 3: Experimental field of miscanthus at University of Illinois.

Willow biomass was studied as an energy source for farm-based power generation thanks to its low ash content, high heating value and high ash-fusion temperatures (Pian & Volk, 2009). An advanced gasifier system utilizing multi-staged enthalpy extraction technology (MEET) was adopted in this study, in which high-temperature preheated air was injected into the gasifier vessel. Poplar is another biomass energy candidate studied extensively (Fischer, Prieler, & van Velthuizen, 2005) (Guidi, Tozzini, & Bonari, 2009).

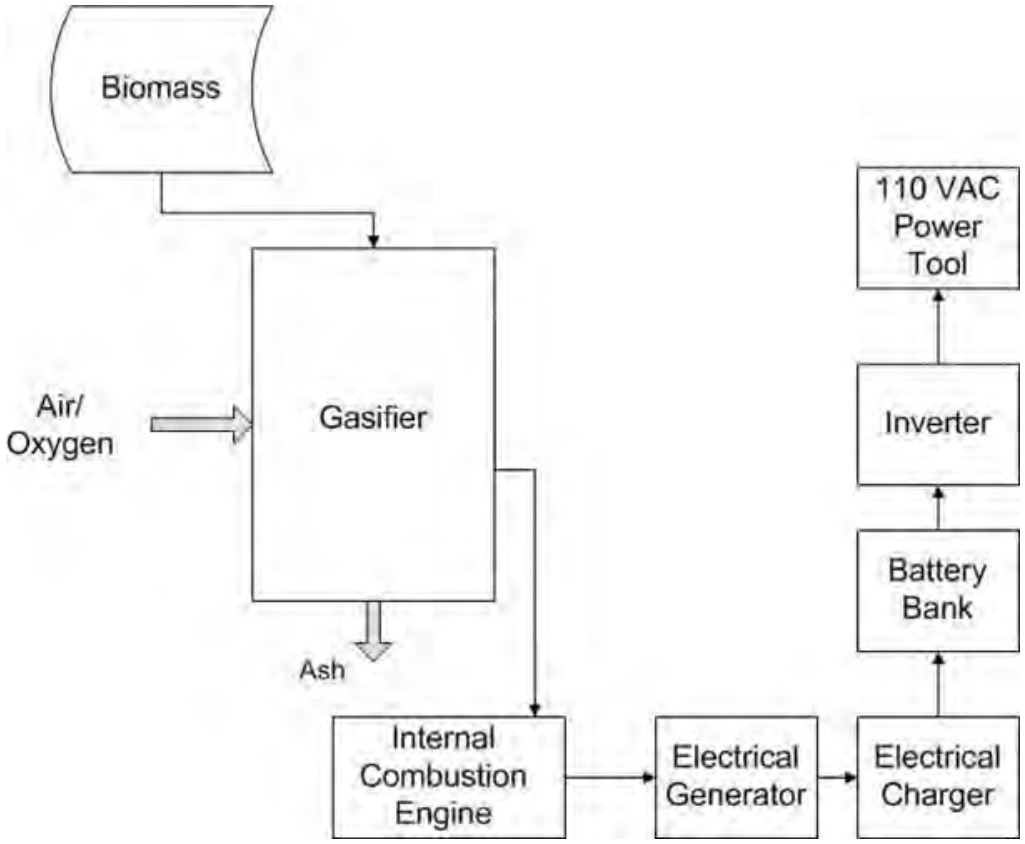
Besides dedicated energy crops, agricultural residue is a major source of biomass renewable energy. The major advantage of using those residues is that there is no disruption in the current agricultural and land management practice. For example, corn stover has been studied for its renewable energy uses (Carpenter, et al., 2010). Russ Zeeck stated that "Corn stover – all the leaves, cobs and stalks leftover after the corn is harvested – is America's most abundant source of sustainable biomass" (Pollack, 2009) (Next Step Biofuels, 2008).

Biomass Gasification

There are several major pathways to convert biomass into energy: ethanol fermentation (White & Plaskett, 1981), anaerobic digestion, and gasification (Sofer & Zaborsky, 1981) (Gupta & Demirbas, 2010). Gasification is a process that uses heat, pressure, and/or steam to convert carbonaceous materials directly into combustible gas known as syngas, which is composed primarily of carbon monoxide and hydrogen. Gasification technologies offer the potential of clean and efficient energy (Stiegel & Maxwell, 2001) (Rezaiyan & Cheremisinoff, 2005).

Biomass gasification technologies are expected to play an important role in future energy systems. The syngas has a wide range of applications including direct use in gas turbines, internal combustion engines, boilers, and fuel cells. It can also be used to produce second-generation fuels using Fischer-Tropsch synthesis (Pinto, Andre, & Gulyurtlu, 2009), and synthesis of methanol, dimethyl ether and other value-added chemicals. The syngas can also be used to produce pure hydrogen as the third generation clean fuel (Stiegel, Breault, & Andrus, 2008) (Li, Zeng, Velazquez-Vargas, Yoscovits, Fan, & Lowrie, 2010). A laboratory gasification system has been established in the Center for Clean Energy Research and Education (CENCERE) at the university, as shown in Figure 4. The system includes a gasifier/reactor that converts biomass into combustible syngas. The gasifier uses the Imbert design (Food and Agriculture Organization of United Nations, 1986), which is suitable for generating low tar wood gas to power internal combustion engines.

Figure 4: Laboratory gasification system at our institution



The gasification system includes an internal combustion engine (Timpe, Mann, & Schmidt, 2000). The industrial implement engine features a 4-cycle overhead-valve design with a horizontal-shaft, water cooling and twin cylinders, cast iron cylinder liners and aluminum block construction (Kohler engine: LH755, 2010). The reactor supplies combustible gas to the engine that is coupled with an electrical generator, rated at 10kw. The generated electricity is used to charge a battery bank, which is inverted to provide 110v AC power output (Hamilton, 2009).

The system is also equipped with an auxiliary pyro-coil for engine exhaust gas heat recovery and an auger feed drying bucket for biomass fuel supply. The heat recovery system shows students how energy can be conserved and recycled in the process (Heselton, 2005). The above system is intended to provide students with a complete experience in biomass renewable energy conversion and utilization.

Integrative Learning on Biomass Renewable Energy

It is imperative that our students are educated in terms of global sustainability through clean and renewable energy (Roth, 2010) (Læssøe & Öhman, 2010). Biomass renewable energy is expected to provide more future job opportunities for our students (Committee on Prospering in the Global Economy of the 21st Century, 2007). A 2009 study showed that the number of jobs in America's clean energy economy grew 9.8% while traditional jobs only increased by 3.7% from 1998 to 2007 (Mwase & Keniry, 2011). The challenge is how to keep students interested in learning biomass renewable energy.

The CENCERE at our institution brings transformational changes in the way students learn the science and technology of global significance. Adopting an investigative learning model, students may be engaged in a series of student-led research activities on biomass renewable energy (Figure 5). Students will design and implement their own research plans based upon the available biomass resources, which include the following tasks:

- Identifying biomass sources.
- Testing heat value and moisture content of the biomass.
- Processing the biomass into a useful form.

- Gasifying the biomass to produce combustible syngas.
- Using the syngas to drive an internal combustion engine and an electrical generator.
- Charging a bank of batteries and inverting to provide 110v AC power output.

Figure 5: Integrative learning on biomass renewable energy.

Students will also study synthesis gas, which can be converted into pure hydrogen or liquid fuel as a source of renewable energy (Stiegel, Breault, & Andrus, 2008). This study will be particularly of interest to students in science majors. It will provide students with the opportunity to study the cutting edge science related to renewable energy (Li, Zeng, Velazquez-Vargas, Yoscovits, Fan, & Lowrie, 2010).

In addition, students will study the impact of biochar (gasification by-product) on the carbon-capture and ecological systems (Center for Energy and Environmental Security, 2010) (Lehmann, 2007). Our gasification system provides students in biological science with an opportunity to study the effect of gasification by-product on soil, plants, and ecological system or biodiversity.

Conclusion

Renewable energy offers great potentials for the world to reduce dependency on fossil fuels. It can lead to cleaner environment, better preservation of natural resources, and more economic opportunities to the communities. Our institute has been a leader in resource conservation, environment protection, and renewable energy. The construction of a new Renewable Energy Center (REC) and the establishment of a new Center for Clean Energy Research and Education (CENCERE) exemplify our commitment to a sustainable energy practice. The CENCERE fully integrates student learning with opportunities brought by the REC. CENCERE promotes interdisciplinary collaborations across the campus, including academic departments and schools, facility planning and management, as well as student body.

With the experience in a complete cycle of renewable energy generation and utilization, students will develop a real passion, knowledge, and skill for using renewable energy to reduce our dependence on foreign oil and to maintain a sustainable social, economic, and environmental system for many generations to come.

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Storing and Maintaining Virtual Machines in Computer Technology Labs

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Abstract
A computer technology lab typically needs to support students from multiple classes. Each class may require students to create and manage multiple virtual machines (VMs). Storing and maintaining multiple copies of virtual machines quickly becomes a problem for educators, lab managers and students. This work aims to explore possible solutions to efficiently manage and maintain students' work on virtual machines. Five approaches were carefully studied, including registry database, system state data, system restore, virtualization snapshots, and linked-clones. After comparing the different approaches, it is apparent that snapshots and linked-clones can be used to greatly reduce storage space and quickly restore student work.

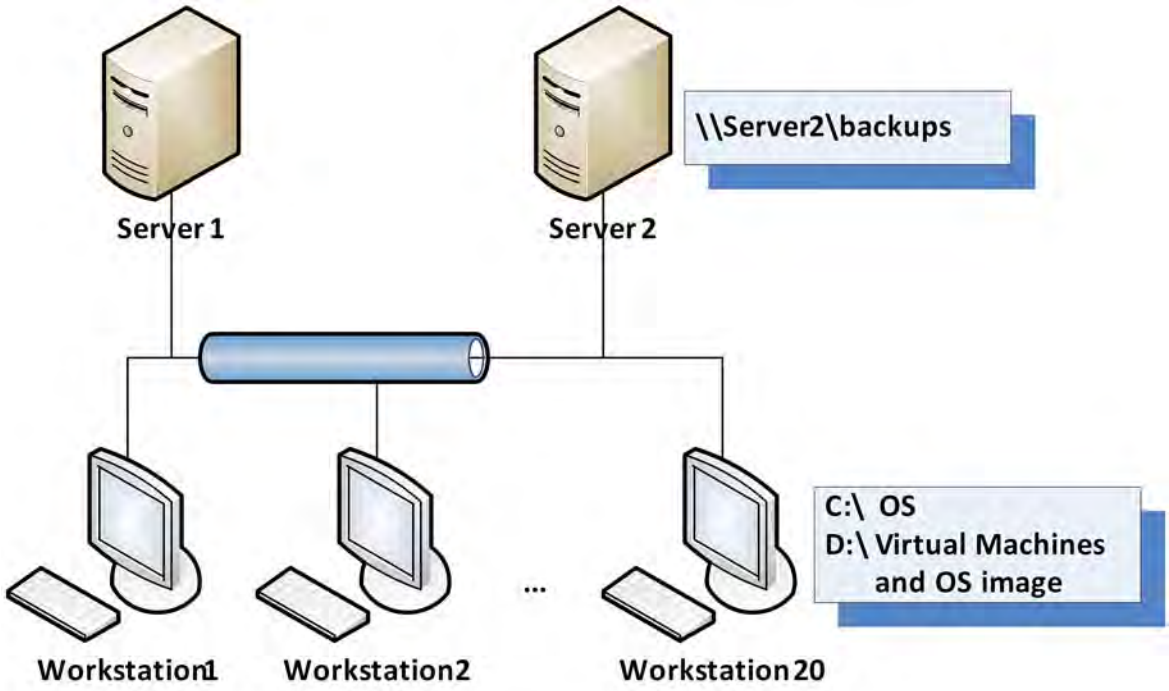
Introduction
The advances in virtualization technology provide computer technology educators and students a flexible environment to teach and learn different operating systems at minimal costs. Products from different vendors and organization, such as VMware vSphere/Workstation, Xen Hypervisor, Microsoft Virtual PC, and Oracle VirtualBox, enable students to explore different operating systems (OSs) in a virtualized setting without the need to purchase computer hardware for each. For example, a student in a server technology class can install and run a VM of Windows Server 2008, SUSE Enterprise Linux Server, Ubuntu Server on a Windows 7 desktop computer.

While enjoying the benefits of virtualization technology, a computer technology lab begins to face new challenges. Educators and students may create too many VMs. This not only creates an increased demand for storage space, but also consumes instruction time waiting for the VMs to be installed, backed up, and restored for use. Even worse is that students from different classes often need to share the same host computer. This frequently results in one student to inadvertently deleting or modifying a VM that belongs to another student from a different class. It is necessary to study the strategies to store and manage VMs in a computer technology lab.

The goal of this study is to investigate several possible solutions, and identify which solution may be best suitable for computer technology labs.

Problem Statement
Figure 1 represents a typical lab environment. Servers might be available for user authentication (such as Active Directory) and file storage of student work. Each student workstation has either two physical hard drives or is partitioned to have two logical drives. Hosting operating systems, such as Windows 7, are installed on C drive while the C drive images and students' virtual machines are stored on D drive. The main advantage of storing virtual machines on a separate drive is that when something bad happens to the hosting environment, such as malicious programs attack the lab computers, one can easily re-image the OS on C drive without losing students' work (their virtual machines) on the D drive.

Figure 1. Typical Computer Technology Lab Topology



Computer technology curriculum typically covers a range of prevailing OSs, such as the Windows desktop OS family (XP, Vista, Windows 7), Windows Server OS (2003/2008), Linux desktop OS (Ubuntu, Suse, Redhat), Linux Server OS, and Macintosh OS. Except for Mac OS, which are not widely supported on various virtualization products, educators and students can install multiple instances of those OSs in their virtual environment. This suggests that there will be several virtual machines to be stored on the D drive. The size of each virtual machine is not large for a local machine: from about 2 GB (XP) to 20 GB (Server 08 loaded with services). But the numbers can add up pretty quickly if there are many classes sharing the same lab. In addition, some classes require students to use multiple OSs to implement directory services and systems integration. If not carefully managed, the local disk space will be depleted quickly. Even if student workstations are equipped with multi-TB hard drives, it will still be a tremendous burden to back up all the virtual machines to the server space. And if students need to back up their multi-GB virtual machines simultaneously over the network at the end of each lab session, it may take more than 15 minutes or more. As a matter of fact, from the authors' own experiences, backing up only 7 Windows Server 2008 virtual machines concurrently over a 1 gigabit per second (Gbps) switched LAN to a server with a 60+ megabytes per second (MBps) sequential writing capability hard drive takes more than 40 minutes. And to back up a Windows Server 2008 virtual machine to a locally attached USB flash drive (write performance around 7~10 MBps) may also take more than 30 minutes.

Without a big investment to upgrade the network and storage devices, is it possible to back up multiple virtual machines in a timely fashion? Or to put it differently, do you need to back up the entire virtual machine to save students' work? Is it possible for students from different classes to share a virtual machine while retaining their own work? Are there alternatives to using the local computer for shared storage?

Table 1. Typical Virtual Machine Operations

Operations	Frequency	Need to backup
Change computer names (such as join a domain, leave a domain)	Often	Yes
User management (change passwords, add/remove users)	Often	Yes
Hardware management (add/remove device, managing device drivers)	Often	Yes
Software management (install/uninstall software)	Often on server (roles and services). Less often on client	Yes
Computer management (Network settings and Group Policy changes)	Often	Yes
System updates	Often	Optional

To begin investigating this problem, one needs to understand what operations students typically perform on those virtual machines, as shown in Table 1.

Possible Solutions:

The methodology of the study was to explore different back up utilities or implementation strategies that come with the operating system or the virtualization software and answer the following questions.

1. Is it applicable to back up all the OSs or one particular OS?
2. Can it backup/restore all the six typical types of operations?
3. How big is the backup size and how fast to back/restore?

Third party software was outside the scope of this study. Since we were interested in efficient solutions, backing up an entire OS or virtual machine were not examined. The tests in this study were conducted on a Dell Workstation. The hardware specs are as follows: CPU: Intel core i7-860 (quad core)

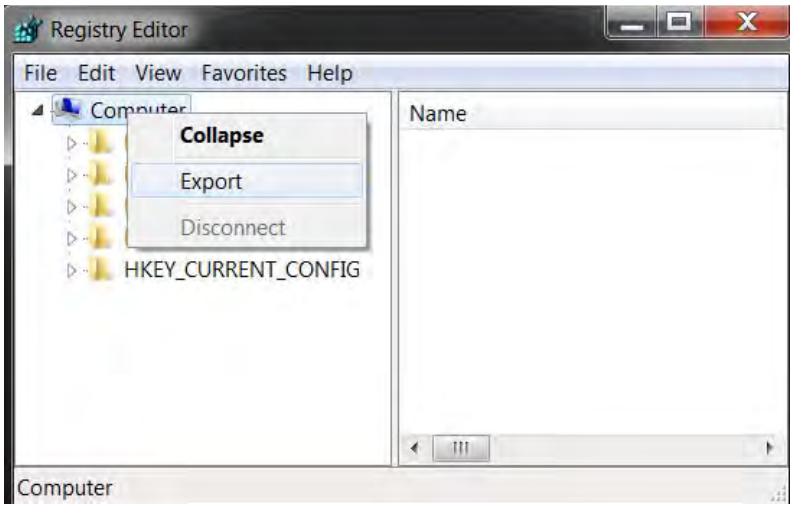
- RAM: 8 GB DDR3 1333 MHz
- Host OS: 64-bit Windows 7 Professional
- Hard Disk: SATA II, 7200 rpm, Sequential Read (64K) 100 MBps, Sequential write (64K), 60 MBps

For all the virtual desktop OSs, the settings are single processor single core and 1 GB RAM. For all the virtual Server OSs, they are set with single processor, dual cores, and 2 GB RAM.

Solution 1: Registry Backup/Restore

For all Windows products, most system configuration changes are recorded in the registry database. It was possible to back up the entire registry database by choosing the 'export' option using the Registry Editor (regedit.exe), as shown in Figure 2. The size of the backup was about 35 MB for a Windows XP SP3 VM and only takes about 5 seconds. However, the entire registry cannot be imported through Registry Editor because certain registry entries are locked by system services. As a result, registry backup can only restore some configurations, such as network settings. It cannot restore computer name changes, software changes, and any changes made to the currently logged user.

Figure 2. Back up the Entire Registry Database in Windows OSs



Solutions 2: System State Backup/Restore

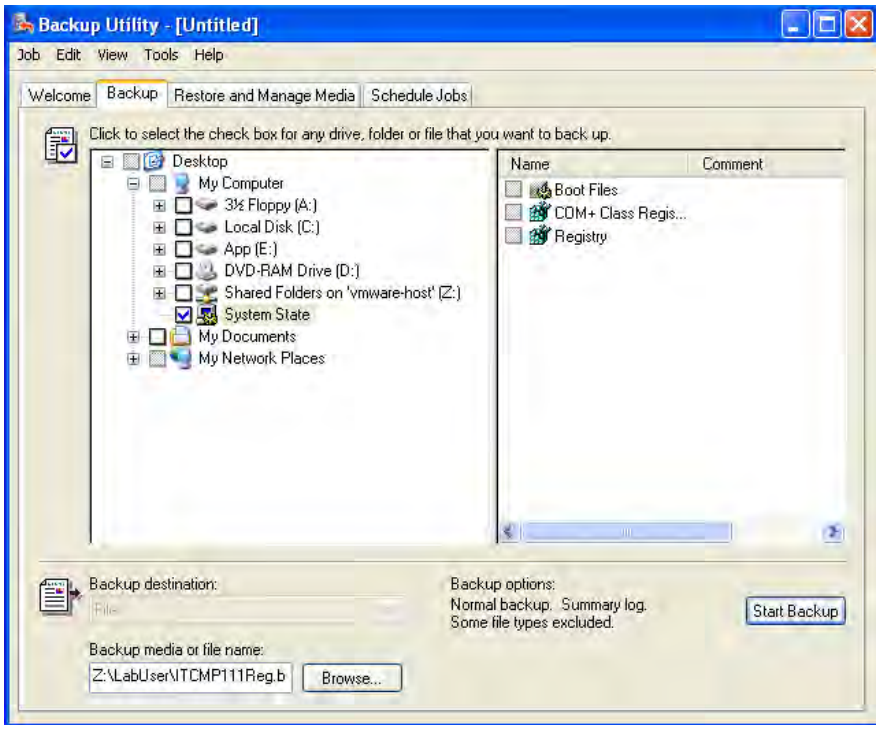
System state data includes a number of system components in a Windows operating system (Microsoft, 2005), such as registry database, boot files, and Windows system files. To backup system state, one can select 'System State' in the Windows backup utility (See Figure 3).

However, such a graphical user interface (GUI) does not exist on all Windows products. Windows 7, for example, does not provide this option in a GUI based backup utility. To back up system state in Windows 7, one needs to use command line. For example, to create a backup job named "Base System" that backs up the System State data to the file z:\Labusers\win7base.bkf, the following command should be used:

ntbackup backup systemstate /J "Base System" /F "Z:\Labusers\Win7base.bkf"

Our non-comprehensive tests suggest that for Windows OSs, backed up System State data appears to be capable of restoring all six types of changes listed in Table 1. The problem was that the backup size was large and the time it takes to back up and restore the system state was significant. For instance, on a Windows XP SP3 machine, it takes 1 min and 22 seconds to back up, and 6 minutes and 45 seconds to restore. The size of the backup was about 500 MB and it contains 2613 different files. On a Windows Server 2008, the backup size of system data was about 7.6 GB. And we had to stop our test because after 24 minutes, it only processed 33% of the files.

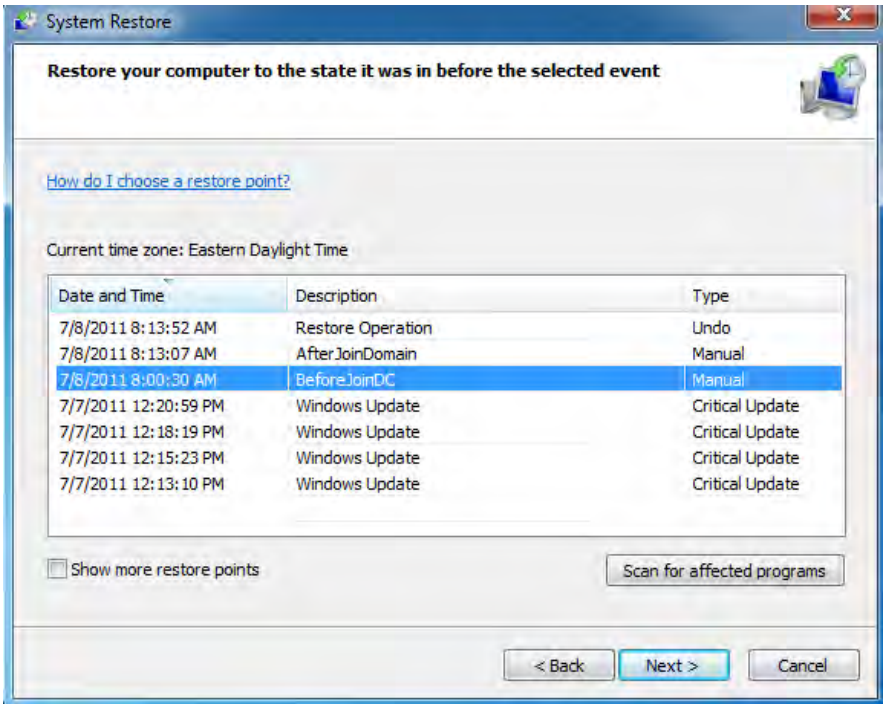
Figure 3. Backup System States from Windows XP



Solution 3: System Restore

The System Restore utility can also be used to backup and restore Windows registry files and certain dynamic system files (Schmidt, 2012). A user can manually create a restore point before making changes to a system and then restore the system to one of the previously stored states, as shown in Figure 4.

Figure 4. Using System Restore on Windows 7



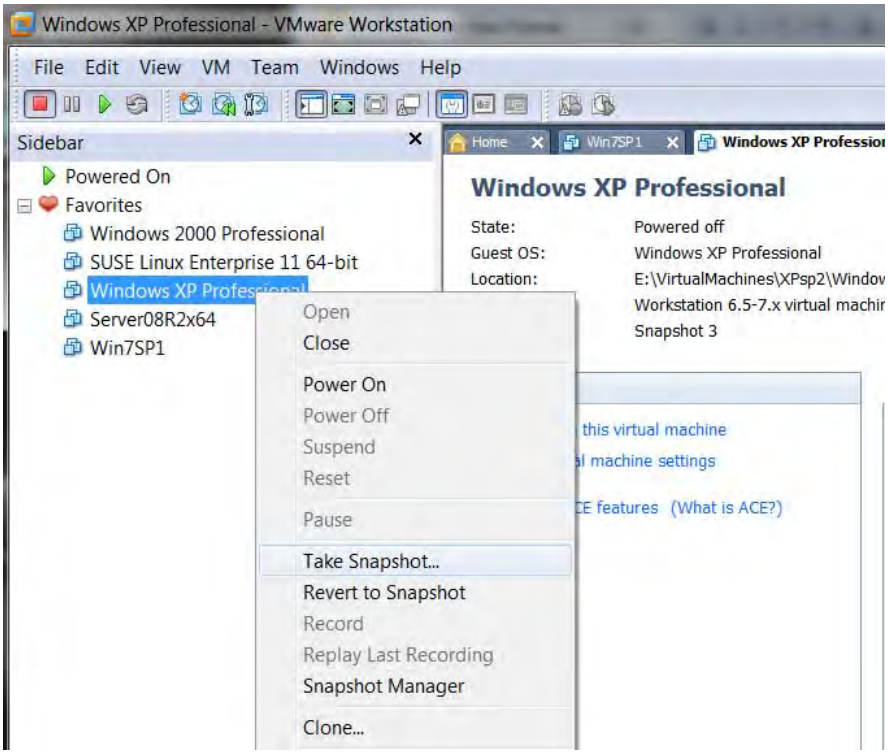
Using a Windows 7 VM, it appears to be a good solution. Creating a restore point takes about 15 seconds. Restoring to a previous state will cause the virtual machine to restart but the entire process was only about 1 minute on a clean Windows 7 VM. The System Restore hides all the files and information in a system protected folder and does not provide the size information to users. From the time it took, we speculate the size should be less than 20MB. And from our non-comprehensive tests, it can handle most of the six types of changes described in Table 1.

There are several problems associated with this approach however. First and foremost, this utility is missing in Windows Server 2008 the OS. This means using System Restore can only help backup and restore the following OSs: XP, Vista, Windows 7, and Windows Server 2003. Secondly, the restore information is hidden in the system protected folder and users cannot backup system state to a network location, neither can they restore the system from a network location. In addition, backing up or restoring a system requires users to first log on to the system. If one user changed the password, other users will lose access to that virtual machine and would not be able to conduct a system restore.

Solution 4: Using Snapshots of Virtualization Applications

Popular virtualization products, such as VMware Workstation, Xen Hypervisor, and Oracle VirtualBox all support the ability to do a snapshot. A snapshot captures the entire state of the virtual machine including memory state, settings state, and disk state (VMware, 2010, p205). Even though VMware Workstation was the only virtualization application used in our tests, it is highly likely that similar results can also be achieved on other virtualization products. Users can create a snapshot when the system is running, or when the system is shutdown. Figure 5 illustrates how to create a Snapshot when a virtual machine is powered off.

Figure 5. Take a VM Snapshot using VMware Workstation



Taking a snapshot while a VM is running incurs additional storage overhead because if a virtual machine is allocated with 2GB virtual RAM, then a 2GB file will be created to capture the state of the memory. Since the main purpose of this study was to store and manage a virtual machine shared by students enrolled in different classes, there was really no need to store the memory state.

The size of a snapshot can range from 5 MB to more than 700MB (on a Windows Server 2008). Compared to the size of the virtual machine, the size of a snapshot was much smaller because it records only the differences between current state and its parent state. Regardless of the size of a snapshot, the capturing process of a powered-off VM is almost instant and there is no perceivable delay from the user's perspective.

The approach of backing up the state of a virtual machine was applicable to all the Operating Systems: Windows desktop OS, Windows Server OS, Linux Desktop OS, and Linux Server OS. And the preliminary results also show it was capable of preserving all six types of operations listed in Table1.

In our test, it was observed that a new snapshot creates/updates three files. The snapshot metadata file, with the .vmsd extension, describes the relationship of all the snapshots. Another file with the .vmsn extension describes when the snapshot was created and where it was stored. The last file (a virtual disk file with .vmdk file extension) stores the updated virtual machine state. It was also observed that after a snapshot was created, VMware workstation begins to write information to the snapshot .vmdk files and stops writing to its main virtual disk file. For example, on a 64-bit Windows Server 2008 virtual machine, the main VMWare virtual disk file was about 14.3 GB and virtual disk files for snapshots varies from 5 MB to 674 MB. To back up the virtual machine and its various states, one only needs to back up the parent virtual machine (big in size) once per semester and back up snapshots more often (much smaller in size).

Solution 5: Team Linked Clones

Another alternative to having students create and store full VMs on the local computer is to have the VMs located on a storage server. One of the primary advantages is the security of the VMs. Students would be required to use individual login credentials to gain access to their own VMs on the server. If the students are working in groups, then the VMs could be stored in a shared folder in which only group members were given authorization to access. This approach effectively eliminates the possibility of students inadvertently modifying or deleting the VMs of other students, removing the need to create backups. However, this alone does not address the issue of storage capacity of the virtual machines.

In addition to storing VMs on a server, students can use the Team feature within VMWare Workstation to create linked clones. A linked clone is a copy of a virtual machine that maintains an ongoing link to that parent virtual machine (VMware, 2010). The linked clone is based on a snapshot of the parent virtual machine. By linking the clone, all of the applications and system files that were present at the time of the snapshot are maintained by the parent virtual machine. The linked clone only contains the changed files. Using a base installation of Windows Server 2008 that was 5.92 GB as the parent virtual machine, the linked clone was only 59.3 MB.

A concern was whether running a virtual machine hosted on a server would result in performance degradation. A series of time measurements were taken. As can be seen in Table 2, we measured the time it took to reach the "Control+Alt+Delete" screen in the Windows Server 2008 startup. We then recorded the time it took from when the password was entered until the "Server Manager" window opened after login. This point was chosen since it is the point when the system startup processes have completed. We compared the times for virtual machines located on the host computer and on the server. Time differences between the parent virtual machine and the linked clone were also compared. As can be seen in Table 2, there were no time delays caused by hosting the virtual machines on a server.

Table 2. Load Time Measurements

Storage Location	Virtual Machine	Start to "Control+Alt+Delete"*	Password Entry to Server Manager*
Local Host	Parent	59.43 (5.18)	31.43 (7.64)
Local Host	Linked Clone	52.90 (0.86)	24.10 (1.02)
Server	Parent	54.15 (0.72)	24.00 (2.13)
Server	Linked Clone	53.68 (0.85)	25.18 (2.01)
*Note: Measurements are in seconds and the standard deviation is in parentheses.			

Solution Comparisons

Table 3 compares the five possible solutions explored in this study. Using snapshots and linked clones to store and maintain virtual machines appear to be a good fit in computer technology labs.

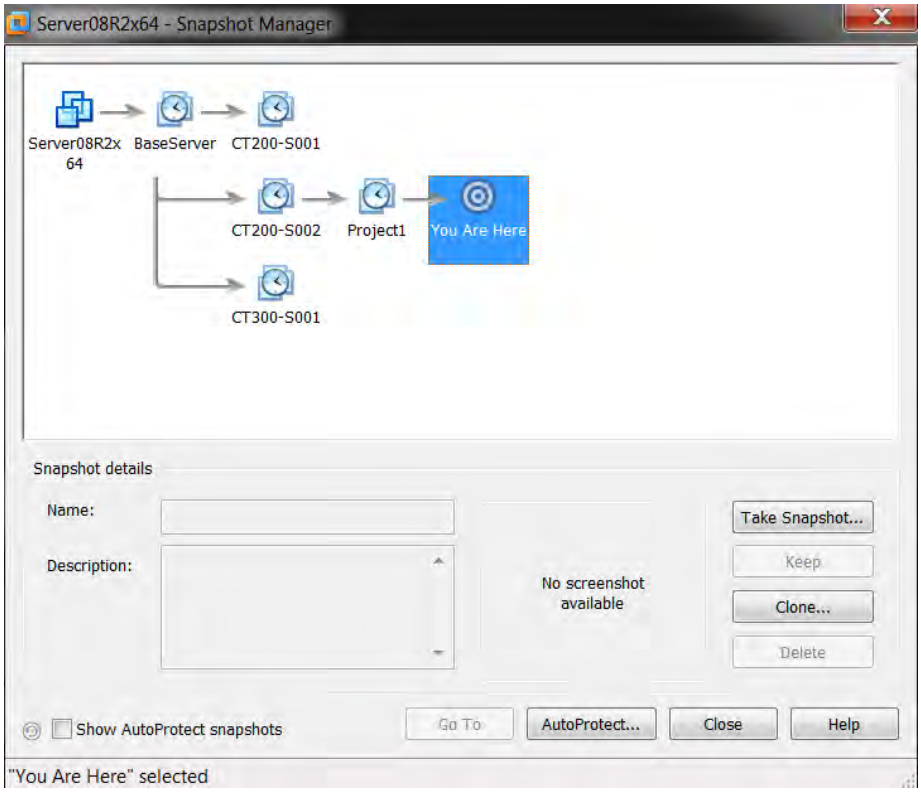
Table 3. Comparisons of Possible Solutions

Solutions	Applicable OS	Can backup/restore major operations	Size and time to backup and restore
Registry	All Windows OS	Only some small changes	Small and reasonably fast
System State	All Windows OS	Yes to all	Huge and very slow
System Restore	Most Windows OS	Yes to most operations	Small and reasonably fast
Snapshots	All guest OS (everything except Mac)	Yes to all	Small to medium, very fast
Linked Clones	All guest OS (everything except Mac)	Yes to all	Small to medium, not required

Conclusions

This study revealed that using snapshots can be an effective way to backup and restore the state of a VM. It suggests that it is possible for students from different classes to share the same VM while maintaining their own work. Figure 6 illustrates a strategy of how a Windows Server 2008 VM can be shared by three classes: CT200 section 1, CT 200 section 2, and CT 300. At the beginning of the semester/quarter, a unique VM can be created/cloned on a student workstation. Backing up the entire VM only needs to be conducted once per semester/quarter after the VM was created. Each student will need to back up their own snapshots to either their portable storage media or their server storage space. Alternatively, log-off scripts can be developed to automate this process at the end of each lab session.

Figure 6. Using Snapshots for Different Classes



Since VMware workstation supports up to 100 snapshots (VMware, 2010), it is likely to be sufficient for a computer lab to support all the VM states within a semester/quarter.

Equally efficient is the use of linked clones when using the Team feature within VMware Workstation to provide a simple and effective strategy for securely maintaining VMs in a classroom environment. Only a single VM for the desired OS would need to be created in a shared location on the server. From there, students would be able to create and store linked clones on the server in individually secured directories. To simplify the process even more, the directories could be mapped to the individual student through login scripts and/or Active Directory account properties. These VMs could then be incorporated into a centralized backup strategy if there is concern over loss or corruption of the VM. Future research will implement this strategy in a production environment to investigate the performance impact and limitations of the strategies.

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Two Successful Student Projects: Solar Air and Solar Water Heating Training Units

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Abstract
Solar thermal heating systems are a supplement to traditional heating systems and can dramatically reduce heating costs of homes and businesses. Five undergraduate and graduate students built both solar space heating and solar water heating portable training units (called mini-labs) as part of their independent study classes in the Industrial Technology Program. Both units are portable and can be tested in different locations and conditions and are being used in lab sections of renewable energy classes. Students involved in these projects learned to distinguish between photovoltaic (solar electric) and solar thermal and understand the uses of both; have knowledge of how to identify a proper site for a solar thermal system, and have resources to explore local installation options. Both portable units are being used for lab sections of the energy classes and the educational workshops that are offered to K-12 students and teachers at various school systems. This paper discusses solar thermal technology, step by step construction of two training units, and how to use them in the energy curriculum.

Introduction
Students graduating from engineering and technology programs may become involved in buying, managing, and trading alternative energies during their careers as part of their job requirements. It is essential for engineering and technology students, at a minimum, to be familiar with renewable energy technologies and their applications and implementations. Establishing courses in renewable energy with an adequate hands-on teaching laboratory will involve undergraduate and graduate students, faculty, and the community in learning about alternative energy and its impact on society. Hands-on renewable energy related classes, labs, and projects promote alternative energy education at university campuses. Fully functional laboratory training equipment delivers applied energy education for students especially those who are not exposed to state-of-the-art renewable energy information.

Solar energy, when absorbed by a surface, converts to either thermal or electrical power. The amount of solar energy reaching the earth from the sun over a period of one day or one year is very large. The amount of solar energy earth receives is larger than the energy used by living beings for an equivalent period. Solar energy should be captured at a useful temperature, transported, and perhaps stored for later use. Solar energy installations are better suited to locations with good solar energy availability, but carefully designed and installed systems can be useful even in cloudy locations during different months of the year (Crabtree and Lewis, 2007).

One of the most commonly usage of solar energy is in direct heating. There is a large number of applications of solar heating; such as space heating of buildings, heating water, crop drying processes in agriculture, growing food in greenhouses, cooking food etc. The diffuse and temporally variable availability of solar energy requires several components. These components include access to large collection areas to capture the energy and convert it to heat, suitable storage means to hold the heat until it is needed, well insulated distribution methods, and highly effective controls to avoid wasting the energy after it is collected (Solar Thermal Systems, 2011).

Any method of solar energy capture and use must be viewed within the context of the system of which is a part as well as the one of the methods of nature of the weather. Flat plate solar collector technology to heat water, for example, should be based on the actual need, be compatible with the energy storage capability of the heating system, and work properly with

a conventional backup system. A passive system for heating building space should be balanced against the insulation of the structure, and the air exchange to create a healthy environment (Vanek and Albright, 2008).

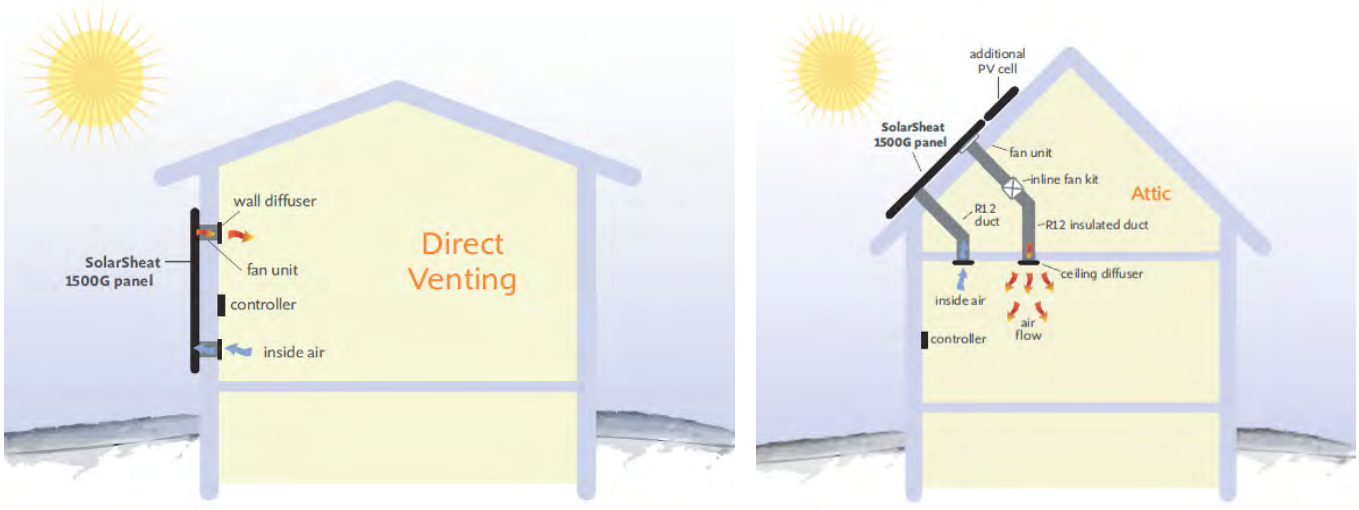
There are different types available for both active and passive solar thermal technologies. The active system uses a pump to control water flow while the passive system uses no pump in the water heating systems. Passive solar heating technologies such as solar glazing and thermal storage are used to develop optimum passive heating designs that are sensitive to geographic locations as well as system parameter values. Both active and passive systems can be either direct or indirect. The types of active solar heating systems are: a) flat-plate solar collector, b) evacuated-tube solar collectors, and c) concentrating collectors. The types of active solar heating systems are: a) direct gain, b) indirect gain (trombe wall), and c) isolated gain (Solar Water Manual, 2006).

This paper includes the development and implementation of two projects students have designed and built that focuses on solar thermal energy, primarily for water and space heating. Students enrolled in renewable energy classes in the Industrial Technology program have successfully accomplished a variety of alternative energy projects. These projects included a hybrid 2KW wind and photovoltaic power generating system, a solar tracking system with 170W solar module, installation of a skylight, an electric boat, hydrogen fuel cell training unit, human power e-bike, renewable energy training unit and recently a solar thermal space heating and solar thermal water heating systems. Both the air and water heating systems were implemented and tested by different groups of students. The learning outcomes of the students were: a) learned the viability of solar air and water heating technology, b) determined the applicability of the systems, c) investigated the efficiency of both systems in different locations and angles, and d) studied how these systems vary in different seasons. In order to provide mobility for the two projects, wheeled carts were designed using a computer design and drafting software tool. After the design of the complete system (with real dimensions), was approved by the instructor, the wheeled carts were built to test both systems in different locations and at different months of the year.

Solar Thermal Space Heating

Solar air heating systems are a supplement to regular heating systems and can dramatically reduce heating cost. A solar air heater transfers solar radiance into heat. Air in the building is circulated through a collector on an exterior wall where it can gain up to thirty degrees before being vented back into the room. The SolarSheat 1500G panel heats inside air. The amount of heat is based on the volume of air passing through the solar panels and the degree of sunshine. It is a supplemental heating system and does not work at night. Figure 1 shows the diagram of a 1500G space heating system (Your Solar Home Inc, 2005).

Figure 1. Schematic diagram of how the 1500G works



A 1500G glazed secondary air heater (passive device resembling a large door) was mounted on a mobile triangular shape wood structure built by students. A DC powered Fan with a thermostat was used to circulate the air for measurement and test purposes. The air circulation and quality of warm air were tested at different times and locations during the day and under different weather conditions. Using the portable solar air heating system shown in Figure 2, the following questions

were assigned to guide the student research and air heating systems.

- Does a solar air heater work at night?
- Can I mount the air collector upside down?
- What happens during cold weather?
- Can I mount the system horizontally?
- How long does the installation of the system usually take?
- How does the efficiency of the system change with a change of tilt angle of the module?
- Will it produce heat on cloudy days?
- Do air heaters need to face true south and at a tilt angle of 90 degrees to the sun?
- Do windy days affect the efficiency of the module?

Figure 2. Solar air heating system

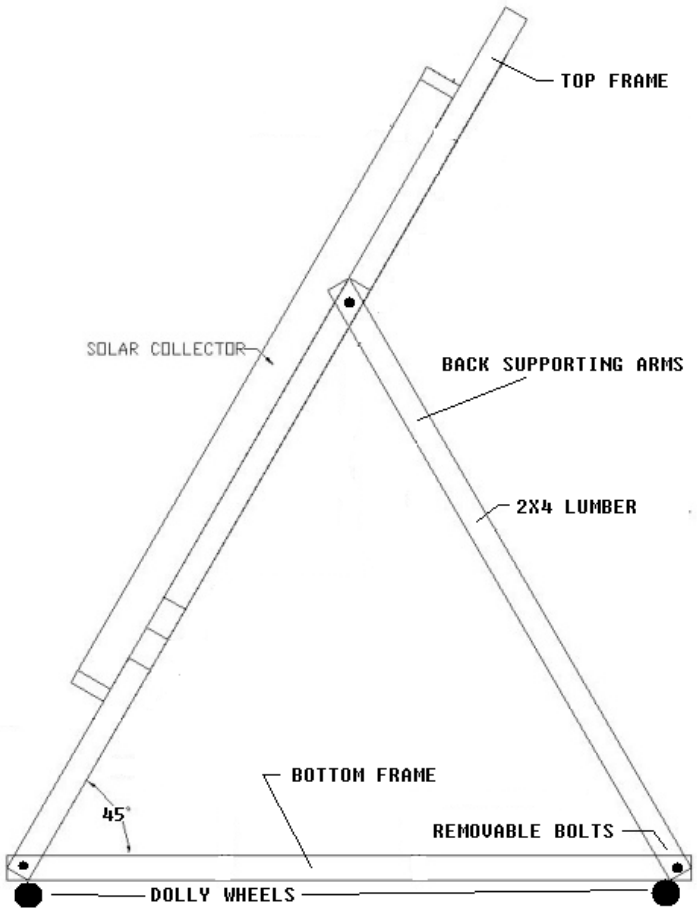
The purpose of this project was to create a solar air heater for the purpose of teaching students about solar space heating systems. Solar air heating systems are supplemental heating systems that work in conjunction with, but independently of, the main heating system. The more hot air produced by the solar air heater, the less the primary heating system has to work and, therefore, the less fuel consumers have to purchase. Solar air heating systems are different from most traditional heating systems in that the heating fuel is entirely free. With a solar air heating system, the initial (and only) investment is the air heater and the installation cost.

For this project the student groups were given a solar space heater and assigned the task to build a supportive stand that could be adjusted to different angles for test purposes. Students were allowed one semester to complete the assigned task. In the final design of the supportive stand the arms and legs were built to raise the air heater to 45 degrees. Mounts were attached in order for the air heater to be adjusted to different angles. One of the important things that students had to do was to make sure that it was easy to move. This was achieved by putting casters on each leg of the stand. The wood structure was adjustable in order to allow the air heater to lie flat. This design made it easy to store the unit when not being used.

Procedure

The assignment was for the students to design and build a stand with wheels to turn the SH 1500G solar air heater into a standalone training unit that could be folded flat. Transported to test sites. Stored for a long periods of time. Students began the design process with the following data: how much weight the stand needs to hold, the weight of the collector (roughly 82 lbs), and the need for the stand to collapse or fold for storage. Finally, the project groups had to determine the optimum angle for sunlight to reach the solar collector. The design of the frame is shown in Figure 3.

Figure 3. Frame diagram



Solar Thermal Water Heating

Solar water heating improves the daily lives of owners, especially during warm days, as it reduces the need to heat water on the regular water heater. During cold days, the solar water heater is usually drained to protect it from freezing, and users resumed heating water in the regular heater. Today, about 1.2 million buildings in The United States have solar water heating systems. This number does not include about 250,000 solar-heated swimming pools (Solar Water Manual, 2006). There is still a lot of room for expansion in the solar energy industry due to increasing oil prices and global warming issues. There are no geographical constraints. For cold climates, manufacturers have designed systems that protect the components from freezing conditions. Solar water heating systems can work wherever the sun shines. In the United States the use of solar thermal systems is a major factor in the residential realtor market. This has a large impact on local and national energy usage and conservation. Conventionally, the primary use of solar thermal in this market has been for swimming pools, domestic water heating, as well as space heating. The easy method of harvesting energy is to expose fluid-filled pipes to the sun's rays. Modern solar collectors, which heat water for pools and general household use, are constructed from a combination of magnifying glasses and fluid-filled pipes that run through the collector.

Students involved in this project learned to distinguish the difference between solar electric and solar thermal, have an understanding of the uses of both, have a good understanding of how to identify a proper site for a solar thermal system, and have resources to explore local installation options. Initially a wheeled cart was designed using a computer design software tool. All major components were shown in the design. After the instructor approved the design of the complete system (with dimensions) a wheeled cart was built to test the solar heater system in different locations. The passive solar water heating system is shown in Figure 4.

Figure 4. Solar water heating system

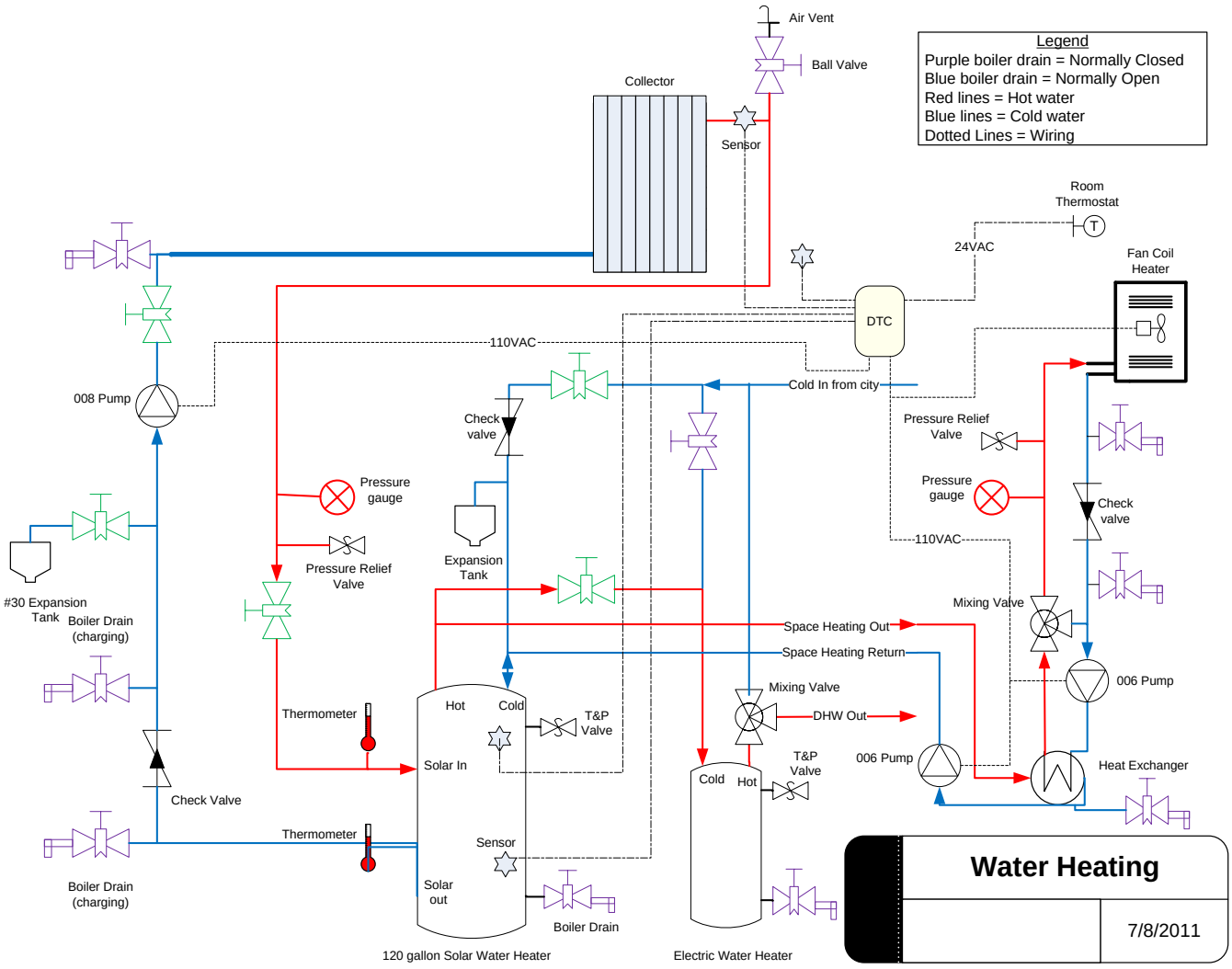
The Solar Water Heating System shown in Figure 4 was constructed using the following components:

- 2'X3' Sample Collector
- Standard Mount Kit for AE Series
- 100 PSI Pressure Gauge 1/4" MPT
- D5/710B PV Circulating Pump- threaded
- 35-250F Thermometer
- 10 Gal. SS DB Tank w/ Heat Exchanger
- 3/4" Cast Iron Flanges
- Taco 1/40 HP Bronze Pump, 0-6 GPM
- Eagle 2 Differential Temperature Control w/t Display
- Air Vent, 150 PSI, 1/4" MPT
- "MAXI-FLOW" Spring Check Valve, 3/4" SWT
- 3/4" 2-WAY Sweat Ball Valve
- Kyocera KS10 10W 12V Solar Panel
- AET PV Mount
- Whirlpool 15G Tank w/ Electric Element
- TACO 1/25 HP Cast Iron Pump, 0-14 GPM
- Eagle II Data Port Adapter
- 3/4" Boiler Drain
- GPM Flow Meter
- 150 PSI Pressure Relief Valve

Procedure

In this project students were provided a detailed diagram of the system in order to study the components and connections. The students became familiar with the components of the water heating system in the classroom before beginning work on the projects in the laboratory. Using the provided diagrams and manuals, students investigated and built two heating systems that will be used to teach students in future labs. There were some sections of the project that were going to be completely connected only one time. These sections were the piping and electrical connections. Figure 5 presents the detailed diagram of the solar water heating trainer.

Figure 5: Solar water heating diagram



Conclusion

Industrial technology students successfully accomplished two different projects with faculty advisement by taking independent study and renewable energy courses. During this project students learned how a solar air and water heater will transform solar energy into heat. Students also understood that through convection, warm air naturally moves up. This requires you to install a one way fan to move the warm air down making the warm air travel out slower and have more time to heat up by conduction from the solar radiance. The instructor received positive feedback from the students about the projects they completed and especially the content of the renewable energy classes. There are many students interested and want to become involved in such projects and eager to learn how those technologies work. Due to budget considerations

it is not possible to purchase all the necessary equipment to involve students in the projects. However, students have talked to local companies to get major discounts on the tools and equipment they need. Some students are beginning to take independent studies and bring their own tools and minor equipment to start projects in which they are interested.

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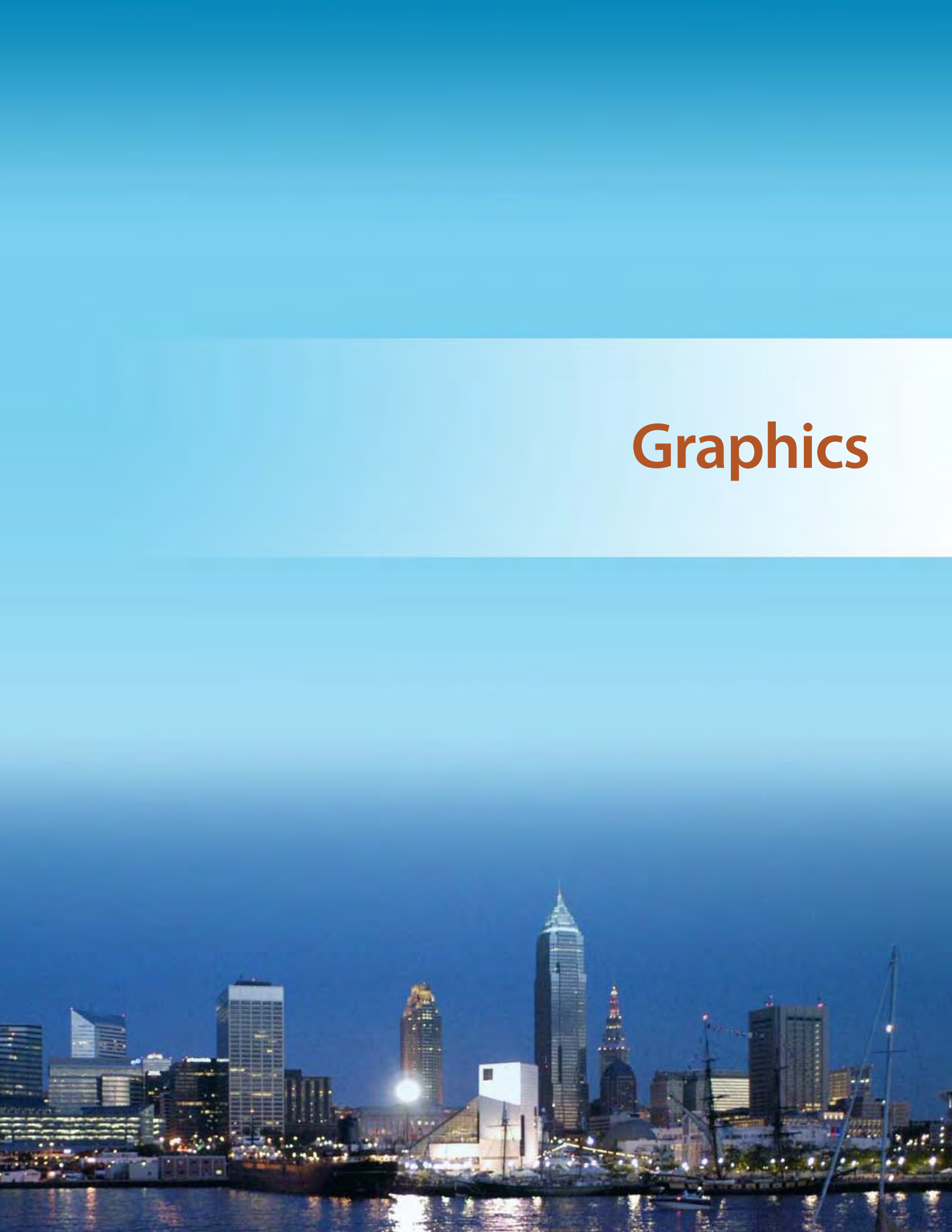
Graphics



Converting Legacy Maps into 3D Models

Selected as the Best 2011 ATMAE Conference Proceedings Paper!

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Abstract
This research investigates methods and work flows for the conversion of legacy mapping to digital format. Study areas for the work included three oil fields in the Illinois Basin for which legacy mapping was available. The research identified specific workflows for digitizing, a defined suite of maps and digital products as project deliverables, and development of three dimensional models for management presentation. The outcome of this work demonstrated a relatively low cost method for increasing the return on monies invested in subsurface exploration.

Introduction
Legacy mapping refers to existing hardcopy maps and map products showing past work. Such mapping is often the result of significant field work and intellectual effort; as such, it represents a substantial monetary investment. A significant amount of legacy mapping currently exists as proprietary industrial information, and in the absence of new exploratory data, this mapping may still be current, even if completed decades ago. Current use of legacy map data represents a further return on the original investment. This use is facilitated when legacy map data are available in digital format.

Hard copy-to-digital conversion typically involves digitizing of a hardcopy map. In theory, digitizing is simple and straightforward; in practice, it can be time consuming and expensive. Digitizing needs thoughtful planning and careful execution to ensure that digital products retain original mapping precision and meet management expectations for data use. When the digitizing process is directly followed by the development of basic digital mapping products, data from legacy mapping can be used immediately for asset management and presentation graphics. Basic mapping from the digitizing process provides a basis for enhanced geological interpretation, three dimensional (3D) subsurface modeling, and plotting of the 3D relative location of adjacent fields.

This research describes experience in the hardcopy-to-digital conversion of legacy mapping and the presentation of these data as standard, 3D map products. Mapping used is that of oil and gas fields located in the Illinois Basin. The work done is intended to support the location of by-passed hydrocarbon resources in the basin. The U.S. Geological Survey estimates these as including 214 million barrels of oil and 4.65 trillion cubic feet of natural gas (Swezey, 2007). Specifically, this work addresses the following questions: (1) How can digitizing work flow be organized to decrease cost and time? (2) What basic work products can be directly output during legacy map conversion? (3) How can legacy map conversion deliver immediate utility?

Previous Work
The digitizing process is well known and is discussed at length by a number of authors (Krygier, J. & Wood, D., (2005); Lo, C.P. & Yeung, A.K.W. (2007); Longley, P.A., Goodchild, M.F., Maguire, D.J., & Rhind, D.W. eds. (1999); Demers, M.N. (2005); and Kellie, (2010b). Digitizing typically proceeds in three steps: map calibration using georeferenced coordinates, the digitizing process itself, and quality control and data export to the mapping or modeling program.

Legacy mapping may employ almost any datum as a geometric basis for mapping. Regardless of the current coordinate system, legacy mapping needs to be georeferenced to a defined coordinate system prior to digitizing so that a consistent mapping system results. Once mapping is available in geodetic coordinates, conversion is possible to any map projection. Conduct of the digitizing program is described by Demers (2005). He suggests use of a defined order for digitizing features and use of common feature (attribute) names. Kellie (2010b) states that features should be digitized using standard layers to facilitate export.

Quality control for the digitizing process is discussed by Lo and Yeung (2007), and Kellie (2009; 2010; 2011). Lo and Yeung (2007) suggest digitizing discrete points as opposed to streaming data to minimize data set size. For quality control, Walsh and Brown (1992) propose redigitizing and volume computation, while Kellie (2011) suggests using RMS error to ensure calibration quality, and using the congruence method for evaluating digitizing precision.

Delay in receipt of deliverables is a common complaint by persons contracting for, or directing, legacy map conversion. Immediate delivery of a standard map set for each field directly following digitizing makes completed mapping available for both technical and management use. Map types to be included as deliverables depend on the intended use, but examination of current technical reports show use of traditional planimetric maps, structural contour and isopach maps, stratigraphic sections, cross sections and 3D block diagrams (Ciftci, et al. (2004); Dull (2004); French & Kearns (2004); Matsuda, et al. (2004); McNeill, et al. (2004).)

Procedure

Based on the above, work was undertaken to address the questions posed at the beginning of this paper. Three existing oil and gas fields for which legacy mapping was available were selected as study areas. These were: Apex Consolidated (Rose ,1968); Kincaid Consolidated (Dean, 1988); and Mode (Zuppann & Kerrigan, 1988). Figure 1 shows the location of each oil field.

Figure 1. Study area location map.

Prior to beginning work, digitizing protocols were developed, standard map deliverables were identified, and methods for generating immediate return on the digitizing effort were examined. Digitizing protocols specify procedures intended to organize the conduct of work, ensure work quality, and minimize errors and omissions. The protocols used in this work were: (a) use of the state plane coordinate system for all georeferencing; (b) employment of a layering scheme for all digitizing; (c) use of the congruence method for quality control.

Deliverables for each field included: (a) traditional two dimensional structural contour and/or isopach maps with longitudinal and lateral sections; (b) three dimensional surface and/or isopach models; and (c) a three dimensional polychromatic wireframe model for use in technical presentations. A common mapping format was developed. This included a standard title block, listing of map type, location map, company name, and map metadata (horizontal datum, vertical datum, and map source).

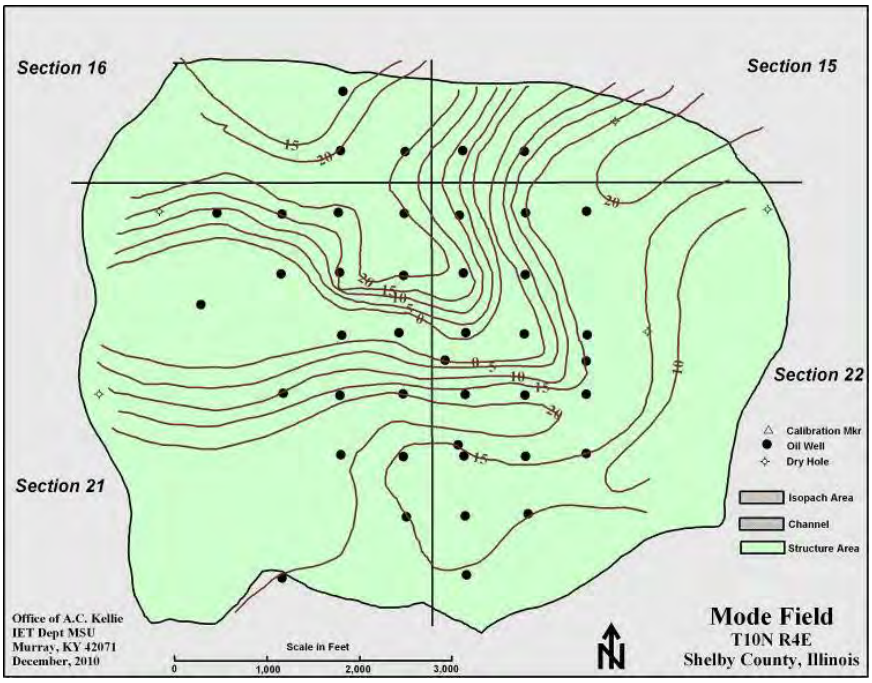
Results

Results from this research addressed the three questions posed at the beginning of this research: (1) How can digitizing work flow be organized to decrease cost and time? (2) What basic work products can be directly output during legacy map conversion? (3) How can legacy map conversion deliver immediate utility? These are addressed by topic below.

Work flow

Didger software (Golden Software, 2001) and a CalComp digitizing table were used for all digitizing in this project. Digitizing employed the protocols described.

Figure 2. Results of digitizing for Mode Field.



Georeferencing for all mapping used the appropriate state plane coordinate system. The Coordinate Conversion Tool of the Kentucky Geological Survey provided geodetic coordinates for Apex Consolidated (Kentucky Geological Survey, 2010). Earthpoint (2010) provided geodetic coordinates for Kincaid Consolidated and Mode fields. The Geodetic Toolkit of the National was used to convert geodetic to state plane coordinates (National Geodetic Survey, 2010).

The standard layering scheme included contours, isopachs, oil wells, dry holes, faults, gas wells, land system, text, and blanking area. Additional layers were generated as needed by the specific field. Figure 2 shows some of the results of digitizing at the Mode field. Because of data density, only selected layers of the map are shown.

Data from digitizing were exported as both (x,y,z) data files and graphics files to Surfer (Golden Software, 2002) software. Surfer gridded the x,y,z data for use in contouring and modeling. To test model quality, contours from gridding were overlain on graphic contours to test the degree of congruence.

Figure 3. Congruence test for Apex Consolidated.

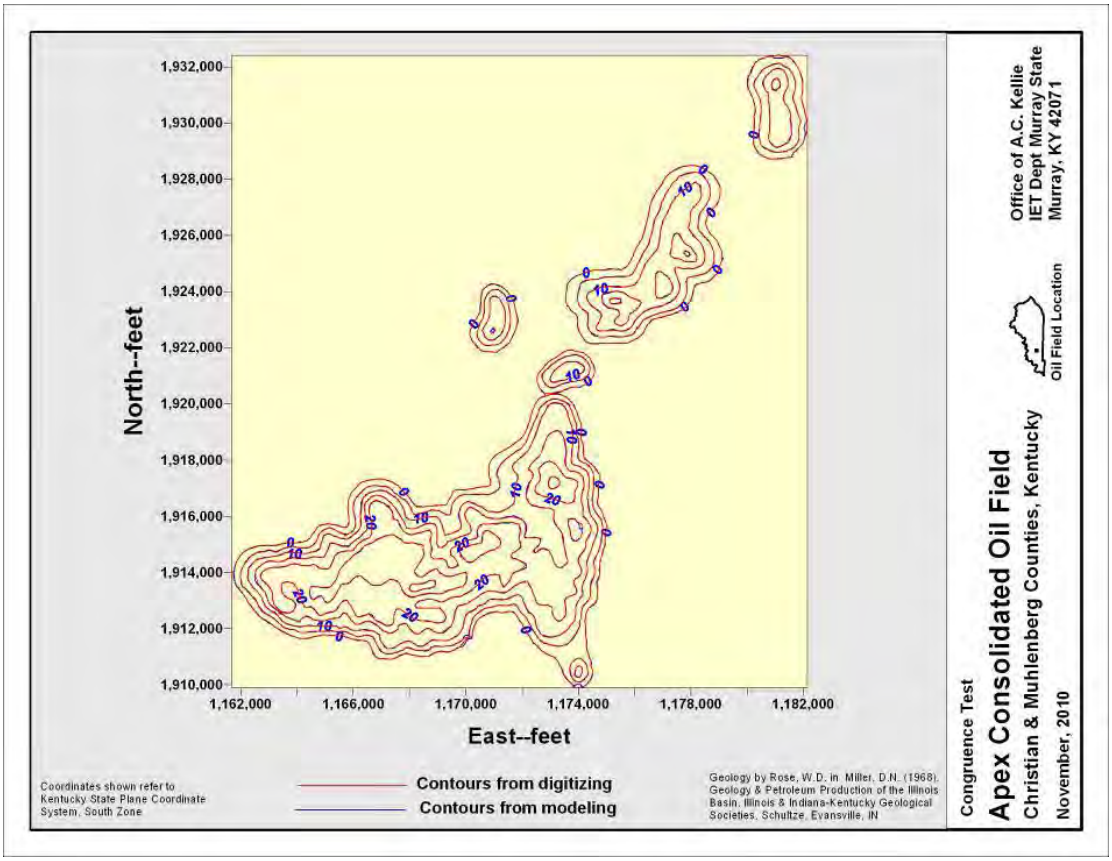


Figure 3 shows a typical contour validation map. If gridding and graphic contours were not congruent, supplemental contours or spot elevations were digitized on the legacy map. The process was repeated until the two sets of contours matched.

Work products

Preparation of a digital data file and map template for each field facilitates development of a suite of map products for immediate use. In this research, three map products were developed for each field: (a) a standard 2D structural contour or isopach map; (b) a 3D subsurface model with isoline drape; and (c) a 3D polychromatic wireframe model intended for technical presentation.

Figure 4 shows a standard isopach map for Apex Consolidated. This map employs a digital image map as a background. Isopachs are draped over the image map. A brown hue is used to show the Jackson sandstone and the standard pattern for sandstone is used for the sections. Because the features mapped are interpreted as barrier islands, blue is used for the map background. Although figure 4 shows a traditional map product, the use of tint, color, and pattern aids interpretation, and because the image is available in digital format, revision or editing is facilitated.

Figure 4. Standard isopach map and sections for the Apex Consolidated field.

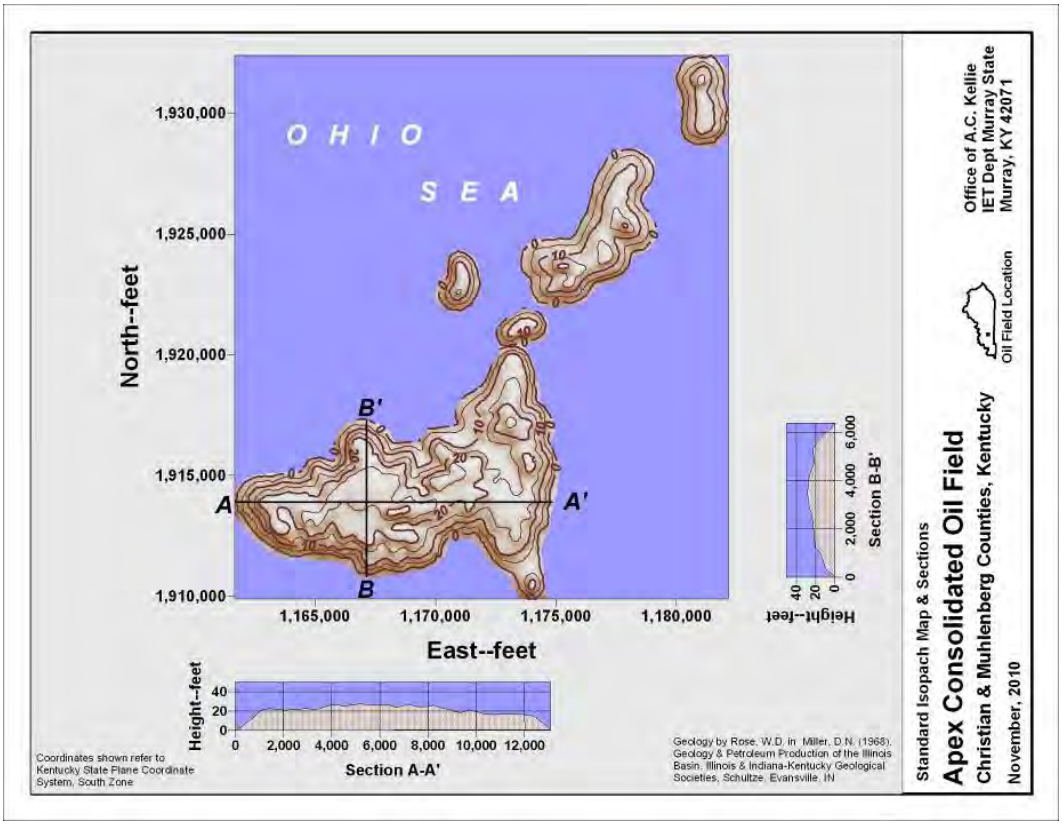
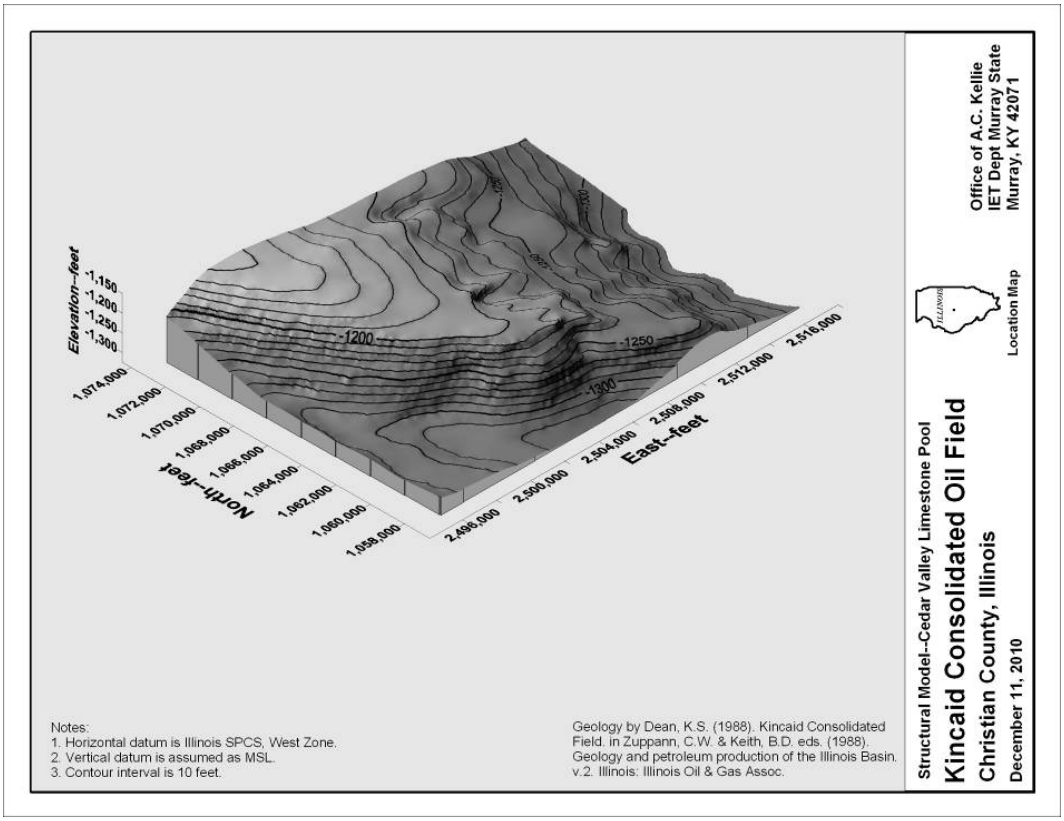


Figure 5 shows an example of a 3D structural model for Kincaid Consolidated. A gray color is used to represent limestone on what is interpreted as an anticlinal nose.

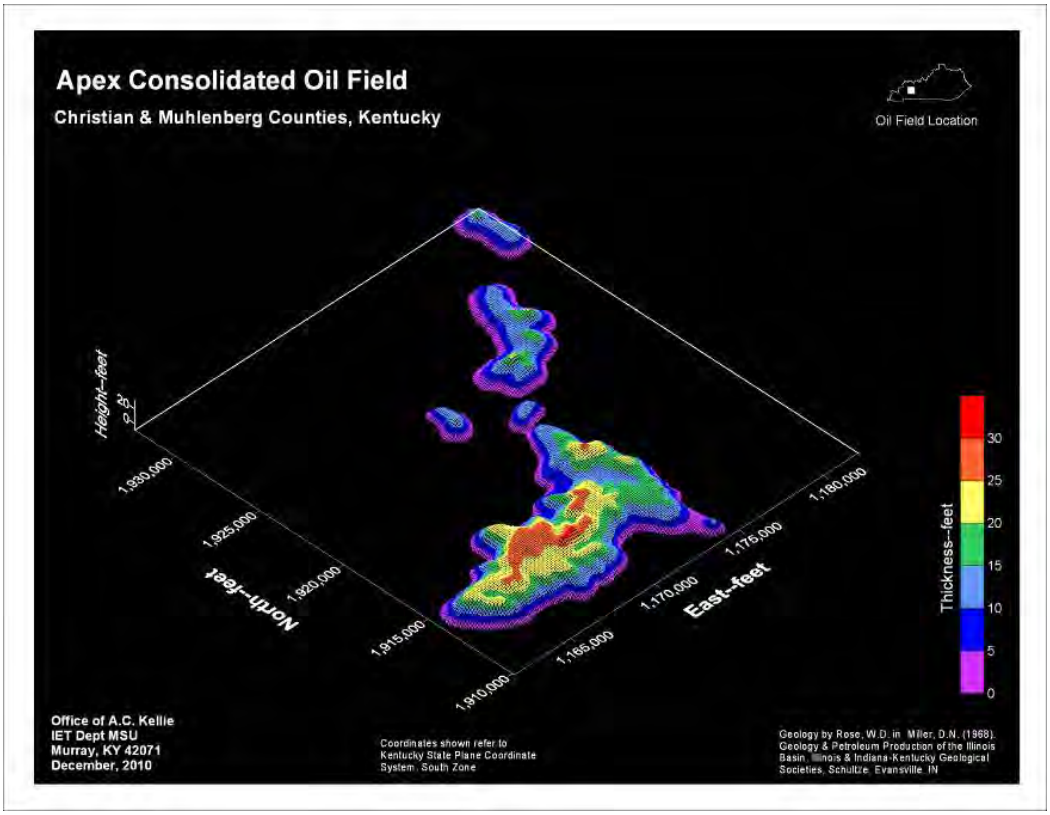
Figure 5. Three dimensional structural model of the Kincaid Field.



Contours are used to show surface elevation below sea level. An orthographic projection is employed with a model rotation of 45 degrees and a tilt of 35 degrees. The resulting view is from the southwest corner of the site.

Figure 6 shows the polychromatic wireframe model developed for Apex Consolidated. Unlike the other products developed in this work, the wireframe model was intended for use in technical presentations that would be projected in a darkened room. A polychromatic color scheme on a black background focuses attention on the model. An orthogonal projection is used with a model rotation of 45 degrees and a tilt of 40 degrees. The view shown is from the southwest corner of the field.

Figure 6. Polychromatic wireframe model of the Apex Consolidated Field.



Immediate utility

A map conversion project involves an investment of time, money, and resources. Outcomes should support both technical and management objectives. This research suggests two methods for doing this.

First, the conversion project should be conducted incrementally, i.e., on a field-by-field basis. There are two reasons for this. First, digitizing results require verification before being accepted as precise models of legacy map data. For example, this research showed a routine need for supplemental digitizing in areas of low relief. Digitizer recalibration and setup time for supplemental digitizing can be avoided by verifying digitizing quality before moving on to the digitizing of another field. Second, repetitive elements in the conversion process can be identified and automated early in the project. For example, in this research the need for standard graphic elements—title block, company logo, location map, map metadata—wasn't apparent until the deliverables were being prepared.

Second, outcomes from the conversion should include both data and graphic products. These should be posted to the company server or project website immediately after being completed and verified. Digital data can be used by engineers and scientists for work at a project level. The scientist or engineer will manipulate the data as needed. Graphic outcomes can be used by management to support work at a strategic level. The difference in the deliverable must be recognized during the conversion process. For example, this project used a different graphic format—background, arrangement, and color—for presentation graphics than for standard mapping.

Conclusions

This research showed that legacy map conversion can provide accurate digital information from existing hard copy mapping in a timely manner. Experience with this work resulted in the following conclusions: First, digitized data must be validated prior to use in modeling. This prevents use of incorrect data in mapping, modeling, and decision making. Second, the conversion project should be conducted in an incremental, field-by-field, manner. Working thus facilitates data validation and identifies process work flow problems. Third, conversion results should be posted immediately for use by others. The posting should include digital data, a limited suite of standard map products, and presentation graphics.

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Management

Toward a Technology Management Core: Defining What the Technology Manager Needs to Know

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Introduction

With the increasing demands on organizations to do "more with less," and produce acceptable market results, productivity and performance standards continually raise the expectations on competitive success. To meet these expectations, organizations should create learning opportunities that combine the application of technical management skills along with the softer skills involved in people management. Technical managers with little training or past experience with non-technical skills often perform poorly in technical management positions (Kroecker, 2007). Because this generation lives in a highly technical environment, managers need to be proficient in dealing with knowledge workers and systems; therefore, there is a growing emphasis on the application of management competencies (Thamhain, 1990). Additionally, as the baby boomers shift from the marketplace to retirement, experienced technical leaders will be exiting the workplace. Within the next 10 years, the U.S. will experience a greater than threefold surge in leadership turnover in engineering and technical organizations, increasing the competition for a progressively scarce resource (Vieth & Smith, 2008). As indicated above, the necessity for competent technical managers will be a critical success factor for organizations to stay competitive.

Given that today's labor market demands graduates who are competent in both technology and management, higher education has the opportunity to produce these graduates. For example, the Dulaimi study (2005) highlighted the need for academic and professional development programs to provide the right balance, in content and emphasis, between the technical knowledge and the people management skills for young professionals. Unfortunately, higher education is reacting slowly despite the need to develop graduates who are technically competent managerial professionals. The mission of the Association of Technology, Management, and Applied Engineering (ATMAE) is to educate professionals dedicated to solving complex technological problems and developing the competitive technologist and applied engineering workforce. These technology management professionals or technologists are described in various ways.

The National Research Council defined technology management as the link between science, engineering, and management (1987) and (ATMAE) described it as the "field concerned with the supervision of personnel across the technical spectrum and a wide variety of complex technological systems" (2009, para. 6). The International Technology Education Association (ITEA) identified the characteristics of a technologically literate person as an individual who has knowledge of processes to develop systems within practical contexts that solve problems and extend human capabilities (2006). With such a wide variance of characteristics used to describe the technologist, i.e., technical managers, the body of knowledge is not clearly defined for technology management. The authors of this paper support the development of a common technology management core with appropriate and defined competencies. The purpose of this paper is to describe a core body of knowledge using competencies as a base for a technology management model. In order to accomplish the purpose, the authors asked the following questions:

- What is the core body of knowledge for an entry-level technical manager?
- What are the core competencies for an entry-level technical manager?

The remainder of this paper will focus on the basic elements of a technology management core body of knowledge, entry-level competencies of technical managers, and introduce a competency model.

Technology Management Core Body of Knowledge

As organizations advance technologically, the need for technical leaders will be vital. In benchmark companies like Rockwell Automation and GE Healthcare, the identification and development of the next generation of technical leaders is a strategic imperative (Vieth & Smith, 2008). Promoting individuals based solely on technical knowledge is becoming more difficult due to the need for sound managerial decisions across technically complex environments. Nair, Patil and Mertova (2009) found a competency gap between engineering traits of graduates and the expectations of employers. They asserted that students need a combination of technical (hard), managerial (soft) and global (multicultural communication) competencies to be successful. Additionally, the Society of Manufacturing Engineers' (SME) Manufacturing Education Plan: Phase 1 (1997) and Phase 3 (2001-2002) reported the following competency gaps in order of importance: business knowledge skills, project management, written communication, supply chain management, oral communication, international perspective, quality, problem solving and teamwork. The proficiency of graduates is measured by entry into the job market and long-term career success. Education and professional development increase the proficiency of graduates and close the competency gaps.

Historically, higher education focused on the education process or the inputs into the systems. Now, higher education is increasingly asked to provide student outcomes or competencies (Allen, Ramaekers & Velden, 2005). At the university level "Technology Management programs typically include instruction in production and operations management, project management, computer applications, quality control, safety and health issues, statistics, and general management principles" (ATMAE, 2009, para. 6). In fact, a required management curriculum is what distinguishes ATMAE accredited four-year programs from two-year programs. It also distinguishes the discipline from pure engineering programs (i.e., mechanical, electrical, civil, etc.). The American Society for Quality (ASQ), the Association for Operations Management (APICS), and the Project Management Institute (PMI) all have well-recognized bodies of knowledge for their professional constituents. However, ATMAE accrediting standards do not specify a core body of knowledge for management; only a range of required hours (12-24) and a list of potential subjects. In addition, the current content areas of production planning and control, quality, safety, and management on the Certified Technology Manager (CTM) exam are not aligned with the accrediting standards or with a recognized body of knowledge for technical management. Although there are planned revisions to both accreditation and certification standards, there is no coordinated effort to align these revisions with a recognized body of knowledge.

Using published literature and previous studies, a common perspective of technology management is attainable within the discipline. However, as Minty (2003) explained, this must be undertaken with knowledge that technology management is neither grounded in general business nor engineering, but is a unique body of knowledge grounded in sociotechnical management. The term socio-technical refers to people and technology or systems. Engineering and industrial technology programs have used terms associated with socio-technical theory such as six sigma, continuous improvement, autonomous teaming and re-engineering (Shaughnessy, 1977). Sociotechnical systems reveal the interdependence of technology, people, the external environment and the work design (Hendrick & Kleiner, 2001, p. 26). As the authors gathered a sociotechnical framework for a body of knowledge, it was necessary to determine the appropriate competencies.

Technology Management Competencies

The progression toward competencies is recognized by higher education. Educational institutions are now being asked to provide measurement of student learning. Developing a competency model for technical managers enables higher education to prepare students for the workforce. Meier, Williams, and Humphreys (1997) summarized the competencies deemed essential for success of newly hired employees. The competencies were grouped into seven thematic areas ranked in order of importance: communications, quality, cultural values, team development, technology, contemporary business concepts and problem solving. Additionally, Meier and Brown conducted a follow-up study in 2008, which yielded similar competencies.

Competency modeling is an organized structure for defining the skill; knowledge and attitude (SKAs) that students need to know to be proficient in their field of study and ultimately their career. Competence is a function of performance that goes beyond knowledge. Competencies can be defined as observable behaviors exhibited by technical mangers that are successful, both in terms of their results and the process or behavior, in enabling those results (Teodorescu, 2004). Approaches to competency model development include selecting competencies from lists to field research on competencies. Calhoun (2008) created a Health Leadership Competency Model through a literature review, expert panels and surveys. She described the development of the model using reverse engineering. The model development included approaching sought after outcomes, then determining the appropriate behaviors and developing the core technical and

managerial competencies. Rifkin, Fineman, and Ruhnke (1999) developed a competency model that contained a hierarchical framework of the technical manager's role, critical accomplishments, work activities, skills, knowledge and personal attributes. Because of the sheer rigor, expense and time commitment of competency development, other methods have surfaced that are also reliable. The panel method is a where a group of experts collaborate to develop a set of competencies (Rajadhyaksha, 2005).

Choosing a competency-based model for the technology management core supports the change of ATMAE accreditation standards from a traditional approach to an outcomes based approach (ATMAE, 2009). The Outcomes Based Accreditation Model is based on the philosophy that programs are educating technical managers on student learning outcomes that are in high demand from industries that hire technical management graduates. The traditional approach to accreditation was to create a set of standards and activities that each program aspired to achieve. The outcomes-based model strives to create a closed-looped process that defines technical management competencies, assesses effectiveness through placement and success of graduates, and improved upon by industry expectations.

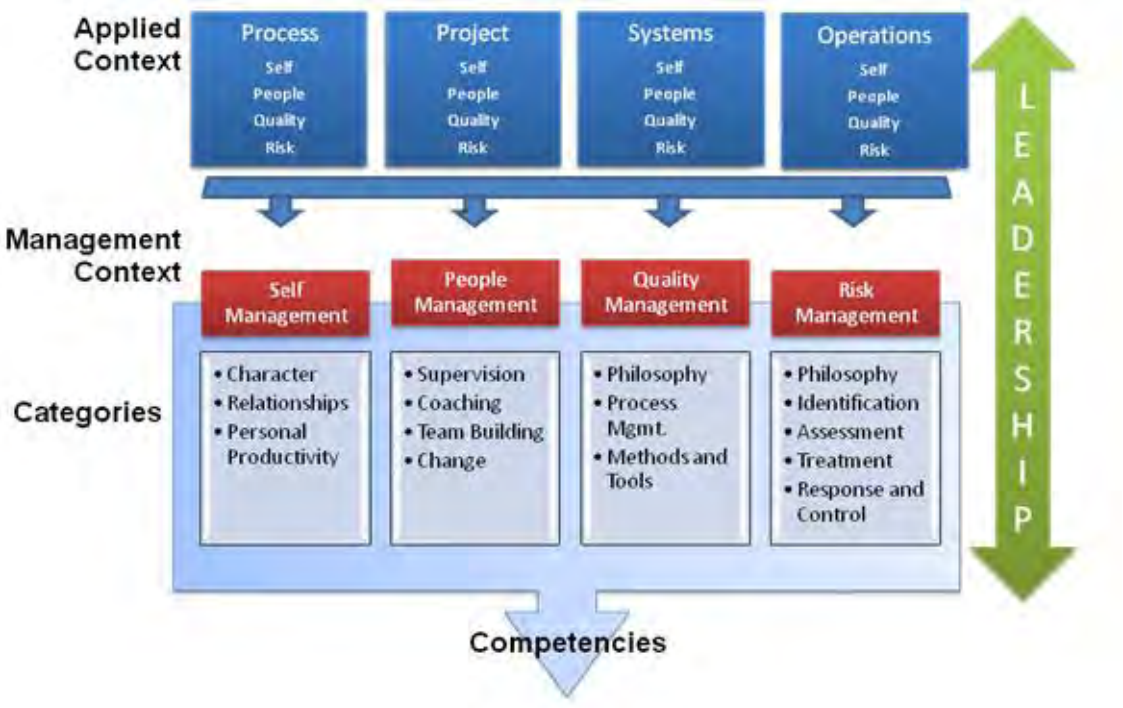
Methodology

The competency development approach used in this paper is based on research of existing models and panels of industry and educator expertise. The Management Division of ATMAE formed a sub-group in 2010 to begin to define a technology management body of knowledge and a set of core competencies. Based on the sub-groups interaction with industry, industry experience, and academic experience in technical management, the sub-group developed an initial competency model. The initial competency model was discussed with industry professionals and networks of the sub-group, presented to advisory board members of ATMAE accredited programs, and reviewed by ATMAE members at a conference forum. In addition, the competency model was benchmarked against existing literature and research. After multiple revisions, based on input from educators, industry professionals, and research, a management core model was developed and presented below.

ATMAE Technology Management Competency Model

The management core model shows the generic entry-level competencies for a technology manager within a category of knowledge for a specific managerial context. The competencies are applicable to systems, operations, processes, or projects and linked throughout by accepted leadership principles. See Figure 1 for an overview of the model.

Figure 1. Technology Management Model



To understand the model, it is important to define the contexts, which are the situations or environments where the competencies are applied. The project and process environments are well known with projects being the one-time application of processes to produce a unique product or service. Systems refer to the management of technology across disciplines and companies in an integrated fashion for the purpose business venture and development. Supply chain management is an example. Operations, on the other hand, are the management of technology within a specific industrial specialty. Common industrial contexts would include those listed by the Bureau of Labor Statistics (BLS, 2011) such as manufacturing, construction, telecommunications, or retail trade. It is the assertion of the authors that the same competencies are utilized regardless of the applied context and can be classified into four management areas. The managerial context areas are self-management, people-management, quality-management, and risk-management and are well-supported in literature. While the literature may refer to them using slightly different terms, they are mentioned in leadership and management writings frequently. For example, it is well-accepted that in order lead people effectively a manager must have self-management (Covey, 2004; Rajadhyaksha, 2005). The other two threads that run through literature consistently are managing quality and risk.

Within each management context, competencies are categorized into generic and recognizable themes. From this, specific competencies were developed to assess content and outcomes. The competencies are purposely broad to allow for flexibility and interpretation. The competencies may have popular synonyms that could be justifiably used instead. Rather, the intent is to establish a baseline for further refinement. See the Appendix for the full model. To illustrate, the competencies for the self-management context are shown in Table 1.

Table 1. Self-Management Competencies.

Category	Competency
Character	• Values • Integrity • Responsible • Capable • Enthusiasm
Relationships	• Communication • Cooperation • Emotional/Social • Spiritual • Trust • Influence
Personal Productivity	• Motivation • Resourcefulness • Discipline • Knowledge • Passion • Vision

Next Steps and Future Challenges

Without a recognized and accepted body of knowledge for technology management, the discipline of industrial technology, engineering technology, and applied engineering will continue to be confused with other technical disciplines. Clarity regarding the socio-technical competencies of technology management is imperative. These competencies should be congruent with ATMAE accreditation standards and CTM certification. In order for technology management programs to survive and thrive, these competencies should be recognized internationally. ATMAE membership and industry advisory boards should discuss and provide feedback on these technology management competencies. In particular, the Management Division of ATMAE must take a lead role in its refinement. Adoption of technology management core competencies should be incorporated into the CTM exam. With an agreed upon and certified body of knowledge, educational learning outcomes that are congruent with industry needs and revised accreditation standards for technology management will result. The next steps are to gather additional expert feedback through panel discussions with educators and industry personnel; sending the model for adoption by ATMAE through a vote of the Management Division members; and aligning the model to certification.

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Appendix - Technology Management Competency Model

Figure A1. ATMAE Management Model

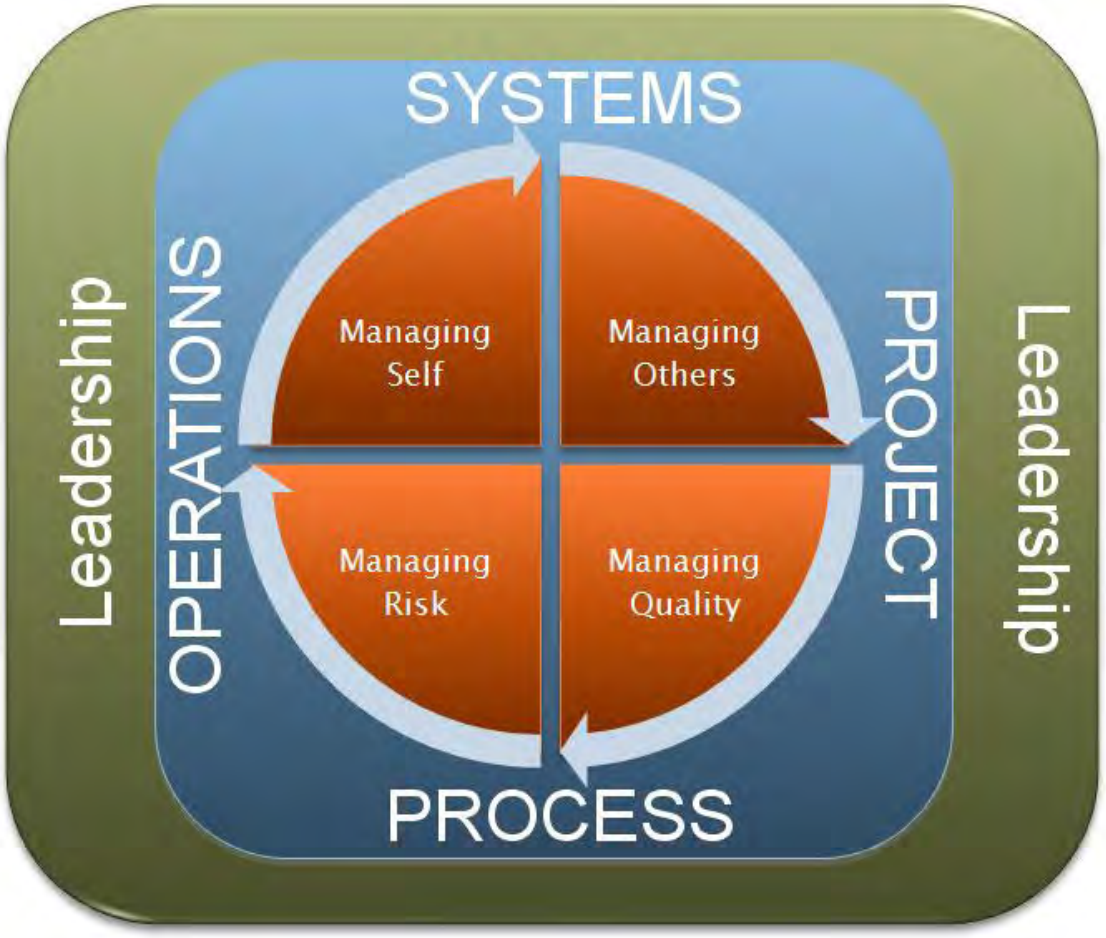


Table A1. Self-Management Competencies

Category	Competency
Character	•Values •Integrity •Responsible •Capable •Enthusiasm
Relationships	•Communication •Cooperation •Emotional/Social •Spiritual •Trust •Influence
Personal Productivity	•Motivation •Resourcefulness •Discipline •Knowledge •Passion •Vision

Table A2. People Management Competencies

Category	Competency
Supervision	•Planning •Organizing •Staffing •Leading •Controls/reporting •Resource allocation •Decision-making •Listening
Coaching	•Mentoring •Counseling •Appraisal
Team Building	•Facilitation •Problem solving •Group dynamics
Change	•Alignment •Empowerment •Respect •Support

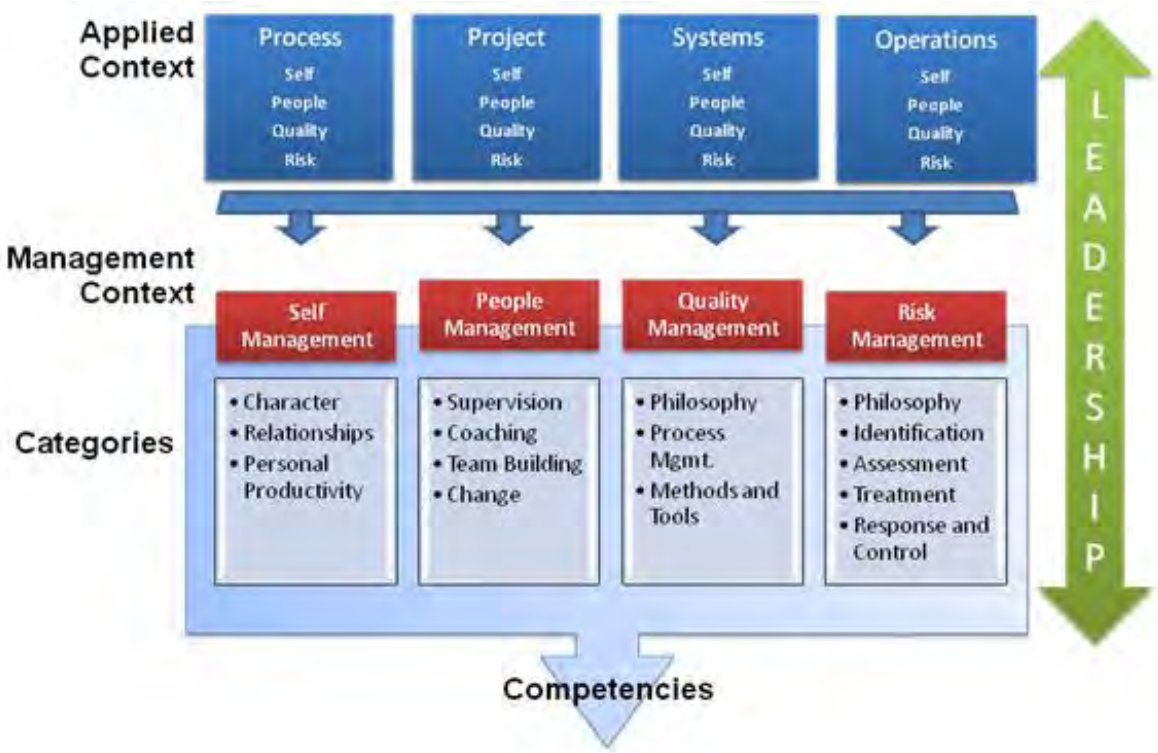
Table A3. Quality Management Competencies

Category	Competency
Supervision	•Planning •Organizing •Staffing •Leading •Controls/reporting •Resource allocation •Decision-making •Listening
Coaching	•Mentoring •Counseling •Appraisal
Team Building	•Facilitation •Problem solving •Group dynamics
Change	•Alignment •Empowerment •Respect •Support

Table A4. Risk Management Competencies

Category	Competency
Philosophy	•Culture and context •Objectives •Risk tolerance/appetite
Identification	•Opportunities •Tools and techniques •Risk taxonomies
Assessment	•Analysis •Drivers •Prioritization
Treatment	•Treatment selection •Action planning/mitigation
Response and Control	•Policy deployment •Governance •Evaluation •Compliance and reporting

Figure A2. Technology Management: The Full Model



Nanotechnology

Enriching Engineering Technology Curriculum through the Introduction of Nanotechnology

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Abstract
Nanotechnology has been utilized for more than 2000 years, but its importance has grown in recent times because of the large scale developments in the technologies that aid in the utilization of nanotechnology. Although many of us are not directing our attentions seriously towards nanotechnology, we cannot deny the fact that it is going to be the main ingredient in most of the objects that we are likely to come across in the near future. Therefore it is imperative that all engineers and technologists should be aware of what nanotechnology has to offer. This prompts the need for a well-educated and trained work force to sustain the growth of this nascent technology. This paper explores the opportunities and ways to incorporate Nanotechnology curriculum in Engineering Technology programs.

Introduction
The importance of Nanotechnology has grown in recent times because of the large scale developments in the technologies that aid in its utilization. It is already present in many of the electronic products that are being used today. Although many of us are not directing our attentions seriously towards nanotechnology, we cannot deny the fact that it is going to be the main ingredient in most of the objects that are likely to come across in the future. Therefore it is imperative that all engineers and technologists should be aware of what nanotechnology has to offer. A number of applications are already utilizing nanotechnology in day to day life. We may not be aware but they are already there. A few examples are: Solar Cells, Clothing, Batteries, Automobiles, Food and Beverages, Environment and Drug Delivery Systems. It is estimated that by 2015 we may require about 2 million nanotechnology personnel at various levels. A good number of them are going to be in the design and manufacturing of various devices that incorporate nanotechnology. The essence of nanotechnology is size and control. The properties of matter change drastically when they are reduced in size. With these special properties it is possible to obtain many new products which are not otherwise possible. The inclusion of nanotechnology in ETD (Engineering Technology Department) curricula will benefit these programs. This paper will present a case for including nanotechnology into the curriculum of most of ETD groups, so that enough trained personnel can be available that have the minimum training and understanding of the subject to be included in the nanotechnology job market.

Historical development and definitions of Nanotechnology
A lot of research is going on about the use of Nanotechnology to the future of mankind. What is Nanotechnology? A large number of definitions are being given for Nanotechnology. Some of the definitions are:

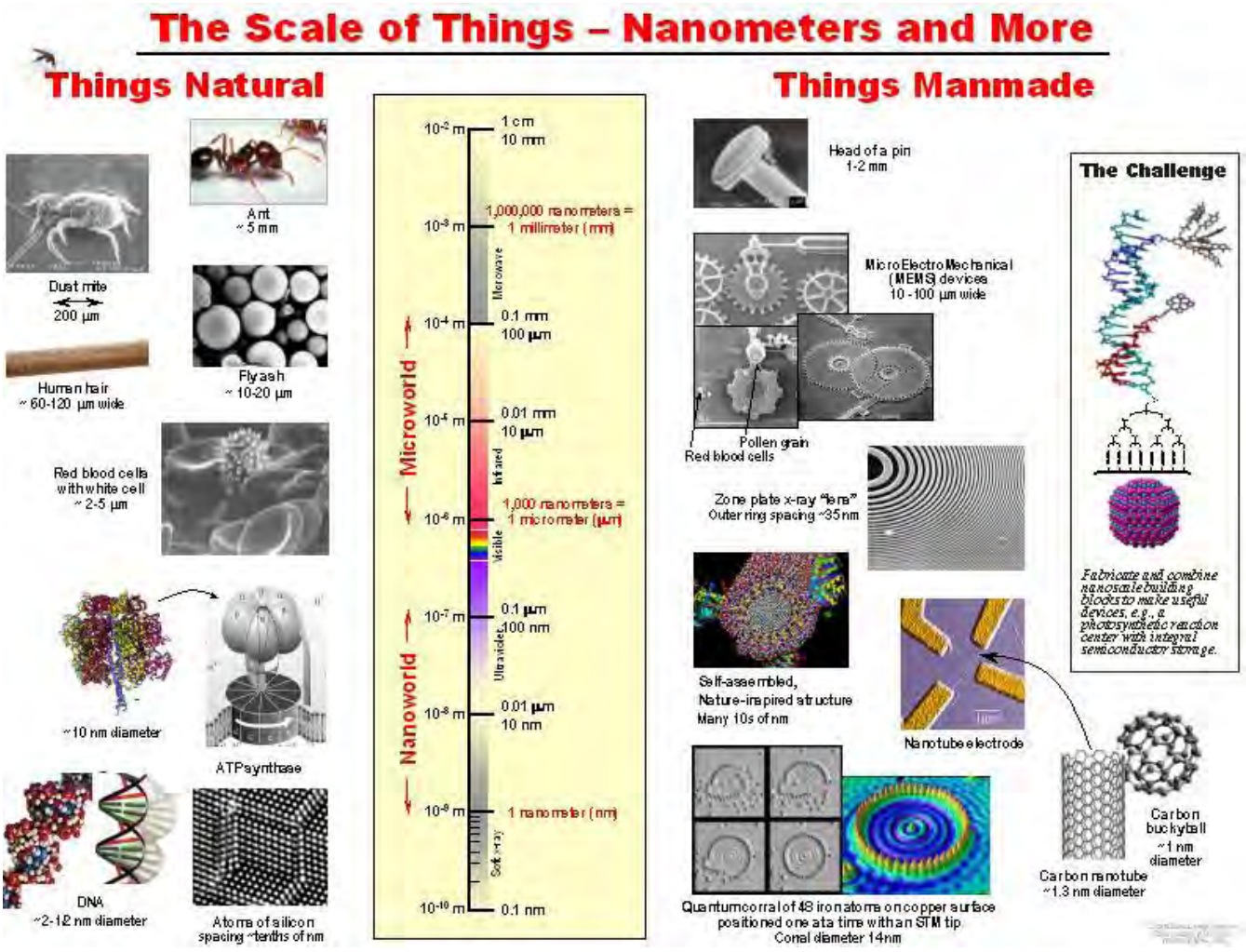
- The design, characterization, production and application of materials, devices and systems by controlling shape and size of the nanoscale (E. Abad et al., 2005).
- Nanotechnology is the ability to observe, measure, manipulate, and manufacture things at the nanometer scale, the size of atoms and molecules (John F Mongillo, 2007).
- Nanotechnology is the creation of functional materials, devices and systems through control of matter on the nanometer length scale (1-100 nanometers), and exploitation of novel phenomena and properties (physical, chemical, biological, mechanical, electrical...) at that length scale. – NASA
- Nanotechnology is a group of emerging technologies in which the structure of matter is controlled at the nanometer scale to produce novel materials and devices that have useful and unique properties - Foresight Institute

When we mean nano it is really small. How small? To be precise it is 10^{-9} m, i.e., one billionth of a meter. Atomic sizes are normally measured in Angstroms (Å). An Angstrom is 0.1 nm. It is that small. There can be ten hydrogen atoms in a nanometer. Nano is derived from the Greek word nanos (νάνος), which means dwarf. During the Roman times (2000 years ago) the word had changed to "nano" but it continued to mean "dwarf". Broadly various objects that we come across in the nature as well as manmade can be divided into three scales, macro, micro and nano. These scales are shown in Table 1. These different items are diagrammatically shown in Figure 1 to appreciate the size scale with reference to nano. In SI units, Pico is below nano. However the natural objects that we are familiar with so far are all made within nano scale and there is still no object that has been identified in Pico scale. Hence, nanotechnology is the final frontier for nature building.

Table 1: Broad scales of the objects

Macro	Normal scale	The sizes of things we're accustomed to using and seeing; i.e., anything bigger than about a millimeter.
Micro	Smaller than the macro-scale	Sizes from about one millionth of a meter to one ten thousandth of a meter; i.e., sizes from about a micrometer to about 1/10 of a millimeter.
Nano	Smaller than the micro-scale.	Sizes from one billionth of a meter to one ten millionth of a meter; i.e., sizes from about a nanometer to about 1/10 of a micrometer.

Figure 1. Comparison of different natural and manmade objects in different scales. (The "Scale of Things" chart was designed by the Office of Basic Energy Sciences (BES) for the U.S. Department of Energy using U.S. taxpayers' dollars. http://science.energy.gov/bes/news-and-resources/scale-of-things-chart/)



History of nanotechnology

The evidence for the use of nanotechnology is available for more than 2000 years. Most of the early use of nanotechnology is probably accidental and obtained by crude trial and error methods practiced over long periods. The soot present in a fire is composed of nano particles as can be seen from the current high powered microscopes such as Atomic Force Microscope (AFM). Egyptians used black eye shadow mixtures that are now known to contain nano-particles of galena, or lead sulfide. Galena crystals, that naturally form 5-nanometer particles, were also used as hair color by Romans and Greeks, as far back as 2400 BC. A very interesting application of nanotechnology is used by Romans in the 4th century AD. It is the Lycurgus cup which is an extraordinary cup is the only complete example of a very special type of glass, known as dichroic, which changes color when held up to the light. The opaque green cup turns to a glowing translucent red when light is shone through it. The glass contains tiny amounts of colloidal gold and silver, which give it these unusual optical properties (British Museum). Analytical transmission electron microscopy revealed the presence of minute particles of metal, typically 50-100 nm in diameter. X-ray analysis showed that these nanoparticles are silver-gold alloy, with a ratio of silver to gold of about 7:3, containing in addition about 10% copper.

The identification of silver-gold alloy particles indicates that the dichroic effect is caused by colloidal metal (Ian Freestone et al., 2007, pp 270 - 277). The stained glass windows used in the medieval churches throughout Europe contains nanoparticles to give the requisite colors. These stained glass windows though are 1500 year old, still maintain their colors without fading. The nanoparticles of copper oxides were added to produce green, cobalt for blue, silver for yellow, and gold for red glass. Faraday in 1857 learned to reproducibly use gold to make gold nanoparticles (M. Faraday, 1857, p.145). He saw that these gold nanoparticle solutions could have a variety of colors from violet and blue to red. He did not have the tools to see them, but he deduced that the colors must be due to incredibly small gold colloidal particles, which we call today as gold nanoparticles. The procedure he developed is today called colloidal chemistry. The solutions he used are today called colloidal solutions.

Wootz was an exceptional grade of iron ore steel first made in southern and south central India perhaps as early as 300 BC. Wootz was extracted from raw iron ore and formed using a crucible to melt, burn away impurities and add important ingredients, including a high carbon (nearly 1.5%) content. The Damascus swords were made by forging the small cakes of wootz steel from India (Sharada Srinivasan and Srinivasa Ranganathan, 2004). Recent study (M. Reibold et al. 2006, p 286) with transmission electron microscopy indicated the presence of carbon nanotubes and cementite nanowires in genuine Damascus sword that provided their remarkable quality.

Richard P. Feynman on December 26, 1959, gave a talk at the annual meeting of the American Physical Society at the California Institute of Technology, entitled "There's Plenty of Room at the Bottom". This is considered as the start of the modern nanotechnology. During this talk he envisaged machines making the components for smaller machines themselves capable of making the components for yet smaller machines, and simply continuing the operation until the atomic realm was reached. He presented a case for miniaturization by taking the example of writing the entire 24 volumes of the Encyclopedia Britannica on the head of a pin. He explained "The head of a pin is a sixteenth of an inch across. If you magnify it by 25 000 diameters, the area of the head of the pin is then equal to the area of all the pages of the Encyclopedia Britannica. Therefore, all it is necessary to do is to reduce in size all the writing in the Encyclopedia by 25 000 times. He further explained "A biological system can be exceedingly small. Many of the cells are very tiny, but they are very active; they manufacture various substances; they walk around; they wiggle; and they do all kinds of marvelous things – all on a very small scale. Also, they store information. Consider the possibility that we too can make a thing very small which does what we want – that we can manufacture an object that maneuvers at that level". He was referring to the living cells, DNA and other proteins in our body.

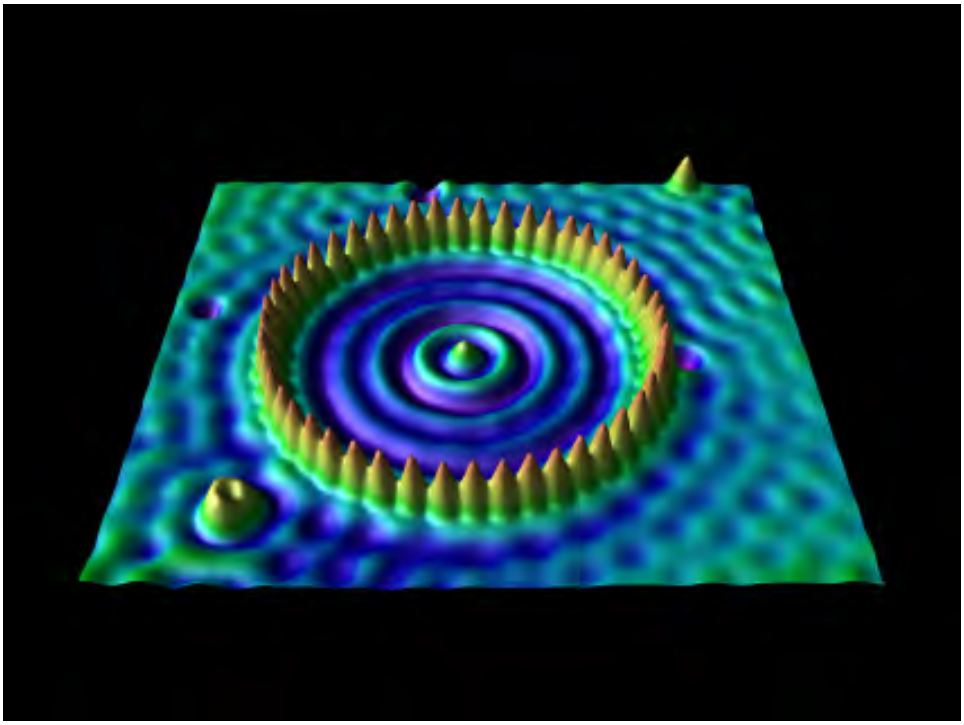
Norio Taniguchi coined the word Nanotechnology (N. Taniguchi, 1974) in 1974. He said "'Nano-technology' mainly consists of the processing of, separation, consolidation, and deformation of materials by one atom or one molecule". Drexler originated the concept of molecular manufacturing in 1977 (Eric Drexler,1981,p. 5275-5278). There after a number of developments that has led to the great interest in Nanotechnology as shown below for some of the modern milestones:

- 1959 R. Feynman Delivers " Plenty of Room at the Bottom"
- 1974 First Molecular Electronic Device Patent filed
- 1981 Scanning Tunneling Microscopic (STM) invented
- 1985 Buckyballs discovered
- 1986 Atomic Force Microscopy (AFM) Invented

- 1987 First single-electron transistor created
- 1988 First designer protein created
- 1991 Carbon Nanotubes Discovered
- 1993 First nanotechnology lab in USA
- 1997 DNA based nanomechanical device created
- 1999 Molecular-scale computer switch created
- 2000 US Launches National Nanotechnology Initiative

Though as shown above, nanotechnology is being used for the last more than 2000 years, interest in it has grown to a large extent in the recent past. The main reason for this is the progress in technology. It is now possible for us to do things at such a small scale in large volume under controlled conditions. It is possible to do things repeatedly with very consistent quality. It is also possible to see these small products utilizing many of the characterization methods available. It is now possible to see at the atomic level as can be seen in Figure 2. "The corral (shown in Figure 2) is made by dragging atoms around using a Scanning Tunneling Microscope (STM) tip. The system was under ultra high vacuum and cooled to 4°K. The original image used for this viewgraph was taken (by IBM) with an STM in 1993. The image shown in this viewgraph is a later modification where color is added and the image is rotated. (M. F. Crommie, C. P. Lutz, and D. M. Eigler, (1993), p. 218-220)

Figure 2 Quantum corral (http://www.almaden.ibm.com/vis/stm/stm.html#corral)



Major Advantages that Can Be Gained by the Use of Nanotechnology

Being small in size has many advantages, which is not obvious from our knowledge in macro scale. The macro scale properties are different from the nano scale properties.

- Very small size: One immediate benefit of the small size is that a large number of particles can be fit into small sizes. This is obviously going to be a great advantage in nano electronics and computers. For example with a 45 nm gate (silicon transistor) size, the new Intel Pentium quad core microprocessors has 820 million transistors. Nanoparticles are smaller than the wavelength of visible light which means they reduce the chance of light scattering.
- High surface area: Most of the atoms will be on the surface with very few atoms in the interior. As a result the bulk properties will be different. One important attribute is that the melting temperature becomes lower since most are on the surface.

- High surface area to volume ratio: This results in a unique surface environment for most of the atoms. With a decrease in the volume the importance of bulk force decreases and the importance of surface forces increase. Importance of gravity decreases on the nanomaterials. The nano-scale colloidal particles in the solutions will never settle out.
- Quantum mechanical effects are important: Electrons can only have certain energies in atoms due to quantum mechanics. Semiconductor nanoparticles can behave like man-made atoms and have only certain energies allowed for electrons. The size and material composition of nano-scale quantum dots dictates the color they re-emit.
- Wave properties of light are important
- Sizes corresponding to basic biological structures
- Sizes corresponding to macro-molecules
- Unique chemical bonding configurations possible
- Size range in which molecules can self-assemble

Major Current Applications of Nanotechnology

There are many possible applications where these special properties of nanoparticles can be applied. A few examples are given here.

Solar Cells

- Improved efficiencies: novel nanomaterials can harness more of the sun's energy
- Lower costs: some novel nanomaterials can be made cheaper than alternatives
- Flexibility: thin film flexible polymers can be manipulated to generate electricity from the sun's energy

Clothing

- Anti-odor properties: silver nanoparticles embedded in textiles kill odor causing bacteria
- Stain-resistance: nano fiber coatings on textiles stop liquids from penetrating
- UV protection: titanium nanoparticles embedded in textiles inhibit UV rays from penetrating through fabric

Batteries

- Higher energy storage capacity and quicker recharge: nanoparticles or nanotubes on electrodes provide high surface area and allow more current to flow
- Longer life: nanoparticles on electrodes prevent electrolytes from degrading so batteries can be recharged over and over
- A safer alternative: novel nano-enhanced electrodes can be less flammable, costly and toxic than conventional electrodes

Automobiles

- Increased strength of materials: novel carbon nanofiber or nanotube nanocomposites are used in car bumpers, cargo liners and as step-assists for vans
- Lighter weight materials: lightweight nanocomposites mean less fuel is used to make the car go
- Control of surface characteristics: nanoscale thin films can be applied for optical control of glass, water repellency of windshields and to repair of nicks/scratches

Food and Beverage

- Better, more environmentally friendly adhesives for fast food containers: biopolymer nanospheres instantly tack surfaces together
- Anti-bacterial properties: Nano silver coatings on kitchen tools and counter-tops kill bacteria/microbes
- Improved barrier properties for carbonated beverages or packaged foods: nanocomposites slow down the flow of gas or water vapor across the container, increasing shelf life

Environment

- Improved ability to capture groundwater contaminants: nanoparticles with high surface area are injected into groundwater to bond with contaminants
- Replacements for toxic or scarce materials: novel nanomaterials can be engineered to exhibit specific properties that mimic other less desirable materials

Typical Knowledge Inputs Required for Successful Understanding of Nanotechnology

Nanotechnology, which contracts with matter on very small scale, is multidisciplinary. It touches most of the scientific and engineering disciplines. Nanotechnology contributes to the fabrication of devices that interacts with matter at the nanoscale and where nanoscale matter is organized to create larger systems. In order to have a thorough understanding of this field, students should have background in science, engineering principles, instrumentation and processes.

The logical progression of understanding nanotechnology calls for a bird's eye view of nanotechnology and its applications. This will enable students to gather global perspective. Then the students can be introduced to various scientific topics including biology, chemistry, physics and material science. This provides the basic understanding of molecular/cellular biology, proteins, adhesion/quantum mechanics, microscopy, current nanostructures and their effect on the nano systems. The difference between the two types of nanostructures such as: (1) natural molecules manufactured by the human body (e.g., DNA, RNA, proteins), and (2) synthetic nanostructures (e.g., quantum dots, buckyballs, nanotubes, nanoshells) can also be introduced. As an integrator, the Materials Science is introduced to transition the science subsystems into the applied systems –electrical/mechanical engineering, biological applications and ethics.

Typical knowledge input required for Nanotechnology:

a. Introduction
   i. Scaling sizes
   ii. Overview of Applications
b. Basic Scientific Principles
   i. Organisms, Cells and Genes and their evolution and mutation
   ii. DNA, RNA, proteins
   iii. Molecule/cell manipulation
   iv. Quantum mechanics
c. Materials Science
   i. Material properties
   ii. Surfaces
   iii. Microscopes
d. Fabrication of Devices
   i. Working principle
   ii. Electrical and Mechanical Design
e. Fabrication projects
   i. Mechanical Design
   ii. NEMS
   iii. Device Design
   iv. Simulation
f. Applications
   i. Current technology
   ii. Future
   iii. Manipulation
g. Ethics
   i. Decisions
   ii. Responsibilities
   iii. Social consequences

Affordable and laboratory friendly Nano devices can be included as applications: (1) micro/nano-arrays (gene chips or biochips) for DNA analysis, (2) micro/nano-fluidics (lab-on-a-chip) for chemical/medical diagnostics (Mel Mendelson et al., 2004). Then the emerging future applications and their ethical implications can be discussed. In addition, the students can have a class project to design, fabricate and test a simple nano devices.

Suggestions for the Adoption of Nanotechnology into the Engineering Technology Curricula

Already there are indications of the enormous influence that nanotechnology is going to have on technological applications. It is therefore prudent enough to introduce this subject to all the ETD students so that they can be properly integrated with the nanotechnology job market.

We can have one capstone semester worth of courses developed as part of the regular ET program that can serve multiple purposes, like continuing education and post baccalaureate certification. This capstone concentration will cut across the disciplines and focus on the interdisciplinary technological aspects of nanotechnology.

One semester worth of concentration will have a sequence of 6 courses (18 credits). Example of courses for the Nanotechnology concentration can be like the one given below:

1. Materials, Safety, & Equipment Overview for Nanotechnology
2. Basic Nanotechnology Processes
3. Materials in Nanotechnology
4. Patterning for Nanotechnology
5. Materials Modification in Nanotechnology
6. Characterization, Testing of Nanotechnology Structures & Materials

Faculty across the disciplines can offer and own one or two courses in the technology discipline. This arrangement has several potential including interdisciplinary research, summer programs, continuing education etc. Also, it will generate additional dollars through grants and course offerings.

Conclusion

The need and urgency in including nanotechnology with the ET curricula was discussed in the paper. Specializing in the technology of the nano world will be advantageous to technology students in securing exciting jobs in all levels of nano manufacturing industries. Developing new programs and curriculum will provide the nanotechnology industry with a flexible set of educational resources and a core of trained human power while increasing the general public's awareness. This will also facilitate in the future creation of standardized curriculum, educational programs and industry validated certification.

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Safety

Analysis of Safety Decision-Making Data Using Event Tree Analysis

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Introduction

The analysis and prediction of employee decision-making patterns are important parts of managing worker safety. The identification and assessment of hazards workers face in daily workplace decision scenarios provides a valid starting point from which to begin a systematic approach to quantifying the role of humans in safe work environments (Targoutzidis, 2010; Ale et al., 2008; Khakzad, Khan, & Amyotte, 2011).

Historically, industrial researchers and practitioners have employed many techniques to identify and estimate hazards confronted by employees in daily work routines (Kingman & Field, 2005). Some of these include: cause and effect diagrams, fault tree analysis, decision tree, and event tree analysis (Baumont et al., 2000; Khakzad et al., 2011; Kingman & Field, 2005). Because of its bottom-up logic modeling approach and the usefulness in evaluating management decision options (Clemens & Simmons, 1998), event tree analysis (ETA) was chosen as the analysis tool in this case.

Construction of an ETA is a multi-step process. The end result is an examination of a safety system's response to an initiating event and the various paths of system successes and failures. However, the first step is identification of the initiating event. Once the initiating event is recognized, the next step is to isolate the safety countermeasures that are intended to respond to the event. The first two steps of construction form the basis of the event tree. Next, the sequences of events which occur following the initiating event are characterized and probabilities are assigned to each event in the sequence. Probabilities of individual event sequence are multiplied together along each path to calculate the probability of system success and system failure.

Traditionally, probabilities of the ETA are drawn from data that were established through prior analyses (such as equipment failure data) or human error predictions (Gertman & Blackman, 1994; Moriyama & Ohtani, 2009). However, none of these methods have adequately addressed the role human decisions play in risk in the workplace (Baumont et al., 2000). Human decision-making analysis offers a rich portrait of the process humans use to select their decision choice in a safety sensitive scenario (Mintz, 2004). The focus of this paper is to test whether the data generated from a decision-making scenario analysis can be used to develop a simple event tree and to calculate valid probability estimates of decision paths in both success and failure domains.

Using data from a previous decision-making simulation, an event tree is constructed. The initiating event, safety countermeasures, event sequences, and event probabilities are generated based on data from a hypothetical safety decision-making simulation. Once probabilities are calculated for each decision path, those paths with the highest probabilities of failure can be targeted for educational intervention. Implications for safety education and the potential uses and limitations of ETA in safety management are discussed.

Event Tree Analysis

Event tree analysis is based on binary logic, where an initiating event either occurs or does not occur (Institute of Engineering and Technology, 2010). Well-designed systems typically have a set of barriers called countermeasures that are intended to stop or reduce the effect of consequences which occur as the result of an initiating event. If the countermeasures do not function or do not function at the appropriate level, a failure of the safety system occurs. If the countermeasures function as designed, the safety system is successful (Rausand & Hoyland, 2004). Safety countermeasures may be technical, such as an alarm or an automatic battery back-up. Alternatively, safety countermeasures may be administrative, such as a supervisor's approval or permitting requirements (Rausand & Hoyland, 2004).

Event tree analysis functions in both the failure and success domain. This means that an ETA can explore each step of system failure by each component or can illustrate how a safety system works successfully to prevent a safety initiating event from causing damage or injury (Clemens & Simmons, 1998). The analysis has been successfully used in various scenarios, including in the evaluation of emergency response systems, assessment of new or improved operating procedures, and management decision options (Clemens & Simmons, 1998; Rausand & Hoyland, 2004).

There are several advantages to using the ETA methodology. The analysis provides a good way to graphically present the sequence of events which occur after the initial accident or event (Rausand & Hoyland, 2004). Additionally, ETA allows the evaluation of multiple or co-existing system failures and allows for the identification of ineffective countermeasures (Clemens & Simmons, 1998). Finally, detailed knowledge of the end event or outcome of each sequence of events is not needed to estimate risk of system failure (Clemens & Simmons, 1998).

The ETA methodology also has several limitations. The analysis does not recognize the initiating event that sets the safety system in motion – this must be pre-determined by the analyst. Therefore, new initiating events are not "discovered" when using ETA. Furthermore, only one initiating event or safety incident can be analyzed at one time. The advantage mentioned above concerning the evaluation of multiple system failures (safety countermeasures) can also be viewed as a disadvantage in that it is difficult to differentiate levels of loss within individual sequence pathways (Clemens & Simmons, 1998; Rausand & Hoyland, 2004).

Human Factors in Workplace Safety

Human components have been found to play a significant role in models which attempt to explain why workers act in a safe manner. In this paper, the main human countermeasure is the action of the safe shutdown procedure rather than taking a safety shortcut. Several factors have been found to influence the employee's decision on whether to follow safety procedures. Simard and Marchand (1995) report that micro level factors such as work processes, hazards, and work group cohesiveness contribute to workers' willingness to follow and promote safety initiatives. In their work, they found that many micro level factors are influenced by macro-level factors such as managerial support and commitment. Numerous researchers have found supervisory and management commitment to be an important part of organizational and group safety outcomes (Clarke & Ward, 2006; Thompson et al., 1998; Zohar, 2000).

From an employee perspective, a supervisor's lack of priority given to safety could negatively impact their commitment to safety. Mosher (2011) and Keren et al. (2009) demonstrated that the worker's perception of their supervisor's commitment to safety, as measured by a safety climate assessment instrument, positively influences the worker's likelihood of making a safe decision choice. To test the probabilities of system success and failure paths in the safety decision-making process, probabilities were drawn from data from a safety decision-making simulation where the employee has the option of taking a safety shortcut (Keren et al., 2009; Mosher, 2011).

Collection of Decision-making Data

Limited research has explored the worker's safety decision-making process. Keren et al. (2009) established a framework for an examination of the relationship between safety climate and safety decision-making, where the decision making process reflects proximate behavior. Decision Mind™, a software platform using the decision process tracing method (Keren et al., 2009), was used to collect decision-making data. Decision process tracing is an approach used to capture cognitive processes by directly evaluating the information an individual uses to form a judgment and the sequence with which the information was examined (Ford et al., 1989).

A key advantage of process tracing is that it addresses the intervening steps between information acquisition and decision choice. Decision process tracing has several key advantages over self-reported questionnaires, which depend on recall ability and researcher observation of work behavior, which is cross-sectional at best and may have other serious biases (Guldenmund, 2007). Decision process tracing also has benefits not realized with structural modeling. The former focuses on the processes humans use to analyze and gather information in preparation to make a decision choice while the later emphasizes the outcome of the decision choice (Ford et al., 1989). Mintz (2004) adds an additional strength of the process tracing methodology – the ability to isolate decision rules and models used in the decision-making process as well as test the association of situational and personal factors with the decision process and the final decision choice. It is these data which will be tapped to establish the decision paths of the event tree.

In the ETA, the dilemma presented in the decision scenario (the cooling system failure and the resulting alarm) represents the initiating event. Personal and systemic factors (Mintz, 2004) form the basis of the event sequences and describe the outcome resulting from each decision choice. The probability of the decision is calculated based on how many participants chose to follow the safety procedure rather than take a shortcut.

Construction of the Event Tree

Construction of an event tree involves of six major steps (Clemens & Simmons, 1998). First, the initiating event is determined. This event is the action or occurrence which sets the safety system components in motion. In this scenario, the initiating event is the option for the employee to take a safety shortcut when completing the re-start of the cooling system. The second step begins by asking how the existing safety system is tested by the initiating event. Challenges to the initiating event are known as countermeasures (Clemons & Simmons, 1998). From there, alternate logic sequences are used – one a successful path where the safety system operates as designed and the second a failure path where countermeasures do not function as designed to stop undesirable outcomes from occurring. In the event tree demonstrated in the paper, the major decision affecting the safety of the system in question is the worker's decision to follow safety procedures when beginning the automatic shutdown of the cooling system. The data from the decision scenario that were used in the event tree are shown in Table 1 along with hypothetical probabilities assigned to the system countermeasures.

Table 1. Possible Decision and System Responses

Decision Choice or System Countermeasures	Frequency	Total Possible Frequency	Probability
Respond to the alarm	128	160	Failure = 0.2 Success = 0.8
Follow safety procedures to begin automatic shutdown	154	160	Failure = 0.04 Success = 0.96
System countermeasure fails	8	160	Failure = 0.05 Success = 0.95

The next four steps of the event tree construction involve the calculation of probabilities. Using a fault tree analysis or other analysis, the probability for the initiating event is determined. As is normally the case in a decision tree, the probability of the initiating event is assigned a probability of one (Clemens & Simmons, 1998). Next, the probabilities of the logic paths are calculated using standard event tree notation as shown in Table 2. Once the probability of each path is calculated, the probabilities of all failure paths and all success paths are figured by adding the probabilities together for each type of path (Clemens & Simmons, 1998).

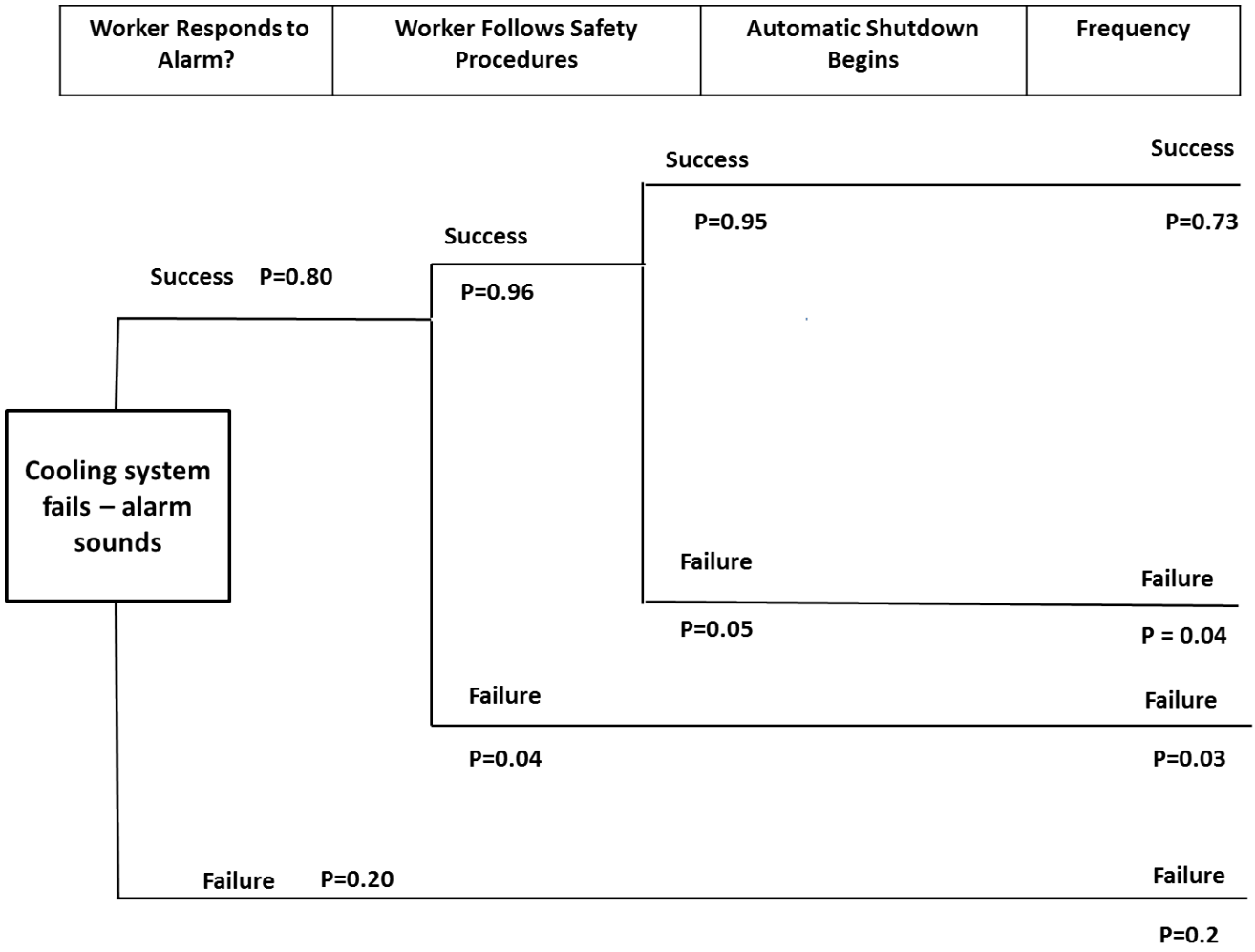
Table 2. Logic path probability formulas

Event	Domain	Equation
Failure of cooling system causes alarm – initiating event	NA	$P_{SystemFail} = 1$
Employee fails to respond to alarm	Failure	P_{alarm}
Employee responds to alarm	Success	$(1-P_{alarm})$
Employee fails to follow safety procedures	Failure	$(P_{safe} – (P_{alarm}P_{safe}))$
Employee follows safety procedures	Success	$(1-P_{alarm} - P_{safe}(P_{alarm}P_{safe}))$
Automatic shutdown fails	Failure	$((P_{shutdown}P_{safe}) – (P_{shutdown}P_{safe}P_{alarm}))$
Automatic shutdown commences	Success	$P_{safe} – (P_{safe}P_{alarm}) – (P_{shutdown}P_{safe}) + (P_{shutdown}P_{safe}P_{alarm})$
System failure probability	Failure	$P_{alarm} + (P_{shutdown}+P_{safe}) – (P_{shutdown}P_{safe}P_{alarm})$
System success probability	Success	$P_{alarm} – (P_{shutdown}P_{safe}) + (P_{shutdown}P_{safe}P_{alarm})$

Estimation of Probabilities

The probability of the initiating event was assigned as one incident per month. Failure decision paths were calculated by taking the number of people who did not chose the safe decision option and dividing it by the total number in the sample. The probability for success paths were calculated by subtracting the opposite failure paths from one. To determine the probability of each path, the probabilities calculated at each decision choice are multiplied together. Finally, to estimate the probability of system success and failure, the probabilities of all paths in each domain are added together. The event tree with the calculated events and failure and success paths is shown in Figure 1.

Figure 1. Event Tree for Cooling System Failure



Based on the estimates from Figure 1, the probability of system success was calculated to be 0.73 and the probability of system failure was 0.27. Based on these probability estimates, the ETA suggests that human decisions play a major role in safety outcomes in the work environment. In the absence of safety-minded employees, the probability for success in terms of safety outcomes decreases markedly. When the systemic failure of the cooling system alarm is taken out of the probability estimate in the failure domain, a failure probability of 0.07 still remains, with approximately half (0.03) of the failure directly attributed to the worker's choice to take a safety shortcut by not following the safety procedure. The interpretation, calculated over a month time period (as noted with the probability of the initial event), indicates that in every month a failure probability of approximately 0.03 can be directly linked to the unsafe decision choice made by employees.

Limitations and Implications

Although the use of decision-making data resulted in a completed event tree and valid calculations of probabilities, several limitations exist for using this type of data. First, although decision-making scenarios are narrowly defined, the outcomes from such a scenario can be difficult to illustrate graphically in an event tree. Part of the reason for this is the multiple possible outcomes, which are impossible to trace on one event tree.

Second, the decision-making scenario data are specific to the individuals who completed the scenario. In addition, the use of decision-making data in ETA examines a system based on human actions but does not adequately account for interactions between systemic countermeasures and human responses that would occur in an actual scenario. Although the data from a decision-making simulation is used as a basis for the probability human actions, probabilities for the system responses were based on hypothetical human error calculations. The ideal system analysis would include actual data from both human and

system components, but such a system is difficult to construct from a hypothetical perspective. Including all components from both system and human limitations would be large and cumbersome to calculate without the use of advanced software. Finally, the lack of a sequential chain of events in decision-making situations makes decision-making scenarios difficult to illustrate in the linear and binary logic constraints of the ETA methodology.

However, this does not mean that there is no role for ETA in examining safety systems involving humans. The event tree allows practitioners and researchers to easily see where the largest probabilities for system failure exist. In the case of this event tree, outside of systemic failures, the largest probability for failure occurred when the employee failed to follow safe procedures when initiating the automatic shutdown. In addition, the event tree allows practitioners to better target educational intervention toward system components with the largest probability for failure.

Event tree analysis cannot serve as the only component of system safety, but it can play an important role in identifying system failures and successes. The use of ETA to examine decision-making systems has great potential in terms of targeting high risks to worker safety. For optimum use, decision scenarios should be fairly structured and have limited decision choice options. Narrowly defined decision-making scenario data can be used to spot unacceptably high probabilities for failure as well as reward and encourage high probabilities of success.

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Applications of Small and Micro Technologies in Unmanned Systems to Support Public Safety and Homeland Security

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Abstract
Previously, the military establishment has been the primary developer and user of micro technologies associated with unmanned systems. As these technologies become available commercially, a need exists to integrate the use of the technology into local or regional public safety and homeland security incidents. The purpose of this presentation is to explain several key factors to consider when using micro technologies and unmanned systems in support of public safety and homeland security officials. Real time information is critical to the decision making process for public safety and homeland security officials to make assessments and quickly resolve crisis situations. Unmanned micro-vehicles and micro technologies are well suited to remotely observe, gather essential information, and immediately relay it to incident responders. These technologies can provide extremely important support during responses to hostage situations, hazardous environments, search and rescue, natural disasters, border patrol and many others. The true benefit is having remote resources providing real time support to incident responders. This paper discusses the use of several different types of micro-vehicle platforms in public safety scenarios and their use of associated technologies such as GPS, autopilot, communication, and sensor devices.

Introduction
Currently, unmanned vehicle systems are in limited use for public sector missions worldwide. The development of civilian unmanned technology in the United States currently lags behind military unmanned technology development largely because of unresolved regulatory and technological issues (DeBusk, 2009). Traditionally, it has been the military establishment that has led the way in emerging unmanned technologies. While the military remains on the forefront and continues to be one of the biggest users of unmanned technologies, non-military applications, especially those of small and micro vehicles, are gaining in popularity and usage (Minniear, McNabb, & Baker, 2010). These unmanned vehicle systems have the potential to augment civil disaster and emergency incident response and recovery efforts. Optimal design of land and aerial systems for such applications will lead to unmanned vehicles that provide the greatest potential for relief and response to emergency and disaster events while addressing public safety concerns and regulatory requirements (DeBusk, 2009).

Progressive disaster and emergency response services in the United States are supported by modern networks of law enforcement, fire protection, military, the Department of Homeland Security, and other special service personnel. Unmanned ground vehicle (UGV) systems have actually been used for support work in hazardous situations for over a decade (Leggiere, 2010). The concept of implementing unmanned aerial vehicle (UAV) systems to assist their efforts is not a new idea; but, has been proposed for many years (DeBusk, 2009; Young, 2006). To effectively utilize these systems requires best possible design of several different types of micro-vehicle with associated technologies such as GPS, autopilots, communications, and sensor devices.

Applications for Public Safety and Homeland Security
Small and micro technologies have immediate applications for public safety and homeland security (Minniear, McNabb, & Baker, 2010). Police forces in particular from around the world are becoming increasingly interested in using small unmanned systems in their activities (Davis, 2011). They may be used to track, survey, or simply monitor activities in a geographical area. In many cases, they are able to move or interact with objects on the ground (CSIP, 2009; CSIP, 2010). UGVs that support activities for public safety and homeland security are usually small and lightweight for mobility. They can be easily adapted to the latest security requirements according to the mission. They employ highly modular design

and can be rapidly fitted with various sub-assemblies (CSIP, 2010; ETS, 2010). Most UGVs are controlled through a remote operator's transmitter and an onboard receiver. Images and data are returned from the vehicle via an onboard transmitter to the operator's receiver (Minniear, McNabb, & Baker, 2010). Global Positioning System (GPS) information, if included, is a key factor in data location and analysis. Typical uses include explosive disposal of suspicious package or device processing, reconnaissance and surveillance of sensitive sites, sampling and collection of hazardous materials such as chemical, biological, radiological, and nuclear materials (CSIP, 2010).

Small UAVs are usually less than 55 pounds and are able to carry one or more payloads such as cameras or sensors. A micro air vehicle (MAV) may be as small as a few centimeters in length and wingspan. Small and micro UAV systems may be controlled manually or autonomous depending upon design characteristics and mission requirements. UAV systems designated small or micro by the manufacturer sometimes overlap in size because there is no single authoritative definition of sizes. They have different levels of automation that can be utilized to control the vehicle; and, each system needs a minimum of two processors, one for a remote transmitter and one for an onboard receiver (Minniear, McNabb, & Baker, 2010). To provide value as remote eyes and ears for the operator, each UAV must have the ability to transmit images and/or data as well as receive. The operator must be able to receive the transmission and view it for improved situational awareness and store it for further analysis Minniear, McNabb, & Baker, 2010). GPS information provides improved data analysis and is critical for vehicles in an autonomous navigation mode using an autopilot. Although small, these technologies can have large impact. They can provide immediate and time critical information to public safety individuals during disaster or emergency crises; and, may be applied to other services such as highway patrol, traffic routing, and utilities monitoring. (DeBusk, 2009).

The Potential for Improved Information for First Responders

Disaster and emergency response and relief efforts include all actions by first responders and subsequent assistance efforts during and immediately following a catastrophic event. The primary purpose of response and relief efforts is to save human lives. Secondary purposes are to preserve and maintain the environment, protect property, keep the peace, and uphold governmental authority. (DeBusk, 2009). In any event, incident commanders and crisis leaders have a critical need for information to support their situation awareness and to formulate effective response efforts (GAO, 2007).

Contemporary manned response and recovery systems include ground vehicles, conventional fixed-wing aircraft, and rotary-wing aircraft. However, UAV systems have the greatest potential to improve the effectiveness and capabilities first responder by enhancing and providing advanced predictive capabilities and early warning (Baker, McNabb, & Minniear, 2010). These new UAVs are may be carried by an individual, launched by hand, and may include GPS navigation with an autopilot. A wide variety of system types of all sizes with varying capabilities already exist with even more under development. (DeBusk, 2009).

Public safety or homeland security events for which UAV systems could be implemented include, but are not limited to: severe storms, tornados, hurricanes, wild fires, tsunamis, floods, earthquakes, avalanches, civil disturbances, oil or chemical spills, and urban disasters. (Kamien, 2006). Advanced vision systems can provide ground operators a clearer picture of developing scenarios and offer a greater breadth of situational awareness for the incident commander resulting in more efficient and effective responses (DeBusk, 2009).

The Department of Homeland Security (DHS) is already using Predator-Bs by General Atomics Aeronautical Systems, San Diego, C.A., to patrol U.S. borders with Mexico and Canada, review flood waters along the Mississippi River (Wasiluk, 2011), and to obtain infrared (IR) pictures of major wild fires (Holub, 2011).

While Predators are larger aircraft, small UAVs and even micro-systems are being tested and incorporated into the missions of U.S. Customs and Border Protection (C&BP) and the U.S. Coast Guard (Finnegan, 2010). With UAV technology, the C&BP can have someone watching a monitor at headquarters and agents in the field can be deployed to an area where there is likelihood of encountering illegal border crossers. C&BP calls the UAV technologies force multipliers (McCarter, 2011). The new small and micro-technology UAVs are small enough to be carried by individual personnel in the field and hand launched.

One approach already underway is the research and development of Micro-Aerial Vehicles (MAV) at Wright State University under the guidance of Dr. George Huang. In a personal interview on June 6, 2011, Dr. Huang stated the goal of his team is to

develop and build micro-aerial vehicles small enough to enter a building, go into each room, and then conduct surveillance operations. According to Dr. Huang, the size is very important to enter small spaces such as doing search and rescue operations under building rubble after an earthquake. With a micro aerial vehicle, just the size of an insect, first responders can send it in, make contact with the people, even take pictures or audio of the situation inside, and help the responders understand what needs done. MAVs can help us locate, excavate, and save survivors.

To develop the MAV, Dr. George Huang and his team studied the dragonfly and the ladybug. From each, they determined how the insects sense air flow direction and ascend or descend as needed to conserve energy. While the MAV is currently radio controlled, Dr. Huang hopes to develop sensors for the body of the MAV so it can determine flow direction and react autonomously. The team's goal of miniaturization also presents major challenges which make power and sensor payloads a challenge.

Preparing Operators and Analysts as Part of the System

With regard to public safety, homeland security and the use of micro-technology systems, training the system operators must come first. Several means are available to accomplish effective training. On-site or manufacturer training classes can be arranged. Some university programs may offer short courses on UAS operations. Military training is probably considered to be the best (Minniear & Baker, 2010).

Analysts training may be more difficult to accomplish. Given the highly specialized nature of photo/sensor analysis interpretation, limited avenues are available to receive such training. Many analysts receive training from military or government programs. As stated by Mr. Hugh Bolton, President and CEO of the Advanced Technology Intelligence Center, Dayton, OH, in a personal interview on June 6, 2011, some private sector training centers exist, but these centers may require security clearances in order to receive the training.

The technologies required to present the obtained data to the analysts and the decision makers include the vehicles, an expanded and enhanced communications network, and dynamic databases working cohesively as a living network. This network serves to relay data to the analysts and decision makers as well as interface with first responders on site (DeBusk, 2009). In addition, these technologies include small and micro aerial, ground, and marine vehicles as carriers of the initial sensors. Many first responder agencies actively conduct practice exercises with the technologies to become familiar and more efficient in their operations.

As has been emphasized, timely and accurate information is the key factor in the decision making process. Public safety and homeland security leaders must be able to have speedy access to this information to effectively direct the response to a crisis situation (Kamien, 2006). With effective training, the small and micro-technology systems can provide decision makers with essential remote eyes and ears for the critical information link in the process.

Key Factors to Consider

The benefits of using small and micro-systems are many. Most are extremely portable and can be deployed in a relatively short period of time. This allows an operator to move a system, whether ground or aerial, directly to an area of concern and launch the vehicle immediately. Bigger systems might take longer to prepare and launch; hence, they take more time to gather critical information. Information about an event or situation is time sensitive and essential to any decision maker. Smaller systems may be able to operate lower to the ground and move in and out of confined areas of operation better than larger systems. Just as in larger systems, small UAV systems are reprogrammable and can operate autonomously utilizing autopilots, GPS, and earth mapping. The sensors can include high definition filming with electro-optical (EO) and infrared (IR). Other information gathering devices may be utilized as dictated by the mission specific requirements.
Unfortunately, very small technologies are often misunderstood. With a great deal of hype about micro-technology, some enthusiasts say it will solve the all the world's problems. In contrast, critics cite concerns ranging from regulatory and intellectual property issues to the idea of self-aware, self-replicating machines that would ultimately take over the world (Ratner & Ratner, 2004).

While some police forces have been interested in exploring the possible use of UAVs for law enforcement and public safety, the Federal Aviation Administration (FAA) remains very reluctant to allow their widespread use. It has, in at least one case, shut down the testing of UAVs by a local police department (Finnegan, 2010). As stated previously in this paper, there are numerous applications for micro-systems in support of public safety and homeland security. At this juncture, several obstacles exist to allow easy implementation of the UAVs.

First, the methods to properly train, educate and deploy the micro-systems on a regular basis with proficiency and precision are still lacking. Operators must continually hone their skills lest they become non-proficient and lack confidence in skill sets (Minniear & Baker, 2010). Of the major issues preventing first responders from using unmanned systems, two of the largest are situational awareness (SA) and user interaction (Leggiere, 2010). Training, practice, and skill building can address these two issues.

Another obstacle is cost and expense. The costs of operating large unmanned systems can become more than double the costs of operating a manned system. Operating one UAV can take a crew of several Border Patrol agents for a Predator system. In contrast, the small and micro UAVs require a much smaller cost in terms of personnel support with the higher costs in miniaturization (McCarter, 2011).

Acquiring the resources and financing to purchase these complex and expensive systems presents a major problem for most organizations. Simply making a system smaller does not necessarily make that system any less expensive. Many of the smaller systems can start at $50,000.00 and even higher. The sensors and cameras are often in the tens of thousands of dollars, too, and may even exceed the cost of the vehicle in some cases. The lack of funding opportunities and reduced budgets certainly can make these systems difficult to acquire and maintain.

In his interview, Dr. Huang also stated that, generally speaking, there is a definite price to pay for miniaturizing the system. As the system or vehicle platform become smaller, the payload must be lighter and mission time becomes shorter. Additionally, when using small systems over full sized systems, weather conditions become a big factor in mission success or completion. The smaller systems are much more susceptible to wind, temperature and relative humidity. A small or micro UAV uses much of its power to fight wind strong currents or may be completely swept away. Larger systems with bigger and stronger propulsion capabilities can overcome the weather, carry larger payload, as well as possibly have increased loiter time.
Another limitation for both large and small unmanned systems is dealing with the FAA and airspace restrictions. While efforts are underway to integrate unmanned systems into the National Airspace System (NAS), the inability of the vehicles to see and avoid other aircraft is a major stumbling block. Hence, the FAA has placed very strong restriction as to the altitudes and areas of operation on unmanned vehicle operations.

As with other similar systems, small and micro technology unmanned systems are most often very complex. They can become more complex by the engineering of smaller, lighter and stronger components. Given the smaller size of the components, they are inherently more difficult to repair. Special diagnostics are often required in order to pinpoint faulty components. In light of the complexities, repair may require the entire system or vehicle be returned to the manufacturer. Depending on the situation, the result may be quite expensive and might create down time or loss of capability for an extended period of time.

Interfacing can provide special challenges as well. Many parts of a small or micro system rely on inputs and information from different subsystems. For example, what may first seem to be a simple problem with a flight control might be rooted in the control itself, an actuator, a receiver or even a radio controller. If it is in fact the radio controller, then various other subsystems will be affected as well. Interference from outside sources must also be anticipated and managed. Depending on the system, electrical and microwave sources may play havoc with respect to control inputs or even live streaming video from the vehicle. Operators are always on the alert for possible interference.

Micro Technologies Integration at Indiana State University

Indiana State University (ISU) Aviation has recently created an Unmanned Systems program to meet the ever increasing demand for training and human capital development in the field of unmanned systems. The focus at ISU is not just on the unmanned aerial systems (UAS), but on all unmanned systems to include ground and marine systems as well. Students at ISU are exposed to the individual systems as well as are introduced to the integration of the different systems and how they complement each other during real world scenarios.

ISU utilizes specialized teaching methods to cover micro systems and sensors associated with rotary, fixed wing, lighter than air, tracked vehicles and marine systems. The intent is to demonstrate how all systems can work in sync and provide timely information that is critical to decision-makers. One scenario currently under development is to have a 17 foot airship execute an airdrop of a micro tracked unmanned ground vehicle into a potentially hostile or contaminated area and, in turn, and have both vehicles transmit live streaming video of the developing situation from multiple perspectives. While

certain limitations must be overcome, students are exposed to the concept of small and micro technologies, multiple sensor systems, and their integration into scenario based training situations.

In addition to the student training and education at ISU, the university has also just created a new Center for Homeland Security and Crisis Leadership. This center works closely with the Aviation Technology Department to integrate unmanned systems micro technologies into scenarios used to train crisis leaders. As noted earlier, these resources are critical with respect to providing real time information for officials in public safety and homeland security. Proper utilization of these components can help to make quick assessments and resolve crisis situations.

Summary

In the preceding pages, identified were many applications of micro-technologies in unmanned systems and how this technology may support crisis leaders associated with public safety and homeland security. As an emerging technology, small and micro unmanned systems can be useful in building situational awareness, overall assessment and delivering critical information. While there are certain complexities and challenges with these types of systems, the advantages of using them far outweigh any obstacles that may be encountered. Integrating small and micro technology unmanned systems into any situation as an information source takes proficiency and coordination among the participants. Without this, the advantages of these systems can quickly disappear. As small and micro unmanned systems become more readily available and are more often used in the public safety and homeland security sectors of our society, confidence levels will rise and demand for such technologies will increase.

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Do Workplace Assigned Mobile Communication Devices Increase Employee Stress: An Investigative Study

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Abstract
Workplace stress can cause numerous mental and physical health problems. These problems can range from mild anxiety to serious problems that could cause death. With the rapid advance in communications technology, mobile communication devices are new possible stressors that have become prevalent over the past few years. However, mangers that require employees to monitor their communication device after work hours and while on vacation could be placing undue stress on their employees' well-being. Two surveys were created to study the correlation between workplace assigned mobile communication devices and workplace stress. The surveys included questions about the employee's background, stress levels, workplace stress, and their workplace assigned mobile communication device and were completed by employees in various companies and careers. The reliability of the second survey was evaluated using the Cronbach Alpha test and was determined to have a reliability of 0.943. The results of the second survey were analyzed using the chi square test statistic (χ^2) as a tool for analyzing their statistical significance. The total χ^2 value obtained at 95% level of significance and 32 degrees of freedom equaled 95.9. The critical value at the same degrees of freedom was 46.194. Thus, the null hypothesis was rejected at the 95% level of significance. Thus, there appears to be a significant correlation between stress and workplace assigned mobile communication devices.

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Introduction
Stress is defined as the reaction of the human body to external stimuli that are caused by social, occupational, environmental, and psychological factors that are perceived as threats. The amount of stress felt depends as much on the individual's ability to deal with the external stimuli as the relative intensity of the stimuli. It is an important issue in the workplace and is present in a hidden form most of the time. Approximately 25% of all employees have high levels of stress. Stress costs organizations in the United States up to $300 billion per year and accounts for up to 85% of medical costs (Adams, 2009).

Workplace stress exists in private corporations as well as government organizations. It is a topic that does not seem to be openly and regularly discussed. Stress can lower productivity, decrease morale, and cause employees to develop unhealthy habits. Stress can have a profound effect on an employee's life. It can lead to physical and mental health problems. The inability to disconnect from work implies that stress levels don't decrease while an employee is away from work. Workplace stress can then add to any stress in the employee's personal life. It can affect their bodies by causing headaches, back pain, chest pain, heart disease, heart palpitations, high blood pressure, decreased immunity, upset stomach, and sleep problems.

With the advent of mobile communication technology, it is common practice for employees to be assigned a workplace mobile communication device. Employees may be required to carry these mobile devices after normal business hours, on the weekends, and while on vacation. These employees are essentially on-call, similar to a doctor. Mobile devices can cause employees to lose the ability to disconnect from work and have a complete personal life. The expectation of employees to maintain constant communication starts with the manager. The manager controls the mobile device policy and

expectations. The manager essentially has complete control over this source of stress. Managers need to be aware of this potential stressor and evaluate if constant communication is necessary to maintain organizational functions. (Mazmanian, Yates, Orlikowski, 2006).

In view of the novelty of the practice of assigning mobile communication devices at the workplace, little research exists that seeks to evaluate whether there is indeed any correlation between such devices and workplace related stress. A methodology was formulated to evaluate just such correlation and is described in the following section.

Initial Survey

To determine if workplace assigned mobile communication devices have an adverse effect on the stress levels of employees, two surveys were created. The initial survey determined employees stress levels and the relationship to workplace assigned mobile communication devices. It was uploaded to an internet survey site. A link to the survey was e-mailed to several active employees in many different companies and career fields. Links to the survey were also posted on several internet forums. Participation in the survey was voluntary. The survey contained questions about background, work organization, general stress, and information about workplace assigned mobile communication devices. It was completed by people who work who have workplace assigned mobile communication devices and people who do not have workplace assigned mobile communication devices. The group of people without workplace assigned mobile communication devices is considered the control group and the group with workplace assigned mobile communication devices is considered the test group. The null hypothesis states that there is no correlation between workplace assigned mobile communication devices and employee stress. Survey results were analyzed for statistical significance. Results of survey 1 are presented in table 1. It will be appreciated that most of the questions in survey 1 were Yes/No type of questions. The total sample size for the first survey was 121.

Table 1: Results of survey 1 to investigate correlation between stress and workplace assigned mobile devices.

Question		**Answers Number**		**Answers Percent**	
1	Are you?	Male - 101	Female - 20	Male - 83%	Female - 17%
2	What is your age?	20-29 yrs - 35	30-39 yrs - 33	20-29 yrs - 29%	30-39 yrs - 27%
		40-49 yrs - 29	50+ yrs - 24	40-49 yrs - 24%	50+ yrs - 20%
3	How long have you been in your current position?	0-2 yrs – 22	2-5 yrs – 50	0-2 yrs – 18%	2-5 yrs – 41%
		5-10 yrs – 29	10-15 yrs – 10	5-10 yrs – 24%	10-15 yrs – 8%
		15+ yrs – 10		15+ yrs – 8%	
4	Do you ever worry about work while you are not at work?	Yes - 97	No – 24	Yes - 80%	No – 20%
5	Do you exercise regularly?	Yes - 63	No – 58	Yes - 52%	No – 48%
6	Do you have any stress reduction techniques?	Yes – 68	No – 51	Yes – 57%	No – 43%
7	In the past two years has your work place stress increased?	Yes – 89	No – 32	Yes – 74%	No – 26%
8	Do you think that your job satisfaction has declined because of stress?	Yes – 51	No – 69	Yes – 43%	No – 57%
9	Do feel that you are in control of your job?	Yes – 80	No – 41	Yes – 66%	No – 34%
10	Do you feel that your department is sufficiently staffed for the workload?	Yes – 57	No – 64	Yes – 47%	No – 53%
11	Do you feel stress from work?	Yes – 102	No – 16	Yes – 84%	No – 19%
		Answers Number		**Answers Percent**	
12	Do you feel your stress diminish after you leave work?	Yes – 87	No – 33	Yes – 73%	No – 27%

13	In the last two years have you taken a mental health day?	Yes – 34	No – 87	Yes – 28%	No – 72%
14	If you have taken a mental health day, do you feel that it was required because of workplace stress?	Yes – 30	No – 4	Yes – 88%	No – 12%
15	Have you received workers' compensation from a stress related condition?	Yes – 0	No – 121	Yes – 0%	No – 100%
16	Do you worry about taking vacation?	Yes – 57	No – 64	Yes – 47%	No – 53%
17	Does your workplace have a stress policy?	Yes – 8	No – 37	Yes – 7%	No – 31%
		Don't know - 76		Don't know – 63%)	
18	Do you think that your employer/supervisor is concerned with workplace stress?	Yes – 50	No – 70	Yes – 42%	No – 58%
19	Do you have a mobile communication device that was assigned to you by your employer?	Yes – 66	No – 55	Yes – 55%	No – 45%
20	Are you required to carry your work mobile communication device after work hours?	Yes – 62	No – 4	Yes – 94%	No – 6%
21	Approximately how many hours per week do you spend conducting business on you work mobile communication device while not at work?	1-2 hrs – 30	2-5 hrs – 30	1-2 hrs – 39%	2-5 hrs – 39%
		5-10 hrs – 10	10-30 hrs – 4	5-10 hrs – 13%	10-30 hs – 5%
		30-40 hrs – 2	40 + hrs – 1	30-40 hrs – 3%	40 + hrs – 1%
22	Do you ever conduct business on your work mobile communication device while driving?	Yes – 65	No – 20	Yes – 76%	No – 24%
23	If you use your work mobile communication device while driving, does it make your commute more stressful?	Yes – 31	No – 34	Yes – 48%	No – 52%
24	Are you required to take your work mobile communication device with you on vacation?	Yes – 36	No – 30	Yes – 55%	No – 45%
25	Do you feel that your vacation is relaxing knowing that you are responsible for you work mobile communication device?	Yes – 12	No – 24	Yes – 33%	No – 66%
26	Do you feel that your life would be less stressful if you did not have to carry a work mobile device outside of work?	Yes – 26	No – 40	Yes – 39%	No – 61%
		Answers Number		**Answers Percent**	
27	Do you feel that your life would be more stressful if you did not have to carry a work mobile communication device outside of work?	Yes – 24	No – 42	Yes – 36%	No – 64%
28	Have you ever been treated by a doctor for a condition that was diagnosed to be stress induced?	Yes – 24	No – 97	Yes – 20%	No – 80%
29	If you answered yes to the previous question, was the diagnosis after you started carrying a work mobile communication device?	Yes – 5	No – 11	Yes – 31%	No – 69%

Statistical analysis using chi-squared test reveals that the null hypothesis (Ho) was accepted for group two and rejected for groups three and four. The alternate hypothesis (Ha) was rejected for group two and accepted for groups three and four. This implies that employees are aware of stress and are actively participating in stress reducing techniques. The null hypothesis was rejected for group three implying that workplace stress is having an adverse effect on employees. This is largely due to issues controlled by the employee's manager. The null hypothesis was also rejected for group four. This shows that workplace assigned mobile communication devices have an adverse effect on employee stress. Thus, it was concluded that these devices invade personal time and make it difficult for employees to disconnect from work

Follow-Up Survey

A follow up survey was created for employees who have been assigned a mobile communication device at their workplace and who are presumed to carry the device after work hours. This survey was based on a Likert type scale that allows survey respondents to rank quality from low to high. The data collected from Likert Scale surveys can be grouped into nominal data, ordinal data, interval data, and ratio data. Nominal data represents categories without numerical representation. Ordinal data can be ordered but it is not possible to measure distance. Interval data can be put in order and can be measured for distance. Ratio data has meaningful order, distance, and fractions between variables. The results from the second survey will be considered nominal data. (Allen, Seaman, 2010).

It targeted stress directly related to carrying a workplace assigned mobile communication device after work hours. The survey was printed and distributed to employees at various levels. The results were collected in a folder in a neutral location. The survey was also posted online and a link to the survey was e-mailed to employees who have a workplace assigned mobile communication device. Participation in the survey was voluntary. The total sample size for the follow up survey was 21. Results of this survey are presented in table 2.

Table 2: Results of follow up survey

1	Are you required to carry your workplace mobile communication device after work hours?				
	Never	Only when on-call	Half the time	¾ of the time	All the time
	3	1	0	4	13
	14%	5%	0%	19%	62%
2	Who requires you to carry it?				
	Self-imposed	Group Head	Manager	Director	Vice President
	5	0	3	9	2
	26%	0%	16%	47%	11%
3	Do you have a required response time?				
	None	40 minutes	30 minutes	20 minutes	10 minutes
	15	1	1	1	2
	75%	5%	5%	5%	10%
4	What are the consequences for missing a call or e-mail after hours?				
	None	Verbal	Dept written	HR written	Termination
	8	11	1	0	0
	40%	55%	5%	0%	0%
5	Are you specifically rated for your after hour responses on your annual performance review?				
	No	Small percent	Medium percent	Large percent	All of review
	14	3	2	1	0
	70%	15%	10%	5%	0%
6	Approximately how many hours per week do you spend conducting business on you workplace mobile communication device while not at work?				
	0-10 hours	11-20 hours	21-30 hours	31-40 hours	40+ hours
	17	3	0	0	0
	85%	15%	0%	0%	0%

7	Do you get paid for using device after hours?				
	Double time	Overtime (1.5)	Straight time	After 5 hours	No
	0	0	2	0	18
	0%	0%	10%	0%	90%
8	Do you exercise regularly?				
	No	1-2 times per week	3-4 times per week	5-6 times per week	Daily
	4	8	6	2	1
	19%	38%	29%	10%	5%
9	Do you take your device with you while you exercise?				
	Never	Only when on-call	Sometimes	Most of the time	Always
	14	0	0	3	4
	67%	0%	0%	14%	19%
10	Is exercise enjoyable with device?				
	Never	Rarely	Sometimes	Most of the time	Always
	9	2	1	5	2
	47%	11%	5%	26%	11%
11	Do you ever conduct business on your workplace mobile communication device while driving?				
	No	1-2 times per week	3-4 times per week	5-6 times per week	Daily
	3	10	2	3	3
	14%	48%	10%	14%	14%
12	Are you required to respond to the device while driving?				
	No	When on-call	Sometimes	Most times	Always
	15	0	1	2	3
	71%	0%	5%	10%	14%
13	Do you e-mail and make calls while driving?				
	No	Only hands free calls	All calls	Calls & emails when stopped	Calls & emails always
	4	7	6	3	1
	19%	33%	29%	14%	5%
14	Do you think that your driving suffers?				
	No	A little	Sometimes	Most of the time	Always
	5	9	5	1	0
	25%	45%	25%	5%	0%
15	Does it make your commute more stressful?				
	No	A little	Sometimes	Most of the time	Always
	6	7	4	2	0
	32%	37%	21%	11%	0%
16	Are you required to take your workplace mobile communication device with you on vacation?				
	No	Only when on-call	Sometimes	Most of the time	Always
	8	0	2	6	5
	38%	0%	10%	29%	24%
17	Do you feel that your vacation is relaxing knowing that you are responsible for your device?				
	No	A little	Sometimes	Most times	Always
	4	1	2	8	2
	24%	6%	12%	47%	12%
18	Do you feel that your vacation is stress reducing?				
	No	A little	Sometimes	Most times	Always
	1	1	4	8	6
	5%	5%	20%	40%	30%

19	Do you think that your device increases the stress of your life?				
	No	A little	Sometimes	Most times	Always
	4	8	7	2	0
	19%	38%	33%	10%	0%
20	Do you feel that your life would be less stressful if you did not have to carry a workplace mobile communication device outside of work?				
	Always	Most times	Sometimes	A little	No
	0	5	4	3	8
	0%	25%	20%	15%	40%
21	Do you feel that your life would be more stressful if you did not have to carry a workplace mobile communication device outside of work?				
	No	A little	Sometimes	Most times	Always
	4	5	4	5	1
	21%	26%	21%	26%	5%
22	Would you rather not carry the device after hours?				
	Always	Most times	Sometimes	A little	No
	1	2	8	2	6
	5%	11%	42%	11%	32%
23	Do you feel that the device interferes with your personal life?				
	No	A little	Sometimes	Most times	Always
	5	5	9	1	0
	25%	25%	45%	5%	0%

Initially, the results of the follow up survey were tested for reliability using Cronbach's alpha reliability test, which measures the internal consistency reliability. This test is a reliability technique that requires a single test to produce a unique estimate of reliability. The cronbach's alpha reliability coefficient was calculated to be 0.943 suggesting extremely high internal consistency.

Next, the second survey responses for questions four, ten, fourteen, fifteen, eighteen, nineteen, twenty, twenty-one, and twenty-three were used since they related directly to stress. The results were analyzed using the chi squared test statistic. The expected value was arrived at by multiplying the number of responses for a question by the total number of same value answers for all questions divided by the total number of values. The total chi-square value was calculated to be 95.9. It was then compared against the chi-square distribution table value for 95% probability with thirty-two degrees of freedom. The chi-square distribution critical value is 46.194, which is less than the total chi-square value of 95.9. This implies that the null hypothesis is rejected suggesting a strong correlation between workplace assigned mobile communication devices and increased employee stress.

Qualitative Comments

It was recognized that there should be room for qualitative data in a study of this nature. Thus, it was decided to offer space on the first survey for respondents to voice their opinion on workplace assigned mobile devices. The following is an excerpt of comments received with the first survey.

1. I think that having to carry around my cell phone, or as I like to refer to it, the ball and chain "after" work hours means that I am never truly off from my job. The phone rings no matter if I am home, the movies, church, or dinner with my friends. Unfortunately, I am also worried about not having the phones because I do not feel that I can trust any of my coworkers with any type of responsibilities.
2. I do have stress but I think my job would be more stressful if I was made to carry a work cell phone or blackberry.
3. Blackberry is very addictive simply because email is so easy to check. I find that I read and reply to messages in times/locations that were previously strictly "down time" (Bathroom at work, bathroom at home, during commute, eating dinner with wife). The end result is that the company gets more man-hours of work per day from me – both on and off the clock. I've heard directors say that they have been personally scolded for failing to respond quickly to emailed questions from VPs. So I guess the absence of a formal HR Blackberry policy doesn't stop VPs from enforcing a "must carry / must monitor / must reply" policy.

4. I feel that management holds me accountable for actions outside for my control. This is one reason why the "Crackberry" is "necessary" for my job. I cannot enjoy vacation due to all the time needed to prep for my departure and once I return. It would be even worse without my "Crackberry" to keep me informed of what is going on. This just adds to stress due to not being at work to handle the situations that will arise.
5. Just seeing the light change on my blackberry from green to red while sitting at home is stressful (means I have a new email).
6. My life was stress free in my old position. I left my work at work when the workday was over. I have a new position and now have a Blackberry. My stress level has increased because I am expected to answer it at all times. I recently got in trouble because I didn't answer an e-mail at 2am.

Conclusion

Workplace assigned mobile communication devices increase the stress levels of many employees. Almost half of the initial survey respondents (39%) and second survey respondents (45%) who carry a workplace assigned device answered that their lives would be less stressful if they did not have to carry their workplace assigned device outside of work. This shows that workplace assigned devices have a direct effect on the stress levels and an indirect effect on the health of employees. Managers who require their employees to carry their workplace assigned devices after work hours are increasing the stress levels of their employees. However, managers may not be aware that they are responsible for adding a stressor to their employee's lives. The managers may not view a workplace assigned mobile communication device as a stressor. They may just view the device as an invaluable work tool that links them with their employees all the time. The respondents who stated that their lives would be less stressful if they did not have to carry their workplace assigned devices after work hours would happily leave their devices at work and resume using them the next work day to help reduce their stress levels.

The second survey included three direct questions that determined the respondent's thoughts about their workplace assigned mobile communication devices. The first question (19) determined if their device increased stress to their lives. Less than half of the respondents (43%) thought that their device added significant stress to their lives. This is still a significant percentage that should be considered. Their workplace device is singularly adding a stress to these respondent's lives that was not present before they received their device. Their device represents an instant increase in stress. The second question (22) determines if they would rather not carry their device after hours. A significant percentage (58%) of the respondents would rather not carry their device after hours most times. There may be certain times when it is important to have the device after hours to finish unresolved business or when the employee is on call. The rest of the time, the device can interfere with the respondent's personal life. The final question (23) determines if the device interferes with the employee's personal life. Most of the respondents (75%) replied that their device interferes with their personal life to some extent. The employee's personal life is the greatest influence on decreasing workplace stress. Something that interferes with the employee's personal life is going to interrupt its ability to decrease workplace stress. Employees need to disconnect from work to allow their stress to be reduced and revitalize themselves.

It can thus be concluded that managers are increasing the stress of their employees by requiring them to carry their workplace assigned devices after business hours and while on vacation. This stress can be reduced by evaluating the needs of the organization and establishing the requirements for workplace assigned devices. Managers need to weigh these needs against the possible health effects of stress and the workplace factors associated with stress. These factors can include decreased productivity, increased absence, and lower morale.

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