Developing the Future Workforce

2013 ATMAE Conference Proceedings
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Review Process & Statistics

The ATMAE 2013 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 2013 Annual ATMAE Conference, “Developing the Future Workforce,” in New Orleans, Louisiana, November 19-22, 2013. The Proceedings include all of the conference presentation abstracts that were accepted through the peer-review process and which were presented at the conference, and the Conference Proceedings Papers, based on accepted presentations, which were submitted and accepted through a secondary peer-referee process.

The reviews of presentation proposals and conference papers were led by ATMAE Division and Focus Group leaders. 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. Review panelists evaluated the presentation abstract and papers pursuant to the review criteria, ranked each, and a cumulative rank-ordering system was used to help select the presentations and papers to be presented and published.

The ATMAE 2013 Conference Presentation Abstracts were subject to a double-blind peer review process. The peer-review process led to acceptance of 78% of presentation proposals, 233 accepted of 299 proposals submitted. This Proceedings document does not include presentations that were withdrawn by the authors, or those in which the presenters failed to attend the conference to present their work. Included in the abstracts are the presentation proposals, also peer-reviewed, that were accepted for the Student Research Presentation Competition.

The ATMAE 2013 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 2013, of 233 accepted conference presentations, 29 were expanded into longer papers and were submitted for the peer-review process (12.5% of accepted presentations.) The double-blind peer review process led to acceptance of 14 of the papers (48.3%) of the papers submitted. These 14 Conference Papers represent 6% of the proposals accepted for presentation at the 2013 ATMAE Conference, and only 4.7% of proposals submitted.

Best 2013 ATMAE Conference Proceedings Paper: “An Investigative Study of Rapid Prototyping and Traditional Model Building in the Architectural Design Studio” (Graphics track) by Ms. Shahnaz Aly and Miss Morgan Armistead of Western Kentucky University. This paper was selected in a blind peer-review by six members ATMAE members who served on the Board of Directors or as Division leaders, from the eight papers that were submitted for the Best Paper process after being selected as “best in track.”

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DEVELOPING THE FUTURE WORKFORCE

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ADMINISTRATION
Significance of Amount of Student Involvement as a Predictor of Recruitment, Retention, Academic Achievement and Employment

Presenters:

Dr. Mehmet Emre Bahadir, Murray State University, Department of Engineering, Engineering Technology and Physics, Murray, KY 42071, 270-809-3293, mbahadir@murraystate.edu

Mr. Joseph Rudy Ottway, Murray State University, Department of Engineering, Engineering Technology and Physics, Murray, KY 42071, 270-809-6897, jottway@murraystate.edu

Need:   Globalization and the diffusion of technology have changed many rules and practices at every scale from individuals to governments. Institutes of higher education are no exception to this transformation. Today, universities are adopting new business models and identifying more quantifiable outcomes to evaluate the success of their academic programs. Recruitment, retention, academic success of students and employment of graduates are some of the measurable parameters that are applicable for evaluation purposes. The challenge on the educators is to concentrate their limited resources on the most efficient methods and tools to improve those parameters. Student organizations require more attention for their proven efficiency in the new business model.

Overview:   Student organizations and extracurricular activities have always received positive perception from students, educators and administrators. The general opinion is that students' involvement in extracurricular activities helps them develop their soft skills. Student organizations deserve more attention to investigate the potential benefits for the students and the academic programs. In this presentation, amount of student involvement in student organizations will be demonstrated as a predictor of recruitment, retention, academic success and employment rate.

Major Points:
•   Best practices for advising student organizations
•   Role of student organizations in recruitment, retention, academic success and employment
•   Predicting recruitment, retention, academic success and employment by the amount of involvement in extracurricular activities

Summary:   In this presentation, past student data and records will be analyzed to demonstrate the relationship between the amount of student involvement in student organizations and the success in recruitment, retention, academic achievement and employment.
Radical Redesign - Facilities, Curricula, and Content Changes to Rejuvenate a Low-Enrollment Manufacturing Program

Presenter:

Dr. Bill D. Bailey, Southern Polytechnic State University, Marietta, GA. 30060, 678-915-7242, Wbailey2@spsu.edu

Need: Manufacturing technology curricula are often important to a college, because they are important to local industry even though they may have relatively low enrollment. 1) They also tend to require significant resources in terms of equipment and floorspace. 2) While these programs emphasize hands on learning, that often happens at the expense of instructional structure and systematic assessment. 3) Increasingly there is recognition of the value of broader skills traditionally housed in liberal studies, and that these skills need to be integrated into technical courses.

Overview: Faced with all three of these issues, faculty at a community college developed an integrated response. The subject of this case study is a machining program at a community college, which included a one year machining diploma, a two year associate degree in Tool, Die and Mold Making and various certificate programs. Shortly after the Tool, Die and Mold Making program was added, a local company which was a major source for jobs in this field experienced cutbacks. While there was still a need, and modest enrollment, it was not expected to grow much. In order to preserve the future of these programs, the faculty initiated a redesign to optimize laboratory space and instructor utilization. The machining program had been in place for 30 years, with the same instructor, who was retiring. It was an ideal time to redesign and improve the instruction. Finally, there was a college wide effort to integrate workforce skills (communication, critical thinking, technical, and interpersonal skills) into every course. Faculty decided to address all three issues in a single redesign.

Major Points:
- Laboratory consolidation saved about 40% of floor space
- Equipment consolidation improved the state of equipment and availability for students
- A structured, tiered system of assessment was instituted, including self-assessment
- Curriculum redesign combined laboratory sections, and reduced total instructor hours
- Curriculum redesign provided more flexibility for students working various shifts
- Curriculum redesign leveraged distance learning technologies for both classroom and laboratories

Summary: Attendees will understand the redesign model that provides an integrated solution. The three problems addressed by the redesign were optimal use of physical and teaching resources, a structured approach to hands on instruction and assessment, and the integration of workforce skills into technical courses which were previously addressed only in general studies.
Administration

Qualitative Research Results Related to Lack of Female Students Enrolled within the Industrial Distribution Program at a Midwestern University

Presenter:

Mr. Greg Benson, Doctoral Candidate, University of Nebraska at Kearney, Kearney, NE 68849, 308-865-8287, bensonge@unk.edu

Need: Recruiters from companies with employment opportunities within the ID discipline often comment about the lack of female ID graduates from the university's ID program. During my conversations with company recruiters and other company representatives it is often disclosed that the issue related to the lack of female ID graduates is not unique to the university; rather, it is a challenge they are continually having to deal with within their business environment.

Overview: In this presentation, I will share results from my qualitative research project which may prove useful to academic programs and companies facing the challenge of recruiting females into traditionally male dominated academic majors and employment opportunities. Within the presentation I will provide qualitative data, analysis, and conclusions associated with my research interviews with female students within the university who chose ID as an academic major and those who chose a different academic option within the university's College of Business and Technology. The insight provided from this project may assist companies and postsecondary institutions in revisiting their recruiting strategy in order to attract more females into employment opportunities which have been traditionally filled by male applicants.

Major Points:
- Male/Female ratio in ID related occupations
- Review of male dominant findings in STEM fields
- Female students' perception of ID discipline
- Analysis of my research findings compared to past STEM research findings
- Conclusions and Recommendations

Summary: Attendees of this presentation will gain an understanding of the perception of the ID discipline by female students at the university, and how their perception of the ID discipline compares to the viewpoint of females in other male dominated disciplines such as those found in STEM related positions. The information presented may be useful by other academic and business planners as they develop and/or revise recruiting strategies to improve low female participation in traditionally male dominated occupations.
Certified Technology Manager Certification Exam: Closing the Loop

Presenter:

Dr. Robert A. Chin, East Carolina University, Greenville, NC, 27858-4353, 252-328-9648, chinr@ecu.edu

Need: A robust assessment process is the key to ongoing improvement of overall program performance and thus the successful production of program graduates, who are what we claim them to be. Robust in that the assessment process is a fact based, bottom up review of all key processes, products, and services associated with the program under scrutiny. During the spring of 2012, a study was conducted to ascertain the readiness of selected senior technology management and applied engineering students from a selected ATMAE accredited program to pass ATMAE’s CTM certification exam. The same study was conducted in the spring 2013 to ensure the procedures yielded reliable results. The purpose was to ensure potential program improvement recommendations suggested during the fall of 2012 were valid and should be implemented.

Overview: A decision was made to ascertain the value of employing ATMAE’s CTM certification exam to assess the effectiveness of a technology management and applied engineering program’s professional core of courses (aka the management foundation requirements courses) and the readiness of students for employment in technology management and applied engineering occupations. The content of ATMAE’s CTM certification exam was compared to the content of the program’s professional core of courses. Senior technology management and applied engineering students, who have fulfilled most if not all their professional core of course requirements, were pretested. Then this sample of students sat for ATMAE’s CTM certification exam.

Major Points:
- Background: Institution; Program; Students
- Method: Survey of CTM Certification Exam Content vs. Professional Core Content; Pre-Testing Students; Professional Core Courses Completed by the Students; Nature of Interventions
- Results
- Discussion: Exam and Courses Comparison; Students’ Background; Student Performance
- Conclusions and Recommendations

Summary: The background, method, and results of a study to ascertain the readiness of selected senior technology management and applied engineering degree students to pass ATMAE’s CTM certification exam will be presented. Following the presentation, an opportunity to discuss the study’s findings will be provided. In addition, an opportunity to discuss the study’s recommendations for revising the program’s management foundation requirements will be provided.
Administration

Assessing Scholarly Outlets

Presenters:

Dr. Robert A. Chin, East Carolina University, Greenville, NC, 27858-4353, 252-328-9648, chinr@ecu.edu

Co-Author: Dr. Michael Behm, East Carolina University, Greenville, NC, 27858-4353, 252-328-9674, behmm@ecu.edu

Need: The proliferation of outlets for disseminating the results of scholarly and creative undertakings—i.e. journals and conferences and their resulting proceedings in particular—continues to occur at an explosive pace. This proliferation is due in part to the improved time-to-market strategies employed by the various scholarly undertakings/endeavors, aided by the Internet, the entrepreneurial spirit of publishers and conference organizers, and the increased pressure to publish, regardless of an institution’s Carnegie Classification. Some of the more aggressive tactics, many of which are quite subtle, undermine the scholarly process and distort the knowledge base by flooding disciplines with research findings that do not adhere to the scientific method and the means for disseminating those findings. Thus those tactics undermine and threaten the pursuit of new knowledge.

Overview: The purpose of this presentation is to rekindle a spirit of protectionism in light of the recent tactics available that undermine and threaten the pursuit of new knowledge. It examines (1) how the proliferation of technology, management, and applied engineering journals is enabled, (2) its impact, and (3) strategies for addressing the threat to the pursuit of new knowledge. In the pursuit of new knowledge, published research, which typically goes through several iterations of review before it is published, archived, and retrieved for use, eventually, serves as the springboard from which new knowledge is produced. Faculty, administrators, and promotion and tenure committees should understand and be able to draw conclusions on how scholarly impact in a discipline is measured. In general, we recommend assessing quality over a simple count of quantity. An author’s decision where to submit or present their scholarly and creative undertakings is an important determination that will establish the ultimate value of that research.

Major Points:

• The journal publication process and its significance.
• The predatory scholarly publishing process and how it is enabled.
• The impact of predatory publishing.
• Examples of predatory technology, management, and applied engineering journals and their practices.
• Exercising due diligence in the publication of manuscripts.
• Exercising due diligence in the service to publishers and journals.
• Summary.

Summary: Various means for disseminating the results of scholarly and creative undertakings exist to help add to the body of new knowledge. Some of those means, however, undermine the dissemination of new knowledge and results in the misrepresentation of data and creates the appearance that there is more information than really exists. By exercising some due diligence, technology, management, and applied engineering can mitigate and ensure that its body of scholarly and creative works truly represents its accomplishments.
Administration

**Working on the Supply Chain!**

Presenter:

Dr. Sid Connor, Appalachian State University, Professor and Director, North Carolina Center for Engineering Technologies, Hickory NC 28602, 828 328 6183, connorsg@appstate.edu

Need: Fewer students are entering (and completing) engineering and technology programs in higher education. These programs address the knowledge and skills that have been and will continue to be the core elements of the United States success story: Creative individuals with science, math, engineering, and technology skills to innovate products and processes into our future. Students appear to lose interest in science and math between elementary grades and post-secondary schools. This presentation describes one model that appears to be successful in engaging students and teachers in engineering related activities that foster continued interest in STEM.

Overview: The presentation will include a description of the successful summer camp programs including information regarding the curriculum, student selection, teacher selection, sample activities and the results of follow up surveys with parents and teachers. The attendees will discover how the camps began in summer 2010 and have increased in numbers each subsequent year. Over 500 students have been involved in these camps in the four years since its inception. In addition, 66 teachers were hired over the four years and trained to deliver the curriculum. In addition, 63 students majoring in elementary and middle school education were hired to participate in the camp delivery. The presentation will include information regarding the impact on the public and private school teachers that were hired to deliver the camps (perhaps the most sustainable aspect of this initiative). The presentation will include the budget used to conduct the camps. Students leave the camps with an understanding of what engineers are and what they do.

The objectives of the camps are: 1) to help students understand various disciplines of engineering and what the engineers do; 2) to provide engaging activities that demonstrate to students (and teachers) that engineering is fun and exciting; 3) To give teachers the tools, competence and confidence to use engineering activities in their mainstream classroom. (Teachers have methods classes in many subjects; often the math and science methods classes are weak or non-existent. We are aware of no elementary/middle school teacher education programs that include a methods class on teaching engineering); 4) To give students exposure to some of the tools of engineering.

Major Points:

- The Design of the Program
  - Identifying activities to engage students
  - Identifying teachers to deliver instruction in the camps.
  - Engaging industry in the student selection and program delivery process
  - Managing the camp activities day-to-day.
  - Results of effective camps.

- The increased interest in STEM for students and teachers as perceived by the students' parents and the teachers themselves.

Summary: Attendees will learn an effective method of reaching out to the community/public schools and provide lasting experiences for students and teachers. STEM oriented individuals will populate engineering and technology curricula at community colleges and universities and address a gaping need in industry for the future. Attendees should leave this presentation with enough information to start this initiative in their own region. These camps have created great public relations for our operations. The word-of-mouth has spread far and wide and the success of the camps has had a positive influence on other aspects of the university.
Administration

Technology & Innovation Living Learning Student Community: A Pilot Study

Presenters:

Dr. Sonya R. Draper, North Carolina A&T State University, Greensboro, NC 27411, 336-285-3153, drapers@ncat.edu

Dr. Sherry Abernathy, North Carolina A&T State University, Greensboro, NC 27411, 336-285-3097, sfaberna@ncat.edu

Dr. Mitchell E. Henke, Chowan University, One University Place, Murfreesboro, NC 27855, 419.575.1100, henkem@chowan.edu

Need: The Technology & Innovation Living Learning Community (LLC) was piloted in the fall of 2012 for new college freshmen majoring in technology programs in the School of Technology (SoT) at North Carolina A&T State University. The LLC was designed to help students transition into their programs and overcome fears, provide them an opportunity to network with individuals from diverse backgrounds, work in a team environment, bond with members of the LLC, and enhance valuable skills that can be used in class and throughout their careers such as teambuilding, creativity, time management, communication, listening, presentation and relationship building. Ultimately, the program’s goal is to provide a strong, cohesive community of diverse learners that are successfully retained and graduated within their college majors.

Overview: The SoT Technology & Innovation Living Learning Community (LLC) consists of 21 students who live in a technology-themed clustered portion of a residence hall. The purpose of the LLC is to educate students on the other LLCs as well as the resources, services, and programs available on campus, and the significance on why it is so important to volunteer. The learners also participate in academically and intellectually engaging learning activities designed specifically for them, and enjoy all the same amenities as other residents, yet benefit from a unique living experience.

Major Points:
- Help students create a strong link between their lives in the residence hall and learning experiences in the classroom.
- Provide an environment that is conducive to building a strong, cohesive peer support system that will serve the students throughout their academic and professional careers.
- Help students gain an understanding of what it means to be a part of a global community.
- 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: The SoT Technology & Innovation Living Learning Community (LLC) benefits students by providing a mutual support network, tutoring programs designed to increase retention and overall academic performance, and transforming a residential setting into an active, supportive and exciting place to live. The program also helps students find help and encouragement informally through networking with peers, and meet people who have a common goal. During the spring 2013 semester all students were retained and five made the Dean’s list.
Development of an Incremental ‘Digital Badge’ Approach to ATMAE Certification

Presenter:

Dr. John J. Earshen, SUNY/College at Buffalo, Dept. of Technology, Buffalo, NY 14222-1095, 716-878-4305, 
earshejj@buffalostate.edu

Need: This presentation proposes a superior alternative to the current comprehensive single-exam approach to ATMAE certification. Currently, those individuals seeking an ATMAE certification must schedule and take a single comprehensive, proctored online exam. Examination results are maintained by the ATMAE office. The design of the existing ATMAE certification system has at least two strong impacts: 1) The onerous task of preparing for a single comprehensive examination is probably repelling a portion of individuals who have interest in certification, but who are unwilling to invest the perceived significant time necessary to prepare for a single exam, and 2) ATMAE is responsible to maintain accurate records and serve as the verifying clearing house for all certifications issued – an ongoing activity not without expense. What if ATMAE could mitigate these two strong impacts to positive effect? Enter the ‘Digital Badge’ concept. Rather than taking a comprehensive single online exam to prove mastery within a BOK, what if we could segment the BOK into a series of much smaller segments and then provide individual much smaller, more focused exams the preparation for which would be much less ominous? Each small segment exam successfully passed would result in the issuance of a ‘Digital Badge’ certifying competence in a portion of the BOK. Students could sit for an individual badge exam immediately after completing a course covering the topic (rather than waiting perhaps several semesters for a comprehensive exam). To earn the ATMAE certificate, simply acquire the required number of individual digital badges, and ATMAE Certification is automatically granted. Software company Mozilla, with backing from the MacArthur Foundation, has developed an online ‘Open Badge Infrastructure’ (OBI) designed to support any badge issuer. Further, Mozilla is set up to act as an external verifier of digital badges and certification using a portable ‘digital backpack’ that travels with the individual and is Internet accessible. Importantly, Mozilla does not charge to maintain these digital badge records; it is offered as a public service through their not-for-profit foundation.

Overview: This presentation presents a cost effective alternative to the current comprehensive single-exam approach to ATMAE certification.

Major Points:
• Statement of the problem and its significance – ATMAE Certification is not as widely sought by program graduates as we would like. There is significant cost to maintain and verify certification records at ATMAE headquarters.
• Review Mozilla’s Digital Badge and Digital Backpack approach and architecture.
• Synthesis – Presentation of suggested alternative certification approach: 1) Disassemble the BOK for each ATMAE certificate into a series of smaller digital badge exams, 2) Work within the existing Mozilla OBI system to establish Mozilla as the clearinghouse and maintainer of ATMAE certifications and digital badges.

Summary: Adoption of this alternative approach is expected to increase the number of those seeking ATMAE certification; adoption of Mozilla’s OBI system will decrease ATMAE administrative costs.
Administration

Career and Technical Education Recruitment Strategies: What’s Cheap and What Works

Presenters:

Ms. Susan Ely, Ivy Tech Community College, Lafayette, IN 47905, 765-269-5159, sely3@ivytech.edu

Need: Program enrollment in career and technical education programs is down for many high school, two year and four year institutions. While marketing initiatives may be used for the institution as a whole, reductions in funding have made it difficult to promote individual programs. Decreases in funding have also resulted in a reduction of program specific outreach events, field trips and career days to help increase awareness of the value of career and technical education. A new paradigm of program recruitment strategies is required for an increase in enrollment.

Overview: This presentation will focus on program specific marketing and recruitment strategies used in the College of Technology to promote the Automotive, Advanced Manufacturing, Design, Energy, Industrial Technology, HVAC and Welding programs. The presentation will review techniques aimed at high school students, undecided college students, students interested in transfer opportunities and incumbent workers. The presentation will also highlight tips for new programs or programs aligning with specific workforce needs.

Major Points:

• Population specific recruitment strategies
• Low cost resources for marketing and recruitment
• Making the most of existing partnerships to increase your pipeline
• Sharing resources to lower cost and increase reach in your marketing plans
• Best practices for various forms of media

Summary: Attendees will learn recruitment strategies that have proven success with regard to increasing program enrollment in career and technical education programs. This program will benefit instructors, administrators and business representatives, as linkages between stakeholders will be emphasized. Attendees will be provided with examples of marketing materials and promotional strategies that are easy to implement for low costs and can be custom tailored to their program’s needs.
Administration

Application of the Six Sigma DMAIC Problem Solving Process to Student Recruiting

Presenter:

Dr. Dennis Field, Eastern Kentucky University, Richmond, KY 40475, 859-622-6781, Dennis.Field@eku.edu

Need: Recruiting can be a haphazard process. Potential target audiences include not only high school students, but students coming out of two-year programs at community and technical college systems, and undeclared students already on campus. Given the fact that student recruitment is critical to the health of all programs, methods to improve the recruiting process are needed. The Define – Measure – Analyze – Improve – Control (DMAIC) process offers a formal approach to track, document, and potentially improve student recruiting.

Overview: The presentation will summarize a case study of the DMAIC process as it applies to student recruiting. The use of various quality tools such as brainstorming, CT tree, flow charting, value stream mapping will be highlighted.

Major Points:
• Student recruiting is critical to the health of all programs
• Formal approaches to recruiting can be of benefit to the process
• The DMAIC process offers a proven approach to problem solving

Conclusion: Given the critical impact of student enrollments on the financial health of universities and community colleges, as well as the viability of individual programs within those institutions, approaches to increasing the effectiveness of the recruiting process must be explored. The Six Sigma DMAIC process is one approach that should be investigated.
The Scholarship of Teaching and Learning for ATMAE Faculty

Presenter:

Dr. Steve A. Freeman, Iowa State University, Department of Agricultural and Biosystems Engineering, Ames, IA 50011, sfreeman@iastate.edu

Need: Continuous curriculum improvement and accountability for student learning has become common across higher education. This process starts with reflective practice as faculty thinking about their courses and make changes to improve student learning. However, we need empirical evidence to determine if what we do in the classroom is effective. The Scholarship of Teaching and Learning (SoTL) can provide this empirical evidence. SoTL also makes this work public available so that other faculty can both critique the work and build on the work - both critical factors in moving our technology disciplines forward. SoTL also increases the credibility and respect of the work we do as teachers in the classroom by adding to the literature concerning technology related curricula.

Overview: The Scholarship of Teaching and Learning (SoTL) is transforming higher education. SoTL invites faculty take curriculum improvement and student learning more seriously by better defining what learning outcomes are most important for students to master and then doing a systematic assessment of how their current teaching practices have helped students to accomplish these outcomes. This workshop will prepare ATMAE faculty to participate in SoTL activities.

Major Points:

▪ Scholarship of Teaching and Learning (SoTL) will be defined, clarifying the difference between scholarly teaching and the scholarship of teaching and learning.
▪ The importance of SoTL for ATMAE faculty will be discussed with emphasis on the role SoTL can play in ATMAE accreditation processes.
▪ Administrative support structures to support SoTL work among faculty will be discussed.
▪ The process for ATMAE faculty to get started with SoTL projects will be explained.
▪ Participants will leave with drafts of SoTL research questions and the framework for conducting SoTL work as part of their continuous improvement efforts.

Summary: Participants will walk away with a clear understanding of: what SoTL is; the benefits of SoTL for themselves, their students, and their programs; how to conduct SoTL projects within their courses and curriculum; and a framework for completing a SoTL project upon return to their own campus.
Professional Dispositions: The Influence of Geographic Region

Need: There is an immediate need to define and foster professional dispositions in all students bound for the workforce. In an effort to better define what constitutes professional dispositions for educators nationwide, it is necessary to examine how opinions regarding professionalism may vary from region to region across the United States. A preliminary study involving a sample of students and employers in the Southeastern United States showed that employers place a high value upon confidentiality and honesty, traits that students surveyed did not view as essential to professionalism. Preliminary work also indicated that workplace culture has a significant influence upon behaviors viewed as professionally unacceptable as well as those deemed as professionally essential. Broadening our work to a nationwide sample makes it possible to more accurately define professional dispositions, taking regional differences into account, allowing workforce-bound students to be better prepared to make positive contributions to their organizations after graduation.

Overview: This presentation will briefly explain the importance of defining and fostering professional dispositions in students. A methodology for determining what constitutes a professional disposition will be discussed. Regional differences in defining professionalism across the country will be addressed, as well as discussion as to how educators should use this information to develop professional dispositions and corresponding behaviors in students.

Major Points:
- Professional dispositions are a key factor in student placement and career success
- Because the culture of the workplace influences what behaviors are viewed as acceptable and/or essential, it is also critical to understand how professionalism is viewed in different regions of the United States.
- Educators should use this information to help prepare students for full-time employment

Summary: This presentation will explore the need for fostering professional dispositions and behaviors in students. It will also discuss prevailing perceptions about what constitutes professional dispositions and behaviors in different geographic regions of the country.
Advisory Boards: Partnering Strategies to Link Industry and Education

Presenter:

Dr. James W. Jones, Ball State University, Muncie, IN 47306, 765-285-1433, jwjones@bsu.edu

Need: Program leaders face seemingly constant challenges to keep curricula relevant to the industries they are presumably preparing students to enter. Maintaining a proper balance between core requirements, theory, and application can be difficult, particularly when the industries themselves are rapidly changing and introducing new technologies and innovations. However, an industry advisory board can provide needed guidance, feedback, and resources for program success.

Overview: While many technology programs have industry advisory boards, they are often haphazardly formed, poorly maintained, and under-utilized, with the result being weak attendance and participation from both industry and faculty representatives. However, the industry advisory board can be developed into a powerful ally and resource, assisting the technology program in a wide variety of endeavors from curriculum considerations to course involvement, internship and graduate placement, development and fundraising, and accreditation. Successful strategies to help administrators partner with industry leaders to form a new or revitalize an existing advisory board are provided, along with approaches to encourage faculty and administrative involvement on the university side.

Major Points:

- Purposes of industry advisory boards
- Formation and maintenance
- Composition and structure
- Industry and university participation
- Curriculum involvement and approaches
- Accreditation
- Influencers for success
- Challenges
- Conclusions and recommendations

Summary: Attendees of this presentation will understand how industry advisory boards can be used to support program areas. Best practices, challenges, recruitment, purposes, and potential pitfalls to avoid are covered as they relate to the administrator of a technology program.
Smartphone Applications for Technology, Management, and Applied Engineering

Presenters:

Dr. Martin P. Jones, Missouri State University, Springfield, MO, 65804, 417-836-5154, martinjones@missouristate.edu

Co-Author: Dr. Richard N. Callahan, Missouri State University, Springfield, MO, 65804, 417-836-5160, nealcalhahan@missouristate.edu

Need: The development and use of software for smartphone applications is growing at an exponential rate. There is also an increasing volume of articles published in technology and management journals that discuss the use of smartphone applications. We will present the analysis of our literature survey of journal articles that advance the use smartphone (and other mobile platforms) software and associated sensors in support of technology, management, and applied engineering needs.

Overview: Google estimates that there are currently over one million software applications written for Android and iPhone platforms. Furthermore, they estimate that there have been over ten billion downloads of these applications and such usage is growing exponentially. Smartphones are becoming the ubiquitous choice for personal communication, data gathering, and decision making. Smartphones are essentially handheld computers with the additional versatility of mobile internet connectivity and built-in sensors. These sensors typically include accelerometers, light, sound, magnetic, and proximity sensors, GPS, and cameras. Additional sensors have been developed that can be interfaced with smartphones such as thermal, infrared, and dimensional devices. Our literature survey reveals that this versatility has enabled applications in diverse fields ranging from diagnosing medical conditions to measuring the rotational speeds of fans. This paper will both assess the state-of-art in smartphone applications and also identify areas of opportunity for specific use in technology, management and applied engineering.

Major Points:

- Smartphones applications are ubiquitous and growing exponentially.
- There are many smartphone related articles published in technology and management journals.
- This literature will be reviewed and analyzed for the purpose of identifying new technological and industrial uses of smartphones.

Summary: Attendees will understand the versatility of smartphone applications specifically geared to technology, management, and applied engineering needs. This will potentially lead to increased use of smartphones in a wider variety of fields beyond the typical consumer market.
Different, Not Deficient: Challenges Women Face in the STEM Workforce

Presenters:

Dr. Lynda Kenney, Department of Technology, University of North Dakota, P.O. Box 7118, Grand Forks, ND 58202-7118, 701.777.2197, lynda.kenney@und.edu

Ms. Pam McGee, Department of Technology, Minnesota State University—Moorhead, 1104 7th Street, Moorhead, MN 56563, 218.477.2466, mcgeepa@mnstate.edu

Need: Despite the increase in female labor force participation, women remain substantially underrepresented in most science, technology, engineering, and math (STEM) fields. The small number of women in these and similar fields have variously been attributed to discrimination and differences in ability or choice.

Overview: Research reveals that women are different, not deficient in their ability to succeed in STEM related careers, and that stereotypes are impacting women’s decisions to pursue and remain in STEM career fields, including stereotypes relative to abilities, societal influences, and workplace environments. Women face differential barriers to entry into the technical and scientific fields that discourage their participation. If these barriers were eliminated women and men would enter technical occupations in equal numbers. Included in this study are discussions and recommendations targeted toward parents, educators, and industry to reduce the effects of stereotypes as they relate to the challenges that women face in STEM career fields.

Major Points:
• Nature of the study
• What the literature says about women in STEM career fields
• How stereotypes about abilities, societal influences, and workplace environments impact women
• Recommendations to engage more women in the 21st Century STEM workforce

Summary: This presentation shares research that was conducted and based on the theory that women are different, not deficient in their ability to succeed in the STEM workforce. The researchers convey that stereotypes are impacting women’s decisions to pursue and remain in STEM career fields, including stereotypes relative to abilities, societal influences, and workplace environments. Included in the presentation are discussions on how to reduce the effects of stereotypes as they relate to the challenges that women face in STEM career fields, and recommendations on how to engage more women in the 21st Century STEM workforce.
Need: The demand for an educated workforce continues to grow across America and is critical for the nation to remain competitive in the global market. Many jobs that used to only require a high school diploma now need at least an Associate’s Degree with advancing technology in business and industry. A shortage in the educated workforce in rural areas remains a problem for many industries and further inhibits economic development and growth. Community college facilities in rural areas can help bridge the gap by providing necessary education to the local community to help provide a more educated workforce and increase job opportunities for local residents while also spurring economic development.

Overview: A partnership developed in fall of 2010 between Ivy Tech Community College in Crawfordsville, IN, the City of Crawfordsville (Redevelopment Commission), and Montgomery County. Ivy Tech was seeking to expand the current leased facility because it was near capacity. The College approached the City and began to have discussions with the Mayor and the Crawfordsville Redevelopment Commission (CRC). The CRC constructed and opened a nearby commerce park in 2005 that remained vacant. Ivy Tech proposed working with the City on the development of a new Ivy Tech facility in the Commerce Park that the City would lease to the college. Ivy Tech and the CRC agreed that a location in the Commerce Park would provide the most benefit for all parties involved. Ivy Tech would remain near its strategic location close to the interstate and would provide a catalyst to draw in other business and industry to the area. Several other business/industrial parks that Crawfordsville competes with for clients in the central region of the Indiana have an educational institution as an anchor. Montgomery County, also very interested in promoting economic development, agreed to help financially back the new City-owned Ivy Tech building. This partnership, a unique collaboration of City and County government with Ivy Tech, was forged with community support to promote the education of the area workforce and spur further economic development. The new location enables the college to offer more courses across several programs, a full business administration associate’s degree on site, and provide space for the Ivy Tech Corporate College to expand workforce training in the area. Ivy Tech continues to develop additional sites using this model of partnership in other communities as well.

Major Points:
- Community colleges can help increase the level of education in rural areas but often need additional resources to expand to serve these students
- Partnerships with local government and the community can help provide the resources for colleges to establish satellite campuses and expand them which is beneficial to all involved
- Local government and the community are eager to increase economic development, raise the level of workforce education, and expand job opportunities for residents

Summary: Attendees will understand how a partnership between City and County government and the community worked to build a new rural satellite community college facility that is beneficial to all parties involved, which could possibly be duplicated in other communities.
In The Door Faster Equals Out the Door Faster: Examining an Accelerated Degree Program Starting in High School for Rapid Workforce Development

Presenter:

Dr. Doug Koch, University of Central Missouri, Warrensburg, MO 64093, ph. 660-543-4439, koch@ucmo.edu

Need: Several technology fields are experiencing shortfalls for their current and projected workforces. In preparation for these professions, many students are accruing large debts after having to complete four to six years of college following high school graduation. There exists a need to compress the time frame to enter the workforce by completing a bachelor’s degree more quickly and without the high debt often associated with a college education. Such a process would provide the needed workforce for these high demand fields, recruit and retain students into those professions, and provide affordable and efficient education for them.

Overview: This presentation will provide information on accelerated degree programs and examine a particularly unique program that enrolls students as early as their sophomore year in high school. Through efficient use of dual credit, collaboration with a community college, and articulation at the university, the students will complete a bachelor’s degree two years after high school graduation. The program is in its first year and has a 20-student cohort participating with additional degree options being developed. The program incorporates required internships throughout the program, eight total. The internships provide outcomes based education as well as funding for the cost of education. The objective of the program is a student that can enter the workforce earlier yet with more real world, hands-on experience and little or no debt. The presentation will also present findings on the students’ perceptions and reasons for participation as well as plans for longitudinal study of the program and the students’ success.

Major Points:
- Pros and cons of accelerated degree programs
- Overview of current “Innovation Campus” program students have entered into.
  - Curriculum structure and sequencing
  - Collaboration among High School Tech Center, Community College, and University
  - Internships and their unique differences from traditional internships
- Research findings on students’ perceptions and reasons for participating
- Longitudinal study plans and expansion of other programs

Summary: This presentation will provide information on an innovative, accelerated degree program. It details information regarding the selection process of students, the curriculum sequence, the eight required internships and the importance of long-term studies of the program. The intent of the accelerated program is to provide innovative ways to develop the future workforce.
Administration

Better Understanding Online Faculty Workload as an Administrator and Learning ways to Promote Online Faculty Success

Presenter:

Dr. Edward J. Lazaros, Ball State University, Muncie, IN 47306, 765-285-5647, ejlazaros@bsu.edu

Dr. David Hua, Ball State University, Muncie, IN 47306, 765-285-5659, dhua@bsu.edu

Need: Administrators often struggle to understand the faculty workload of faculty who teach online courses. The workload of online faculty can often be difficult to define and quantify. There is literature that suggests faculty often spend more time per student when teaching online when compared with face-to-face courses. Administrators need to learn ways to determine online faculty workload. Those in administrative roles also need to be aware of strategies to assist online faculty such as providing support and mentoring services.

Overview: During this presentation, conference attendees will be introduced to strategies for determining online faculty workload at the university. Conference attendees who are in administrative roles at their universities may find this information particularly useful. Literature that documents the workload of online and face-to-face faculty will be presented. Evidence that suggests online faculty invest more time and energy than their face-to-face counterparts will be discussed. Strategies to promote online faculty success will be illustrated. These include providing mentoring opportunities for online faculty and technology support services.

Major Points:

• Strategies that administrators can use to determine online faculty workload at the university level
• Comparing the online and face-to-face workloads
• Strategies to promote the success of online faculty
• Mentoring opportunities for online faculty
• Technology support services for online faculty

Summary: Conference attendees will leave the presentation with an understanding of how to better define and quantify the workload of university online faculty. Attendees will benefit from information that comes from recent literature that documents the workload of online and face-to-face faculty. Those who are in administrative roles at their universities will benefit from strategies to promote online faculty success. Administrators will leave the presentation with ideas that will make them better prepared to provide mentoring opportunities and offer technology support services to faculty who teach online courses.

Presenters:

Mr. Terry Marbut, Jacksonville State University, (256) 782-5034, tmarbut@jsu.edu

Dr. Jess Godbey, Jacksonville State University, (256) 782-5080, jgodbey@jsu.edu

Dr. Dana Ingalsbe, Jacksonville State University, (256) 782-5229, ingalsbe@jsu.edu

Need: Does the name of an academic program have an impact? Will the name affect graduate employment opportunities? Will it influence recruitment? Many institutions have changed or are contemplating program name changes based on the professional organization’s change from the National Association of Industrial Technology (NAIT) to the Association for Technology, Management, and Applied Engineering (ATMAE). A preliminary study indicates that there are implications associated with the name of an academic program. Compiling and analyzing information from an institution that has changed programs names to reflect applied engineering could provide valuable insight for those debating name changes.

Overview: This presentation will provide the results of a comprehensive study based on a previous preliminary research. Analysis will highlight survey data regarding the impact of the name changes. Participants include high school students, community college students, current University students, alumni, and potential employers.

Major Points:

- Selection of new program names
- Impact on recruiting
- How high school and community college students interpret program names
- How our current students reacted to the name changes
- Perceptions of our alumni to the name changes
- How potential employers perceive graduates of certain programs

Summary: Attendees will gain an understanding of the impact of program names on these study participants which may be useful as they consider program name changes.
Tailoring Syllabi to Satisfy Industry Expectations for the Future Workforce

Presenter:

Dr. Devang P. Mehta, North Carolina A&T State University, Graphic Communication Systems and Technological Studies, Greensboro, NC 27411, (336) 285-3109 x53109, mehtad@ncat.edu

Need: It is extremely important that what we produce that meets customers’ expectations and become a successful product. In academia students are our products and companies that hire them are our customers. Customers look for specific product characteristics before making a buying decision. For example, to purchase a TV set, customers search for its peculiar characteristics, such as, size, LCD/LED/plasma, resolution, PIP and 3D features, Internet capability, audio and video quality, weight, brand, and of course, price—a few to mention. Similarly, companies that hire graduates look for specific employee characteristics, like, in-depth knowledge in a hiring field and a variety of skills that include but not limited to technical, leadership, personal, and interpersonal. As a result, it is utmost important that students have all the necessary skills and knowledge in order to sell themselves when they leave the campus.

Overview: This presentation discusses the development of syllabi that satisfy industry expectations to hire students. In today’s economy there are fewer jobs and more competitions. Employers are going to hire those students who satisfy their employee trait wish list. In addition, the hiring process creates a burden on the company’s budget, so employers will be extra careful on employing someone. As educators we have to make sure when students graduate, they have developed basic employee characteristics, like thorough knowledge in the area of interest and essential skills that comprise of technical, leadership, personal, and interpersonal—a few to list. It can be achieved by integrating employee characteristics into the syllabi.

Major Points:
▪ Introduction
▪ Industry Expectations
▪ Development of a winning syllabus
▪ Summary

Summary: Attendees will comprehend the necessity of tailoring syllabi that meet industry expectations. The presenter will provide examples on how to incorporate employee characteristics that companies search for in the workforce into a syllabus.
Administration

**Strategies for Passing the ATMAE Certification Exams**

Presenters:

Dr. Mark R. Miller, The University of Texas at Tyler, Department of Human Resource Development and Technology, Tyler, TX  75799, 903-566-7186, mmiller@uttyler.edu

Dr. Heshium R. Lawrence, The University of Texas at Tyler, Department of Human Resource Development and Technology, Tyler, TX  75799, 903-566-7331, hlawrence@uttyler.edu

Dr. Dominick E. Fazarro, The University of Texas at Tyler, Department of Human Resource Development and Technology, Tyler, TX  75799, 903-565-5911, dfazarro@uttyler.edu

Need: As more and more university and two year programs use the ATMAE certification exams for assessment, the average number of individuals passing the exams continues to decline. Moreover, some programs have a higher passing rate than others even though their curriculum does not reflect the content of the exam as well as others do. In addition, many individuals taking the exam are not adequately prepared for them and are not cognizant of the preparatory materials that are readily available.

Overview: This presentation will focus on the key factors that are involved with passing the ATMAE certification exams. In addition, this presentation will review the content that is covered on each of the exams.

Major Points:

- Brief overview of the need for the ATMAE certification exams
- Description of how ATMAE exams are currently being used for assessment by programs
- Outline of the content covered by the exams for improved program fit
- A review of effective methods for improving the pass rate of certification exams
- Review of unsuccessful strategies that program coordinators continue to use annually

Summary: As a greater number of programs continue to use the ATMAE certification exams for assessment, the overall annual average pass rate for them has continued to fall over the past several years. This presentation will focus on the factors that contribute to the decline of the overall pass rate and review strategies that have proved effective for passing the exams. In addition, content covered for all of the exams will be briefly examined so program coordinators can select the most appropriate exam for their particular programs.
Developing an ATMAE Online Accreditation Self-Study

Presenters:
Dr. Tim Obermier, University of Nebraska at Kearney, Kearney, Nebraska 68849, Professor and Chair, Industrial Technology Department, 308-865-8504, obermiert@unk.edu
Mr. Greg Benson, University of Nebraska at Kearney, Kearney, Nebraska 68849, Instructor, Industrial Technology Department, 308-865-8287, bensonge@unk.edu

Need: The need exists to continue to explore how the Internet can provide benefit for the ATMAE Accreditation process. As more institutional data is available online it is logical to keep the information online when presenting it in an accreditation self-study. An online accreditation self-study is not simply a PDF file of the completed self-study posted online. It is a structured menu driven content management system which can both archive essential data year over year and present it in a logical manner to the accreditation visiting team. The benefit of increased collaboration among faculty as the self-study is developed, and ongoing archive for accreditation data are key to overall improvement of the accreditation process. Visiting team members also benefit since accreditation reviews are increasingly incorporating analysis of institutional information found on websites. The online accreditation self-study aggregates information into a collective source making it easier for the visiting team to conduct their review.

Overview: Since 2002 over the past eleven years the University of Nebraska at Kearney Industrial Technology Department has developed and delivered three accreditation self-studies completely online via the Internet using web content management systems. The first was open access with an archaic web navigation system and the second was password protected with an improved navigation menu. The third self-study was completely revamped due to the new ATMAE outcomes based accreditation model. This presentation will provide an overview of how the process has worked, the benefits to be realized from all parties involved, and the steps to make it happen.

Major Points:
- How to develop an online accreditation self-study.
- Benefits of online accreditation self-studies by all parties.
- Structural recommendations for the self-study to provide clarity for the visiting team review.

Summary: This presentation will provide an overview of the step-by-step process of developing an online self-study, the benefits to be realized from all parties involved and methods to provide clarity for the visiting team from the perspective of a department having completed and delivered three completely online ATMAE Accreditation self-studies since 2002.
Administration

*Increasing Retention and Graduation Rates for Students in the School of Engineering and Technology*

Presenter:

Dr. Olusegun Odesina, Professor and Associate Dean, Central Connecticut State University, New Britain, CT 06050, 860-832-1833, Odesina@mail.ccsu.edu

**Need:** Research has shown that fewer that 4 out of 10 incoming freshmen will complete their degree in four years and barely 6 in 10 will complete at the end of 6 years, (Carey, 2005). The loss of potential graduates in engineering could not come at a worse time for the United States of America. There is global competition to produce graduates who are knowledgeable and skillful and the well-paid jobs will require these skills. Statistics has shown that United States is producing 70,000 engineers a year, versus 350,000 from India and 600,000 from China. It is necessary to find ways to retain and graduate our students if we do not want to lose the competitive edge and thus our quality of living.

**Overview:** The goal at CCSU is to increase the success of engineering students by enhancing their problem solving skills in the three initial engineering science courses within the Mechanical and Civil Engineering Program curricula. These courses (Statics, Dynamics, and Mechanics of Materials) constitute the beginning of the critical path towards graduation in Mechanical and Civil Engineering, acting as prerequisites to fourteen and ten subsequent courses, respectively. Christopher Drew reported that studies have found that roughly 40 percent of students planning engineering and science majors end up switching to other subjects or failing to get any degree, (New York Times, Nov. 4, 2011). The reason attributed to this attrition is what was described by David E. Goldberg, an emeritus engineering professor as “the math-science death march.” According to him, “freshmen in college wade through a blizzard of calculus, physics and chemistry in lecture halls with hundreds of other students. And then many wash out”. This presentation focuses on efforts at Central Connecticut State University to increase retention and graduation rates of undergraduate students.

**Major Points:**
- Use of the Live and Learn community
- Scheduling all first year students in the same section of First Year Experience courses
- Used of certified peer tutors and the student services center
- Use of professor guided supplementary problem solving sessions.

**Summary:** Retention and Graduation efforts must be multifaceted involving several activities. It is not enough to employ a single approach to aid in the retention of students as their learning styles are different. The more opportunities students have in exposure to the information, the better the chances for success. Participants will learn about retentions efforts at Central Connecticut State University School of Engineering and Technology.
Administration

**Development and Implementation of a Comprehensive Student Recruitment Initiative**

**Presenters:**

Ms. Donna Painter, Assistant Professor, Department of Applied Engineering, Safety & Technology, Millersville University, Millersville, PA 17551, donna.painter@millersville.edu

Dr. Barry David, Professor & Chair, Department of Applied Engineering, Safety & Technology, Millersville University, Millersville, PA 17551, barry.david@millersville.edu

**Need:** With demographic trends pointing to a decline in high school graduates coupled with growing competition among institutions vying for a reduced population, programs must be proactive in order to maintain or increase student enrollment. Developing and implementing a comprehensive targeted plan of action is necessary for programs to remain vital.

**Overview:** This presentation will offer a student recruitment plan developed by faculty to address concerns about future enrollment declines. The development of a comprehensive recruitment plan includes an introspective analysis of what we are currently doing to connect with prospective students and how we can better meet the recruitment goals of the department.

**Major Points:**

- Introspective analysis
  - Students currently in program
  - Department external communication
  - External perceptions of programs
  - Effectiveness of current recruitment efforts

- Developing a recruitment plan
  - Calendar & Timeline
  - Budget
  - External communication
    - Tours and visitations
  - Department display materials

- Conclusions and recommendations

**Summary:** Attendees will learn how awareness of future enrollment predictions triggered a response from faculty that resulted in a concerted effort to identify and implement an immediate student recruitment plan of action. The recruitment model can easily be replicated and implemented at a relatively low cost.
Retention Processes That Work

Presenter:

Dr. Charles Patrick, Chief Academic Officer and Professor, Penn State University – Worthington Scranton, 120 Ridge View Drive, Dunmore PA 18512, 570-963-2510, wcp13@psu.edu

Need: Traditional higher education is under tremendous pressure to recruit and retain good students. Student retention is commonly defined through the metrics of: (1) fall-to-fall semester continued enrollment in classes, typically measured as the percentage of students retained fall-to-fall from the freshmen to sophomore level; and (2) on-time graduation typically measured as the 4 or 6-year graduation rates for first-time, full-time, bachelor degree seeking students. These definitions are, however, limited in scope. More broadly, retention includes, but is not limited to, continued enrollment semester to semester, retention of “at-risk” students (developmental and first generation college), part time and adult student retention, and transfer student retention to bachelor degree. Given the resource squeeze in higher education, colleges and universities must implement retention initiatives that are effective and efficient. Colleges and universities need to implement retention processes that work.

Overview: This presentation focuses on retention processes that work rather than simply arranging retention data in different ways. These retention processes have been implemented at two very different public institutions. Morehead State University in Kentucky is a regional, comprehensive university enrolling approximately 11,000 students. Penn State University – Worthington Scranton is a commonwealth campus of Penn State enrolling approximately 1,300 students with multiple bachelor-level programs plus support of students transferring to other Penn State campuses. At both institutions, several retention processes are underway with methods in place to determine their effectiveness. Success of these retention processes is proven and data driven.

Major Points:

- Push for student retention in higher education
- Understanding and using retention data
- Description of retention processes that work
- Methods to measure process efficacy and data support
- Continuous improvement in an institution

Summary: Presentation participants will be provided an overview of the impetus for increasing student retention processes and efficacy. A discussion of retention data will follow as a lead into a description of active retention processes at two institutions. Methods for measuring the effectiveness of these processes will be explained and examples provided. Finally, a continuous improvement approach will be discussed. Participants will be provided information by the presenter, with emphasis placed on transmitting information. While this approach is not an active learning strategy, an informal approach will be used in this audience of peers. The presenter will design the presentation with distinct intervals and examples placed to allow participants opportunities for questions and audience interaction. The author of this presentation is an experienced public speaker who knows how to manage a presentation in order to involve participants in higher-order thinking (analysis, synthesis, evaluation).
Administration

Evaluating Faculty in Meaningful Ways – A 3-Decade Synopsis

Presenter:

Dr. Charles Patrick, Chief Academic Officer and Professor, Penn State University – Worthington Scranton, 120 Ridge View Drive, Dunmore PA 18512, 570-963-2510, wcp13@psu.edu

Need: Evaluating faculty equitably and productively is a difficult task with a long history. In recent years, however, the emphasis on faculty evaluation has increased due to a growing demand by the general public, state legislatures and federal agencies for more accountability in higher education. Further, institutions must use evaluation processes as a foundation for tenure and promotion decisions. A fair yet rigorous evaluation system contributes to an institution’s ability to find and retain the best faculty, which is good for students, the institution and ultimately the faculty themselves.

Overview: Many factors must align to develop an equitable and productive faculty evaluation process including: (1) well defined policies, (2) clearly articulated and consistent processes, (2) emphasis on improvement, (3) a faculty receptive to critical review, (4) academic administrators willing to be candid, and (5) support from upper administration. The three tiers of faculty performance and thus evaluation, namely teaching, research and service, are well known. Each institution attempts to productively evaluate each of these three tiers effectively but the processes are many times plagued by politics, poor leadership, a misshapen culture of evaluation, and lack of transparency. This presentation focuses on faculty evaluation processes that are research based and tested in a 30-year career by a veteran faculty member and academic administrator.

Major Points:
- Change in higher education affecting faculty evaluation
- Understanding key elements of evaluation, including culture
- Developing an evaluative culture for measuring productivity
- Evaluation process documentation – examples that work
- Landmines of faculty evaluation

Summary: Presentation participants will be provided an overview of faculty evaluation considerations. A discussion of faculty performance data will follow as a lead into a description of effective evaluation processes. Examples of process documents will be provided and discussed. Participants will be provided information by the presenter, with emphasis placed on transmitting information. While this approach is not an active learning strategy, an informal approach will be used in this audience of peers. The presenter will design the presentation with distinct intervals and examples placed to allow participants opportunities for questions and audience interaction. The author of this presentation is an experienced public speaker who knows how to manage a presentation in order to involve participants in higher-order thinking (analysis, synthesis, evaluation).
Coordinating Multiple Program Assessment: The use of ATMAE Certification Exams in College-Wide Program Assessment

Presenters:
Dr. Randy Peters, Indiana State University, Terre Haute, IN 47809, (812) 237-4962, randy.peters@indstate.edu
Dr. Mike Hayden, Indiana State University, Terre Haute, IN 47809, (812)237-3359, michael.hayden@indstate.edu

Need: Many states are implementing procedures in an attempt to increase the ROI of public universities and institutions. Outcomes Assessment is a tool that is used to formulate many indicators on a dashboard of performance. Assessment has often been done separately and inconsistently throughout the various college units and often has been dependent on specific program accreditation. A more streamlined approach to assessment of programs can save money and increase faculty productivity

Overview: This presentation describes an institution’s practices, progress, and results in consolidating and streamlining the assessment activities related to regional accreditation; multiple program accrediting bodies, e.g., ABET and ATMAE; and state and institutional requirements. ABET and ATMAE accreditation standards are used as a framework for the process. ATMAE Certification is also an integral part.

Key Points:
• Consolidating and reconciling the multiple assessment audiences, e.g., regional accreditation, ABET & ATMAE, etc.
• The role of ABET and ATMAE accreditation
• The role of ATMAE Certification
• The relationship of assessment to strategic planning and other administrative concerns
• The relationship of assessment to faculty workload and what happens in the classroom
• How to effectively and efficiently manage the above

Summary: There is no need to reinvent the wheel or treat the seemingly competing requirements of regional vs. program accreditation, planning vs. what we actually do, teaching vs. assessment as versus (as separate and burdensome tasks). Program accreditation practices can provide the framework for various assessment requirements and other faculty and administrative concerns.
Administration

**Educating the Future Workforce: A Matter of Skills!**

Presenters:

Dr. Patricia Polastri, Texas A&M University - Kingsville, TX 78363, (361) 593-2125, patricia.polastri@tamuk.edu

Mr. Todd Alberts, Indiana State University, Terre Haute, IN 47809, (812) 237-3357, Todd.alberts@indstate.edu

Need: Current students graduating from colleges and universities entering the workforce are not adequately prepared for the challenges presented in their new careers. There is a lack of both soft and hard skills required to perform satisfactorily, and this phenomenon is experienced throughout all majors in academia. Particularly, students in technological areas lack diverse skills that should and could be provided during their education. Industry reports demonstrate that they require a better prepared workforce; however, academia is not satisfying this demand. It is an urgent matter to align industry needs with the skills provided to students in order to obtain the workers industry demands.

Overview: Attendees will be presented with a series of traits and skills demanded by industry. Skills are divided into hard and soft, managerial and technical providing a holistic view of the current business environment needs. Methods of identifying and integrating these needs into current curriculum’s syllabus will be addressed. A selection of methods will be introduced for further discussion and evaluation.

Major Points:

- Skills, what they are and why they are important.
- Industry, domestic and global, their challenges and needs
- Education, Sustainability and Management
- Global competition

Summary: The need to produce a better qualified workforce today is incumbent in all industry sectors. The US can no longer ignore this necessity and expect to remain competitive. Students in technical areas in particular seem to lack skills that prove to be indispensable in today’s workforce. There is an urgency to develop a workforce capable of dealing with the uncertainties of today’s business environments in both technical and non-technical terms.
Steps to Successfully Implementing Computer Assisted Infrastructure (CAI) for Automated Learning in Undergraduate Engineering and Technology Education

Presenter:
Mr. Oscar A. Rodriguez, Associate Professor, Ivy Tech Community College, School of Applied Sciences and Engineering Technology, 200 Daniels Way, Bloomington, IN 47403, 812.330.6053, orodrigu@ivytech.edu

Need: The decline in enrollment of Science, Technology, Engineering, and Mathematics (STEM) graduates in highly technological societies is a concern for political leaders, educational and business leaders, this is especially critical in the U.S.A (R.P. Polsani, 2004). At the heart of the problem lies the slow level of adoption of computer and information technology (ICT) by educational and training institutions to help alleviate the problem (W. Bates & G. Pole, 2003). In essence, more individuals could be educated and trained if there was willingness and know-how in terms of design, development and implementation of initiatives that will employ current Computer Assisted Instruction (CAI) to provide access to engineering and technology education to potential students and trainees that would be willing to educate themselves in any STEM related field (Z.L. Berge and M.P. Collins, 1995).

Overview: In order to create more opportunities for students, business and industry workers to have flexible formats that may allow them to complete engineering and technology programs’ courses requiring hands-on laboratory experiments it is necessary to have available computer aided instruction (CAI) to engineering students anytime and anywhere (Leedy Paul D. & Jeanne E. Ormrod, 2008). These systems not only will allow students in engineering and technology courses acquire new skills and knowledge, but it will prepare them for further scientific and technical education, and for careers in the world of high technology. The implementation of such systems is an ambitious project that requires time and knowledge in integrating existing technologies to standardize Content Learning Systems and to comply with academic criteria as well as meeting accreditation standards required in engineering education programs.

Major Points:
- Needs analysis of the context where CAI infrastructure will be implemented.
- Specifying the resources involved in a CAI infrastructure for DOL.
- Analysis of the process to automated hands-on teaching and learning.
- Evaluation of the CAI infrastructure.

Summary: Attendees will be able to study the context where CAI for engineering education is implemented, they will learn to identify and specify the equipment requirements, learn about implementing the CAI system, and be able to evaluate the effectiveness of such CAI infrastructure. The model presented can be replicated based on specific case and needs analysis.
Administration

Outcomes Assessment, Rubric Development, Competency Based Artifacts, and Coordination of Industrial Advisory Board Input

Presenter:

Dr. David L. Rouch, Chair and Professor, Ohio Northern University, Ada, OH, 419-772-2170, d-rouch@onu.edu

Need: In General, all Universities and programs within a university are being challenged to provide data that documents the quality and value added learning outcomes that are being expected of completers of programs. Also, the latest ATMAE accreditation guidelines have been revised to require assessment data that show the level of effectiveness of programs and communicating that to the general public.

Overview: This presentation will describe the process the Ohio Northern University Technological Studies Department used for identifying learning outcomes/competencies, the use of artifacts to demonstrate student competence, the development of assessment rubrics, and the coordination of these outcomes with the University’s general education curriculum requirements.

Major Points:

• Industrial Advisory Board involvement with the major programs and the development of a Body of Knowledge and Identification of Outcomes
• Development of a matrix of outcomes and courses
• Coordination of outcomes and assessments in courses
• Artifact assessment development and procedures
• Assessment rubrics
• Pitfalls to avoid
• Interfacing with university general education curriculum requirements

Summary: Post-Secondary education is receiving increased scrutiny in national media regarding increasing costs of a college education and what value that education actually provides students. Attention to accreditation and assessment issues relating to providing the general public with actual measurable results from a particular major, its outcomes for job placement, graduate satisfaction, employer satisfaction, and a real world (Industrial Advisory Board) stamp of approval is critical to the future success of University programs.
Administration

Building the 21st Century Workforce – An Innovative Approach Used to Provide a Skilled Workforce to Advanced Manufacturing Industries for the Next Twenty Five Years

Presenters:

Mr. Sam Rowell, Dean/Associate Professor, Advanced Technologies Division, Northeast State Community College, Blountville, TN 37617-0246, 423-354-2582, ssrowell@northeaststate.edu

Co-Author: Mr. Robert J. Wilson, Instructor, Northeast State Community College, Regional Center for Advanced Manufacturing (RCAM) at the Kingsport Academic Village, Kingsport, TN 37660, 423-354-5543, rjwilson@northeaststate.edu

Need: Nationally 12 – 15 thousand skilled workers are retiring each day; thirty million college bound students ages 18 – 24 years are not pursuing Advanced Manufacturing careers. In this presentation, we will present the strategic and tactical approach employed by Northeast State Community College and the Advanced Manufacturing Partnership (AMP) to provide a qualified skilled workforce to satisfy the immediate and future needs of regional industries.

Overview: The Advanced Manufacturing Partnership (AMP) is a public/private initiative to address the skilled labor issues in the Northeast TN region. AMP members include: major industry partners, chamber of commerce, State of TN Economic and Community Development, and Northeast State Community College. The collaborative efforts of the AMP have developed the Regional Center for Advanced Manufacturing (RCAM). This 26,000 square foot training facility is designed to provide technical training for those seeking A.A.S. technology degrees, company sponsored apprenticeship programs, and incumbent worker training.

Major Points:

• Take care of existing regional industries.
  ▪ Developed 700+ hrs. of skilled, hands on laboratory training for credit
  ▪ Provided noncredit options for short term training for small industry needs
• Developed pipeline of “skilled labor”.
  ▪ Degree programs which align with industry training
  ▪ Outreach through K-12 programs both in-house and mobile activity
  ▪ Career Development Services Center – connecting students to employers
• Support Economic Development Initiatives
  ▪ Serve as a resource for Economic Development Initiatives, as well as hosting Site visit Teams of companies seeking to locate in this region

Summary: Attendees will understand the model used to provide a qualified skilled workforce to back fill the steady outflow of skilled workers (baby boomers) from regional industries, as well as an active program to build interest in advanced technologies as a career option to K-12 students.
Administration

Developing a Program Outcomes Assessment Model for ATMAE Accreditation

Presenters:

Dr. Ernest J. Sheldon, CSTM, Indiana State University, Terre Haute, IN 47809, 812-237-2865,
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Dr. Farman Moayed, PE, Indiana State University, Terre Haute, IN 47809, 812-237-3461,
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Need: ATMAE programs are migrating toward outcomes assessment models for accreditation. Many colleges and universities have not yet developed their own assessment models. We found it to be a major challenge to validate outcomes while preparing our 2010 accreditation self-study.

Overview: Shortly after our accrediting team visit ISU implemented a mandatory outcomes assessment process for all university programs. By incorporating the model we developed for our own internal assessment into our ATMAE model we were able to strengthen our two-year follow-up report for ATMAE. This presentation will highlight the steps to develop a comprehensive outcomes assessment model useful for virtually any academic program.

Main Points: Primary steps in the assessment process include:

• Identification of program outcomes
• Student Learning Objectives (SLO) for each outcome
• Assessment plan, including strategies and assessment methods for each SLO
• Assessment schedule (3 year cycle)
• Assessment rubrics for SLO’s
• Closing the loop

Summary: The presentation will provide an overview of the outcomes assessment model the Safety Management programs at Indiana State University utilized during our initial outcomes-based accreditation self study and 2-year follow-up report. While an identical model certainly would not suit every program or university, the concepts of this model appear solid. An ATMAE presentation like this would have provided our program with much-needed assistance.
Utilizing Faculty Advisor Models to Prepare Students for Successful Participation in a Increasingly Diverse Workforce

Presenters:

Dr. Isaac Slaven, Eastern Illinois University, Charleston, IL 61920, 217-581-7259, islaven@eiu.edu

Mr. Todd Bruns, Eastern Illinois University, Charleston, IL 61920 217-581-8381, tabruns@eiu.edu

Need: Research has shown that businesses are utilizing an increasingly diverse workforce. The ability to work well with others, regardless of differences in age, nationality, cultural or religious beliefs, gender, race, or sexual orientation, is a key component to maintaining the excellent communication and interpersonal skills that businesses rely upon. While universities and colleges have formalized instruction in subject knowledge, there is little in the way of specific programs that demonstrate tomorrow’s workers’ professionalism in a diverse work environment.

Overview: This program utilizes the role of faculty advisors to introduce two different student organizations (PRIDE, an LGBTQ+ student organization, and the ATMAE Student Group) to the concepts of diversity and professionalism in interpersonal communications. The purpose of the project is to formalize learning objectives of successful navigation of interpersonal differences, increased awareness of diversity issues, and improved communication styles. The learning objectives are obtained by knowledge exchange (information presented to the students by the advisors) and a facilitated experience exchange among the students.

Major Points:

- Workforce diversity is continually increasing.
- Successful communication and interpersonal skills will include the ability to communicate professionally in diverse work environments.
- Students can benefit from formal awareness training via outside-the-classroom learning environments such as student organizations, guided by faculty advisors serving as facilitators.

Summary: Attendees will see the results of utilizing non-formal learning environments to improve students’ skills in nebulous but vital areas pertinent to future success in the workforce.
Administration

The Possible Effects Changing the Classification of Instructional Programs Codes Could Have on Your Programs

Presenters:

Dr. Michael Williford, Associate Provost for Institutional Research and Assessment, Ohio University, Computer Services Ctr 301A Athens, OH 45701, (740)-593-1059, willifor@ohio.edu

Dr. Todd Myers, Associate Professor, Department of Engineering Technology and Management, Ohio University, Stocker Center 124b Athens, OH 45701, (740) 593-1921, myerst2@ohio.edu

Need: ATMAE programs are classified by their colleges/universities under a variety of Classification of Instructional Program (CIP) codes, such as industrial arts, industrial technology, or materials engineering. Current interest among ATMAE programs in changing their Classification of Instructional Programs codes (CIP), if pursued, could more appropriately and accurately describe them but could also have major ramifications on the program's state funding allocations, eligibility for STEM awards, comparative faculty productivity and salary studies, and college rankings guides. This presentation will review the hierarchical CIP code structure, how CIP codes are used by colleges/universities and state/national agencies, and observations from senior administration as to effects that changing CIP codes have had on other programs which have pursued such a change.

Overview: This presentation will review the CIP codes and how changing your program code could positively or negatively affect ATMAE member programs.

Major Points:

• Classification of Instructional Programs codes structure and uses
• Institutional Impact of changing CIP codes
• Program Impact of changing CIP codes

Summary: At the end of the presentation the attendees will understand Classification of Instructional Programs codes and how they relate to ATMAE member programs.
Online Standards and Accreditation: Where Do The Two Meet? An Investigation of Standards for Online Learning Evaluation and the Effects on National and Regional Accrediting Bodies

Presenters:

Dr. Ronald Woolsey, University of Central Missouri, School of Technology, Warrensburg, MO 64093, 660-543-4340, woolsey@ucmo.edu

Need: The growth of web based learning has stimulated must discussion related to online and web based teaching and learning (Carnavale, 2000). Quality standards are being distributed by many organizations globally and accrediting bodies are moving to adapt to this relatively new method of delivery (MSCHE 2011). Universities need a methodology to ensure the integrity of their education while students deserve a commitment to receive quality education regardless of the delivery method.

Overview: Instructional technologies vary between course, instructor, major and university but the standards established by accrediting bodies are evolving to include these delivery methods. Initiatives by CHEA, The Higher Learning Commission and organizations such as NACOL, QM, and WCET continue to develop assessment rubrics for online courses.

Major Points:

- What current evaluation tools are available to schools currently delivering web based online degree program?
- Are these standards and tools appropriate for different educational levels and learning communities?
- How do the online development standards related to program accreditation?
- What is the cost of implementation for campus wide quality initiatives?
- What are the pros and cons of using a campus wide quality rubric?

Conclusions: Information presented in this study will serve as a reference to help establish a baseline for educational institutions to develop policies related to online distance learning. The challenge for administrators is adopting policies that ensure integrity without suppressing innovation and research while enabling academic freedom for it faculty.

References:


Administration

How to Develop and Prepare Online Programs for ATMAE Accreditation

Presenters:

Dr. Ahmad Zargari, Morehead State University, Morehead, KY 40351, 606-783-2429, a.zargari@moreheadstate.edu

Dr. Yuqiu You, Morehead State University, Morehead, KY, 40351, 606-783-2410, yu.you@moreheadstate.edu

Need: As the demand for online courses/degrees in technology programs is increasing, the need for ensuring quality becomes essential. The online Technology Management degree was designed to meet the expanding need for challenging jobs in technology and technology management. The BSTM program specifically targets Community and Technical College associate degree graduates from technology/engineering-related disciplines.

Overview: As the state and federal funding for higher education institutions decline, colleges depend upon student’s enrollment to support their programs. Technology and engineering related programs move toward expanding access to higher education for non-traditional/employed students through offering online/hybrid courses. With a significant number of online technical programs, maintaining and ensuring the programs quality has become an issue of major concern. Adhering to the ATMAE accreditation standards will increase the quality of technology programs and enhance their visibility. The BSTM goal is to strengthen the program quality using contemporary educational technology and Quality Matters certified instructors. The faculty plan to prepare the program for ATMAE accreditation based on Outcome Assessment method in 2014.

Major Points:

• Enhance the delivery of online programs
• Maintain quality of online programs (Quality Matters)
• Assessment of online courses
• Prepare online programs for ATMAE accreditation
• Future challenges and directions
• ATMAE accreditation of online programs

Summary: This presentation focuses on preparing an online technology management program for ATMAE accreditation. The issues concerning the assessment of online courses will be discussed. The opportunity for ATMAE to accredit the online programs will be discussed.
A Comparative Study of Faculty Salaries in Management, Engineering and Related Disciplines: The Need for Establishing a Benchmark and Enhancing Visibility in a Market Driven Economy

Presenters:

Dr. Ahmad Zargari, Morehead State University, IET Department, Morehead, KY, 606-783-2429, a.zargari@moreheadstate.edu

Dr. Charles Coddington, East Carolina University, College of Technology and Computer Science, East Carolina University, Greenville, NC 27858 coddingtonc@ecu.edu

Need: Faculty shortage in ATMAE programs and how the next generation of ATMAE faculty will 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 that 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 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 profession in the 21st Century.
ATMAE Faculty Demographics and Salaries: Trends and Characteristics of the ATMAE Faculty

Presenters:

Dr. Ahmad Zargari, Morehead State University, AET Department, Morehead, KY, 606-783-2429, a.zargari@moreheadstate.edu

Dr. John Sutton, University of Central Missouri, School of Technology, 660-543-4439, jsutton@oak.edu

Dr. Charles Coddington, East Carolina University, College of Technology and Computer Science, East Carolina University, Greenville, NC  27858 coddingtonc@ecu.edu

Need: The primary purpose of this presentation is to present the 2013 demographics data collected to determine the characteristics of the ATMAE faculty, and to update the data on the Demographics section of the ATMAE website. 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 survey form will be communicated with the deans, department chair-persons, 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.

Major Points:

• Faculty salaries will be presented and compared with similar disciplines.
• The primary field of preparation of ATMAE faculty will be discussed.
• 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 administrators to make informed decisions regarding the future of the profession.
CONSTRUCTION
Construction

Analysis of Job Market from the Perspective of Green Building

Presenters:

Dr. Hans Chapman, Department of Applied Engineering and Technology, Morehead State University, Morehead, KY 40351, 606-783-9339, h.chapman@moreheadstate.edu

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Co-Author: Dr. Sanjeev Adhikari, Department of Applied Engineering and Technology, Morehead State University, Morehead, KY 40351, 606-783-2416, s.adhikari@moreheadstate.edu

Need: There is a significant amount of research being performed aimed at reducing the high consumption of energy in the construction industry. Green construction concepts minimize energy consumption during and after construction of buildings and other structures. Current growing practices in Leadership in Environmental Design (LEED) need to be implemented more in the construction industry and also that need to be introduced to students to make more marketable upon graduation.

Overview: The U.S federal government, state, and local agencies are establishing new policies to reduce energy consumption in communities, businesses, offices, schools, homes, and other facilities. 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, engineering technology students can benefit from LEED training to prepare them for emerging energy efficient technologies. Utilizing green construction 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. This study focuses on green construction from renewable energy sources, conducted by engineering technology students together with Habitat for Humanity at Morehead, KY.

Major Points:

• Study job market trend in the Renewable Energy and Green Building Industry
• Introducing to Renewable Energy and Green Building course on Current Engineering by understanding industry Job prospective
• Renewable energy (geothermal, biomass, solar and wind energy) to produce energy at home

Summary: 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 construction, and operations. Thus, construction students will benefit from LEED training to prepare them for emerging energy efficient technologies. Green Engineering Technology has a key role to play in energy and environmental sustainability in the U.S economy.
Construction

Needs Assessment and Program Design for Building Information Modeling in Higher Education

Presenters:

Mr. Ken Bertolini, South Dakota State University, Brookings, SD 57007, 701-429-7700, Kenneth.Bertolini@sdstate.edu

Need: Building Information Modeling (BIM) is becoming a standard expectation for owners of construction projects. College graduates are expected to be well versed in both the benefit and implementation of BIM. Higher education needs to survey industry to understand the expectations for what graduates of a four year program should know about the BIM process. That information needs to be utilized in course and program designs that will best prepare graduates to advance the construction industry.

Overview: Students in a four year construction management program need to be prepared when entering the construction industry with knowledge regarding Building Information Modeling. Industry mandates are increasingly requiring constructors to provide BIM for construction projects. Industry is now expecting graduates of CM programs to have knowledge of BIM from their curriculum studies.

Major Points:
- Need for a survey of construction companies
- Need for a survey of Construction Management programs
- Recommendations to Construction Management programs regarding what is requested by the construction industry
- Construction Management program changes

Summary: Attendees will be provided with needs assessment data from the construction industry and program design recommendations for Construction Management programs regarding Building Information Modeling (BIM) implementation. Follow up discussions will be held regarding how to best prepare students as they enter the construction field.
Safe by Design: A Look at Building Design Methods and Construction Techniques Aimed to Decrease Violence at Educational Institutions

Presenters:

Mr. Juan Chavez, University of Central Missouri, Warrensburg, MO 64093, ph. 660-543-8636, JCC63100@ucmo.edu

Dr. Doug Koch, University of Central Missouri, Warrensburg, MO 64093, ph. 660-543-4439, Koch@ucmo.edu

Need: In recent times there has been a dramatic increase in school violence throughout the United States. Towns and cities across the country have been affected by school shootings and violence that target the vulnerable. Newspaper headlines chronicle the widespread loss of lives at educational institutions, and such news causes panic amongst all the population. The need to design and build safer schools and civic buildings is great. Most school buildings were built and operated with the mentality of an era that is past, where little attention was paid to violence and its effects on the population. An understanding of school building design meant to tackle today's problems is needed, as well as the realization that schools cannot be built and function as they once did.

Overview: This presentation will provide information on civic building design, especially in educational institutions, that is meant to deter violence. An analysis of different building layouts, materials, and planning as well as how BIM and 3D can be used to aid in safer designs will be presented and discussed. The presenters will explore different design philosophies such as safer room layout, means of egress, and selection of materials that can help maintain a safer school.

Major Points:
- Pros and cons of current building designs
- Implementing BIM and 3D for safe design and visualization
- Research on different approaches to building layouts and school planning
- Alternative building design and layouts

Summary: This presentation will focus on a different approach to the design of current educational buildings where recent dramatic events have demonstrated to be ineffective against violence. The goal is to present a safer alternative to this problem and discuss the design methods used in achieving said goal.
Construction

Putting Design-Build into Action: Interdisciplinary Student Teams on Home Rehabilitations

Presenters:

Mrs. Janet Fick, Ball State University, Muncie, IN 47306, 765-285-5164, jfick@bsu.edu
Dr. James W. Jones, Ball State University, Muncie, IN 47306, 765-285-1433, jwjones@bsu.edu
Mr. Mike Mezo, Ball State University, Muncie, IN 47306, 765-285-5649, mmezo@bsu.edu

Need: Utilizing the skills learned in their construction management classroom while learning to work collaboratively on interdisciplinary teams will better prepare students for their future in the construction industry. Aiding a local nonprofit organization in rehabilitating vacant houses allows the students to accomplish this goal while affecting actual change in their local community. The interdisciplinary team analyzes each home’s needs, redesigns as necessary and completes the estimate and construction drawings.

Overview: To further their goal of home ownership for lower income families, in 2010 Habitat for Humanity nationally expanded their focus from strictly new home construction to include rehabilitating existing vacant homes. Since rehabilitation projects require individualized evaluations and redesigns, Habitat found the shift to rehabilitation required more time commitment than their current staff could handle. The Greater Muncie Indiana Habitat for Humanity asked the Ball State construction management program if they could coordinate an interdisciplinary group of university students to assist them in analyzing existing homes which they will be rehabilitating. The projects allow the students to participate in “real world” design-build projects. Habitat requires the emphasis be on affordability, sustainability, longevity and constructability. This presentation discusses a case study of an immersive learning course which has given students from the construction management, architecture, interior design and historic preservation programs the opportunity to work together while helping their local community. The lead faculty member will discuss the initial setup of the course, the execution and the refinements of the subsequent semesters.

Major Points:
• Student selection
• Challenges unique to interdisciplinary teams
• Faculty preparation and observations
• Estimating and scheduling
• Administrative issues and solutions

Summary: Attendees will learn the value of combining an interdisciplinary approach with the opportunity for service learning in actual design-build projects. Attendees will understand the challenges and opportunities of coordinating the skills of an interdisciplinary group of students with the needs of our partner organization, including the selecting the students, analyzing the houses, recommending solutions and identifying potential problems as they relate to the faculty member.
Building Green Homes: A Comparative Analysis of Residential Green Rating Systems

Need: Building high performance green homes, whether new construction or rehabilitating existing homes, focuses on creating homes which are energy efficient, sustainable, economical to maintain, and create a healthy indoor environment. Many systems include elements of all of the above, but which is the best fit for a specific project?

Overview: There are several green housing rating programs which will be analyzed and compared, including the International Green Construction Code, the NAHB National Green Building Standard ICC-700, LEED for Homes, Energy Star Certified New Homes, EarthCraft, Earth Advantage, System Vision and Enterprise Green Communities. Each covers generally the same elements, yet has their own focus, whether for the new construction or the rehabilitation of existing homes. The comparing and contrasting the similarities and differences between the systems will be discussed. The focus will be on determining which rating system would work best to certify a specific residential project. Cost and scheduling implications will also be discussed.

Major Points:
- Discussing residential green housing rating programs
- Comparing the similarities of the rating systems
- Contrasting the differences of the rating systems
- Determining the optimal system to rate a specific residential project
- Impact on project costs
- Impact on project scheduling

Summary: Attendees will learn the basic components of several green housing rating systems, including the International Green Construction Code, the NAHB National Green Building Standard ICC-700, LEED for Homes and Energy Star Certified New Homes. Attendees will understand the similarities and differences between the systems, as well be able to determine which rating system would work best to certify a specific residential project. Attendees will also be able to evaluate cost and scheduling implications.
Construction

A Study of Associated Schools of Construction Management Programs’ Core Curriculum

Presenter:

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Need: Construction Management programs have no standard content requirements for membership in the Associated Schools of Construction. The member programs are only vetted by major focus. In 2012 a study was published on courses and areas of content in the ASC member programs as of Dec 2011; however, the core content of the programs was not studied. Feedback from peers indicated interest in comparing Construction Management Program core courses or required courses to see if there were any correlations. Additionally, this information can be used to support content of an ATMAE certification exam for graduates of these programs.

Overview: This presentation will cover the core content of ASC four year Construction Management programs as of their 2012/2013 undergraduate catalogs as available online. Additionally, courses offered as directed electives will also be noted, as well as common General Education courses required by the ASC member programs.

Major Points:

- Current number of the ASC programs for four year Construction Management degrees.
- A report of Core Courses and relative percentages of these courses in the ASC programs.
- A report of elective courses and required General Education courses in these programs.

Summary: This presentation will summarize the Core Courses in ASC member programs, and note commonalities in electives and General Education requirements for these programs as of 2012-2013 undergraduate catalogs available online.
Construction

Radio Frequency Identification Technology: A Construction Industry Model

Presenters:

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Dr. James W. Jones, Ball State University, Muncie, IN 47306, 765-285-1433, jwjones@bsu.edu

Need: The construction industry is considered as a knowledge intensive domain due to its highly dynamic nature. Consequently, it is following the general trends of employing automation methodologies that can increase projects’ control, productivity, and safety and among other aspects. Over the last decade, Radio Frequency Identification (RFI) technologies and Devices (RFID) have been utilized in an attempt to achieve the aforementioned goals. Due to uniqueness of each project, some implementations attained acceptance by the industry over others. Consequently, evaluating the different uses of this technology and its level of success is an essential step to identify (1) the potential of this technology for the construction industry; (2) risks associated with its use; (3) challenges hampering spread as an automated solution, and (4) future research and practice opportunities, where RFI technologies can assist in developing new solutions in addition to existing ones for the construction industry.

Overview: A number of researchers and companies have investigated the use of RFID to enhance project control, safety, transportation, data collection, material monitoring, productivity analysis, etc. Furthermore, the Construction Industry Institute (2000) and CoreRFID LTD (2008) have identified a number of potential application areas for RFID technology in the construction sector. Even with these attempts, its use has not yet reached its full potential. Consequently, the objective of this study is to (1) find out what efforts have been made to raise the awareness of RFID; (2) recognize where has RFID application been successful; (3) identify the parameters leading to success or failure of RFID use; (4) define the future opportunities of RFID use in the construction industry, and (5) highlight the needed efforts to reach the full potential of this technology.

Major Points:

• The current practices of using RFID in the construction industry
• Parameters leading to the success of RFID use
• Challenges facing the expansion of RFID use in the construction industry
• Potential area of RFID use in this sector
• Needed efforts to enhance the use of RFID in the construction industry

Summary: Attendees will (1) develop an understanding of RFI technology and its successful use in the construction industry; (2) gain knowledge about the factors affecting this technology from reaching its full potential; and (3) expand their knowledge of effective ways by which the construction industry can benefit from the full potential of RFID.
A Builder’s Approach to a City’s Push for Environmental Accountability - Energy Star Building in Cleveland, Ohio

Presenter:

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Co-Author: Mr. Nickolas Hovis, Construction Management student, Ohio Northern University, n-hovis@onu.edu

Need: Society has recognized the need for sustainable concepts in the building industry. More important, states and cities have recognized the push to develop, design, and build facilities and homes that are sustainable for the future. This case study was developed to show how one city, Cleveland, Ohio has mandated the use of sustainable concepts, in particular, the Energy Star guidelines for appliance, energy, and building envelope placements. As our future leaders in the industry, students need to understand the importance of those sustainable metrics that are changing the mandates in the building industry, especially in urban areas.

Overview: The ENERGY STAR® rating system is a joint program venture of the U.S. EPA and the U.S. Department of Energy to protect the environment through energy efficient products and practices. As energy needs continue to escalate, programs such as this are needed to reduce our carbon footprint in the United States. Faced with inadequacies in the building industry, the City of Cleveland developed a program which uses ENERGY STAR® practices and guidelines to commit itself in becoming environmentally accountable for the construction of commercial and residential structures. ENERGY STAR® (ES) has now become a staple in the construction industry in Cleveland and has changed the responsibilities of owners, contractors, city officials when it comes to garnering ES rating. The city of Cleveland is the first in the State of Ohio to implement the ENERGY STAR rating program as a requirement in the construction industry and to require new construction in the residential and commercial arena to follow the energy management strategies and testing procedures. This case study details the development of those practices in conjunction with the city’s ENERGY STAR® program and one builder’s ability to use this program as a stepping stone for success in the residential building industry. Sutton Builders is a small to medium size company that has actively pursued the ENERGY STAR® concepts implemented by the city with positive results. As such, the case study objectives will:

Major Points:
- Outline the development of the program and builder component
- Guidelines and regulations surrounding the implementation of the program
- Responsibilities of all users
- Requirements and credentialing of the builder to obtain ENERGY STAR®.
- Lessons learned

Summary: Readers of this case study will see how the formulation and implementation of programs such as the ENERGY STAR® have on our future successes in the construction industry. Additionally, it will expose the ability of builders to develop and adapt to the needs and demands of new programs such as ENERGY STAR® aimed at increasing the efficiency of building industry concerning sustainability applications in building structures.
Construction

Changing Needs for Scheduling Software Proficiencies Required for CM Graduates

Presenter:
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Need: In a pass study (Scheduling Software Requirements to Meet CM Graduated Needs, ATMAE 2013) it was identified that 38% of the contractors are using Primavera software while another 38% was and/or using Microsoft Project. It was concluded from this study that 1) Construction management students need to be introduce to both Primavera and Microsoft Project software 2) Resource loading should be introduce to both Primavera and Microsoft Project software and 3) the use of Excel to schedule may need to be introduced.

Overview: There has been a shift over the last couple of years in the use of scheduling software by construction companies. While larger projects are using Primavera there seems to be a shift to use Microsoft Project on smaller and Mid-size projects. In addition, some smaller companies are using Excel to Schedule their project. The purpose of this study is to verify and recommend what scheduling software should CM students should be introduce to and what topics should be covered.

Major Points:
• Need of Construction management students to be introduced to both Primavera and Microsoft Project software.
• Introduction of resource loading to both Primavera and Microsoft Project software.
• Does the use of Excel to schedule be introduced?
• A comparison of Primavera to and Microsoft Project including both performance and cost of software.
• Determine the advantages and disadvantages of using Primavera in a network versus a standalone mode.

Summary: Almost all the construction companies interview were using scheduling software (90%) on their projects. 38% of the contractors are using Primavera software while another 38% was and/or using Microsoft Project. About 21% of the scheduling was being done by a Scheduler, but the majority of the scheduling was being done by Project Managers (67%). 45% cost/size of projects were in the 1 million to 10 million rage range, about 30% of the projects were under 1 million, while 25% of the projects were larger than 10 million. 70% of the companies were scheduling resources.
Construction

IT Tools for Optimization of Asset Management in Construction Logistics

Presenters:

Dr. M. D. Salim. University of Northern Iowa, Cedar Falls, IA 50614-0178, (319) 273-2537, salim@uni.edu

Dr. Shahram Varzavand, University of Northern Iowa, Department of Industrial Technology, Cedar Falls, IA 50614, 319-273-6428, Shah.Varzavand@uni.edu

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Need: Construction logistics is the movement and scheduling of personnel assets, material assets, equipment assets for the purpose of supporting a construction project or projects. Several dynamic uncertainty factors affect construction logistics and any of these factors can lead to catastrophic system-wide failures completely stopping useful work at a construction site. Thus, 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 tackling or elimination of uncertain factors such as equipment breakdowns, 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. 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 IT tools, e.g., 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
- IT Tools
- System Design
- System Implementation

Summary: The purpose of this topic is to evaluate different techniques available for asset management in construction logistics and present a system to manage assets in construction logistics and infrastructure types of problem. Importance of special interfaces with databases will be covered.
Con
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Delivering Accountability: Commissioning, Operation, and Maintenance of Green Construction

Presenter:

Dr. Shinming Shyu, Eastern Michigan University, Ypsilanti, MI 48197, 734-487-6419, sshyu@emich.edu

Need: Surpassing transportation and manufacturing industry, the built environments accounted for 39 percent of the total U.S. energy consumption. With the persistent increase of global energy prices and associated building operational costs, the demand for high performance buildings has been shaping the future of building industry. To deliver buildings meeting owner’s project requirements (OPRs), performance criteria are to be formulated as the basis of design (BOD) during the early stage of integrated design process. Further, to address accountability, the post-occupancy building performance needs to be measured, verified, and documented to prove the actual fulfillment of intended design, and thereby successful delivery of green construction. Thus, it is critical for design and construction industry to incorporate in its practice the emerging requirements for accountability.

Overview: The past decade has witnessed the growing popularity of building performance rating systems, which have been utilized mainly as guidelines for creating certifiable design projects. Despite the positive influences of building rating systems on advocating sustainable design, concerns for the discrepancies between the actual performance of certified buildings and their design intent remain unequivocal. With the introduction of International Green Construction Code (IgCC) in 2012, the actual performance of building systems is required to be recorded, reported, stored and displayed through measurement devices. In this study, measures required by IgCC to ensure performance accountability, such as commissioning, operation and maintenance, will be analyzed and examined.

Major Points:

• Energy metering, monitoring and reporting
• Minimum energy measurement, verification and display
• Automated demand-response (Auto-DR) infrastructure
• Commissioning plan and report
• Pre- and post-occupancy commissioning
• Building operations and maintenance documents

Summary: The building delivery process has gone through a paradigm shift from traditional linear procedure to an integrative process in order to facilitate collaboration among relevant parties in delivering buildings. With the adoption of IgCC by governing jurisdiction, the building delivery team is required to provide evidence to verify the consistency of actual building performance with design intent. To ensure the compliance with code requirements for performance accountability, building environmental systems, assemblies and components are to be designed, installed, calibrated, and recorded via seamless commissioning, operation and maintenance process.
Utilizing Renewable Energy Biomass Gasification Ash as an Admixture in Concrete for Sustainable Green Environment and New Construction Applications: An Experimental Pilot Study

Presenters:

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Need: Sustainability and environmental protection are two primary duties for every individual living on this planet. Based on current fuel consumption rates, it is reported that almost all fossil fuels will be depleted in 1~3 generation(s), and greenhouse gases emissions due to fossil fuels' burning will result in "the global average sea level rising between 7 to 23 inches higher than it was in 1990." This threatening data manifests that a mission for developing a "renewable" and "clean" energy is imperative. While biomass is a major source of renewable energy, the ash generated from biomass gasification process poses a great challenge towards accomplishing a total sustainability. Incorporating this biomass gasification byproduct into conventional Portland cement concrete will not only consume this ash, but also may lead to developing a new type of concrete suitable for certain structural and/or architectural applications within the construction industry.

Overview: The Renewable Energy Center at Eastern Illinois University consumes 30,000 tons of biomass annually, producing a huge amount of ash as a byproduct. Finding a value for this ash is a challenge in order to accomplish a total sustainability of the biomass renewable energy process. A multidisciplinary team was formed to conduct an experimental research to study the effects of adding biomass ash to Portland cement concrete mixes for use in sustainable construction applications.

Major Points:

• It is imperative to develop a "renewable" and "clean" energy
• Biomass gasification is an ideal solution for the energy shortage and global warming
• Environmental effects and sustainability challenges of biomass ash and potential applications
• Understanding characteristics and chemical compositions of biomass gasification ash
• Applications of biomass gasification ash in concrete as structural and/or architectural element
• Environmental and sustainability effects of concrete modified by biomass ash
• Physical & mechanical characteristics of concrete (mixer) mixes modified by biomass gasification ash

Summary: As a renewable energy source, biomass gasification is expected to help reduce the nation’s dependency on foreign oil or other fossil fuels. The ash generated from the process remains one of the challenges to achieve total sustainability of the renewable energy process. The experimental study funded by Illinois Sustainable Technology Center will help finding sustainable construction applications of ash from one of the largest biomass projects in the nation; the Renewable Energy Center of Eastern Illinois University.
Construction

**Tablet and Cloud Computing in the Construction Industry**

**Presenters:**

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**Need:** Rapid adoption of tablet computing by many industries has transformed traditional data collection, analysis, synthesis, and presentation into simple and intuitive applications. The impact of tablet computing on aviation and medical fields are extraordinary, nonetheless once again construction industry appears to be lagging behind in embracing of new technology, techniques, and concepts.

**Overview:** Instinctive and flexible capabilities of tablet computing can be applied to wide variety of daily construction activities. Cloud base tablet computing can facilitate and streamline collaboration among architect, owner, contractor, and suppliers. Regrettably only handfuls of construction applications exist on mobile operating systems including Apple iOS and Android platforms. Overwhelming majority of these applications such as Autodesk’s AutoCAD WS, DesignReview, Buzzsaw, Bluestreak, Bentley’s Navigator, ProjectWise, Structural View, Graphisoft’s BIMx, and recently released Prolog are mainly sidekick to their PC base system. Unlike many industries, farming and construction have not been outsourced thus far; in order to repel overseas competitors construction industry in the US must modernize rapidly. Applications to speed up communication between stakeholders, decision making, client approval, drawing mark-up, and enhance collaboration and transparency are needed.

**Major Points:**

- Available tablet and cloud based construction applications
- iOS versus Android operating systems
- Advantages and disadvantages of cloud based computing
- Requirements for development of in-house proprietary Apps

**Summary:** As nature of tablet and cloud computing evolves into a more ubiquitous, user friendly, and intuitive form, construction industry will be compelled to rapidly phase out its cantankerous paper based business practice. Cloud based tablet computing may even aid the construction industry to abandon its sluggish, inefficient, and antagonistic approach to project delivery.
Innovative Underwater Construction Projects Applying Deep Ocean Technologies

Presenter:

Dr. Wafeek S. Wahby, Eastern Illinois University, School of Technology, Charleston, IL 61920, (217) 581-2318, wswahby@eiu.edu

Need: Expanding development projects for housing and enterprise can be quite a challenge in countries that have a limited land area, such as Japan, particularly as population and its daily demands increase. Planners are seriously considering not only land reclamation projects but they are also exploring the feasibility of investing in underwater construction projects utilizing deep ocean technologies. Tourism and hospitality industries are also looking into exploiting this venture for its obvious value and appeal to their clients.

Overview: This paper reviews several underwater technologies that can be utilized for building under water construction projects, it also discusses the benefits and the challenges facing such an enterprise, and the solutions suggested.

Major Points:

• History and current status of underwater construction projects.
• Challenges facing underwater construction projects and possible solutions.
• Deep ocean technologies adopted.
• Developing new building materials, equipment and methods, as well as qualified and well trained personnel for building under water construction projects.
• Operational, safety, and maintenance aspects associated with underwater structures.
• Future prospects of underwater construction projects.

Summary: Thanks to deep ocean technologies, the old adage “The sky is the limit” may soon be extended to include “and the bottom of the ocean is the other limit!” Deep ocean technologies empower developers and technologists to venture—literally—into uncharted waters as innovative underwater construction projects may soon be wide spreading, utilizing deep ocean technologies.
Construction


Presenters:

Dr. Lewis Waller, North Carolina Agricultural & Technical State University, School of Technology, Greensboro, NC 27411, 336-334-7199, lw985723@ncat.edu

Need: Although critics disagree, advocates of energy efficiency programs believe that the energy programs drive energy efficiency and eventually reduce energy consumption. The conflicting views presented in theoretical discussions and empirical findings, as well as the extensive financial investments made into these programs substantiate the need to investigate the impact of these programs on energy efficiency. While some empirical studies have analyzed individual energy programs, few have assessed the impact of multiple energy programs and contextual factors on energy efficiency in the complex U.S. commercial buildings sector.

Overview: High energy consumption increases U.S. dependence on foreign oil and environmental degradation. Despite the improvement in energy efficiency technologies, there has been slow progress in the adoption and diffusion of these technologies. State governments are encouraged to adopt policies and programs to enhance a comprehensive and effective approach in driving the diffusion of energy efficiency technologies and strategies in the U.S. buildings sector. This study investigated relationships existing between five energy programs and electricity intensities, while controlling for price, climate and regional variations. Panel data regression methods were used to analyze state level secondary data from 2006 to 2009. The notable drivers of electricity efficiency were: the public benefits funds program; the building energy codes program; the financial incentive program; and the price of electricity. Together, the five programs investigated accounted for approximately 9% of the reduction in commercial electricity intensity.

Major Points:
- Energy consumption in the U.S. commercial buildings sector
- Problem statement and research hypothesis
- Methodology
- Drivers of energy efficiency in the U.S. commercial buildings sector
- Conclusion and recommendations

Summary: Attendees will be exposed to the energy programs and contextual factors which drive energy efficiency and have a sustained impact on U.S. commercial electricity consumption. Findings will assist stakeholders make decisions regarding the adoption or continuation of energy programs. In the long term, energy efficiency could help reduce environmental degradation and U.S. dependence on oil.
Analysis of Construction Management Graduates’ Perceptions of a Higher Education Program and Employability Skills Implemented in the Workplace

Presenters:

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Need: Satisfaction is important in both academics and career, and it is something most individuals seek on a personal level. Students want academic satisfaction in their major and from the program of study; likewise institutions are implementing strategies and goals to provide satisfaction for their students lifelong career. Higher education leaders want to know whether their program provides the necessary employability skills for their students’ career success. Also, they want to identify with the latest trends that are implemented in the workforce so they can keep their courses relevant and current. The Construction Management Program at North Carolina A&T State University examined their students' academic satisfaction as it relates to their job. This paper presents data on whether the students were satisfied with their academic studies and how well the studied materials transferred over to their career in the construction industry.

Overview: This presentation will provide data on construction management students' academic satisfaction and whether the materials which they studied in the classroom were transferrable to their first job in the workplace. The emphasis centered on whether students attained job satisfaction because they were well prepared through their higher education area of study, or were they dissatisfied because of what they learned was insufficient or unrelated, perhaps leading to frustration within their working career. The presentation will also provide recommendations on what the Construction Management Program needs to implement into their curriculum to better prepare student for the workplace.

Major Points:

- Academic Satisfaction
- Higher Education and Employability Skills
- Students Career Success
- Transition from Classroom to Workplace
- Higher Education involvement with Industry

Summary: This paper presents findings regarding students’ academic satisfaction with their program of study (Construction Management) as it relates to them being effective in the workplace. It is essential that students obtain the employability skills which are needed to be successful in their career. This presentation will share information that can help educators better develop their course content to meet the demands of the workplace.
Construction

**Analysis of Asphalt Shingles as a Reclaim Waste Material for Highway Pavement**

**Presenters:**

Dr. Ni Wang, Department of Applied Engineering and Technology, Morehead State University, Morehead, KY 40351, ni.wang@moreheadstate.edu

Co-Author: Dr. Sanjeev Adhikari, Department of Applied Engineering and Technology, Morehead State University, Morehead, KY 40351, 606-783-2416, s.adhikari@moreheadstate.edu

**Need:** Asphalt shingles is used as roof material mostly on residential construction. Currently in the U.S., approximately 80% of homes are manufactured annually and according to the National Association of Home Builders (NAHB), an estimated 7 to 10 million tons of shingle tear-off waste every year. It is possible to mix reclaim asphalt shingles (RAS) in hot mix asphalt and used in highway construction and maintenance. This keeps tonnage of waste out of the landfills and saves some raw asphalt oil from being used in the first place, thus lowering the environmental impact of the asphalt in all aspects.

**Overview:** In this research, reclaim asphalt shingles (RAS) is used on highway maintenance. Hinkle Contracting Corporation LLC will be used for the production and testing of the mix designs the asphalt plant. There are three asphalt mixtures produced for testing, a control (0% RAS), 5% RAS, and 10% RAS by weight. The mixtures were batched, mixed and compacted in the lab. Dynamic modulus (|E*|) and Asphalt Pavement Analyzer (APA) Rutting Test are used. The RAS mixes are better on both fatigue cracking and rutting resistant compared to the control mixes.

**Major Points:**

- Analysis of asphalt shingles as a reclaim waste materials
- Investigating three asphalt mixtures, a control (0% RAS), 5% RAS, and 10% RAS by weight
- Asphalt Shingle mixes are better on both fatigue cracking and rutting resistant compared to the control mixes

**Summary:** Reclaimed asphalt shingles is mixed in hot mix asphalt and used in highway construction and maintenance. This keeps tonnage of waste out of the landfills and saves some raw asphalt oil, thus lowering the environmental impact. Three asphalt mixtures produced for testing, a control (0% RAS), 5% RAS, and 10% RAS by weight. The RAS mixes are better on both fatigue cracking and rutting resistant compared to the control mixes.
What Will Happen When Environmental Qualities Meet Performance In A Building Design?

Presenter:

Dr. Bahar Zoghi, P.E., LEED AP, Farmingdale State College, State University of New York, Farmingdale, NY 11735, 631.794.6124, zoghimb@farmingdale.edu

Need: The United States, after China, consumes most of the world’s energy. According to the U.S. Department of Energy, the U.S. global consumption in 2010 was 19%. The buildings sector alone accounted for 7% of it. The U.S. building sector is responsible for about 41% of the total energy consumption in the U.S. The total building principal energy consumption in 2009 was about 48% higher than the consumption in 1980. The main causal factor was the usage of space heating, cooling, and lighting. Even though the building sector consumed 40% of the total primary energy, 74% of it was electricity usage. Electricity demand in the buildings sector has more than doubled since 1980. Conserving energy is one the most important goals in the building sector in order to help climate change, energy cost, protect and preserve the environment.

Overview: Effective building design is the most important aspect that has been neglected in most buildings in the past half century. It was reported by the U.S. Department of Energy that the total consumption of building sector increased by almost 50% in 30 years. This increase was due to heating, cooling and lighting of the space. In order to be in harmony with nature, the orientation of a conventional building isn’t usually considered. Before the invention of the HVAC system, the buildings had an efficient green design. During this time, most of the buildings were built to have the convenience of HVAC systems. They were also oriented to be closer to the street. In the past 10 years the effect of climate change, energy cost, and environmental concerns awakened the building sector to synchronize with nature again and look at the possible ways to easily save energy. Building orientation has a positive outcome on the efficiency of the building. This effect is appearing in LEED prerequisites and credits in many different places, such as energy, atmosphere, indoor environmental quality, as well as BPI (Building Performance Institute).

Major Points:

- A building should be orientated to benefit passive and active solar plan strategies.
- The building should take advantage of as much daylight as possible in order to decrease electrical lighting requirements.
- Natural ventilation will decrease the building’s heating and cooling loads.
- The building can be oriented to align with the existing wind direction.
- Install operable windows so that occupants can take advantage of natural ventilation.

Summary: Orientation of the building can affect many aspects of the design. It has synergy with the cost of energy, as well as internal environmental quality such as ventilation, thermal control, daylight and view of the habitat space. It is a great tool to make peace with nature and be in harmony with the environment.
DISTANCE & ONLINE LEARNING
Impact of Distance and Online Learning on Traditional Educational Institutions

Presenters:

Dr. Mahmoud Al-Odeh, Bemidji State University, College of Business, Technology, and Communication, Technology, Art, & Design Dept., Bemidji, MN 56601, 218-755-4223, malodeh@bemidjistate.edu

Need: Technology innovations are important tools that are used to improve the quality of learning and student achievement. Distance and online learning is an emerging phenomenon that has the potential to fundamentally modify the nature of traditional educational and training institutions. Research shows that adopting suitable online and distance learning strategies will help traditional educational institutions to compete successfully with distance educational institutions. Therefore, it is important to understand the process of applying technological tools and innovations to traditional educational systems. Gaining understanding of the advantages of implementing online and distance learning strategies will also encourage traditional educational institutions to adopt these strategies. Finally, identifying the challenges of implementing online and distance learning will assist in clarifying any ambiguities regarding these strategies.

Overview: This research aims to investigate the positive and the negative impacts of distance and online learning in traditional educational institutions. The research focuses on four positive impacts of distance and online learning—the high quality of this form of learning, the global distribution that it causes, its high level of flexibility, and its low costs—as well as the challenges that it poses—the need for access, skills, and high motivation for its use as well as its tendency to create isolation. The research concludes that traditional schools must develop assessment strategies and tools to assure the high quality of their programs, avoid the disadvantages of distance learning, and prevent student plagiarism.

Major Points:

- Clarifying the difference between the outcomes of distance education and classroom-based learning.
- Showing the importance of technological innovations in improving the quality of learning and student achievement.
- Describing distance learning as an emerging phenomenon that has shaped and modified the nature of traditional educational institutions.
- Exploring the challenges and difficulties of using distance and online learning strategies in traditional educational institutions.
- Addressing the significance of developing assessment strategies and tools to assure the high quality of distance learning, avoiding the disadvantages of distance learning, and preventing student plagiarism.

Summary: Attendees will learn of the importance of adopting distance and online learning strategies in traditional institutions and the reasons for using distance learning in these institutions. They will also gain understanding of the need for assessment strategies to assure the high quality and to avoid the difficulties.
Teaching Hands-on Online: A Proposed Solution for RFID Classes

Presenter:

Dr. Kevin Berisso, University of Memphis, Dept. of Engineering Technology, 203 Engineering Technology Bldg. Memphis, TN 38152, 901-678-4300, kberisso@memphis.edu

Need: When teaching radio frequency identification (RFID) classes, there have traditionally been two camps of thought. The first is to teach the theory. Since little or no equipment is required, this allows for the easy transition to on-line formats. The second camp of RFID education includes hands-on activities that have traditionally been hampered by the high cost of the RFID systems. Although some industrial educators have tried to overcome this through the use of simulations, the problems and challenges of RFID are often lost on the students. This presentation will demonstrate one way to overcome the hurdles associated with hands-on, RFID education.

Overview: In 2003, Wal-Mart announced its landmark 2005 RFID mandate. In late 2011 Macy’s changed its “wait and see” stance, announcing plans to implement RFID in all of its stores by the end of 2012. The result of these, as well as other retail-based initiatives, has resulted in an increased need for EPCglobal based RFID education. As a potential source of revenue for on-line programs, teaching RFID to both students and industry individuals in the retail supply chain has the potential for huge returns. Until recently, the prime impediment to this has been the cost of the equipment for the students. At $800 or more, students couldn’t afford to purchase their own equipment and schools were reticent to lend out thousands of dollars of equipment. This is changing with the increased availability of USB based RFID readers. The solution that will be introduced in this presentation costs $199 – the same as many of the RFID theory books. With the inclusion of this RFID reader, the numerous online resources currently available and the ready availability of sample tags, hands-on based RFID education is finally a reality.

Major Points:

• A method for being able to teach hands-on RFID is proposed
• Hardware is introduced that will allow students to affordably touch and feel real, industry standard RFID readers and tags
• A suggested curriculum will be outlined, including hints on how to help students to obtain the necessary samples and equipment.
• Resources will be made available, including free interactive online tools

Summary: There currently exists the need to develop a future workforce that has had a realistic, hands-on education in the use of EPCglobal based radio frequency identification. In the past, hardware costs resulted in unacceptable compromises in EPCglobal-based RFID education. This is changing with the introduction of EPCglobal compliant hardware that costs less than $200. This presentation will introduce the participants to a solution that will allow them to provide hands-on, lab based distance education to students and industry for a fraction of the traditional costs. The result will be increased online enrollment, improved student experiences and ultimately a better educational solution.
Distance & Online Learning

Enhancing Student Interaction and Communication in an Online Technology Course with VoiceThread

Presenter:

Dr. Jason L. Davis, Texas A&M University-Commerce, Commerce, TX 75429, 903-468-8682, Jason.Davis@tamuc.edu

Need: Communication is considered a crucial skill in industry, particularly in the area of management. As the concept of globalization is seeing greater emphasis in business and industry, and educational institutions are experiencing continuing pressure to deliver programs online, many Engineering & Technology programs face the challenge of introducing forums of communication that facilitate and foster effective interaction in a virtual environment. A lack of exposure to relevant technology can put graduates at a disadvantage when entering a global marketplace in which an increasing amount of communication is conducted electronically.

Overview: The Program Committee for the Technology Management Degree Programs at Texas A&M University-Commerce examined the means of communication utilized in the courses in their primarily online degree program and found that the mode of interactive communication between students was essentially limited to that of text-based interactions through traditional, asynchronous, threaded discussion forums. The committee expressed concern that this limited mode of interaction does not adequately prepare graduates to utilize the more advanced forms of communication used in the field. One program faculty member, with experience in implementing educational technologies, undertook the task of transitioning some of the traditional, text-based discussion activities in an online, undergraduate Technology Management course into a more interactive and engaging form of online interaction utilizing the Web 2.0 tool, VoiceThread. The VoiceThread application enables participants to present and respond asynchronously to information in any combination of text, graphical, audio, and video formats.

Major Points:
• Need to prepare students in online courses to communicate effectively in a global environment
• Web 2.0 tools offer students opportunities to interact electronically in a variety of modes
• VoiceThread can be utilized as an advanced alternative to the traditional, text-based discussion boards

Summary: Attendees will be introduced to the VoiceThread application and presented examples of how this Web 2.0 tool was implemented in an undergraduate Technology Management course to provide students with a practical opportunity and experience in utilizing advanced communication modes beyond that of strictly text-based interaction. The model of implementation presented can be easily incorporated into any web-enhanced or online engineering or technology course.
Distance & Online Learning
The Use of Softchalk Software to Enhance Delivery of Course Materials for Hybrid and Online Courses

Presenter:
Mr. Bob Dixon, Walters State Community College, Morristown, TN, 37813, 423-318-2758, bob.dixon@ws.edu

Need: The delivery of online course materials has been a challenge for technical programs at community colleges. In order to be successful, online students need to be self-motivated in order to maintain the proper pace for the course. They also have to be motivated to teach themselves with the textbooks, handouts, and other materials that are provided. Unfortunately, these traits are not typical strengths for the average student entering a technical AAS program. Course development and presentation materials are needed to help these students manage their online academic activities, and Softchalk is a useful tool that can be used to meet these needs.

Overview: The presentation will introduce attendees to Softchalk and how it operates within a student management software system. The presenter will demonstrate how to link videos from outside sources, add text for reading assignments, create quizzes and activities to support the content delivered, and how the Softchalk modules are formatted for uploading into the student management software system. The presenter will also demonstrate how student use of Softchalk modules can be tracked and, if desired, graded for student preparation or participation credit.

Major Points:
- Need for a software to help create an interactive environment to keep students motivated and on task while participating in an online or hybrid course through a semester
- The ease of developing such an environment through the use of tools like Softchalk
- The ability for student engagement to be monitored and graded through the Softchalk interaction within the student management software system
- Enhancement of course deliverables that make it easier to engage students so they can teach themselves within an online or hybrid environment
- Engaged students means improved grades and student success in online and hybrid courses

Summary: Attendees will understand how online and hybrid curriculum delivery can be enhanced in a manner that will increase student learning, which will lead to increased student success in such courses and programs. Attendees will also see how easy this development can be using tools like Softchalk for curriculum development.
Distance & Online Learning

Fostering Social Presence through Faculty-Student Interaction for Successful Online Learning

Presenter:

Dr. Megan S. Downing, Organizational Leadership Faculty, Northern Kentucky University, Department of Political Science, Criminal Justice, & Organizational Leadership, FH 338 Highland Heights, KY 41099, 859.572.1312, downingm@nku.edu

Need: Online learning has developed a significant presence in higher education, and the demand for online and hybrid-delivered courses continues to grow. With this sustained growth, attention to teaching practices that foster successful online learning is necessary. Instructor social presence, as established through instructor-student interaction, is a key component of a meaningful online or hybrid learning experience. Research shows that social presence impacts students' learning experience, level of satisfaction, level of perceived learning, and their connection with faculty. Establishing social presence fosters trust, respect, and rapport, thereby facilitating a faculty-student relationship that is conducive to successful learning. An understanding of online students’ perceptions of instructor-student interaction can help educators develop strategies to support and motivate online learners. This important knowledge can prepare faculty for choosing instructional practices that best establish a sense of social presence and instructor immediacy.

Overview: Faculty actions, or lack thereof, inform students’ perceptions of faculty commitment and their impression of the online learning experience. This session will demonstrate strategies identified through a qualitative research study for fostering social presence in the online learning environment. Topics will include practical approaches in course design, feedback, and communication practices that form authentic faculty behaviors and resonate among students’ perceptions of faculty-interaction, fostering a successful teaching and learning experience.

Major Points:
- Student-identified instructor practices that establish social presence
- Indicators of faculty-student interaction that foster social presence
- Student-ascribed meaning to faculty-student interaction
- Template for assessing indicators of faculty-student interaction
- Recommended techniques in course design and instructor activity for establishing social presence

Summary: Although technology provides the medium for online learning, instructors create the learning environment through both interactive behavior and design choices. Attendees will gain an understanding of student-identified instructor practices that establish social presence in the online learning environment and the meaning students ascribe to these practices. Attendees will leave this session with practical ideas for application in online and hybrid-delivered courses to foster social presence and a successful student learning experience.
Distance & Online Learning

E-Advising for Student Success

Presenter:

Dr. Megan S. Downing, Organizational Leadership Faculty, Northern Kentucky University, Department of Political Science, Criminal Justice, & Organizational Leadership, FH 338 Highland Heights, KY 41099, 859.572.1312, downingm@nku.edu

Need: In this digital age, students seek flexible advising options. Traditional, on-campus visits and limited advisor office hours do not always work. Students and advisors should implement e-advising methods to support student needs. Many practical solutions are available with no- or low-cost technologies. However, the “instant” communication of many technologies also fosters an expectation for immediate advisor response. Advisors need to identify tools and practices that can be easily implemented to serve e-advising needs, while also providing an appropriate balance of challenge and support to foster student understanding and self-sufficiency.

Overview: The Organizational Leadership Bachelor’s degree program is delivered in three formats: traditional, fully online, and evening-accelerated courses in the program for adult-centered education (PACE). This diverse student body requires a flexible and innovative advising approach to accommodate student schedules, personal and professional obligations, and conflicting time zones. In this session, we will discuss how the primary advisor for this program is embracing and surviving the e-advising process, building a culture of student self-sufficiency and responsibility, and maintaining advisor-student relationships.

Major Points:
- Communication plan
- E-mail strategies
- Appointment scheduling
- Surveys and/or forms
- Social Media
- Functional documents for student reference
- Tutorials and webinars
- Developing an information depot

Summary: In this session we will examine techniques for implementing e-advising with tools already at your disposal, including managing e-mail and appointment scheduling, using collaborative technologies, integrating social media, leveraging the advising syllabus, and developing progress toward degree documentation. Attendees will leave this session with practical ideas for managing e-advising, fostering student accountability, and promoting student persistence toward degree completion.
Distance & Online Learning

Designing Online Curriculum for Soft Skills Courses: Challenges, Opportunities, and a Case Example of Online Instruction

Presenters:

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Mr. Daniel Lybrook, Purdue University, West Lafayette, IN 47907, 765-494-7676, lybrood@purdue.edu

Need: Technology has changed the way that colleges and universities deliver courses. These changes have encouraged all forms of courses to be re-designed from traditional face-to-face (F2F) instruction to hybrid and online forms of instruction. Although re-designing any course can be challenging, it is particularly difficult to re-design a course that focuses on human-oriented, soft-skill type content and learning objectives. As is often the case, soft skill type courses in a F2F environment rely on students to demonstrate their abilities through small group interactions, presentations, and role play methods. However, these training methods do not translate well into an online environment.

Overview: This session will discuss some of the challenges of re-designing a course that is soft skills oriented. It will also address some strategies on how to reframe soft skill learning objectives in an online environment. A case example of a course presented at Purdue University on developing Change Management and Innovation skills for technologists will be used to highlight some of these challenges and re-design strategies.

Major Points:

- How soft skill type courses differ from other courses in terms of their learning objective and traditional methods of instruction.
- Identify some of the challenges of presenting material in an online format from an instructor/instructional designers view and the student view.
- Opportunities that online instruction presents for courses with soft skills objectives.
- Case example of how to re-design soft skill courses for online environments

Summary: Attendees will learn about some of the challenges and strategies for developing or re-designing soft skill type course content in an online environment by examining a case example of a course that was re-designed for the online delivery focusing on change management and innovation for technologists.
Distance & Online Learning

Converting Traditional Student Organization into Online Learning Community

Presenters:

Mr. Armen Ilikchyan, Bowling Green State University, Bowling Green, Ohio, 419-494-5944, iarmen@bgsu.edu

Dr. John W Sinn, Bowling Green State University, Bowling Green, Ohio, 419-372-2439, jwsinn@bgsu.edu

Need: With the rapid advancement and expansion of online education the number of students who are attending universities from remote locations via the Internet is also increasing. However, not all student services, which are traditionally offered as part of the learning experience, are yet available for such students. As a result, the non-traditional students are placed at a disadvantage with traditional students. In this presentation, we will share our experience from converting a traditional student organization, the student branch of the American Society for Quality (ASQ) at Bowling Green State University (BGSU), into an open web-based learning community.

Overview: A student is a student. Regardless of whether they attend a university traditionally or through the Internet, enrolled in one course or three, located in the USA or abroad, they should be able to receive all benefits of being a student. In order to accommodate the growing number of online students in Quality Systems programs at BGSU, the leadership group of the ASQ student branch, an official university student organization, has begun adapting all organization’s activities to be remotely accessible via the Internet. Currently, the branch established strong presents in social networks with growing number of followers on Facebook and successfully video broadcasted one of its professional workshop events using a free live streaming service.

Major Points:

• Online students should be able to access the entire spectrum of services that are typically available to traditional students;
• Professional student organizations play an important role of connecting students with the professional world; thus, their online presence and accessibility becomes critical;
• An online student organization can be built with freely available services and equipment;
• Online ASQ student branch at BGSU might serve as a model and/or as a guide for converting other student organizations into online format.

Summary: Attendees will learn how, in order to complement the online learning experience, a traditional student organization can be converted into a web-based learning community by using freely available services and equipment. The approach for building the online ASQ student branch at BGSU can serve as a guide for converting other traditional student organizations.
Distance & Online Learning:  
**Improving Pedagogically-Based Laboratory Learning**

Presenters:

Ms. Sumbul Khan, Western Kentucky University, Bowling Green, KY 42101, 270 790-7404,  
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Dr. Gregory K. Arbuckle, Western Kentucky University, Bowling Green, KY 42101-1066, 270-745-6592,  
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Need: Laboratory experience in students’ learning has a significant role in the field of applied science. Engineering Technology education requires understanding the relationship between theory and practice. In engineering technology laboratories, demonstrations enhance student learning and interest in the subject matter. Based on this concept, hands-on experience in laboratories is essential for student learning. Even though laboratory experience is crucial in engineering technology education, it faces some problems. Insufficient laboratory conditions that include lack of ability to observe demonstrations due to overcrowding and inability to maximize knowledge due to lack of visibility, negatively impact laboratory learning. Considering these limitations that constrain laboratory experience, investigating and developing alternatives to improve laboratory learning becomes inevitable.

Overview: Developing alternatives to enhance laboratory instruction will improve laboratory learning in a wide variety of fields related to applied science including: CNC, Robotics, PLCs, manual machining, nursing, biology, chemistry, and other engineering laboratories as well. Enhancing pedagogically based laboratory instruction will establish a model that can be replicated in similar laboratories at other universities.

Major Points:
- Laboratory instruction methods for engineering education.  
- Application of e-learning in pedagogically based laboratory learning.  
- Application of current advances in multimedia and technology to enhance laboratory experience.  
- Effectiveness of incorporating technology and multimedia in instructional methods compared to traditional methods of instruction.

Summary: In order to ensure that the instruction method selected is most optimal will require implementation of the model and feedback on student learning outcomes. Other universities can utilize this model to enhance their laboratory learning and create an environment that trains their students to become more competitive.
Distance & Online Learning

**Lean Manufacturing – A Study on Distance Learning Curriculum Improvements**

Presenters:

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Ms. Jing Lu, Purdue University, West Lafayette, IN, 47907, 765-586-3701, lu59@purdue.edu

Mr. William Shuck, Purdue University, West Lafayette, IN, 47907, 317-525-7175, wshuck@purdue.edu

Co-Author: Dr. Edem Tetteh, Paine College, Augusta, GA, 30901, 706-821-8259, etetteh@paine.edu

Need: Lean Manufacturing is crucial to the manufacturing industry as well as the economy’s growth as a whole. However, the effect of globalization also has an impact on students. There are many different students now from all walks of life. This self-classified group of “College students” is larger and more diversified than ever before. Therefore, it is necessary to determine a more efficient way of delivering course material and providing an equal opportunity to learn.

Overview: The rapid globalization of the world’s economy and production processes has led to many developments that allow for more efficient and cohesive collaboration among companies and people. The development of Lean Manufacturing is one of these improvements. A study on a reverse-designed, distance learning, lean manufacturing course has been conducted through the use of syllabi as an instrument. The results of this survey will ultimately allow for the development of a more effectual on-line, asynchronous lean manufacturing course.

Major Points:
- The change of student demographics and its relation to learning environments
- Impact and importance of lean manufacturing on industry and academics
- Description of an on-line, asynchronous lean manufacturing course
- Analysis of the results of the syllabi study that was conducted
- Conclusions based on study and goals for the development of such a course

Summary: This presentation will explain how globalization has affected learning atmospheres. With a broad group of students who have many different backgrounds, a better way to deliver course materials must be developed. Using the field of Lean Manufacturing as the focus, a conducted study will culminate in results leading to insights on how to improve the college distance-learning environment, thus accommodating all types of students.
Distance & Online Learning

Implementation of Virtual Desktop Infrastructure in Engineering Design Courses

Presenter:
Dr. Samson S. Lee, Central Michigan University, Mount Pleasant, MI 48859, 989-774-5817, samson.lee@cmich.edu

Need: The growth of student numbers taking classes which utilize various computer applications means increasing requirements of resources, including, but not limited to the number of workstations and licenses for the software packages adopted by the classes. Accommodating workstations for students to access the software packages can be a great challenge especially when the laboratories are often occupied by multiple classes. Central Michigan University started to explore VDI (Virtual Desktop Infrastructure) solutions and deployed different systems in the Mt. Pleasant campus. In this presentation, the current VDI adopted by College of Science Technology and a new exercise of School of Engineering and Technology implementing VDI for the classes are introduced.

Overview: Engineering Design Courses often utilize a big named software packages, such as Dasault System CATIA and Siemens NX. Making these systems available to students is quite challenge due to the limited resources, such as the number of laboratories, licenses for the packages. Even though some company offers student versions, it is often a system with a limited function with license for less than only a year. It can cause not only incompatibility between the systems of school and students but also an extra financial burden for student through academic years. The School of Engineering and Technology is taking a great advantage of recent implementation of VDI at CMU, optimizing usages of software packages by making the all application available not only in the campus laboratories but also 24/7 in students own systems. The impact of this exercise is evident on students’ performance in classes, and it has been very applauded by students, faculty, and IT management.

Major Points:
• Need of Virtual Desktop Infrastructure for classes
• Benefits of Virtual Desktop Infrastructure for classes
• Multi-platform environments
• Software packages available through VDI
• Off campus access to applications

Summary: Attendees will understand the benefits of VDI in academic setup. A comparison of systems available in current market is also presented for the audience exploring the solutions to deploy various software packages to students and faculty in off-campus.
Distance and Online Learning

The Importance of Social Presence and Retention in Online Courses

Presenters:

Dr. Cathy Robb, Oakland City University, Oakland City, IN 47660, 812.749.1374, crobb@oak.edu

Dr. John Sutton, Oakland City University, Oakland City, IN 47660, 812.749.1272, jsutton@oak.edu

Need: With the growth of online learning in higher education comes a problem of non-completion where students withdraw from a class before the ending date. Numerous studies have shown non-completion is higher for online than traditional college classes. Research has indicated that the lack of motivation is an important contributor to dropout when students study online. Since motivating elements found in a traditional class, such as group pressure and a familiar learning environment, are often absent in online settings, motivational strategies should be purposefully integrated into the course to enhance learner motivation. In this presentation we will present the need for social presence in an online class which can impact student motivation and completion rates, as well as, their final grade.

Overview: The ARCS (Attention, Relevance, Confidence, and Satisfaction) model of motivation focuses on how to create instruction that will lead to stimulating motivation for students to learn (Keller, 1983). The ARCS model is an approach that is intended to enhance the learning environment to stimulate and sustain students’ motivation to learn therefore improving retention and course grade. It is one thing to design learner motivation techniques in a classroom setting where instructors can respond to changes as they happen, but it is a greater challenge to make online learning environments responsive to the motivational requirements of learners. Rendon’s validation theory contends students perform better when they are valued as individuals and made to feel they are members of a college community. (Rendon, 1994).

The ARCS motivation model and the validation theory both support the need for a social presence in online classes to maximize student success. In today’s online learning classes social interaction can be supported by incorporating email and text messages.

Major Points:

• Need for social interaction in online classes
• Importance of student motivation in an online course
• Use of text messages to increase a social presence in online classes
• Use of email messages in increase social presence
• Impacting student motivation through social interaction strategies which can lead to better course performance & retention

Summary: Attendees will understand the ARCS model of motivation and how it can be utilized through current technologies to increase social presence in online courses, which can impact course completion rates and final student grades.
Distance and Online Learning

Various Techniques for Incorporating Audio/Video Lectures into Your Online and Hybrid Courses

Presenters:

Dr. Jim Smallwood, Indiana State University, Terre Haute, IN 47809, (812) 237-3462, jim.smallwood@indstate.edu

Dr. Alister McLeod, Indiana State University, Terre Haute, IN 47809, (812) 237-3455, alister.mcleod@indstate.edu

Need: Many Universities and Community Colleges are moving the delivery of course content online. Some of these courses are completely online, web courses and others are hybrid courses that use the online environment to supplement a face to face course. Either way, there is a need to enhance the online delivery content by incorporating audio and video lecture techniques. Today, most online teaching and learning consists of a delivery method utilizing course management software such as Blackboard. The research reveals that most instructors are using PowerPoint presentations, along with PDF and DOC files, as well as some YouTube videos (The National Center for Manufacturing Education, 2011). However, in order to make for a more meaningful teaching, learning experience instructors could be incorporating various delivery techniques utilizing hardware and software to develop audio/video lectures.

Overview: The purpose of this presentation is to share information on various techniques for incorporating audio/video lectures into your online and hybrid courses. These techniques are deployed through the use of software such as Tegrity and Collaborate, which are add-ons to the Blackboard course management software. Currently, this is the high end of the audio/video delivery for online courses. However, there are other more affordable and in some cases free software that are available to help supplement an instructors online and hybrid courses. Several of these various techniques will be discussed.

Major Points:

• Share information on various techniques for incorporating audio/video lectures
• Discuss Tegrity, Collaborate and other software and associated hardware
• Present current research on delivering online audio/video lectures
• Discuss advantages and disadvantages of these delivery methods
• Explain how this can fit into your online and hybrid courses

Summary: As more and more courses are being delivered utilizing online and hybrid methods it is important to incorporate audio/visual techniques to enhance your lectures. This will provide a more meaningful teaching and learning experience for both the instructor and students. There are various techniques that can be used in the online environment or to supplement a hybrid course. This information will be discussed and demonstrated in this presentation.
Designing and Developing a Comprehensive Organizational Structure for Developing Adult Professional Learners through Distance and Online Learning

Presenter:

Dr. Mitchell L. Springer, Purdue University, West Lafayette, Indiana, 765-496-2983, mlspring@purdue.edu

Need: Adult professional learners have needs not typical of traditional residential-based student learners. These many professional learners have opposing forces prohibiting the traditional residential and residential-hybrid models for educational attainment; family and career are but a few of these. To accommodate working adult professional learners, many delivery models should be employed. This paper describes the organizational infrastructure and distance models required to attract and improve success of this special cohort.

Overview: The Center for Professional Studies in Technology and Applied Research (ProSTAR) was approved by Purdue University under the College of Technology as an academic Center on February 9, 2009. At that time, an effort was initiated to create an underlying infrastructure which would promote the current and future growth of professional studies for working adult professional learners in engineering and technology disciplines. Recognizing the unique needs of adult professional learners, continuous improvement has resulted in significant changes to organize facilities, human capital, processes, practices and methodologies as well as required multi-model delivery of numerous applied engineering and technology programs; this, recognizing and capitalizing on the engineering educational continuum.

Major Points

• Formation of a tightly coupled, highly integrated relationship with the business office for purposes of creating a time-phased rolling-window financial pro forma; supporting expenditures against future anticipated earnings
• Employment of a program management methodology to fully define and differentiate the roles and responsibilities of a professional studies administrative organization as well as contrast the role of other university partners
• Evolution of a financial incentive model for academic departments and faculty involvement in distance-oriented fee-based programs through a ten-year longitudinal study
• Recognizing the criteria for student success, other than undergraduate GPA and GRE, through detailed analysis of 13 years of participant workforce profiles

Summary: This presentation and paper depicts the ever evolving organizational design model currently employed to meet the needs of adult professional engineering and technology workers of the future through distance and online learning. It is based on an exhaustive background of research; both pure and applied (hands-on practical experience). This paper will share the lessons learned, which may be used and applied by a wide-spectrum of similarly inclined organizational units.
Distance & Online Learning

Master's in Construction Management Program: Students' Preferences Regarding a Fully Online Program Compared to a Traditional Face-to-Face Program

Presenters:

Dr. James J. Stein, Eastern Michigan University, School of Engineering Technology, 206 Roosevelt Hall, Ypsilanti, MI 48197, 734-487-1940, james.stein@emich.edu

Mr. Matthew Rottenberk, Eastern Michigan University, School of Engineering Technology, 206 Roosevelt Hall, Ypsilanti, MI 48197, 248-219-8294, mrottenb@emich.edu

Need: The construction industry is fast becoming more and more sophisticated. Therefore, employers are now strongly advocating advanced degrees in Construction Management (CM) to sharpen abilities, hone operating effectiveness, improve corporate image, and increase the bottom line. Many professionals, currently working in the industry, cannot pursue a master’s degree due to work travel and time constraints. An alternative approach is needed in lieu of the traditional face-to-face model. A fully online master’s program allows non-traditional learners the opportunity to study in a more convenient environment. Furthermore, many educators suggest online programs have a potential to increase enrollment and broaden the student body from a regional base to a national and international market.

Overview: The presenters will compare and contrast various existing master’s programs in CM currently being offered online throughout the United States. Moreover, survey results of industry practitioners will be analyzed and presented which examines learner preferences for a fully online graduate degree in construction management.

Major points:

- The construction industry will likely benefit from more accessible educational opportunities for their management professionals at the graduate level.
- Research was conducted to gain knowledge about existing construction management distant learning models taught by other universities at the master’s level.
- The major goal of this study is to gather and analyze survey data regarding preferences of a fully online CM program for qualified individuals pursuing a master’s degree versus a conventional face-to-face class.

Summary: The presenters will benchmark existing CM programs offering master’s degrees online. Additionally, learner preferences for online programs compared to the traditional face-to-face format will be examined.
Distance & Online Learning

**Impact of Conceptualized Learning Experience on the Online Student Learning**

**Presenter:**

Dr. Edem Tetteh, Paine College, Augusta, GA 30901, 706-829-7641, etetteh@paine.edu

**Need:** There is a need to expand the current theory on the effectiveness of online teaching and learning tools through conceptualized learning experiences. The study will examine the impacts of a research and theory based intervention that emphasizes the use of practical applications of abstract concepts coupled with problem-solving learning to impact online students learning.

**Overview:** The workforce of the future will need better prepared workers that are able to ascertain skills and knowledge that require quick decision making and innovative ideas to solve problems using modeling and simulation tools that are prevalent in industry. Typically, modeling and simulation tools utilize multiple simulation tools and packages that show different results that contain wide variations in the solution methodology. As a result it is very difficult to ensure which tools and results are accurate. No tool is considered to be perfect, and the selection of the right modeling and simulation tools are needed for online teaching. This is especially true in the case of teaching science, engineering, and technology topics online, where many concepts are abstract, and need high level mental processing to be comprehended.

**Major Points:**

- Need for a conceptualized learning-based interventions through curriculum enhancement using simulation and modeling.
- The strategy is to help faculty transform their practice from passive lecture based methods to approaches that engage students in active inquiry online.
- Hands-on inquiry properly redistributes the responsibility for learning to students and the student’s role changes from passive recipient of information to a constructivist participant.

**Summary:** Attendees will learn how to enhance programs and capabilities in their online courses at their home institutions. Moreover, they will learn innovative methods to contribute new knowledge to cutting-edge science, engineering, and technology online teaching and learning.
Distance & Online Learning

A Novel Approach to Enhance Undergraduate Robotics Technology Education to Meet Emerging Industrial Work-force Needs

Presenters:

Dr. Francis Tuluri, Jackson State University, Jackson, MS 39217, 601-979-8262, francis.tuluri@jsums.edu

Need: Recent advances in Robotics Technology are opening Industrial Robotics as a potential work force with new opportunities for the present and next generation of students. To gear up to the primary objective of our national robotics initiative towards increasing the productivity of workers in the manufacturing sector, Jackson State University is preparing our students as the next generation workforce to meet this challenge with new courses and training at undergraduate level with innovative teaching and practical strategies. One of the issues that has delayed the use of the “On-Line” teaching environment in the area of robotics has been the inability of the student to conduct their experiments on-line. This necessitates that student must present themselves to the classroom and conduct their experiments with the available classroom robots.

Overview: In this paper we describe a novel and versatile method using a “Virtual Environment” that simulates very realistically the problem to be solved thus providing the student with both the actual results of the computer simulation, as well as, in a graphic way, the resulting movements of the robot. The technique is based on the virtual environment (Robot Virtual World (RVW)) which has been developed by the Carnegie Mellon University using the LEGO NXT robot and the ROBOTC software development tool.

Major Points:

• Need for gearing up with the advances in Industrial Robotics
• Promoting undergraduate Robotics Technology courses
• Meeting the future needs of work-force in Industrial Robotics
• Developing a Virtual Environment Laboratory for advancing Robotics curriculum
• Delivery of on-line Robotics courses through Blackboard distance learning environment
• Practicing problem solving in Robotics courses through on-line facility
• Advancing Robotics programming skills in real time applications

Summary: The simulation environment is being successfully implemented in the robotics curriculum of the Department of Technology at Jackson State University, and the results of the technique will be presented.
Distance & Online Learning

A Study to Determine Best Practices for Developing Effective Small Group Collaborative Learning Activities Using Multi-User Video-Conferencing Technology

Presenters:

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Co-Author: Ms. Cynthia Horta, University of Central Missouri, Doctoral Fellow, Warrensburg, MO 64093, 660-543-4340, chorta@ucmo.edu

Need: Using multi-user video-conferencing technology for effective small group collaborative learning activities can be a challenge for some. A set of best practices is needed to help users experience the efficacy of using multi-user video-conferencing technology. The purpose of this study is to determine best practices for using multi-user video-conferencing technology effectively. Users will be able to concentrate on factors that contribute to the effectiveness of the delivery method (Peterson 2004) by identifying the pros and cons of using this innovative instructional methodology. The study will be done with graduate students enrolled at the University of Central Missouri.

Overview: Instructional technologies vary between course, instructor, major and university. Multi-user video-conferencing technology accommodates multiple learning styles and is an effective way to get away from a “one-size-fits-all” approach (Greenberg, 2004). With the growth of online degree programs it is necessary for researchers to pay closer attention to new technology and investigate the best practices in order to use technology effectively and efficient.

Major Points:

• When using Multi-User Video-Conferencing Technology is Recording the session necessary?
• Are network and hardware upgrades and issue that users need to pay attention when using (M-UV-C)?
• Does M-UV-C require additional planning, time and effort?
• Does users need to pay closer attention to the slight delay that occurs when using M-UV-C?
• Is M-UV-C cost-effective?
• What are the pros and cons of using M-UV-C?

Conclusions: Information presented in this study will serve as a reference to help establish a baseline of best practices for users that will like to engage in this technology. Videoconferencing is intrinsically different from its classroom counterpart and usually requires “role changes, additional planning, and new skills (Amirian, 2000). The goal will be to create, establish and publish a set of guidelines for multi-user video-conferencing software users.
Distance & Online Learning

A Newcomer’s View to Distance Education: Do’s, Don’ts, and Pitfalls

Presenters:

Dr. John Wyatt, Mississippi State University, MSU, MS 39762, (662) 325 7257, wyatt@colled.msstate.edu

Mr. Mickey Giordano, Mississippi State University, MSU, MS 39762, (662) 325 1610, mgiordano@colled.msstate.edu

Need: Industrial technology programs have seen a major increase in the demand for online courses to be offered to non-traditional students. There are many ways in which to deliver these types of courses and it is a minefield for those who have no experience with distance education. This presentation will present the development of the first four online courses for Mississippi State University’s industrial technology program.

Overview: The industrial technology program at Mississippi State University has started to attract the attention of non-traditional students. In an effort to accommodate them the program has begun to offer in the fall 2013 semester online courses to both main campus and distance education students. With the faculty having no experience in distance education there have been many obstacles and opportunities which will be highlighted and a discussion of our thought process in the choice of delivery method for our first four courses.

Major Points:

• How hard can it be?
• Do I / should I get training?
• Managing the change
• How much technology should you use?

Summary: Attendees will get an insight into the opportunities and problem areas that occur to the non-experienced faculty member who is charged with developing an online course. It will show that you do not need to use large amounts of technology as it can sometimes be more of a placebo effect. There will be a discussion on the problems with change management in the moving from the traditional to distance classroom not from the student perspective but from that of the faculty.
Distance & Online Learning

How Does “Quality Matters” Help? - Development of High Quality Online Teaching for Courses Having Intensive Technical Contents

Presenters:

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Need: Due to the rapid technological changes, the workforce with sufficiently trained knowledge in manufacturing is now in high demand in the US job market. To accommodate the educational need, many universities have started offering online, and/or hybrid courses or degree programs, in addition to the traditional face to face instruction method, so that students have the flexibility in scheduling classes and completing the study at their own pace. However, there is still a challenge to maintain quality and teaching effectiveness when courses are offered online. The challenge intensifies with courses that have rigorous technical contents.

Overview: The Quality Matters (QM) program is a nationally well-known quality assurance program for online and blended courses. QM workshops and training sessions have been offered at the University of Northern Iowa in recent years. The courses in the Department of Technology have intensive amount of technical information related to mathematical calculations, logical reasoning, software demonstrations, team projects and presentations. This creates more challenges in developing high quality online courses. The faculty members in this department used the QM rubrics and also implemented other instructional technologies such as Panopto lecture capture software and Adobe Connect in the online courses for teaching effectiveness. In addition to sharing reflections, the presenters will also demonstrate how teamwork and presentation were included in their online teaching.

Major Points:

• Need and Challenges to implement online teaching in technical contents courses
• How Quality Matters rubrics are applied to assure online teaching quality
• Application of Panopto and Adobe Connect in online courses
• Survey assessment, student feedback, and how to improve in the future
• Examples and demonstration on currently offered online classes in Manufacturing Technology, Technology Management, and MS in Technology programs at UNI.

Summary: The rapid technological changes have increased demands for well trained workers who possess new/advanced technical skills. Today, the corresponding advance and development in computer network enable us to deliver courses with intensive technical contents in an online format. Attendees will view and understand the benefits of the online courses developed with the Quality Matters rubrics and the new educational technology, and gain insight from the survey conducted among students who are pursuing technology related degrees at UNI.
ELECTRICAL, ELECTRONICS & COMPUTER TECHNOLOGY
Development of a Traffic Shaping Algorithm for an Efficient Wireless Network on a University Campus

Need: The use of wireless networks has exploded in the last decade. Two of the biggest challenges for wireless networks are security and quality of service (QoS). Mobile use has poured into the university campus at a pace so rapid that technical staff is only able to focus on simply providing wireless access with less time to address these concerns. This presentation will discuss an algorithm to assist in traffic control directed at the QoS issue.

Overview: Wireless Local Area Networks (WLANs) have become the predominant means of gaining network access in the past decade. Historically, educational environments are not the first to incorporate new mobile devices on their networks, but wait until best practices are available to guide the process. The same holds true for implementing network controls that improve the QoS of the campus network. With wireless devices, the ability to change locations causing disconnections from one network access point to another, makes it increasingly difficult to control the amount of traffic being presented to an individual network routing device. This increases the complexity of the rules necessary to develop an efficient network that provides sufficient QoS to the users of the mobile devices. The proposed algorithm is one they can add to their existing toolkit.

Major Points:
- Need for improvement in wireless access on university campuses
- Overview of existing traffic shaping algorithms
- The algorithm development process
- Explanation of the proposed traffic control algorithm and its performance

Summary: Attendees will understand the complexities of managing wireless networks to support a university campus. Various traffic shaping algorithms will be investigated to address the Quality of Service (QoS) issue. The proposed algorithm can be used as a basis for others to improve the QoS on any wireless networks.
Developing an Android Programming Course for Technology Students in a Mobile Age

Presenters:

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Dr. Peter Ping Liu, Eastern Illinois University, Charleston, IL 61920, 217-581-6267, pliu@eiu.edu

Need: There are more than 6.4 billion mobile connections worldwide at the time of writing. Mobile is fueling economic growth, transforming industries, and is redefining the way we live. Android and iOS combined count for about 90% of operating systems (OS) for mobile devices. In the third quarter of 2012, manufacturers, mostly Samsung, shipped 136 million Android-based phones capturing 75 percent of market share, while Apple shipped 27 million iOS-based units taking 15 percent. Whether students are hobbyists or want to be programmers, whether they are doing mobile development for fun or for profit, we think they cannot afford not to learn about Android development. Our students are in an era of mobile applications. They have a strong interest in mobile computing and in implementing their ideas on mobile devices. To satisfy the needs of technology students and to better prepare them for future mobile world, we developed an Android programming course.

Overview: In this presentation, we will introduce Android mobile platform, its architecture, application building blocks, and development tools. Android is a software stack including operating system, middleware, and key applications for touchscreen mobile devices, such as smartphones and tablets. It was created by Google and the Open Handset Alliance (OHA). OHA consists of 84 firms including HTC, Sony, Dell, Intel, Motorola, Qualcomm, and Samsung. Android is Linux-based and is open source. It has a large community of developers, and the programming language is a customized version of Java. We will explain the Android development setup, which requires Java development kit, Eclipse integrated development environment, Android software development kit, and a plug-in for Eclipse called the Android Development Toolkit (ADT). In addition, we will discuss four application components of Android: activities for visual user interface, services running in the background, broadcast receivers that react to broadcast announcements, and content providers that allow data exchange between applications.

Major Points:

- The status of mobile computing
- Android history and system architecture
- Android development tools and installation
- Android app components and development process
- Lessons learned from offering this course

Summary: The current transition to mobile computing has motivated us to develop an Android programming course for technology students. We would like to share our experience with ATMAE audience. We will introduce Android platform, architecture, development environment, application components, and how to write an Android app. We will also discuss the feedback from our students.
Need: 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 and alarming emissions of greenhouse gas. 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. In order for the Earth to continuously support human lives, we must achieve sustainability for the global social, economic, and environmental systems. 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. Among different sources of renewable energy, wind energy is widely distributed, clean, and renewable. Wind energy produces no greenhouse gas emissions and does not use much land.

Overview: Wind energy has been used for centuries in applications like sailing, milling, and pumping water. Energy demands have skyrocketed in the modern industrial world. Wind energy production has grown by orders of magnitude as well. Large scale wind farms have been established to help offset the energy that would be taken from other sources. Small scale projects have seen applications such as those in a more residential setting. The U.S. wind energy industry now consists of more than 45,000 turbines with a capacity to generate more than 60,000 MW. To study wind energy generation technologies, we constructed a laboratory scale vertical wind turbine system. The advantages of vertical wind turbine technology will be explored to help examine the practicality of this design. One advantage of deploying vertical wind turbines over horizontal wind turbines is the wind speed at which the turbines can withstand. The design of vertical wind turbines allows them to operate and remain intact when faced with higher wind speeds. Another advantage of using vertical wind turbines over horizontal is not being concerned with pitch. Horizontal wind turbines typically require adjustment in pitch in order to achieve the best results and to not damage the machinery. These advantages and others will be studied. One issue with the vertical technology is to develop a standard for the amount and the rate of energy being produced. The laboratory scale wind turbine will be tested to address this problem and to help understand the operation performance of these types of wind energy generators.

Major Points

- Sustainability for global social, economic, and environmental systems
- Wind energy generation is widely available and viable
- Practical techniques for harnessing wind energy
- The study of a laboratory scale vertical wind turbine system

Summary: Wind is a viable source of sustainable energy and has the potential to mitigate dependence on diminishing fossil fuels. Techniques and practices of generating energy from wind will be discussed. A laboratory scale vertical wind turbine system provides insight on this technology and its advantages and limitations.
Energy Systems and Sustainability: Making the US More Competitive

Need: Recent issues with energy supplies and cost have heightened the need for more access to alternative renewable energy sources, such as solar, wind, biomass, geothermal, and hydroelectric. While the US is making progress in the development of renewable energy sources, particularly wind and biomass, other countries, notably Germany and Japan have outpaced the US in the production and use of photovoltaic (PV) solar technology. For the US, pressures from the world market have hampered the viability of the PV manufacturing industry. To be competitive in energy systems technology and its utilization, measures need to be in place to ensure development of a more diversified energy mix and to make the manufacturing of renewable energy products attractive on the world market.

Overview: The US consumes about 20% of the world’s total energy supply, even though its population is only 5% of the world’s population. Today, the US depends substantially on fossil fuels, mostly imported petroleum. This poses concerns for energy systems security. According to the World Energy Council (WEC), the U.S places 12th among 90 countries in its Energy Sustainability Index in 2012. Countries such as Sweden, Canada, Japan, and Germany, that use a more diversified energy mix rank higher than the U.S. China’s recent expansion in its economy has given it a major push in energy systems development. This paper discusses the current state of the US energy systems utilization and proposes ways to facilitate more investment in energy efficiency technologies and services to make the US more competitive on the world energy systems map.

Major Points:
- Renewable energy resource utilization
- Environmental issues
- Economic impact
- Research and development

Summary: An effective energy systems approach connects economic growth to a sustainable environment. Many countries are adopting efficient energy technologies and practices. Investing in renewable energy systems is critical to meeting future energy demand and to lessen the effects of climate change. For the U.S to be competitive in energy systems technology and its utilization, measures need to be in place to ensure development of a more diversified energy mix and to make the manufacturing of renewable energy products attractive on the world market.
Electricity, Electronics, & Computer Technology – Automation & Control Systems
Data Acquisition Measurement Techniques with Real-World Project

Presenter:
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Need: The practice of data acquisition has changed since computer and software applications have been extensively dominating all aspect of engineering and technology fields. Data acquisition has been shifted from manual reading to graphically oriented programming environments. We present a real world project which is developed as a lab module and integrated in measurement courses.

Overview: A brief overview of this module is presented in this paper. The objective of this project is to use hardware and LabVIEW software to read pulses and calculate the flow rate and velocity of an industrial turbine flow meter. In order to measure flow rate and velocity, the turbine flow meter is integrated with National Instrument hardware (BNC-2120) and LabVIEW software. The turbine flow meter is a devise to measure the volume flow rate of liquid or gas. While liquid is flowing through the meter, it forces the turbine blades to rotate. Rotating blades pass the mounted magnetic coil that generates conditioned pulses output. The BNC-2120 hardware accepts the pulses through connection with the flow meter, and then graphical communication LabVIEW software performs the calculation that is required for measuring the flow rate and velocity.

Major Points:
• Application of Software and hardware in Industry
• Integrating, wiring and programming of components

Summary: Attendees will understand how to integrate the LabVIEW software and hardware for a real world project. The outcome of this industrial project can be implemented in an instrumentation course.
Simulation of Wind Turbines

Need: Today, as fossil fuel reserves continue to diminish and there is greater public demand for clean, renewable energy, people are looking at wind power as a viable, cost-effective method of generating electricity. Although there are many wind turbines currently in use that supplement the energy created through other means, most turbines in use are relatively inefficient, capturing only a fraction of the power contained in the wind. For this reason, researchers continue to work to develop turbines and blades that can extract more energy, with fewer losses. Computational Fluid Dynamics (CFD) is the prediction of flows using mathematical modeling, numerical methods, and computer simulations. SolidWorks, by Dassault Systèmes, which contains a powerful CFD toolset are used for this research.

Overview: The purpose of this research is to develop more efficient wind turbines. Using computational fluid dynamics simulations, we can rapidly determine the forces on given airfoil or complete turbine surfaces. So far we successfully made a three-dimensional model of an airfoil, applied specific boundary conditions to the flow of air, ran time-dependent simulations, and gained results of the simulation giving me force, pressure, velocity, and vorticity of the air along the surface of said airfoil. This research is being done in an effort to make wind power a more economically viable option and alternative to fossil fuels, and to gain a better understanding of the physical interactions involved in flight.

Major Points:
- Design a wind turbine with a CADD software
- Design and analysis of blades – shape, pitch, camber, length, – angle of attack of the blades, blade arrangements, number of blades used, tower design, method of regulation (braking)
- Use CFD (computational fluid dynamics for simulation of the wind turbine
- Use computational method of “solving” the designs, which is, determining the forces and necessary data on the surfaces being tested in an effort to find a design that increases efficiency.
- Find the lift and drag coefficients at various angles of attack.
- Find the surface pressure and skin friction coefficients, as a function of the position on the chord of a blade profile, at various angles of attack.
- Determine the lift and drag characteristics of each blade design.

Summary: All the information about the project will be shared with academia including design steps, issues, software tools used, theorems, and getting this type of research to classroom environment to increase student understanding on dynamic analysis, and results, etc.
Developing a Customizable Renewable Energy System Laboratory Protocol for an Engineering & Technology Curriculum

Presenters:

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Dr. Rajeev Nair, Assistant Professor, Department of Mechanical Engineering, Wichita State University, Wichita, KS 67260-0133, 316-978-6316, rajeev.nair@wichita.edu

Need: With the increased push by federal and state policy makers to advance America’s technological capabilities in renewable energy, coupled with the increased viability of this emerging technology, it is becoming more important for engineering and technology programs in many universities and colleges to offer courses related to Renewable Energy Systems. These courses are needed to prepare future engineering and technology graduates for the energy workforce. While most current course offerings have detailed curricula that emphasize lecture components, most have yet to establish suitable laboratory protocols, which will offer their students the needed hands-on training to prepare them for the demands of the industry.

Overview: In this presentation the authors put forth an approach and give an example of how to produce a customizable Renewable Energy Laboratory Protocol, referred to here as a cRELp. Their intent is to assist applied engineering and technology programs with developing this type of laboratory protocol. The first half is concentrated on the author’s hierarchal approach to cRELp development. This approach is similar to an upside-down pyramid, which starts with broad deliverables and progressively steps down to more focused outcomes. The second half of the presentation focuses on a case study of the cRELp, intended to be incorporated into the IET 352 Energy Systems and Sustainability course offered at the Department of Applied Engineering and Technology, Morehead State University in Kentucky. This case study includes specific lab exercises, equipment needs and safety considerations in order to give the reader an example of how to formulate a cRELp’s topics and content.

Major Points:

- Core theories and experiments that can be included as part of a course’s laboratory component.
- Laboratory safety issues related to experiments.
- Case study of Morehead State University’s ongoing development of a customizable renewable energy system laboratory protocol.
- Available government and institutional funding for research and course implementation.

Summary: This presentation will benefit programs seeking to establish customizable laboratory protocols related to Renewable Energy Systems, as well as currently available sources of funding for courses and research activities related to this field.
Wireless Autonomous Vehicle Designs and Controls

Presenter:

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Need: EECT focuses on both “hands-on and minds-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 by using an existing RF module that can lead to successful experiences. Based on the success, it can result in a clearer understanding and trigger the interest in applying the concepts to the needed project. 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 subjects appealing and it can easily be adopted in many potential applications.

Overview: An intelligent machine system such as a factory robot or a military drone is multidisciplinary in nature. It involves circuit design, sensor technology, human-machine interface, power systems, dynamics and controls, software engineering, etc. As such, the system integration, system reliability, life cycle cost and maintenance should be addressed in the design of an autonomous system and device. The understanding of the microcontroller, hardware interface, software programming, communication protocols in wire and wireless, and mechanical operations/knowledge are the essential elements in this multidiscipline based project designs and implementations. This project covers theory, hands-on, and programming activities. There will be a live demonstration on the implementations on the related controls and designs.

Major Points:

• Comparison of various available RF modules.
• Introduction of IEEE 802.15.4™-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.

Conclusion: Wireless communication is a popular subject and an increasing demand in applications, but integrate it in class lecture(s) and also make it easily understood and interesting is a challenging task. Applying RF will encounter many obstacles that usually end up with malfunction results and difficult to troubleshoot. However, put the existing RF transceiver module with a pre-developed PIC training system eliminates many uncontrollable variables. This project provides useful tools that make teaching and learning of complex RF subjects appealing and it can also easily be accepted in different applications.
Investigation of the Local Biomass Resources for Sustainable Energy

Presenters:

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Need: It has been widely observed that humans have been living unsustainably, as evidenced by our ever-increasing consumption of natural resources and alarming emissions of greenhouse gases. Developing sustainable energy has been an urgent theme worldwide. Biomass gasification, a technology of converting solid biomass fuels into combustible syn-gases, is proven to be a sustainable, highly efficient and environment-friendly solution. Nonetheless, renewable energy practices and biomass resources are highly dependent upon the local conditions. To maintain regional supplies of biomass fuel, a diversification of biomass resources is critical from a sustainable perspective.

Overview: Identification of biomass resource includes: 1. Testing heat value and moisture content 2. Processing the biomass into useful form including mixing and pelletizing; 3. Measuring the chemical composition of the syn-gas produced by the biomass source. The data of heating value of these fuels will be obtained from a bomb calorimeter. The biomass will be gasified on a laboratory scale downdraft gasifier to generate syn-gases. The produced syn-gases will be gathered and then analyzed through a gas chromatographer (GC) to identify the fuel-gases proportion. Comparison with base-line wood chips provides a comprehensive analysis for further sustainable energy application.

Major points:
- Significance of biomass renewable energy solution for climate mitigation
- Identification of local biomass resources in the region
- Test higher heat value (HHV) of selected biomass resources
- Densification processing of available biomass
- Test the pellet on an experimental scale gasification system and identify the syn gases composition
- Compare the efficiency with the current bio-fuel, wood chip

Summary: The process of identification of local biomass resources will be introduced. Through testing the available biomass fuels and in comparison with wood chips, alternative biomass sources will be identified for the Renewable Energy Center and other sustainable energy applications. The experiments will offer opportunities for students to conduct an integrative and systematic study on biomass gasification.
Faith, Uncertainty and the Fallacy of Security in Depth: Teaching Computer Security and Knowing Why

Presenters:

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Need: We will discuss a variety of computer and network security models, their failures and successes such as multilayer security, security in depth, security through obscurity, faith-based security along with some ideas on how to padlock your own systems, security model trends and techniques plus ideas about how to teach core security techniques in the classroom. The U.S. is in a cyberwar and our computer technology students must understand this and learn how to counter the threats in their daily lives and in the organizations for which they work.

Overview: Information Technologists have received considerable attention lately due to the increased threat from viruses, worms, password crackers, Trojan horses and a vast collection of malware and exploits. We have nothing short of a global cyber war ongoing between criminals and consumers, between criminals and businesses and between governments across the world. Consequently, a variety of security models have been proposed over the past three decades. Security modeling could be likened to driving forward while looking through your rearview mirror. In other words, computer and network security systems are primarily reactive. The very nature of security models means that they are typically out of date by the time they are adopted. The challenge is the need to continuously update the existing models while developing new ones and this challenge should now be part of the core curriculum in both programming and networking.

Major Points:

- Need for understanding a bit of the history of security models, their successes and failures;
- Discussion of why security models are critical to the safety of computers, networks and the organizations that use them;
- Identification of the core areas and ideas of security models, current techniques and future designs;
- Consideration of the teaching methods, curriculum development and topics to deliver to students;
- Suggested course changes, design ideas and recommendations.

Summary: Participants will understand the history, need and curriculum used to construct or restructure a course in computer security that reflects current knowledge of the area, provides ideas about security issues today and discusses the needs of consumers, businesses and government in the area of cyber security. Further, we will discuss what teachers need to present this in an understandable way to computer science students.
Implementation of Lab Modules that Make Abstract Computer Networking Concepts Tangible

Presenter:
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Need: Computer technology has a profound impact in our daily life. Many of the new generation students grow up knowing how to operate several digital devices. However, not many of them understand the underlining theory and functions. Computer networking course content in the classrooms are often introduced with the representation of abstract concepts that often create barriers for learners to conceptualize the theories. This presentation will introduce the curriculum development of a computer networking class, and the lab structure that makes the abstract theory tangible to learners.

Overview: This presentation will demonstrate the curriculum development of a computer networking course, and the design and implementation of lab modules that allow learners to experience and visualize the abstract theories and terminologies. Theories are explained and lab modules are designed to bridge the gap so students can relate the abstract concepts to the concrete hands-on experience. Hands-on units include the functions of layers in OSI and TCP/IP models such as Application Layer, Network/Internet Layer, and Transport Layer. In addition, simulation of Virtual Local Area Network (VLAN) with InterVlan routing, simulation of Ping attack in a closed network, Utilization of building blue prints to design network physical and logical topologies will be covered.

Major Points:
• Overview of computer networking theories – network models
• Overview of the abstract terminology
• Hands-on labs which bridge the abstract and the concrete hands-on.
• Overview of lab structure and setup (with pictures)
• Overview of all lab modules

Summary: This presentation will provide an overview of the development and implementation of computer networking curriculum that can serve as a reference model for technology educators.
Security for The Jetsons: Computer Tools and Technologies for Assuring Confidentiality, Integrity, and Availability of Data and Services

Presenters:

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Dr. Danda Rawat, Eastern Kentucky University, danda.rawat@eku.edu

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Need: The ever increasing migration of data and services from local computer systems to remote, online, and cloud-based servers places a corresponding urgency on securing these systems against unauthorized access. At the same time the demands for always-on and mobile services continues to grow dramatically. Computer network security specialists need to provide assurances regarding the confidentiality and integrity of user and corporate data being maintained regardless of how it is accessed, even while providing a high level of availability. These considerations place exacting demands on the network and advanced tools/technologies are needed for safeguarding sensitive information.

Overview: As new network-enabled computing and communication devices are introduced for domestic use and in the financial, industrial and government sectors, system administrators and designers need to assure confidentiality, integrity, and availability of data and services. Virtualized cloud systems further complicates security issues. As the trend for migrating data to online systems continues the need for offering secure systems continues to rise. Creating a secure system requires continuous assessment of vulnerabilities and using suitable tools for reducing these. The presentation will discuss sources of security vulnerabilities, sample open-source and proprietary software tools that offer exceptional security, along with recommendations for familiarizing computer technology students with these advanced concepts.

Major Points:

• Security vulnerabilities in computer systems, wired/wireless networks, mobile devices, and cloud computing/storage.
• Advanced security tools for maintaining Confidentiality, Integrity, and Availability (CIA triad) along with authentication and non-repudiation.
• Using case studies, sample scenarios and lab activities for evaluating system security and suggesting/demonstrating ways for improving it
• Strengthening critical/creative thinking and practical hands-on skills of computer technology students while security computer network systems and devices.
• Developing a comprehensive view of computer/network security even as technologies change.

Summary: Maintaining security for traditional computer systems and networks, as well as modern mobile communication devices and for cloud systems is an ongoing challenge. The presentation will also provide practical information that typical users can and should use for securing these devices. Selected open-source and proprietary security solutions will be discussed. Sample classroom and lab activities used for preparing computer technology students in this rapidly advancing field will be shared in the presentation.
Study of Regional Biomass Feedstock as Resources for Renewable Bio-Energy

Presenters:

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Need: Fossil fuels are being consumed at an astronomical rate and concerns about the rise in fossil fuel prices, the emissions of greenhouse gases produced by these fuels and the depletion of reserves are becoming more evident. A call for new ways of producing environmentally-friendly electricity and heat production is in order. Fossil fuel based plants are increasing emissions of CO$_2$ on an annual basis which is leading to higher rate of greenhouse gases in our atmosphere. Since it has become generally recognized that dependence on these fossil fuels cannot sustain human growth, renewable biofuels are needed. One of the most promising alternative energy producing technologies is biomass gasification.

Overview: Plant matter is a form of biomass that grows by absorbing solar energy, carbon dioxide, and water through photosynthesis and is mainly comprised of hydrocarbons used to produce a cell wall for the plant. A plant's cell wall is composed of three components known as cellulose, hemicellulose and lignin which vary by species and cell type. Plants can be grown as a dedicated energy crop for biomass gasification and can vary in shape and size, but the application of each must be considered based on geographic locations so that they are able to be a sustainable resource. One of the biggest issues with feedstocks for biomass gasification is transportation of material to the facility which can potentially be overcome with analysis of regional plant growth and favorable conditions for dedicated energy crops.

Major Points:

- Billion ton vision of biomass resources by U.S. government to displace 30% of petroleum applications by 2030
- It is necessary to further research fuel sources for biomass gasification
- All plant are composed of lignin, cellulose, hemicellulose, and other extractives
- Higher heating values are available for each of the plant components
- Analysis of regional plant composition to determine best-fit for biomass gasification
- The barrier for transporting of feedstock may potentially be overcome

Summary: A model will be presented for classifying biomass as a sustainable energy source based on geographical location and localized plant growth to make transportation for biomass gasification economically feasible. This model will be an analysis of the percentage of primary plant components which include lignin, cellulose, hemicellulose, extractives, and voids. An investigation will be presented to determine which biomass resource would be most beneficial for biomass gasification based on regional resources including regional plant growth.
Student Investigation of Personal Computers Disposal Practices

Presenters:

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Dr. Kuldeep S. Rawat, Department of Technology, Elizabeth City State University, Elizabeth City, NC 27909, 252-335-3846, ksrawat@mail.ecsu.edu

Need: The ever increasing demand for computers by businesses and organizations that results from the need to successfully carry out their day to day activities has helped increase the sales of personal computers. As computers become more affordable and newer technological innovations become available, the lifespan of computers become shorter and more computers become obsolete, increasing the number that need to be disposed. Improper disposal of computers could result in them ending up in landfills and incinerators which could cause the toxic materials in computers like lead, cadmium, plastic, and chromium to seep into ground water or become exposed into the atmosphere.

Overview: This project was designed to conduct research in the form of surveys and interviews to determine if managers were aware of the hazards associated with improper waste and disposal, and to explore and test the feasibility of solutions available today. The results showed that businesses and organizations are not aware of the problem of disposal of end-of-life computers; but with proper awareness, most were willing to adopt or improve company policies and procedures.

Major Points:

- Project provided students hands-on experience, a comprehensive experience in teamwork, and the opportunity to apply their management and technology skills.
- This study exposed the need for managers and employees alike to become aware of the problem of accumulation and disposal of end-of-life computers and electronic devices in order to take steps to avoid critical consequences.
- The results from survey showed that health concerns, employer liability, and potential injury at work were the top influence factors.

Summary: This study provides business and organizations with the necessary tools to enable them to deal with the problem of computer waste and disposal. First, in order for businesses and organizations to protect themselves and their employees, they have to be aware of the issues concerning computer waste and disposal. They should familiarize themselves and keep up with federal, state and local laws especially if they operate in different states.
Electricity, Electronics, & Computer Technology - Energy Issues

Enhancing Industrial Technology Studies with Projects in Residential Energy Audits

Presenters:

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Need: There are many people who want to save energy in their homes or small business but cannot afford to build an energy efficient construction or do not much about energy saving practices. Fortunately, there are many no-cost and low cost practices that can help everyone reduce energy waste and save energy dollars. Students in the construction course in Industrial Technology Department at University of Louisiana at Lafayette conduct energy surveys on houses and small businesses and the data is disseminated to educate homeowners and small businesses.

Overview: Smart energy consumption and its environmental impact are most important subjects in many societies. Faculty in the Department of Technology combined studies of alternative energy with energy audit project conducted by students for their communities as part of construction and environmental technology course requirement. The data from various homes and business are gathered and analyzed and results of the study will be presented to the other students and to the home and the business owners.

Major Points:

• Technology students should conduct hands on experiments in as many technical courses as possible. Careers in fields of environmental and energy technology are in demand.
• Environmental and energy conscious students would benefit in understanding power ratings and energy usage of electrical systems such as electrical equipment and electrical appliances found in most homes.
• Energy conscious home and business owners appreciate the value of higher education as it directly benefits them and their communities.

Summary: Energy audits of residential and small business conducted by industrial technology students, ensures a large pool of well-trained students who will be available to enter both the energy and environmental technology sectors. Faculty and students involved in these projects conduct presentations and workshops during the school year. Students give presentations and distribute handouts on how to reduce energy consumption and improve their energy usage habits. These energy audit projects have been a great success in the community.
Installation and Commissioning of a Rotating Shadowband Radiometer System

Presenters:

Dr. Darren Olson, MSET Program Coordinator, Department of Industrial & Engineering Technology, Central Washington University, 400 E. University Way, Ellensburg, WA 98926, (509) 963-1913, olsondar@cwu.edu

Mr. Hunter Slyfield, MSET Candidate, Central Washington University, 400 E. University Way, Ellensburg, WA 98926, (509) 859-4268, slyfieldh@cwu.edu

Need: Attendees will be able to learn about the technical challenges associated with implementing the radiometer system and the benefits that accrued to the both the client and to the university.

Overview: This project consisted of installing and bringing online a Rotating Shadowband Radiometer Two (RSR2) solar energy monitor at an alternative energy facility located in the western U.S. The purpose for this project was to integrate the RSR2 with the facility’s computer network so that solar and meteorological data can be analyzed, both for benchmarking activities and for educational use. Educational activities will occur at the energy facility’s renewable energy center (REC), which provides interactive learning opportunities for the public, and at a nearby university. Some of the engineering challenges for this project were related to physical installation of the system, such as securing the installation for use in extreme weather conditions and wiring the instrumentation into the data collector for transmission. Commissioning the system was also a challenge due to the complexity and number of instruments integrated into the RSR2, which required frequent packaging of the data and wireless data transfers.

Major Points

• Overview of the system’s configuration.
• Challenges related to physical installation and commissioning of the system.
• Analytical capabilities that were a benefit to the client.
• Educational benefits for the public (via the REC) & for Engineering Technology students at the university.

Summary: The presenters will discuss a project in which a rotating shadowband radiometer system was installed at a solar energy facility and brought online. The system was configured to compile the data so that it could be used by the client for benchmarking purposes and to transmit the data wirelessly so that interactive educational displays could be installed at the visitor’s center and at a local university. The presentation will focus on engineering challenges and on the benefits that have been realized from the project.
Electricity, Electronics, & Computer Technology – Automation & Control Systems

Programming the NAO Robotic Humanoid with Object-Oriented Programming Methodology

Presenters:

Mr. Gilbert G. Ramos, Millersville University, Millersville, PA 17551, blazermadd@aol.com

Dr. John R. Wright, Jr., Millersville University, Millersville, PA 17551, John.wright@millersville.edu

Need: “Robotics is one of the latest technological innovations, and a humanoid robot is an ideal learning tool for classes at all levels. Robots allow students to connect theory with practice and discover a wide range of robotics-related fields, such as computer science, engineering, and mathematics. Students gain hands-on experience using NAO, and, when used in the lab, they discover exciting topics such as locomotion, grasping, audio and video signal processing, voice recognition, and much more” (NAO for Education, 2013). The future for robotics in the United States is clear. We must automate our manufacturing processes to remain competitive in the global marketplace. Robotics are an important part of that automation. Humanoids have a host of capabilities that may reveal potential new uses in industry. The NAO robot has technology that makes it easier to program, giving the user amazing capability of which industrial robot users could only dream of.

Overview: The purpose of the presentation is to provide an introduction on how to set-up and program the NAO humanoid. The NAO robot’s capability will be demonstrated as the presenters guide the attendees on how to use the device.

Major Points:
- Introduction to the NAO Robotic Humanoid Platform
- Instruction on how to build and upload/download programs using object-oriented programming techniques
- Demonstration of NAO’s capabilities including facial recognition, object recognition, locomotion, grasping, communication, etc.

Summary: Developing code for humanoid robots involves the use of object-oriented programming techniques that allow us to develop complex control in a fraction of the time that we once did with pure syntax-based languages. Today’s students in applied engineering and technology programs need to be exposed to sophisticated control techniques that will prepare them for the workforce of tomorrow.

Works Cited:
Electricity, Electronics, & Computer Technology - Energy Issues

Converting Biomass Waste to Jet Fuel: Environmental and Economic Impacts

Presenters:

Ms. Banibandana Ray, Illinois State University, Normal, IL 61761, 309-750-1528, bray@ilstu.edu

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Co-Authors: Dr. Jamie Wieland, Illinois State University, Normal, IL 61761, jwiela2@ilstu.edu

Need: In this case study we examine a proposed biofuel production system which uses Fischer-Tropsch thermochemical gasification to convert municipal solid waste to jet-fuel (JP-8). This system has the benefit of not competing with food supplies; however, comprehensive life cycle and techno-economic analyses are required to systematically assess both the environmental and economic costs/benefits of the system.

Overview: Previous work indicates that reductions in CO₂ emissions from biofuels are sensitive to the specific type of biomass input. Here, the proposed input is municipal solid waste. To assess the impact of variation in the waste stream composition, sensitivity analysis is conducted using Monte Carlo simulation. These results are then used in the life cycle and techno-economic analyses.

Major Points:

• Potential costs and benefits associated with biofuel production are discussed in general terms.
• Specific benefits and concerns regarding the proposed biofuel production system are then discussed.
• A life cycle analysis model is presented and examined. Sensitivity analysis of the model is conducted using Monte Carlo simulation.
• Overall conclusions are provided.

Summary: This case study will provide a high-level understanding of a bio-fuel production system in which municipal solid waste is converted to jet-fuel (JP-8). Environmental and economic impacts are investigated by means of life cycle and techno-economic analyses.
Opportunities in Using Mobile Biomass Pellet-Making Equipment for Energy Production

Need: As emphasis on renewable energy grows, private and public sectors across the nation are developing ways to produce alternative fuels. The use of mobile equipment to produce biomass fuel pellets can provide energy in a compact size that is easily manageable and can combat some of the transportation barriers that biomass presents. Since biomass feedstocks are easily accessible in local regions, the need for understanding the methods of using equipment becomes equally imperative. Some accessible feedstocks to use would be wood, corn stover, and different types of grass. By using a mixture of these resources, pellets produced with different percentages of biomass are created.

Overview: This study examines the development of techniques to operate biomass pellet-making equipment. Many different types of feedstocks are available for this production, such as wood, corn stover, and grasses. The equipment includes a chipper, hammer mill, and pelletizer to reduce and process the materials. After the process is standardized, inclusion of other materials can be examined as inclusion to standard hardwood fuel pellets. This presentation will describe some of the barriers and opportunities to using some regionally available resources in the Midwest.

Major Points:
- Application of mobile biomass pellet production equipment
- Creation of best practices, including safety protocol, of equipment
- Use of local feedstocks in renewable energy production

Summary: The audience will see the experience of adapting mobile biomass pellet production equipment for use through the creation of a technique so that locally available material can more effectively be included in biomass pellets that meet hardwood fuel pellet production.
Centralized Image-Based Smart Controller Unit for Multi Agent Detection

Presenter:

Dr. Ravindra Thamma, Central Connecticut State University, CT 06053, 860-830-351, thammarav@ccsu.edu

Need: The traditional track-based unmanned ground vehicle (UGV) cannot deviate from the pre-recognized route due to track limitation in its navigation methods. Track limitation has to be overcome in order to render a UGV more flexible. It is desirable to have a UGV move without predetermined tracks and have the ability to deviate to and from routine routes, in order to have flexibility in tasks.

Overview: This research proposes a navigation system to aid multiple UGVs in navigating to various locations without any physical tracks and without collision with each other. This research demonstrates the image-recognition-based trackless navigation system to enhance the flexibility of multiple UGVs. This research implements an image recognition algorithm to identify the position and orientation of multiple UGVs using a Centralized Image-based Controller Unit (CIBCU). This CIBCU is connected to a vision system and radio frequency (RF) communicator. The CIBCU implements the image recognition algorithm, anti-collision, navigation algorithm, and centralized control center to track and navigate multiple UGVs without physical tracks. A prototype has been developed to demonstrate and test the Vision-based Navigation System. Statistical analyses have been carried out on this newly developed system to find behavior of positioning error.

Major Points:
- Need for a Centralized Image-based Controller Unit
- CIBCU Architecture
- Multi agent detection algorithm
- Conclusions and recommendations

Summary: The Centralized Image-based Controller Unit CIBCU implements the image recognition algorithm, anti-collision, navigation algorithm, and centralized control center to track and navigate multiple UGVs without physical tracks. A prototype has been developed to demonstrate and test the Vision-based Navigation System. Statistical analyses have been carried out on this newly developed system to find behavior of positioning error.
Implementing the Apple iPad with Circuit Simulation into DC/AC and Applied Electronics Courses

Presenter:

Dr. Ron Tuttle, University of Nebraska at Kearney, Kearney, NE 68849, 308-865-8504, tuttler@unk.edu

Need: STEM Education has adapted quickly to tablet technology. The utilization of National Instruments MultiSim electricity/electronics simulation software for computers provided opportunities for students to understand simple and complex circuits in a simulated laboratory environment. A similar experience can now be provided for students with an iPad and inexpensive or free software. Instructional iCircuit examples will be shared and time provided for attendees to share their experiences.

Overview: Fundamental electricity/electronics courses must introduce electrical theory which is many times difficult for students to understand. When students have opportunities to apply this theory to real time operational circuits their understanding is enhanced. This will be a practitioner’s presentation describing how iPads utilizing iCircuits software have been implemented into basic DC/AC Electricity and Applied Electronics courses. Instructional materials, iCircuit examples and applications will be presented.

Major Points:

- Strategies for Implementing the Apple iPad
- iCircuits Simulation Software Demonstration
- iCircuit Schematics utilized in DC/AC and Applied Electronics Courses
- Instructional Strategies for Circuit and Math Applications
- Time for Attendees to Share Experiences

Summary: Attendees will be provided iCircuit schematic examples, instructional materials and encouraged to share experiences. Apple iPad applications and student interest can easily be applicable to all technical and non-technical fields.
Electricity, Electronics, & Computer Technology – Energy Issues

Low-Cost and Portable Mini-Lab Development for Green Energy Education Activities

Presenters:

Dr. Faruk Yildiz, Sam Houston State University, Huntsville, TX 77341, 936-294-3774, fxy001@shsu.edu

Dr. Steven Kane, Sam Houston State University, Huntsville, TX 77341, 936-294-2350, szk001@shsu.edu

Dr. Nedom Muns, Sam Houston State University, Huntsville, TX 77341, 936-294-1190, ith_ncm@shsu.edu

Need: Engineering Technology (ET) degrees are more applied than the more theoretical science based engineering degrees. The technical courses in ET programs as well as those in math and other sciences are taught with more applications and less theory than the related engineering courses. ET courses generally have labs associated with the courses that require applied or hands-on applications of the topics being studied. Lab sections of the most ET course curricula are important because they introduce concepts of the subjects applied to daily life and industrial activities. Due to budget limitations, it becomes an issue to keep labs up to date and to upgrade the existing equipment to offer students new technology challenges. In some cases, programs invest money and time to buy components to build lab equipment by paying less for this equipment, when they can find lower prices.

Overview: Faculty and senior students in Industrial Technology program at Sam Houston State University have been designing, building, and testing training equipment to conduct lab sections of the two existing renewable energy courses and workshops at independent school districts (ISDs). Students are very interested in being involved in the building of training equipment with limited resources. Since 2010, over forty students (mostly undergraduate) were involved in a variety of projects either as volunteers or by enrolling in independent study courses. Some of the projects are listed under major points.

Major Points:

• Building a solar thermal water heating system
• Building a solar thermal air heating system
• Photovoltaic training systems
• Wind energy training systems
• Battery testing system
• Hybrid vehicle training system
• Hydrogen fuel cell system
• Weather station for measurements
• Hybrid wind/solar power house, and other research.

Summary: In this study, student feedbacks, background of the students, details of the each project (funding resources, time, number of students, cost, materials/material specs and vendors, and associated lab workbooks), quantitative data regarding student feedback (like GPA, subsequent career path followed or not followed by the students), high impact (from students' perspective) that projects related to alternative energy projects and their ranks related to other projects will be detailed.
Need: Throughout the years there has been much research in the area of fuel additives that promise to increase the efficiency of the traditional gasoline powered 4 cycle engines. Recently there has been a growing interest in “Hydrogen Boosting”. On-vehicle Hydrogen boosting is performed by generating hydrogen from electrolysis of water, which is powered by the vehicles electrical system. This research calls for the testing of hydrogen boosting; meaning a small amount of hydrogen will be introduced into the gasoline combustion process which is potentially beneficial for improving fuel economy.

Overview: Hydrogen has a higher flame-front speed, it also has the ability to ignite at almost any air to fuel ratio, it has a lower energy of ignition, and a higher resistance to “knock”. It is said that hydrogen boosting aids in the combustion of gasoline to create a more thorough combustion yielding a higher thermal efficiency. This research deals with the designing and fabrication of a hydrogen generator which produces hydrogen by electrolysis. In order to test the effects of the hydrogen booster on the performance of the vehicle, a series of tests have been conducted with the help of a chassis dynamometer. Analytical and Calculated results are compared to get the appropriate conclusion about the benefits. Though theoretically it is proven that hydrogen increases the fuel efficiency and overall efficiency of the vehicle, experimentally this is not accepted. Possible causes for the errors have been identified and future recommendations have been made.

Major Points:
• Background and introduction of the hydrogen booster project
• Research questions and goals
• Testing vehicle specifications
• Research methodology for the three phases of the project
• Design and fabrication of the hydrogen booster kit and the control unit
• Vehicle testing equipment and setup
• Vehicle testing results and data processing
• Conclusion

Summary: Attendees will understand the principle of boosting a passenger car by on-vehicle hydrogen booster kit. They will see the development process of design, fabrication, and testing of hydrogen booster kit and the control unit as a student project.
GRAPHICS
An Investigative Study of Rapid Prototyping and Traditional Model Building in the Architectural Design Studio

Presenters:

Miss Morgan Armistead, Western Kentucky University, 1906 College Heights Blvd 51066, Bowling Green, KY 42101-1066, 270-745-3251, morgan.armistead758@topper.wku.edu

Ms. Shahnaz Aly, LEED AP, Assistant Professor, Western Kentucky University, 1906 College Heights Blvd 51066, Bowling Green, KY 42101-1066, 270-745-5849, shahnaz.aly@wku.edu

Need: Building (physical) architectural models is an integral part of the design studio. Physical models are used to help understand form, spatial organization, scale and proportion. A study was initiated in the Architectural Science Program to compare the approaches for creating architectural models using traditional methods and 3D printing technology with regards to (1) process flow, (2) time, (3) material and (4) precision. This presentation will highlight the models created, the salient features of the two processes and will enable an informed decision regarding modeling approaches (traditional vs. rapid prototyping) for a select design situation.

Overview: The architectural model building process begins with conceptual design; in the traditional physical model building approach once a design has been finalized and drawings prepared (either by hand or computer generated) the scale of the model is decided, materials selected, and the construction process begins. Physical model building by rapid prototyping uses data from a CAD (computer aided design) model. Depending on the type of 3D printing process being used the parts can be built by adding and bonding materials in layers to build the model.

An in depth investigation and study has been ongoing in the Architectural Science Program keeping in mind parameters specifically relevant to the discipline.

Major Points:

• Building architectural models using traditional methods.
• Current trend of model building in the architectural design studio.
• Rapid prototyping and the various 3D printing processes.
• Analysis and comparison of the process flow, time taken to build the models, and precision acquired using each proposed method.
• Outcomes and recommendations.

Summary: Attendees will be presented examples of models created using traditional model building techniques and models created using rapid prototyping. A comparative analysis will also be put forward with regards to (1) process flow, (2) time, (3) material and (4) precision. This can help students, architects and other professionals in the discipline make informed decisions about rapid prototyping becoming a viable option in the design studio for model building.
Graphics

Assessing the Effectiveness of E-Learning for Design and Drafting Technology Courses

Presenters:

Ms. Roya Azimzadeh, University of Central Missouri, Warrensburg, Mo. 64093, 660-543-4062, azimzadeh@ucmo.edu

Dr. Kyle Palmer, University of Central Missouri, Warrensburg, Missouri 64093, 660-543-4303, palmer@ucmo.edu

Need: With technological advancements and the convenience of online learning, many academic institutions around the world have been embracing electronic learning (e-learning) while benefiting from its pedagogical aspects, accessibility, effectiveness, and sustainability. In order to train knowledgeable, skilled, and competitive future workforce, Design and Drafting Technology faculty of the University of Central Missouri seeks innovative methods to maximize students learning and provide world-class education while involving students in hands-on activities harmonious to their learning styles. In our presentation, we will display a resourceful instructional method that involves traditional and e-learning techniques utilized for educating the freshman students enrolled in Design and Drafting Technology courses.

Overview: While some instructors and learners might prefer the traditional face-to-face or online only teaching and learning methods in higher education, studies have shown that students participating in hybrid courses perform the best. The hybrid approach, a combination of face-to-face and online education, has become a popular method, which is especially suitable for technology-related courses that include technical content as well as technical performance. This study compares the traditional face-to-face and hybrid instructional methods while measuring learning and performance of the students enrolled in introductory Design and Drafting Technology courses to explore the strengths and weaknesses of both delivery formats. The results of this study will be valuable not only for enhancing students’ learning and achievement, but also for future academic and institutional innovations.

Major Points:

- Need for advancement of computer-aided design and drafting educational activities
- E-Learning pedagogical aspects
- E-Learning benefits and pitfalls and how to overcome e-learning difficulties
- E-Learning best practices
- Recommendations and conclusions

Summary: Attendees will learn innovative and effective ways of Design and Drafting Technology instructional approaches. The best practices addressed in this presentation can be incorporated into any drafting course to achieve positive outcomes.
Graphics

Methodologies for Teacher to Use Video and Multimedia Technologies to Flip Their Graphic Communications Classrooms

Presenters:

Dr. Carl N. Blue, University of Southern Maine, Gorham, ME 04038, 207-780-5391, cblue@usm.maine.edu

Dr. Charles Weiss, Assistant Professor of Graphic Communications, Clemson University, Clemson, SC 29634-1353 (864) 656-3447, cweiss@clemson.edu

Need: The traditional one-size-fits-all of education often results in limited concept engagement and severe consequences. Student retention continues to be an ongoing issue for many programs of study and institutions. With the prevalence of communication technologies for producing and posting online video and multimedia, as well as the increased capacity of students’ access, these innovations have paved the way for flipped classroom models.

Overview: Flipped classroom is a reversed teaching model that delivers instruction at home through interactive, teacher-created videos and multimedia, moving the “homework” and in-class projects to the laboratory. Moving lectures and discourse to the outside of the classroom allows teachers additional one-on-one time with each student. Students have the opportunity to ask questions and work through problems with the guidance of their teachers and the support of their peers - creating a collaborative learning environment. Our presentation reviews and provides a meta analysis of documented teaching innovations for developing a flipped classroom model adapted for the Graphic Communications laboratory.

Major Points of this Presentation

• Explore the flipped classroom method to find out how it works and how it can help students at your school.
• Flipped classroom basics
• Available resources for developing a flipped classroom
• Examples of flipped classroom successes

Summary: This presentation will provide both a meta-analysis of flipped classroom models as well as provided strategies for implementation of educational technologies aligned with course examples. The goals are to allow teachers more time to spend one-on-one helping students, and to build stronger student/teacher relationships offering a method for teachers to share information with other faculty. Ultimately the information provided in this presentation will produce strategies that increase the ability for students to “rewind” lessons and master topics while also creating a collaborative learning environment in the classroom.
Graphics

Case Studies of Transformation of Printing Companies in the Digital Age

Presenters:

Dr. John R. Craft, Graphic Arts and Imaging Technology, Department of Technology and Environmental Design, Appalachian State University, Boone, NC 28608, 828.262.6362, craftjr@appstate.edu

Dr. Thomas H. Spotts, Department of Technology, Ball State University, Muncie IN, 47306, 765-285-5913, tspotts@bsu.edu

Need: Cross media technologies are causing print media companies to transform or adapt their business to the demands of clients seeking a variety of new services such as content creation for social media, smartphones, and tablet computers. It is no longer just the business of print. New services for communications media are emerging among traditional print companies transformed by innovations such as cross media. As noted by Jackie Bland, the printing industry is evolving into transformative workflow, offering customers new services in the digital age. Those who teach in higher education need to become aware of the changing dynamics of the graphic communications industry. Transformation in printing is becoming direction (and possibly, a new segment of the graphic communications industry) for companies to adapt to the new age of digital printing.

Overview: Recently, Jackie Bland reported findings from research on the transformation of the printing industry in the United States in the trends issue of the Printing Industries of the America’s trade publication, The Magazine. Cross media is causing companies to rethink their business structure and go beyond by expanding their services. This transformation in printing appears to be one path for companies to remain successful during our current economic times.

Major Points:

• Transformed printing firms or companies defined.
• Share findings of industry case study research on transformation printing workflow.
• Reveal potential models of industry practices representative of the digital age.
• Action plan for implementation into graphic communications courses of study.

Summary: For educators, case study research is a practical method for gathering in-depth data to analyze companies applying the concept of transformational printing. This study examines two companies in the United States to determine if their production organization is characteristic of transformation printing companies. Observations and interviews of key personnel will be made in order to collect data that could be used as a resource for educators.
Graphics

A Novel Extraction Design for Catheter Needles Used on Practice Manikins

Presenters:

Mr. Travis Fisher, Department Applied Engineering and Technology, Morehead State University, Morehead, KY 40351, 937-478-9964, ttfisher@moreheadstate.edu

Dr. Rajeev Nair, Assistant Professor, Department of Mechanical Engineering, Wichita State University, Wichita, KS 67260-0133, 316-978-6316, rajeev.nair@wichita.edu

Need: Currently the nursing students at Morehead State University insert IV catheters into practice manikin’s arms towards their research work for various classes in nursing and preparatory medicine. The syringes they use to insert the catheter are the same ones used in the actual medical field. This means that the syringes are retractable and can be used only once and then meant to be disposed of as per safety regulations. We have designed a novel device that can safely extract the retracted catheter needles for multiple uses with the added benefit of safety. This will eventually help them and the academic nursing/medical industry worldwide save thousands of dollars that are now being spent on new catheter needles.

Overview: Medical students all around the world use practice manikins to study the different techniques used for inserting IV catheters for various intravenous purposes. The problem that we have investigated has nothing to do with the functionality of the IV inserter but of its reuse which is not recommended by the medical academic industry due to safety concerns. The problem is that once the needle is retracted into the safety barrel it must be disposed of. This means that a needle can only be used once per student. For real life use this disposal of the catheter needle after a solitary use is absolutely mandatory due to health and safety precautions. But since the departments only use them on practice manikins, sterility is of no major concern. After investigating and brainstorming multiple designs and their functionalities, using the concept screening and scoring matrices, we have narrowed down on a sleek and elegant ‘Recatheter’ design, that in addition to being a stationary portable device for extracting retracted IV catheter needles for multiple uses, is a very safe and cost effective method for the medical industry throughout the world. Solidworks will be used to design this idea and test for interference and functionality tests, and a fused deposition modeling (FDM) rapid prototyping machine will be used to manufacture a working prototype of this new ‘Recatheter.’ The success of the device will be measured from its usage history on single IV inserter needles and the data will then be studied and compared for a reflection on this new design.

Major Points:

- Need for a safe and user-friendly device to reset retracted catheter needles within the nursing school department at Morehead State University
- A novel design through intense design paradigms and strategies that can potentially save the biomedical industry thousands of dollars.
- A working prototype will be tested for multiple uses and data generated studied for research enhancement and product improvement.

Summary: A device that extracts retracted IV Inserter needles for multiple uses on simulation manikins will be designed and tested in Solidworks. This design will increase the safety of manually resetting these retracting needles while decreasing the amount of wasted equipment resulting from the disposal of these IV Inserters after only a single use. Prototypes will be built to test for its functionality and usage portfolio.
Graphics

Revising Freshman-Level CADD Degree Plan to Improve Retention

Presenter:

Mr. Derek E. Goodson, University of Arkansas-Fort Smith, Fort Smith, AR 72913, 479/788-7337, Derek.Goodson@uafs.edu

Co-Author: Mr. Max Johnston, University of Arkansas-Fort Smith, Max.Johnston@uafs.edu

Need: A drop in student enrollment in the CADD program as well as a reduction in the amount of returning students between the first and second years of the two-year program indicated that a significant change to the degree plan was needed. Changes made to the program were suggested by a combination of faculty, students, and advisory board members with the intent to revitalize the program and alleviate some of the issues that were at least partially preventing students from selecting and/or staying in the program.

Overview: In response to a drop in both initial enrollment as well as retention between years of the program, the CADD Department at the University of Arkansas-Fort Smith revisited the sequence and content of the initial courses offered in the first year of the program. Previously, the first semester consisted of a 16-week course based entirely on hand drafting and an introductory AutoCAD course. The second semester included a course teaching basic engineering graphics using the computer as well as further study of AutoCAD. However, very little 3D content – basically the last 4 weeks of the 2nd AutoCAD course - was included in the students’ first year. A summer course called “3D Visualization” was revised to include an introduction to the major 3D software packages that are taught in the program and moved to the first semester of the program. The hand drafting course was revised to become a mix of hand drafting techniques and an introduction to the AutoCAD software. This major change resulted in a more efficient delivery of the first semester of AutoCAD and allowed more AutoCAD 3D content to be included in the second semester course. Although still in the early stages, this change has appeared to increase interest in the CADD program as well as the retention rate between semesters.

Major Points:

- Revision of degree plan to increase student interest and retention
- Reimaging of 1st year summer course to appeal to first time students
- Revision of hand drafting course to include CAD techniques
- Can assist students in selecting a field of CAD study (Animation, Architectural, Mechanical, General) by exposing them to advanced software packages early in their degree plan

Summary: Attendees will understand the need for revisions of not only course content but also course placement in the degree plan to help increase student interest and retention. Similar changes could be implemented at any program currently struggling with attracting and keeping CADD students in their programs.
Graphics

The Next Step in the Evolution of CAD: An Overview of Generative Design Technologies

Presenter:

Dr. Stan Guidera, Professor, Department of Architecture and Environmental Design, Bowling Green State University, Bowling Green, Ohio, 419-372-2724, guidera@bgsu.edu

Need: Digital design technologies have become the primary design and representation tools in the STEM disciplines. As these technologies evolve, it is critical that academics and educators in these fields remain aware of current technological trends in order to support their teaching and research efforts and structure coursework in order to assist students in developing skills sets aligned with the future as well as current demands of their intended professions. This presentation will provide attendees with an overview of the developing field of Generative Design and its implications for coursework and curriculum.

Overview: Advances in 3D parametric modeling applications have expanded the functionality of digital design tools in professional and academic environments. Parametric design software evolved rapidly in the last decade of the 20th century and various forms of this technology have become the industry standard in most disciplines. However, the traditional role of parametric design is being re-conceptualized by emerging trends using Generative Design processes. Generative design techniques have emerged from the search for strategies to facilitate the exploration of alternative solutions in design, and in some cases yield unexpected but viable solutions. The underlying strategy lies in the use of computer algorithms, recursive computational procedures for solving a problem. Unlike conventional 3D CAD geometries, algorithmic code can create very complex geometries with small amounts of data.

The presentation will focus on two generative design applications: Generative Components, which uses Microstation as its underlying technology, and Grasshopper, which is used with Rhino 3D, a non-parametric NURBS and surface modeler. Rhino was developed as a non-industry specific 3D modeler intended to serve a wide range of designers. Common to both Grasshopper and Generative Components is a graphical interface that enables users to utilize algorithmic design strategies without requiring experience writing computer code or requiring skills with the use of a scripting language.

Major Points:

• The evolution of generative design and how it differs from conventional parametric design tools;
• Examples of the application of Generative Design Technology (GDT) in professional environments as well as academic environments;
• Characteristics of graphical interfaces for enhancing the ease of use in GDT applications;
• Case studies of instructional applications of GDT by the presenter involving the integration of generative design content with existing academic coursework.

Summary: Attendees will develop an understanding of the key concepts underlying generative design process, and how they are implemented in Grasshopper and Generative Components. The will be presented examples the application of generative design in both professional and academic environments. They will develop an understanding of the pedagogical rationale for the use of generative computing in coursework in order to assess its potential role in their own disciplines and curriculums.
Graphics

Implementation of New Web Standards in Web Design Projects

Presenter:

Dr. Feng Jao, Ohio Northern University, Ada, OH 45810, 419-772-2172, f-jao@onu.edu

Need: With the rapid change of technology, educators are constantly challenged with the advancement of technological systems, and sometimes frustrated in updating their course curriculum to cope with new developed standards. Many web standards have been developed since the late 80s such as HTML and Cascading Style Sheet (CSS). These standards have been evolving and are still moving toward newer standards. As an educator, it is important to investigate the current as well as the future of technology standards to ensure that the course content to be delivered will provide learners the needed knowledge and skills to be productive in their work place. This presentation will address two foundational languages for web design, and the implementation of new web standards in design projects.

Overview: This presentation will demonstrate to teachers the fundamental knowledge on how to develop and design multimedia web pages using HTML (XHTML), and Cascading Style Sheet (CSS). Design theory for non-designer will also be introduced. Several web design projects will be presented in two versions -one with the design using HTML 4.1/CSS 2 standards, and the other with the utilization of updated HTML5 and CSS3 standards. In addition, the presentation will also address the comparison of the web standards, and their future directions.

Major Points:

- Demonstrate the concepts of HTML (XHTML) elements and attributes
- Understand the concepts of Cascading Styling Sheet (CSS)
- Overview of the non-designer’s design theory
- Overview of the history of web standards, HTML and CSS
- Demonstrate web design projects and their revision processes
- Overview of the future standards

Summary: This presentation will provide an overview of web publishing, web standards, design theory and curriculum revisions of design projects.
Graphics

Developing the Future Workforce in the Graphics Discipline by Creating Gaming Courses

Presenter:

Dr. Devang P. Mehta, North Carolina A&T State University, Graphic Communication Systems and Technological Studies, Greensboro, NC 27411, (336) 285-3109 x53109, mehtad@ncat.edu

Need: The graphics discipline is heavily dependent on the computer technology. The technology changes rapidly not just in the area of graphics but also in the fields where graphics are used. It is important to keep abreast with the changing technology, acquire new skills, meet the industry needs, create designs according to the industry standards, listen to advisory board members, make quick changes in the curriculum, and teach students the latest graphics technology to make them prepare for the job market. With the advent of computers, internet, smart devices, 3D animations, and 3D visual effects; the gaming industry has grown drastically in just last few years. There are more games and gaming companies than ever before. As a result, there is a need to develop future workforce to meet the demand.

Overview: This presentation discusses the implementation of gaming courses to develop the future workforce in the graphics field. The essential competencies, such as, creativity, technical, and leadership, are taught in two gaming courses to place students in the growing industry. The intro gaming course covers basic understanding of game story, game characters, and game types. Students develop games using game design software. In the advanced gaming course, students create games by using design software and a programming language. Students acquire leadership skills, like, communication, team-work, open-mindedness, and positive attitude in both the courses.

Major Points:

- Background
  - History of Gaming
  - Market for Games
  - Impact of Games on the Society
- Technical Skills Needed for the Gaming Jobs
- Leadership Skills Needed for the Gaming Jobs
- Development of Gaming Courses
- Summary

Summary: Attendees will understand the importance of developing courses that not only meet the industry demand, but also increase the student enrollment. The presenter will explore the skills and knowledge that are needed for a graphic designer to create games.
Graphics

iPhonography: Using Smartphones to Teach General Photography Courses

Presenter:

Dr. Thomas M. Mitchell, Asst. Professor of Photography, University of Central Missouri, 105F Grinstead, Warrensburg, MO 64040, 660.543.8914, mitchell@ucmo.edu

Need: Institutions desiring to offer popular general education photography courses are challenged by resource needs of computer labs, software, and other workflow demands. Students and parents, bearing an ever increasing burden of college costs, are challenged to purchase advanced cameras when photography is not the chosen disciple or profession.

Overview: The mobile smartphone has become the ubiquitous carry everywhere electronic device. As these devices have become more sophisticated and powerful their advanced features have included ever-evolving digital camera and video functions combined with an array of camera and imaging apps on both Apple and android platforms. These carry everywhere cameras have spawned a revolution in imaging.

Major Points:

- Smartphones are ubiquitous around the globe, every student has one 24/7
- Mobile access and networking is the future of IT and communication
- Smartphone cameras and imaging applications are developing rapidly
- Renown professional photographers advance the use of smartphones to develop creativity
- Students are looking for interesting and technologically inspiring courses
- Higher Education institutions are looking for profitable Gen Ed and elective courses
- Institutions are finding it difficult to offer legacy photographic and imaging courses
- Digital DSLR photography instruction requires considerable costs to students
- Digital photography instruction requires considerable start up costs to academic programs
- Digital photography instruction requires consistent and expensive software and hardware updates
- Academic budgets are consistently challenged often focused on core disciples, not electives

Conclusion: In this environment an opportunity exists for education institutions to consider iPhonography courses which can teach the basics of photography, photographic visions, composition, and creativity in any classroom or on-line where students smartphones can capture images, manipulate or enhance files and deliver those to anywhere anytime through web utilizing social media. The result can be captivated students learning relevant visual skills utilizing cameras and editing devices they already own and carry with them all the time. Finally, smartphones and imaging abilities are import ways to share information when students leave college and enter the workforce.
Graphics

**Sustainable Packaging and Design**

Presenter:

Dr. Antonio Scontrino, University of Northern Iowa, Cedar Falls, IA, 50614, 319-273-2753, antonio.scontrino@uni.edu

Need: With constant pressure from stakeholders, the packaging industry is increasingly considering how its products can be made more sustainable. Packaging represents a key area of focus for reducing our environmental impact. More discourse on sustainable packaging is imperative. Companies need to develop guidelines on sustainable packaging that embed specific design principles that consider using sustainable materials and energy sources.

Overview: Packaging is a criterion for all products to be transported or sold. Traditionally, the request for packaging was only that it protects, informs, and sells. In a society of growing consciousness about the environmental impact, it is argued that the degradation of our natural system because the excessive consumption and misuse of natural resources, is leading us to the breakdown of the economic, social and political framework of civilization. As a result of sustainability awareness, clients are increasingly looking to their designers to help them meet new demands, which is includes changing the system of design and not just select recycled material. As there continues to be growth in the printing industry, there need to be meaningful discourse on sustainability packaging design.

Major Points:
- Definition of Sustainable Packaging
- Consumers’ point of view
- The fundamental area for packaging innovation
- Accepted terms, Eco seals, certifications in current use for packaging
- Packaging Design rules for sustainability
- Packaging Design strategies for sustainability

Summary: With the growing demand for sustainable packaging, companies will need to learn how to deal with the change. From a design standpoint, the visual communication industry must identify opportunities for further improvements. Companies that fail to actively address the issue as part of their commercial strategy will lose opportunity to compete with their forward-thinking counterparts.
Graphics

**Geographic Information Systems Analysis on the Effect of Coal Mining in Individual Communities**

Presenters:

Mr. Brian Sharp, Department of Applied Engineering & Technology, Morehead State University, Morehead KY 40351, bsharp@moreheadstate.edu

Dr. Yuqi You, Department of Applied Engineering & Technology, Morehead State University, Morehead KY 40351. 606-783-2410 yu.you@moreheadstate.edu

Need: Data on the effects of single mining operations on single communities is extremely limited. Little information is available on how mining operations have affected individual communities in the past, and how introducing a new mining operation would affect the said community. Historically environmental and financial assessments of communities can take a good deal of time and carry significant cost with them. A clear and concise assessment of the impact that coal mining can have on a community needs to be addressed, in order to provide taxpayers, government officials, and citizens with quality data that can be used to make informed decisions on the type of impacts a mining operation can have on an individual community. The intent of this project is to design a series of programming sequences using ArcGIS mapping software that will break down larger, national and regional datasets, and apply them to the community in question. The processing model will generate reports on the community's current environmental and economical situation, as well as reports on the potential impacts to the community from the mining operation.

Overview: ArcGIS is a software system developed by Environmental Systems Research Institute (ESRI). This software can be used visualize, question, analyze, interpret, and understand data to reveal relationships. Geographic information systems (GIS) integrate hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information (Environmental Systems Research Institute, 2013). There are many benefits to implementing GIS into an analysis. GIS allows organizations to improve efficiency, do more work with fewer resources, reduce costs, provide better service, and improve decision making (Federal Geographic Data Committee, 2012). This benefit can be used in conjunction with existing geographic data sets to analyze the effects of an action, such as coal mining, on a community. Using ArcGIS in conjunction with available GIS datasets, geographic models will be developed that will analyze the effects of a coal mining operation on a single community within a given area. Kentucky is the third largest producer of coal in the United States with 10% of the national production (Kentucky Energy and Environment Cabinet, 2012), making it a prime candidate for this environmental and economical study.

Major Points:
- The need of the research project
- Introduce the procedure and system architecture
- Analyze the results
- Discuss of further research and study

Summary: This research project will identify the most important factors affecting communities that are related to coal mining operations. Datasets and statistic information will be collected from trusted sources. Then application will be programmed by using ArcGIS software to compile and analyze datasets to generate results and figures. The accuracy and validity of data analysis will be tested and the application will be finalized.
Graphics

Consulting Industry Professionals to Determine the Future Needs of the Graphic Communications Workforce

Presenter:

Ms. Sara B. Smith, University of Northern Iowa, Cedar Falls, IA 50614, 319-273-2746, sara.smith@uni.edu

Need: Educators must continually look towards industry for relevant information on how to best prepare the workforce of the future. This is especially true in fields which are heavily influenced by developing technology, such as graphic communications. As industry changes their strategies, policies, and structures, so, too, do their needs for skills and knowledge in employees change. In order for educators to prepare the best curriculum for students, they need to know how trends such as increased automation in the workflow, increasing services such as variable data marketing, and epublishing, will change the learning outcomes that need to be pursued.

Overview: This presentation will include the results of a study completed for a doctoral dissertation in the spring of 2013. In this study, over 300 industry professionals were invited to participate in a survey with the overall research question: “What impact will technical and business process trends in the graphic communications industry have on the required competencies of its future personnel?”

Major Points:

- Employees need to be prepared to take the place of those who are retiring and leaving the field. Employees who are staying in the field need to be retrained due to changing jobs.
- Educators need to be guided by industry in order to know which topics to focus on and develop for the most relevant curriculum.
- There are many different types of skills – technical, organizational, teamwork, leadership. Employers need to not only identify, but also prioritize the importance of various skills for their future hires.

Summary: Participants in this presentation will be informed regarding industry professionals' opinions of which trends in the graphic communications field will have the most impact on their organizations. Also, participants will learn the results of study that identifies and prioritizes the skills and knowledge they believe will be most important for their future workforce to possess.
Graphics

More Than Just a Graphics Program: How a University’s Graphic Communications Program is Enhancing Student Preparation for Internships and Employment by Becoming the On-Campus Print Facility

Presenter:

Dr. Michelle L. Surerus, Ohio University, Athens, OH, 45701-2979, 828-262-7539, surerus@ohio.edu

Need: Students need more than just technical skills learned in major courses and general education classes. They need real experiences gained only from “live” jobs and working with paying clients.

Overview: Appalachian State University’s Graphic Arts and Imaging Technology (GAIT) program became responsible for on-campus printing when “Printing and Publication” was closed during the summer of 2012. This session will discuss how the integration of the GAIT program and Mountaineer Printing serves to enhance the technical and operational skills of students contributing to a more marketable student upon graduation.

Major Points:

- Changes in curriculum
- Changes in student expectations
- Changes in student roles
- Effects upon classroom instruction
- Benefits of integration

Summary: Attendees will understand how being involved with an on-campus printing operation can contribute to better preparation and enhanced marketability of students upon graduation. In addition, attendees will learn what they can do to integrate some of what is discussed into their curriculum to enhance learning and increase marketability of students entering the workforce.
Graphics

Green Design: Using Solid Modeling, Surfacing, and Rapid Prototyping to Focus on Green Design

Presenter:

Dr. Todd C. Waggoner, Professor of Engineering Technologies, College of Technology, Bowling Green State University, Bowling Green, Ohio 43403, (419) 372-2633, wtodd@bgsnet.bgsu.edu

Need: Using rapid prototyping can eliminate incorrect production of prototypes and developmental models. Current solid modeling packages and the development of surface modeling supports the development of green designs aesthetically.

Overview: Solid modeling and rapid prototyping methods are particularly suited to develop green design strategies. Rapid prototyping can assure correctness of design and prevent wasting resources on inadequate or designs inappropriate to the application.

Major Points:
- Employing contemporary design strategies to create environmentally friendly designs.
- Using part-in-part modeling to reduce rapid prototyping time and material waste.
- The use of traditional bottom up assembly modeling and the more contemporary top down assembly modeling practice will be reviewed, along with part development as they efficient manufacture from the initiation of the design.
- The linkage with solid modeling to both rapid prototyping and CAM-based designing will be discussed.

Summary: Attendees will develop an understanding of the integration of green design strategies into the industrial design process. The power of the solid modeling software as it relates to green design strategies will be showcased. The current developments in surfaces as they relate to green design will be presented along with the environmentally friendly implications of that rapid prototyping can have.
Graphics

CAD/CFD-Based Experimental Designs for Analysis of HVAC Componentry in Industrial Equipment

Presenters:

Mr. Charles M. "Matt" Watson, CSTM, Link-Belt Construction Equipment Co., Lexington, KY, 2651 Palumbo Drive, Lexington, KY 40509, mwatson@linkbelt.com
Morehead State University, Department of Applied Engineering and Technology, Morehead, KY 40351, cmwatson@moreheadstate.edu

Dr. Nilesh Joshi, Morehead State University, Department of Applied Engineering and Technology, Morehead, KY 40351, njoshi@moreheadstate.edu

Need: In designing HVAC componentry for industrial equipment, it is often necessary to theorize and design many versions of a system and/or component. By combining experimental design methods with commonly used analysis tools such as CAD (computer aided design), and CFD (computational fluid dynamics), designers can develop powerful statistical models to analyze various design iterations and utilize graphics visualization. Such an integrated approach can result in a more robust and optimized system design. Not only does this help improve overall system performance but also has the potential to significantly reduce time and cost spent on designing the system.

Overview: In this presentation, we will present the combined statistical and graphical methods used to design, analyze and develop industrial equipment HVAC componentry. A well-thought-out experimental design can be set up by targeting specific design factors and studying their impact on carefully selected system response variables. With CFD simulation performed on 3D CAD model iterations representative of specific design factor combinations, unique airflow and heat transfer diagrams can be generated to analyze system performance. Such an integrated analysis approach requires minimal physical testing, thus minimizing the overall cost and time spent on the project. Ultimately, we not only develop a solution to the immediate problem, but also outline a generic methodology that can be utilized in almost all CAD/CFD-based scenarios.

Major Points:
• Recognition and Statement of the Problem
• Selection of response variables & choice of levels, factors and range
• CFD Simulations on 3D CAD models
• Statistical Analysis
• Conclusion & Recommendations

Summary: The focus of this presentation is on demonstrating the use of CAD/CFD-based experimental designs to solve real-world engineering design problems and how the integrated approach can help save countless hours of physical modeling, mock-ups and prototype manufacturing. The presentation will be of interest to engineering design researchers and professionals.
Graphics

Creating Sustainable Packaging for the Next Generation

Presenter:

Dr. Charles Weiss, Assistant Professor of Graphic Communications, Clemson University, Clemson, SC 29634-1353 (864) 656-3447, ctweiss@clemson.edu

Need: Sustainable packaging practices are the future of packaging and it is important for educators to understand this as they teach their students about package design and construction. Green technology and sustainable practices are now the norm in package production. Sustainable practices are now necessary for any successful packaging business, and this shift toward sustainable practices is only going to grow over the next generation of package production. Along with sustainable packaging comes an important social responsibility as well.

Overview: This presentation will examine four main areas of current packaging trends. The first is creating packaging that is naturally compostable and biodegradable. The second is the creation of packaging using less material. The third is creating packaging that is socially responsible, and the final trend will be major innovations helping to change the nature of package production.

Major Points:

- Producing packaging that is compostable and biodegradable
- Producing packaging with less material.
- Producing packaging that is socially responsible
- Packaging innovations helping to change the face of packaging.

Summary: Attendees will have a better understanding of the current trends in sustainable packaging and how to incorporate them into the classroom. These trends will include compostable and biodegradable packaging, reduced packaging, socially responsible packaging, and innovative packaging.
Graphics

**Data Visualization for the Classroom**

Presenter:

Dr. Charles Weiss, Assistant Professor of Graphic Communications, Clemson University, Clemson, SC 29634-1353 (864) 656-3447, cthewiss@clemson.edu

Need: Data visualization projects allow the user to create and interpret sets of data in a graphical manner. As educators it is important to understand the various ways to visualize data and to determine ways we can incorporate this into our curriculum and to help our students better understand data visually.

Overview: This presentation will explore various manners in which students can use creative ways to interpret and visualize data. Three areas will be covered in detail. The first will be creating infographics using online sources as well as imaging software. The second will be creating charts and graphs with various types of software while also showing how to place these charts in poster format. The third aspect will be examining websites like Many Eyes that provide extensive data sources and online data visualizations.

Major Points:
- Creating data visualizations using websites such as Easel.ly, Visual.ly and Piktochart.
- Creating data visualizations using Adobe Illustrator and other computer programs.
- Creating charts and graphs in programs like Microsoft Excel.
- Creating large size posters to show data visualizations.
- Examining online sources for data visualizations like Many Eyes.

Summary: Attendees will have a better understanding of the various methods of creating and interpreting data visually. Practical classroom applications will also be explored along with suggestions on how to incorporate data visualization projects into the classroom.
MANAGEMENT
Management

**Impact of ISO 9001 Certification on United States Companies Financial Performance**

Presenters:

Mr. Eli K. Aba, Indiana State University, Terre Haute, IN 47809, 812-223-2557, eaba@sycamores.indstate.edu

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Need: In these times of global competitiveness, ISO 9001 is needed for companies to benefit from cost reduction; uniformity in management methodologies; decrease in the bulk of company papers; and the creation of common forms that can be more easily used by several operators. A lot of studies have been done on the qualitative benefits of ISO certification. However, studies on the quantitative benefits are limited and their findings are mixed. This research is aimed to investigate the quantitative benefits considering a longer duration.

Overview: One of the greatest demands in our global economy that have compelled firms to invest increasingly in resources for the enhancement of their management practices is organizational competitiveness. Standards have been playing an increasingly important role in economic and market globalization. Studies on financial impact of ISO 9001 on companies are still inadequate. Therefore, the researchers investigated the impact of ISO 9001 certification on United States companies’ financial performance for a period of five years including one-year prior and three years post-certification. There was significant improvement performance from prior year to certification year.

Major Points:

- Importance of certification to firms
- The relationship between ISO 9000 standards and quality systems
- The relationship between ISO 9000 standards and quality management
- Impact of ISO 9001 on the financial operating performance of firms
- Conclusions and recommendations

Summary: Attendees will understand how ISO 9001 certification impacts the financial operating performance of ISO-certified and non-certified firms. The findings may help users of ISO 9001 to be in the position to make informed ISO 9001 purchase decisions.
Implementing Radio Frequency Identification (RFID) Technology into the Supply Chain Management of Small-to-Medium Manufacturing Factories

Presenters:

Dr. Mahmoud Al-Odeh, Bemidji State University, College of Business, Technology, and Communication, Technology, Art, & Design Dept., Bemidji, MN 56601, 218-755-4223, malodeh@bemidjistate.edu

Need: Using radio frequency identification (RFID) in supply chain management (SCM) is an important strategy for manufacturers’ success. Specifically, it helps manufacturers become more competitive in the global market by improving customer satisfaction and allowing them to charge lower prices compared to their competitors. The literature indicates that although RFID technology has been used for many years in SCM, manufacturers have not achieved maximum benefit from this technology because they have misused it and have not implemented the right plans. Implementing RFID technology in manufacturing organizations is a complicated process for all manufacturers, and particularly for small-to-medium manufacturers. There thus exists the need to clarify the best means of managing RFID technology and implementing a strategic plan that helps managers, especially in small-to-medium manufacturing organizations, implement it successfully within their organizations. This study will help fulfill this need by exploring the advantages of and barriers to implementing RFID to clarify some of the ambiguity in this field and identify the phases in developing this technology for the SCM of small-to-medium manufacturing organizations. Moreover, it will present a nine-step plan for implementing RFID in the SCM of small-to-medium manufacturing organizations.

Overview: This research aims to create a strategic plan that will help managers develop a successful SCM strategy by using RFID technology. This plan will be developed by reviewing real strategies developed and practices used by companies throughout the world, including Wal-Mart, P&G, and Metro (Germany). The significant role of software vendors, such as Oracle, SAP, Microsoft, and IBM, in implementing and developing RFID technology in the SCM field will be discussed, the advantages of and barriers to implementing RFID in SCM identified, and a nine-phase strategy for developing RFID technology in SCM illustrated. Finally, the importance of using assessment programs in measuring the performance of RFID technology will be clarified.

Major Points:
- Investigating the effects and importance of RFID technology in supply-chain activities within organizations.
- Developing a comprehensive strategy for developing RFID in the SCM of small-to-medium manufacturing organizations and clarifying some of the ambiguity in the SCM field.
- Demonstrating that implementing RFID in SCM is a difficult process in which different activities should be performed by organizations to develop effective strategies.
- Proposing a framework that simplifies the process of implementing and developing RFID technology in the SCM of small-to-medium manufacturing organizations.
- Providing visual instructions to facilitate understanding of the proposed strategies.

Summary: Attendees will gain understanding of the difficulty of implementing RFID technology in SCM and acquire knowledge of a proposed strategy for developing and implementing RFID in the SCM of small-to-medium manufacturing organizations.
Management - ATMAE 2013 Student Research Competition

How Kaizen Group Leader Selection Affects Group Participation

Presenter:

Ms. M. Joleen Byerline, CTM, Ph.D. Candidate - HRD and Industrial Training, Industrial Management & Technology Graduate Programs, School of Technology, University of Central Missouri, Warrensburg, MO 64093, byerline@ucmo.edu

Dr. Mark Doggett, Advisor, Western Kentucky University, 270-745-6951, mark.doggett@wku.edu

Need: Estimates suggest up to 60% of U.S. companies are implementing some form of Lean practices (Hurdle, 2009). Given the potential for maximizing the efficacy of Kaizen Event groups and the importance Lean organizations place on incremental improvement, researching methods for increasing Kaizen Event member participation is an important contribution to American industry.

Overview: The purpose of this case study was to determine if members of American Lean Kaizen Events shared common cultural values concerning perceived legitimate power distance with members of American non-Lean group members. The focus of this case study is a central Kentucky Lean manufacturing organization that practiced Lean principles for at least three years and completed a Kaizen Event within twelve months previous to the beginning of the study. The distribution of legitimate power, or position in the organizational hierarchy, of the Kaizen group members was identified. Group members completed survey questions measuring their perceptions of level of participation, encouragement and opportunity to participate, comfort in participating, and the degree the group listened to the member. Data was analyzed to determine if differences in legitimate power affected the participants’ perception of their participation in the Kaizen Event.

Major Points:
- Best practices differ between traditional American and Lean group leader selection
- Which best practices will American Lean Kaizen members’ perceptions of participation support?
- Case study of a Central Kentucky Lean organization’s Kaizen members
- Likert-style questionnaire with data analysis

Summary: Organizational communication research indicates group member participation increases as the legitimate power differences among group members decreases. Lean principles and practices indicate Kaizen Event members will contribute regardless of legitimate power levels, due to member training, education, and the Lean team-oriented culture. Further study is needed to determine if Lean culture and training maximize group member contribution, or if legitimate power levels in Lean environments manipulate participation.
Management

Project-Based Learning for Cost Estimation

Presenters:

Dr. Yi-hsiang Isaac Chang, University of North Dakota, Grand Forks, ND 58202, 701-777-2202, Isaac.chang@business.und.edu

Need: Cost estimation is one of the essential skills for technology managers. Nevertheless the lecture-based, textbook-oriented approach could not provide students an experiential learning environment. A project-based learning approach will be presented on how group projects on estimating cost for technology implementation or charge of technology usage can be used to further enhance students’ learning.

Overview: Courses in cost estimation aim to teach students how to calculate the cost for processes performed or materials consumed. While it is essential to find out the dollar figures, the popular yet simple accounting method used to find direct labor, direct material, and indirect cost often leave room for budgeting errors. To address this concern, new content on process modeling, project management, and activity-based costing were introduced. Six group projects on estimating either cost for technology implementation or charge of technology usage were then brought in with an intention to weave these topics together. Project context, design of group activities, and learning assessments will be discussed. The deliverable from student projects will be presented, and findings and recommendations will be provided.

Major Points:

- Need for a project-based learning environment for cost estimation courses
- The relationship between process modeling, project management, and activity-based costing
- Cost for technology implementation vs. charge for technology usage
- Design and assessment of group project activities
- Findings, student feedbacks, recommendations

Summary: Attendees will be informed about the rationale of utilizing project-based learning for cost estimation courses, design of group project activities, observed and reported impact on classroom learning, and students’ attitude change toward the usage of technology.
Attaining Food Security in Chhattisgarh, India Through the Use of COREPDS (Centralized Online Real-Time Environments Public Distribution System)

Presenter:

Ms. Shweta Chopra
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Dr. Chad M. Laux, Advisor, Assistant Professor, Technology Leadership and Innovation, Purdue University, West Lafayette, Indiana, 63108, claux@purdue.edu

Need: 250 million people sleep hungry in India every day. The Indian government runs various welfare programs to feed its citizen. Public distribution system (PDS) is the largest program of economic support to its citizen. An estimated 160 million households or beneficiary purchase their subsidized monthly entitlement of commodities through the network of 480,000 fair price shops (FPSs). The efficacy of the PDS as an enabler of food security has been hampered by diversion of commodities to the open market and leakages caused by procurement and distribution error. Chhattisgarh, India has tried to address these problems of diversion and leakages through the use of technological interventions effecting 300,000 beneficiaries.

Overview: In this presentation, I will present the design and implementation of COREPDS by Chhattisgarh government to address diversion and leakages in PDS, ensuring food security for its 5.4 million (number in Chhattisgarh state) beneficiary households. COREPDS targets the elimination of diversion by using “online real time mechanical authentication”, at the time of service delivery, at the FPS. I demonstrate the utility of technological interventions such as COREPDS in attaining strategic objectives of the PDS by (i) reducing diversion, (ii) increasing transparency, (iii) empowering beneficiary, (iv) improving service delivery and (v) eliminating rogue FPS.

Major Points:

- Discuss the problem identification and preliminary research on PDS
- Describe the requirement and benefits of technological interventions attaining food security
- Explain the working of COREPDS
- Describe the issues faced by beneficiaries before COREPDS
- Demonstrate the role of COREPDS in solving hunger challenge in Chhattisgarh

Summary: The audience will learn to recognize the relevance of technology in developing countries to ensure food security for its citizen. Furthermore they will become aware of large scale technological interventions utilized by Chhattisgarh government to make commodities available for its beneficiary addressing the application of COREPDS.
Daily Monitoring of Workforce Engagement: Decreasing Metric Lag

Presenter:

Dr. Don Chrusciel, Ph.D., M.S., MBA, Iowa State University, Ames, IA 50011   515-294-3885 dchrusi@iastate.edu

Dr. Jessica Goodman, PT, DPT, Gateway Community College, Phoenix, AZ 85034   602-286-8589 goodman@gatewaycc.edu

Need: Recognizing the importance that the workforce has on organizational success and the impact on customer service, a case can be made that an engaged workforce is imperative to maintain the organization’s competitive advantage. There is a need for organizational staff to be more than just satisfied in the work place. People need to be engaged in their job(s). A review of contemporary literature shows an alignment between engagement and quality customer service and ultimately organizational success. Links have also been found between engagement and work meaningfulness, customer loyalty, performance quality, systemic growth, productivity, safety and psychological availability. Thus, measuring workforce engagement is paramount for organizations who are not only dealing with ongoing change, but have an interest to maximize workforce potential by optimizing engagement as a means to support a sustainable future.

Overview: Workforce engagement is often defined as the commitment, both emotional and intellectual, to accomplish one’s work as well as the mission and vision of the organization. It is the effort beyond the bare minimum. With the understanding that measuring workforce engagement is vital to organizational success, there are multiple means to accomplish this endeavor. Companies like Gallup, Kenexa, Aon-Hewitt, Hay Group, Perceptyx, BlessingWhite and Performance Programs can for a fee conduct an exercise and/or provide the tools to measure an organization’s workforce engagement. There is also a well-known survey instrument, Utrecht Work Engagement Scale (UWES) that allows one to conduct an evaluation per nine thought provoking questions. Regardless of which instrument and/or method, the metric is still a lagging indicator unless it is routinely used. A simple daily good/bad voting method is offered as a means to lessen the potential lag time in measuring engagement and allow organizational leadership to react to situations proactively as they actually occur.

Major Points:

- Workforce engagement and factors clarified
- Workforce engagement measuring via external vendors
- Measuring engagement using the UWES survey instrument
- Measuring engagement on a daily basis pros/cons
- Value in daily monitoring, including the decrease in metric lag

Summary: Familiarity with the concept of workforce engagement is becoming an important phenomenon for all who have interest in an organization’s success when and where people are involved. It is a contemporary topic gaining in interest. Whether one is part of the workforce, soon to become part of the workforce, and/or there is an interest to manage/lead people in a workforce, an understanding of engagement is vital.
Management

**Business Process Redesign Primer: ERP Simulations**

**Presenters:**

Ms. Kim Deranek, PhD Candidate, Purdue University, West Lafayette, IN 47907, 765-427-3574, kderanek@purdue.edu

**Need:** A high percentage of change management initiatives fail in industry today. Companies continue to lose money on redesign initiatives because employees resist change. Obtaining a broad understanding of process knowledge prior to undertaking Business Process Redesign (BPR) initiatives could increase the probability of success for organizations and their supply chain members. This research offers an innovative strategy for fostering collaboration, enterprise knowledge and business process knowledge as a precursor to redesign efforts.

**Overview:** End-user training in manufacturing environments often focuses on transactional knowledge – teaching employees rote skills to facilitate system usage. Because users tend to be trained on functional knowledge, their training may not extend beyond departmental boundaries. Enterprise knowledge is limited and users lack comprehension of how their tasks impact other functional units within the organization and their supply chain. This challenge can be addressed through the use of ERP training simulations, fostering business process knowledge and exposing users to the inter-dependencies that exist within the firm and supply chain.

**Major Points:**

- History of traditional training practices in industry & the supply chain
- Overview of ERP simulation effectiveness in industry & academia
- Research study – use of ERP simulation with experienced users to foster business process and enterprise knowledge
- Results, conclusions, recommendations

**Summary:** Supply chain members often seek to gain efficiencies by modifying processes. However, depending on the level of maturity, employees may be resistant to the change due to lack of foundational knowledge and attitudes. Partners need a means of boosting knowledge, attitudes and technology acceptance before embarking on improvement endeavors to ensure success. ERPsim provides an extension to traditional training that may serve a need not currently addressed. Exposure to the software through an interactive and exploratory approach will not only expose employees to the intricacies of the technology, but will also allow for a broader understanding of SAP concepts, inter-departmental collaboration, and an opportunity to learn how processes are combined to accomplish enterprise and supply chain objectives.
Management

Understanding Cultural Dimensions to Effectively Manage Culturally Diverse Teams

Presenters:

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Dr. Rod Flanigan, University of Nebraska at Kearney, Kearney, NE. 68849. (308) 865-8803 flaniganrl@unk.edu

Need: Multinational companies often rely on individuals around the world to work together in teams (virtual and non-virtual). In many cases team members have diverse cultural backgrounds. Because of cultural differences it makes it difficult for these team members to be managed effectively. This can often lead to conflicts or cases of culture shock. When these situations arise they can be extremely deleterious to the effectiveness of the team. This presentation will introduce and discuss cultural dimensions as they relate to managing diverse teams. It will provide tools, techniques, and recommendations for effectively managing and minimizing the negative effects of having team members with diverse cultural backgrounds.

Overview: Managers should gain an understanding of the nine areas of cultural dimensions: Power Distance, Uncertainty Avoidance, Institutional Collectivism, In-Group Collectivism, Gender Egalitarianism, Assertiveness, Future Orientation, Performance Orientation, and Humane Orientation. By understanding these areas and understand how different cultures align to each of them one can better model their team communications, tasking, and work assignments so that there is less disruption caused amongst the team members.

Major Points:

• To understand the cultures of the different countries, managers need to be able to compare their own cultures with those of other countries.
• Using standardized cultural dimensions and cultural clusters helps to facilitate the management of diverse teams and can improve effectiveness
• Better management decisions can be made to minimize the negative effects of cultural clashes, conflicts, or cases of culture shock among team members.
• Common Tools, Techniques, and Recommendation used for understanding Cultural Dimensions

Summary: Attendees will go away with a basic understanding of cultural dimensions as they relate to performance of globally diverse teams. The cultural dimensions presented are well researched, widely accepted and are common in the management lexicon of organizational behavior. Furthering ones understanding in this area can provided an enhancement to their management skills.
Management

Technology Management Competency Model

Presenter:

Dr. Mark Doggett, Western Kentucky University, Bowling Green, Kentucky 42101, 270-745-6951,
mark.doggett@wku.edu

Need: Management curriculum is what distinguishes four-year programs from two-year programs across ATMAE accredited programs. It also distinguishes the discipline from pure engineering programs. A recognized and accepted body of knowledge for technology management and the required competencies for an entry-level technology manager is important. These competencies should be adopted as part of the ATMAE accreditation standards and the Certified Technology Manager exam. In order for technology management programs to be relevant, common competencies should be recognized and agreed-upon.

Overview: The presentation discusses current research on technology management competencies and the ATMAE Technology Management Competency Model. ATMAE membership was surveyed regarding the model as a foundation for accreditation and certification. Specifically, the survey asked:

• Should the ATMAE Management Division adopt the Technology Management Competency Model as the basis for the development of a common body of knowledge for entry-level technology managers?
• Should the Technology Management Competency Model be the foundation for the ATMAE Certified Technology Manager exam?
• Should ATMAE Management Division encourage the use of the Technology Management Competency Model for the accreditation of technology management programs?

This presentation covers the technology management competencies and a conceptual model. The results will be used to make recommendations regarding a body of knowledge for ATMAE technology managers, accreditation outcomes, and the Certified Technology Manager exam.

Major Points:

• Background for the study
• Methodology of the research
• Findings
• Summary and interpretation
• Next steps

Summary: This is a presentation of research on the perceptions of ATMAE membership with regard to technology management competencies and their relevance to accreditation and the CTM exam.
Management

Assigned Textbooks of ATMAE Accredited Technology Management Programs

Presenters:

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Ms. Sumbul Khan, Western Kentucky University, Bowling Green, Kentucky 42101, 270-790-7404,
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Need: Without a recognized and accepted body of knowledge for technology management, the discipline will continue to be confused with other technical and managerial disciplines. Clarity regarding the body of literature in technology management is imperative. The textbooks assigned by faculty provide insight regarding a recognized body of knowledge that students learn in order to become entry-level technology managers. It is useful for the discipline to know what textbooks are currently being assigned and taught in technology management programs.

Overview: This presentation identifies the textbooks currently being used in technology management programs. Using publicly available information and personal interviews, 84 ATMAE accredited programs offering four-year baccalaureate degrees in technology management, construction management, operations management or an equivalent were surveyed. The assigned textbooks for the technical management courses offered were documented and analyzed. The relationships, commonalities, and variations between programs were studied. The results identify the most critical textbooks, authors and areas of inquiry within these programs. The results will be used to make recommendations to the ATMAE Management Division for the purpose of compiling a technology management body of knowledge (TMBoK) and supporting resource materials that can be used to support the Certified Technology Manager exam.

Major Points:
• Need for the study
• Methodology of the research
• Findings
• Summary and interpretation
• Next steps

Summary: This is a presentation of research on the textbooks used by technology management faculty at ATMAE accredited institutions.
Integration of COTS (Commercial Off-The-Shelf) Software Products – A Quality Management Roadmap

Presenter:

Mr. Kishore Erulkulapati, Bowling Green State University C/O HMSA, 818 Keeamoku Street, Honolulu, HI 96184, 206-445-9103, kerukul@bgsu.edu

Need: A Quality Management Roadmap for Integration of COTS software products. As more and more organizations are incorporating COTS products into existing software systems, a quality management roadmap is essential to mitigate risks (costly software failures, delayed projects, cost overruns).

Overview: More and more organizations are taking the approach of buying COTS products and integrating these into existing software systems rather than building on their own. A systematic literature review reveals that lack of roadmap to integrate COTS into existing software systems is leading to costly software failures, delayed projects, and cost overruns. This presentation will present different strategies used by organizations to integrate COTS products into existing software systems, risks associated with these strategies, and provides a quality management roadmap.

Major Points:

- COTS Integration approaches
- Characteristics of COTS Integration Projects
- Challenges and Risks
- A Quality Management roadmap (Plan-Do-Check-Act)
  - Strategy
  - Planning
  - Concept/Scope Definition
  - Requirements (User/Business/System) Definition
  - COTS product selection Criteria
  - COTS product evaluation and selection
  - System Design
  - Configuration, Integration, Customization, Development
  - Testing
  - Production implementation
  - Training
  - Operations and Maintenance Including Ongoing upgrades

Summary: Information technology especially software has profound impact on the way we live, love, earn, and learn. Organizations can benefit from leveraging quality management practices to improve software quality. A roadmap to leverage quality management practices and gain competitive advantage by mitigating cost, schedule, and quality risks will be provided.
Management
Closing the Quality Gap in Healthcare through Systems Thinking

Presenters:
Mr. Kishore Erulkapati, Bowling Green State University C/O HMSA, 818 Keeamoku Street, Honolulu, HI 96184, 206-445-9103, kerukul@bgsu.edu

Need: Improving quality in Healthcare delivery systems. Healthcare in the US is facing a major crisis. Diffusion of Information technologies in healthcare is relatively low. Usage of information technologies plays a key role in improving quality, safety, and efficiency of healthcare and reducing costs. Smart delivery systems reform part of affordable care act supports using information technology to improve overall healthcare outcomes and this is expected to change the US healthcare landscape.

Overview: Healthcare in the US is facing major crisis due to several challenges. These challenges include the following: Fragmented, clumsy, and complex healthcare delivery systems; Rising healthcare costs; Uneven quality of care; Lack of availability of right information at the right time; Conflicting stakeholder interests; and Lack of access to the required care at required time.

Diffusion of Information technologies in healthcare is relatively low due to the following factors: Financial barriers (Investment needed and return on investment); Technical barriers (Inadequate Infrastructure); and Cultural barriers (Fragmented healthcare delivery systems that support volume rather than outcomes.) Systems approach through Information Technology (IT) automation rather than people approach can improve healthcare delivery outcomes and eliminate human errors. Current IT innovations to improve healthcare delivery outcomes, implementation challenges, and solutions will be reviewed.

Major Points:
- Healthcare Challenges, Barriers, and Impacts
- Silos thinking in Healthcare
- Benefits of using systems thinking and IT automation in healthcare
- Review of IT innovations in Healthcare
  - Electronic Medical Records (EMR)
  - Electronic Health Records (EHR)
  - Personal Health Records (PHR)
  - Computerized Provider Order Entry (CPOE)
  - Clinical Decision Support Systems (CDSS)
  - Handheld devices
  - Internet
- Implementation challenges & solutions

Summary: Information technology has profound impact on the way we live, love, earn, and learn. Healthcare can benefit from leveraging IT to improve delivery outcomes. IT innovations that are expected to change the US healthcare landscape will be reviewed.
Management

Customer Services and Technology Used in Financial Institutions: A Survey Research

Presenters:

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Co-Author: Mr. Yvar Geerman, MS student Industrial Management, University of Central Missouri, Warrensburg, MO 64093, geerman@ucmo.edu

Need: Customer services and technology used in today’s business are subjected to continuous improvement in a pursuit to enhance work performance and customer satisfaction. There were a number of studies presenting important level of different dimensions for the general customers of financial institutions. However, there has not been a specific study focusing on population from the academic environment and their perception regarding customer services and technology used. The purpose of this study is to determine the most important customer service dimensions perceived by three different groups of customers that financial institutions have; college students, employees and retired individuals.

Overview: In today’s economy the United States enjoys different kinds of financial institutions which benefit the consumers based on their interests. Financial institutions are seen very important in the eyes of customers, because customers trust them with their money. If a customer feels unhappy with the product or service he/she is receiving there is a good chance that customer will change to another institution. For that same reason financial firms need to strive to offer their customers the best service possible. According to Russell and Taylor (2009), it takes about twelve positive service encounters to make up for one negative encounter. In addition, technology can help business provide better services, but if customers do not know how to properly utilize these provided tools, it can be a hurdle to the company. Some individuals in many cases need guidance to help them navigate the technology that is presented to them.

Major Points:
- Literature reviews on ten dimensions of customer services in b environment.
- Comparison between three sample groups in college-setting on the most important customer service dimensions.
- Types of technology used and consumers’ behaviors in the financial institutions.
- Measuring customer satisfaction and methods of doing business with the banks.

Conclusions: The summary will emphasize on the customers’ perception of different dimension services and technology used in the financial institutions. The finding will assist the business to improve their work performance and customer satisfaction.

Citation
Management

**How Six Sigma Applies in Hi Tech Companies: A Revised, Integrated Model**

Presenters:

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Need: Currently, increasingly high technology (Hi Tech) companies face competitive challenges to develop and bring new products to the market. It is necessary to see if Six Sigma could be useful to these companies in establishing a positive management system to extend the new product lifecycle. In this presentation, we will present a new model of how Six Sigma applies in Hi Tech companies and demonstrate its effectiveness and usefulness.

Overview: As a global influential systematic methodology, Six Sigma has been widely implemented to improve quality and process and to reduce costs associated with lost sales and lost customers for various industries including manufacturing, finance and health care. Hundreds of Six Sigma projects with remarkable results prove that Six Sigma is able to change and bring those companies to a new level in both the short term and long term. However, in today’s dynamic and competitive market, customers’ needs are becoming more demanding a quicker pace. Innovative products and technologies are emerging every day, so high technology companies face huge challenges to produce high value products, gain more customers and increase the bottom line at the risk of high cost investment. It is fascinating to see how Six Sigma worked for those high technology companies.

Major Points:
- Define Six Sigma and Hi Tech industries
- Discuss new product development, DFSS and DMAIC processes, and TRIZ
- Integrate those methodologies with Six Sigma to create a new model for Hi Tech companies
- Analyze its success factors with process development in Samsung and information technology in Lenovo

Summary: Attendees will understand the basic knowledge of Six Sigma, New Product Development, TRIZ and definition of Hi Tech industries. An integrated model will be presented and effective implementation will be analyzed with case studies of Samsung and Lenovo.
Management

A Cycle Time Reduction Six Sigma Project at Cameron

Presenters:

Dr. David W. Hoffa, CSTM, CSSBB, CMfgT, Cameron, 1806 East Front Street, Business Highway 287 East, Electra, TX 76360, 940-495-3901, david.hoffa@c-a-m.com

Need: As a result of slim margins on a key, high-run product line, upper management decided that a full Six Sigma Black Belt project was required in order to reduce process wastes and cycle time and widen the margin.

Overview: The Six Sigma Black Belt facilitated a team of subject matter experts and led them through two “mini-Kaizens” in order to have them identify wastes and propose ways to eliminate them. By driving out waste in all departments, the cycle time was reduced by 12% (p = 0.010) and the data suggest that throughput was doubled.

Major Points:
- The DMAIC Process and Six Sigma at Cameron
- Revealing waste and opportunities for improvement with Value Stream Mapping
- Process improvements and waste removal
- Statistical data analysis
- Lessons learned

Summary: Attendees will understand how the Six Sigma tools were used to improve cycle time by 12% in the manufacture of a key product, saving Cameron over $268,000 per year. The statistical quantification of the improvement will be presented in detail.
Management

What is Enterprise Six Sigma?

Presenters:

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Dr. Chad Laux, Purdue University, College of Technology, West Lafayette, IN, 47907, 765-494-0742, claux@purdue.edu

Need: Six Sigma has proven to be more than a fad in industry. While many businesses have had great success using Six Sigma, some organizations have failed to correctly implement Six Sigma. The successful management and/or implementation of Six Sigma in organizations takes champion problem solvers with knowledge of the tools, methods, and decision-making criteria.

Overview: It is one thing to be a manager in an organization, but another to be a champion of the methodology. Management needs to understand how to successfully apply and manage the use of this philosophy is needed for sustainability. This presentation is designed to expose participants to Enterprise Six Sigma, a graduate course in Purdue University’s College of Technology. It is geared toward future managers that will implement and manage Six Sigma. This course has been designed to help teach the tools, methodology, and decision-making criteria for implementing and using Six Sigma as a champion problem solver in an organization. Topics will include structure and methodology of Six Sigma deployment, including: systems thinking, change management, business process management, competitive intelligence through international standards, and the future of the discipline. The methodology of Six Sigma at the project level for technical skill building, in addition to practices of implementing and managing Six Sigma at an organizational level, will be discussed.

Major Points:

• Need for undergraduate and graduate curriculum in Six Sigma
• Knowledge needed for implementing and using Six Sigma effectively
• Discussion of the tools that make a Six Sigma project successful
• Discussion of the methodology of implementing Six Sigma at the project level and organizational level

Summary: The course design and curriculum of an Enterprise Six Sigma course taught at Purdue University will be presented. Attendees will understand the approach used within the Enterprise Six Sigma course as well as the methodology and tools used in a successful Six Sigma organization.
Improving Cameron’s Production Order Process with DMAIC and Nonparametric Statistics

Need: At Cameron’s Reciprocating Compression Systems location in Oklahoma City, OK, production orders were frequently not being received in a timely manner. There was a lack of information at the receiving process which hindered the ability to receive orders quickly. Unlevel workload caused overtime hours and affected on-time delivery of units. Orders could take several days to complete, when they should have been only taking a few minutes. Following the DMAIC process within the scope of a Six Sigma Green Belt project, the workload was leveled, the process defect rate was reduced, and the control limits for the number of production orders closed per day were tightened.

Overview: By following the DMAIC process and making some elegantly simple improvements to the way paperwork and materials flow on the shop floor, the Green Belt and her team were able to improve the process dramatically. Workload was made 21% more level; the median days to close production orders was reduced by 75%; and the defect rate was decreased by 78%. As a result of an unusual data distribution, this project required the use of nonparametric statistics, which will be discussed in-depth.

Major Points:
- The DMAIC Process and Six Sigma at Cameron
- Measured baselines for the time to process production orders, defect rate, and the workload levelness in the production order closing process
- Analysis of the problem and solutions using a Cause and Effect Matrix and FMEA
- Nonparametric statistical comparison of the baseline and improved states
- Controls put in place to make the improvements stick
- Next steps

Summary: Attendees will understand how the Six Sigma Green Belt followed the DMAIC process to improve the production order process and how nonparametric statistical tools were used to quantify the improvement to the satisfaction of upper management.
Management

A Simulation-Based Method for Multi-Echelon Inventory Optimization

Presenter:

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Need: Inventory control problems can be broadly classified in two categories: single-echelon and multi-echelon. In single-echelon inventory control problems, the focus is on determining the appropriate level of inventory for an individual unit within the supply chain network. On the other hand, multi-echelon inventory control problems focus on the correct levels of inventory across the entire supply chain network. Thus, multi-echelon problems are far more complex as compared to single-echelon inventory control problems. A wide variety of models have been developed to address single-echelon inventory control problems, but the same cannot be said about the multi-echelon inventory control problems. Thus, there are opportunities for further research in multi-echelon inventory optimization.

Overview: Multi-echelon inventory optimization takes a holistic approach by concurrently optimizing inventory levels of all the individual units across the entire supply chain network. These problems are complex in nature and finding analytical solutions to them can be very difficult, if not impossible. In this presentation, we outline a simulation-based method to address multi-echelon inventory optimization problems. An example multi-tier supply chain network is developed to demonstrate the application of the simulation-based method. We experiment with the simulated model with two conflicting objectives in mind: minimizing average inventory across the end to end supply chain and maximizing overall fill rate or service level. The results show that the solutions generated using multi-echelon optimization can be quite different than the solutions generated using single-echelon optimization. This makes sense since the former takes a far-sighted systems level view of the problem as against the short-sighted individual unit level approach taken by the latter.

Major Points:
• Single echelon vs. multi echelon inventory optimization models
• Overview of a simulation modeling framework
• Modeling multi-echelon inventory system
• Experimenting with the simulation model
• Presentation and analysis of simulation results

Summary: This presentation throws light on complexities in multi-echelon inventory optimization as compared to single-echelon inventory optimization and outlines a simulation-based method to address these complexities. The presentation will be of interest to engineering management professionals who manage inventory control and planning operations in their respective organizations.
Management

A Talent Supply Chain Management Approach to Engineering Workforce Management

Presenter:

Mr. Joseph W. Lampinen, Engineering Services Director, Kelly Services Inc., 1500 W. Shure Dr., Ste. 100, Arlington Heights, IL 60004, 847-255-0243, lampijw@kellyservices.com

Need: Technical managers in contemporary industry are able to access the skills of engineering professionals from a variety of sources, including hiring salaried staff, independent contractors, consulting agencies, project services firms, temporary employment agencies and others. Increasingly, companies make use of contingent workers and other forms of non-employees to deliver mission critical technical projects. Yet, in many cases, there is little transparency or consistency in worker utilization, vendor selection, pricing and quality management. This presentation will discuss the Talent Supply Chain Management model as applied to accessing engineering talent in a variety of formats and from a range of sources.

Overview: Technical managers face multiple problems of demographics and logistics in attracting, selecting and engaging engineering talent. Human resources staff and even technical leaders in the organization may have little visibility into the exact number and types of workers engaged. Talent supply chain management – an amalgam of talent management with supply chain management - provides a holistic approach that offers a broad view of the technical workforce available to and engaged by the organization, enabling true strategic talent planning to occur and yielding competitive advantage to the company.

Major Points:

• Description of the talent problem confronting technical managers
• Identification of various means of acquiring technical talent
• Advantages of combining employee and non-employee (contingent) workers under the talent supply chain management umbrella
• Description of talent supply chain management tactics, techniques and tools
• Implementation guidelines

Summary: Attendees will understand the advantages and principles of a talent supply chain management approach to deploying skilled technical workers. This approach can provide an organization with a strategic competitive advantage.
Management
The Proposed ATMAE Lean Six Sigma Certification Exam: Revised Content, Timeline to Completion, and Accreditation

Presenters:

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Dr. Mark Miller, The University of Texas at Tyler, Department of Human Resource Development and Technology, Tyler, TX 75799, 903-566-7186, mmiller@uttyler.edu

Need: Members of the ATMAE Certification Board have embarked on a new direction for the ATMAE certification exams regarding accreditation. This new direction required structural revisions to the proposed ATMAE Lean Six Sigma Exam. In addition, more lean concepts were added to the exam to better balance its content. The proposed ATMAE Lean Six Sigma Exam was developed as a low cost alternative for students seeking this type of certification and for programs seeking a means of external assessment with regards to accreditation.

Overview: This presentation will focus on the revisions of the exam content based upon an in depth review, the strengthening of the exam through the accreditation process and the timeline in which the exam will be available. Furthermore, this presentation will review the method for revising the content of the exam and its implications.

Major Points:
• A timeline for the inception of this exam
• What the accreditation means for ATMAE
• Review of the format, delivery method, and data analysis provided with this exam
• Outline of the content addressed by this exam

Summary: As the ATMAE Certification Board continues to improve its quality of certifications, the proposed Lean Six Sigma Exam is the first one to be developed under this new standard. The focus of this presentation will be reviewing the new standard and describing how it will improve the proposed Lean Six Sigma Exam as well as give the audience insight into the benefits of the exam.
Adding Reflection to Your Students Leadership Portfolio

Presenters:

Mr. Daniel Lybrook, Purdue University, West Lafayette, IN 47907, 765-494-7676, lybrood@purdue.edu.edu

Dr. Andrew Hurt, Purdue University, West Lafayette, IN 47907, 765-494-7711, hurta@purdue.edu

Need: Reflective practice firmly plants the intellectual discipline needed to discern the big picture in practice episodes as well as to engage in the self-growth necessary if one is to manage and lead others. We do a good job in our programs of presenting applicable theory as well as applications of this theory, but too often the individual antecedents are omitted. This can create the student with incomplete understanding of the “the big picture” and skew their understanding of the underlying theories.

Overview: This presentation will provide a rationale as well as a framework for adding reflection into the student’s understanding of the course material and their relationship to this material. The presenters believe that a student’s leadership capacity and effectiveness are largely functions of employing reflective strategies into their individual practice. Primarily utilized to enhance leadership skills and behaviors, this model is generalizable across disciplines. Training sessions overlook this necessary variable in the interest of theory application. The addition of reflective practice completes the loop and the learning. Examples of reflective classroom practice will be provided, as well as assessment strategies for you and your students.

Major Points:
• Model for reflective practice
• Rationale and need for implementation of this model
• Sample assignments and assessments
• Course changes, conclusions, recommendations

Summary: Attendees will understand the reflective practice model and be able to implement this into their individual practice as well as inculcate into their courses.
Management

**Application of Customer Service Techniques to Investigative Police Reporting**

Presenters:

Det. Kent Martin, Eastern Illinois University, Charleston, IL 61920, 217-581-5526, kdmartin@eiu.edu

Dr. Isaac Slaven, Eastern Illinois University, Charleston, IL 61920, 217-581-7259, islaven@eiu.edu

**Need:** When citizens become victims of or witnesses to a crime they usually receive a visit from the local police. The initial responding officer is expected to collect data needed to file a complete and informative police report. The public expects this service and is entitled to it. The failure to obtain the proper information during the first contact with a victim, suspect, complainant or witness puts an added strain on police agencies that may already be experiencing manpower issues and budget problems. The inability of the initial responding officer to gather the correct information can result in the public losing confidence in the local authorities to investigate and solve crimes. Law enforcement agencies need a way to address these quality problems with a cost-effective and efficacious solution.

**Overview:** This study examines the effect of a training module and job-aid on the proportion of police reports that contain quality deficiencies. A random sampling of reports was examined to determine if the initial responding officer obtained all available identifying information for witnesses, victims, suspects and complainants. An analysis of the types and frequency of errors was used to determine the specific training objectives for all members of the patrol division. An examination of reports subsequent to the issuance of the training module was conducted and the results of that examination were compared with the original study to quantify the reduction in the percentage of reports which lacked the necessary information.

**Major Points:**

- Incomplete/inaccurate information can result in higher costs, wasted time and duplicated efforts
- A training module is cost effective and can be retained as a reference tool for later use
- The delivery of the training module can be completed efficiently and to any size audience
- Interpretation of results can identify other areas where training may be necessary

**Summary:** Attendees will learn about the application of training methods in practice at a university police department. The utilization of training modules and job-aids is an effective method for meeting specific training objectives and providing a cost-effective reference tool for continued use by the police investigators.
Management

The 12-Step Kaizen - An Approach to Driving Continuous Improvement for Excellence in Manufacturing Industries

Presenters:

Dr. Ugo Mgbike, Snyder's Lance, Burlington, IA. 52601. 319-208-5834, umgbike@snyderslance.com

Need: In today's global market, manufacturing industries are looking for ways to minimize operating costs and utilize machinery and equipment more effectively and efficiently in order to maximize profits. As a result, many industries have begun implementing “12-Step Kaizen” process. This drives continuous improvement processes, which help to increase the rate of production. This presentation will describe the 12-Step Kaizen and explain how its application has become a driving force in the process of continuous improvement in many world-class manufacturing industries by using example/experience learned by the authors.

Overview: Kaizen is a Japanese word for “Improvement”. Kaizen philosophy or practice focuses on continuous improvement of processes not only in manufacturing but also in other discipline such as engineering, management, and supporting business processes. The 12 Step-Kaizen is one of the Lean manufacturing tools and a component of Total Productive Manufacturing (TPM), used to solve breakdown problems in order to improve the efficiency of manufacturing equipment and processes. The 12-Step Kaizen is based on “Zero-Loss Mentality” and uses loss data from assembly lines and manufacturing processes to identify and solve actual problems in any manufacturing system.

Major Points:
• Explain the origin of Kaizen
• Describe the 12-Step Kaizen process
• Describe how to use the 12-Step Kaizen to solve manufacturing problems
• Understand the benefits of the 12-Step Kaizen process

Summary: At the end of this presentation, attendees should be able to describe the 12-Step Kaizen process and be able to apply the process to various settings. In addition, attendees should be able to understand the importance of the 12-Step Kaizen as a lean manufacturing tool that is helping world-class industries in continuous improvement process.
Management

**Integrated Quantitative Decision Making Tools for Managers**

Presenters:

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Co-Author: Dr. Borinara Park, Dept of Technology, Illinois State University, Normal, IL 61790, 309-438-7311, bpark@ilstu.edu

Need: Today’s project managers are constantly faced with technical, financial, and environmental decision situations with uncertainty. Often, these situations are too risky, non-trivial, and complex to be dealt with by only intuition and experience of the managers. These managerial decisions should be based on quantitative, comprehensive, and yet communicable information. To produce such useful information, systematic and analytical methods have been applied in the industry in a non-mathematically modeled decision format.

Overview: In this presentation, various risk and decision situations are described and categorized and quantitative yet easy-to-use analytical decision tools are presented and used for the solution process. Specifically, spreadsheet computer software serves as a main solution platform to support the practical and intuitive analytical decision modeling and analysis process. This hands-on software platform plays a critical role in making decision analysis affordable through various embedded decision features and add-in tools. In this intuitive modeling environment, various industry-based decision situations are modeled and analyzed through multiple decision analysis plug-in tools.

Major Points:

- Various decision quantitative decision situations and tools
  - Intelligence-Based Decision
  - Structured Decision
  - Uncertainty-Based Decision
  - Statistical Decision
  - Optimum Decision
- How these are integrated to make optimum decisions

Summary: Attendees will understand what quantitative spreadsheet-based analytical modeling techniques are, how they are applied, and how they can be integrated to analyze and solve complex decision problems and risk situations faced by project managers.
Realistic Overdraft Projection Using a Stochastic Methodology

Need: Contractors develop cash flow projections based on several time scheduling aids and sometimes find revenue profile lags behind because of delayed payments or retainage withheld. In such scenarios, the overdraft borrowing requirement is offset by requesting front or mobilization money (Advance Payment) from the owner. The knowledge about the maximum overdraft for the life of the project is essential to know how much credit available at the bank. Realistic budget and schedule planning dictates contractors to focus on more than just deterministic scenarios, i.e., focus on uncertainties in the project.

Overview: In this paper, Monte Carlo Simulation technique, the stochastic tool, is used in achieving realistic schedules and their related overdraft projections. This paper demonstrates the effect of this approach on project overdraft calculation. Cash flow models are built in a spreadsheet environment and project management tool is used for project scheduling.

Major Points:

- To focus on the uncertainties in the project schedule and project budget.
- To calculate project overdraft, by considering realistic schedules.
- Monte Carlo Simulation tool, can aid in achieving realistic schedules and their related overdraft projections

Summary: This project helps the managers to estimate realistic overdraft using Monte Carlo Simulation Technique.
Management

Airline Consolidation and Globalization: Developing the Future Workforce

Presenter:

Dr. I. Richmond Nettey, Associate Dean, College of Applied Engineering, Sustainability & Technology, Kent State University, Kent, Ohio 44242, 330.672.9476, inettey@kent.edu

Need:  The process of effectively educating and developing the future workforce for airlines in an era of airline consolidation and globalization is worthy of discussions by ATMAE’s membership because the effect of consolidation and globalization transcend the airlines to affect the future workforce and ATMAE’s current membership in academia, business, government and industry.

Overview:  Globalization, or increased integration through closer contacts and interdependence, has enjoyed a significant boost through unprecedented changes in communications, computer technology and transportation (www.globalpolicy.org).  Of the five different modes of transportation (Nettey, 1995), aviation, or more specifically, airline service, has had the most significant impact while it has been most significantly impacted by globalization.  In the 30 year span between passage of the Airline Deregulation Act in 1978 and 2008, there were 160 airline bankruptcies (Fleming, 2010), which have been a major causal factor for airline consolidation.  The primary economic reasons for airline consolidation have been (i) airline profitability and (ii) airline financial stability (Fleming, 2010).  Like other industries, airline consolidation has paralleled globalization and impacted workforce development in many areas.

Major Points:  The economic benefits expected from airline consolidation and globalization include cost reductions through (i) combining complementary assets (ii) eliminating duplicate activities (iii) reducing capacity through operational streamlining and (iv) increased revenue from higher fares associated with the “hub premium,” which may translate into 10-20% (Borenstein, 1989; GAO 1989 and 1990; Lijesen, Rietveld and Nijkamp 2004; Lee and Prado 2005).

Summary:  The proposed session will discuss globalization through the lens of airline consolidation and examine ways in which aviation programs at colleges and universities can develop the future workforce for airlines in a way that can be instructive to other disciplines served by ATMAE.
Management

Using Six Sigma Problem Solving Methodology to Enhance Business Productivity in Non-Woven Industries

Presenter:

Ms. Hala Osman, MSc. MTECH, Kent State University, College of Applied Engineering and Sustainability Technology, Kent, OH 44242, 330-858-9625, hosman@kent.edu

Need: Nonwoven fabrics have made a strong presence alongside woven fabric in the textile industries. That is because the fabric has gradually gained importance in different applications along with medicine, personal care, household wipes. This paper introduces a student project in which the principles of Six Sigma and several tools were used to improve service and production of a business in our community. This project not only helped students to acquire a deeper perceptive in Six Sigma methodology, but also verified the application potential of Six Sigma roadmap in a local non-woven company.

Overview: Traditional fabrics are made by weaving together fibers of silk, cotton, polyester, wool, and similar materials to form an interlocking matrix of loops. Non-woven fabrics, on the other hand, are made by a process that presses a single sheet of material from a mass of separate fibers. This is a challenge for the industry especially when they are dealing with hydrophobic non-woven e.g. polypropylene fiber.

Major points:
- The non-woven production process capability analysis is aimed at determining the improving the process capability if it is not with a view to help increase productivity and profitability.
- How much in terms of dollars is been lost by the company can achieve by analyzing the wet weight of the non-woven wipes and compare it with the target weight which is critical to quality (CTQ).
- *DMAIC* is an acronym for five interconnected phases that helps to define the project goals and can be used when a product or process is in existence at company but is not meeting customer specification or is otherwise not performing adequately.
- Determining the process capability with a view to determine if it was operating at a Six Sigma level using Six Sigma methodology

Summary: The completion of Six Sigma problem solving methodology at the College of Technology not only illustrated how Six Sigma concepts were introduced in the local business area, helping the students obtain a deeper understanding in Six Sigma methodology, but also demonstrated great application potentials of Six Sigma concepts in local companies. The author of this paper is seeking to apply Six Sigma principles to all areas of organizations and validate the value of this approach for local businesses in developing a successful strategy for success.
Management

Quality and Safety Perceptions of Undergraduate Science, Engineering, Technology and Mathematics (STEM) Students

Presenters:

Mr. Sai K. Ramaswamy, Iowa State University, Ames, IA 50014, 515-294-1033, sair@iastate.edu

Dr Gretchen A. Mosher, Iowa State University, Ames, IA 50014, 515-294-6416, gamosher@iastate.edu

Dr Steve A. Freeman, Iowa State University, Ames, IA 50014, 515-294-9541, sfreeman@iastate.edu

Need: Quality and safety systems are both important operational goals for industries in pursuit of excellence. Researchers have identified human perception as a key factor in the successful implementation of quality and safety programs in the work environment. Undergraduate college students in science, engineering, technology and mathematics (STEM) programs will play a vital role in the application and implementation of quality and safety policies in diverse work environments, yet little research has been completed to understand the students perceptions of quality and safety and how the two factors interact in the workplace.

Overview: Many undergraduate students in STEM degree programs will begin careers which may directly or indirectly impact safety and quality initiatives in workplaces. This presentation will review past research completed to highlight the association of quality and safety at workplace. It will outline the importance of an enhanced understanding of quality and safety perception of STEM students. An overview of the previously validated safety survey instrument and quality survey instrument modeled after the safety instrument will be provided. Summarized data gathered in a survey of undergraduate STEM students using a stratified random sample will be shared. Implications for academic curriculum development and workplace training will conclude the presentation.

Major Points:

• Importance of STEM students perception of quality and safety
• Previous work in quality and safety perceptions that formed the basis for this research
• Development of survey Instruments used to measure safety and quality perceptions
• Interactions between quality and safety perceptions based on student’s field of study and demographics
• Application of this research finding in academic and industrial environments.

Summary: Attendees will learn the importance of quality and safety perceptions as measured from undergraduate STEM students. The findings from this project can be used to develop curriculum to enhance the skills and knowledge of students entering the quality and safety systems workforce.
Management

Cross Cultural Communication and the Future Workforce

Presenters:

Dr. Sophia K. Scott, Southeast Missouri State University, Cape Girardeau, MO 63701, 573-986-7383, sscott@semo.edu

Mrs. Belinda McMurry, Southeast Missouri State University, Cape Girardeau, MO 63701, 573-651-2336, blmcmurry@semo.edu

Need: Global competition has been one of the most significant forces that have transformed industry in the United States. As organizations respond to the competitive pressures of the global marketplace, the capacity of technology graduates ability to communicate with their global counterparts can have a long-term effect on their future success. The upward mobility of our technology workforce will depend on the ability of cross cultural communication. Because globalization is a reality, universities should prepare graduates for success as a global technical manager. The purpose of this paper is to assess cross cultural communication of technology students and to identify core global competencies technology students should possess to be effective in the future workforce.

Overview: The majority of goods manufactured in the United States are subject to massive global competition. This globalization provides an opportunity for educators in technology to prepare graduates to communicate cross culturally. In addition, understanding the needed global competencies, technology students can thrive in our global society. This proposal seeks to assess cross cultural skills and provide core global competencies technology students should have for the future workforce.

Major Points:

• Present results of an assessment of cross communication skills
• Identify core global competencies needed by technology graduates
• Make recommendations for technology programs

Summary: This presentation will provide results of a study using an assessment of cross cultural communication skills. Additionally, a discussion of core global competencies technology graduates need for success in the global.
Management

Quantifying Workforce Development: An Empirical Study on the Indicators of Organizational Change in the Built Environment

Presenter:

Dr. Brian H. Stone, Engineering Technology, Western Illinois University, Macomb, IL 61455, 309-255-8776, bstone@wiu.edu

Need: Within the realm of workforce development, much has been written on the broad topic of change management as it relates to organizational learning and growth. However, while there are several well-known authors who have tested change management theories in various workforce organizations, there are no known standards for measuring change that have been both established and standardized which could be used in further longitudinal studies. Additionally, within the varied studies of change management, there is little specific literature on the management of change in the built environment where empirical data is generated from the real-time testing of actual events involving real people. For this reason, the scientific shedding of light on potentially standardized indicators of change within the workforce of the built environment would be beneficial in helping to better understand how management can facilitate and influence workforce development.

Overview: The study of organizational change, organizational learning, and workforce development are closely related in that they attempt to foster planned growth within groups as they carry out organizational goals in projects, classrooms and other work-related environments. By recognizing this common link, I will present a workforce development model that was tested on six different organizations (all related to the built environment) over a two year period which helped to determine what common potential indicators of change occurred across the varied workforce groups. These organizations vary in size from a half dozen members to thousands of employees and are spread across the United States. The findings of such a test will be given in an effort to help pioneer the development of standard measurements of developmental change in organizations within the built environment.

Major Points:

• Truly empirical research on workforce development/change management is relatively uncommon
• Validation measures of developmental change have few standards and are relative
• Over two-year study of six organizations utilizing workforce development practices
• Findings showing common characteristics of developmental change across varied workforce groups

Summary: Attendees will be introduced to the current benefits and limitations of workforce developmental validation and how this researched test helps to identify methods and metrics for verifying actual development in organizations. The effect will contribute to the pioneering effort to successfully identify developmental change in a way that can be used over varied environments.
Management

Leadership Curriculum Development: The New ‘Management’ in Applied Engineering Classrooms

Presenter:
Dr. Brian H. Stone, Western Illinois University, Engineering Technology, Macomb, IL 61455, 309-255-8776, b-stone@wiu.edu

Need: Though the teachings of leadership have been a common workforce development topic for over two decades, the capturing of such education in a university classroom has been attempted mainly in management-related schools such as human resources, business and organizational behavior. Classrooms relating to technology and engineering have embraced many methods of effective management practices but are just now beginning to integrate the practices of leadership as they relate to management in the applied sciences of engineering. As a part of understanding disciplines related to applied technologies, the curriculum development and teaching practice need to include topics relating to leading the workforce in such specific fields.

Overview: For over two decades, the study of Leadership in the workforce has experienced substantial growth. These trends in teaching have been captured in the university classroom by various schools in human resource, business as well as organizational behavior. However, in the applied engineering areas of study there are few courses that teach about the oversight of workforces and have little focus on leadership. For this reason, the author wishes to shed light on the process of developing a leadership curriculum as it relates to Applied Technology University Students and how it contrasts and integrates with the management side of employee administration and oversight. The presented material is intended to count as a pioneering effort in the development of leadership-based curriculum for engineering schools.

Major Points:
• Historical development of Leadership topics in workforce training and development
• Initiation and growth of Leadership curriculum into University Management Courses
• Comparative analysis of current leadership curriculum in Engineering-related schools
• Analysis and recommendation of Leadership course modules that relate specifically to the applied Engineering student

Summary: As the topic of Leadership becomes further emphasized in industry as a more holistic learning approach to workforce administration, educators within the applied sciences should be looking to find ways to integrate such industry trends into the classroom. This presentation attempts to demonstrate a method of doing so.
Identification of Optimal Cutting Parameters in Micro Milling Of OFHC (Oxygen Free High Conductivity) Copper to Produce Micro Channels

Presenters:

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Dr. Muhammad Jahan, Western Kentucky University, Bowling Green, KY 42101, 270-745-2176, Muhammad.Jahan@wku.edu

Need: Machining is an important part of any manufacturing operation. With the size of parts always decreasing, micromachining is becoming more vital. Understanding the techniques and procedures behind micromachining processes is very important to keep the costs down and production up. Micro milling is becoming more important in the aerospace, medical, electro-optics and automotive industries to produce small, accurate, 2D and 3D micro-features.

The micro milling of copper is challenging due to the high ductility of copper, generation of heat during machining and clogging of chips. The identification of optimum cutting parameters in micro milling of OHFC copper is very important in order to minimize surface roughness and burr height in the micro-channels. Optimizing cutting parameters will also improve the dimensional accuracy of the micro-channels.

Overview: This study will identify the most effective cutting parameters for machining micro-channels in OFHC copper. The presentation will also cover the effect of different machining parameters on the material removal rate, surface finish, and dimensional accuracy of the micro-channels.

Major Points:

- Optimize machining parameters for micro milling of OFHC copper
- Micro milling of channels or slots in OFHC copper
- Effect of machining parameters on surface finish, dimensional accuracy, tool life and burr formation

Summary: Industries like the aerospace, medical, and automotive constantly have to adapt to ever-changing parts. Micromachining is a very efficient and accurate way to manufacture these parts. Industries need optimal parameters to help produce these parts efficiently and effectively.
Manufacturing

Improving Process Capability in a Computer Integrated Manufacturing (CIM) Cell with the Use of a Renishaw 40-2 Spindle Probe

Presenters:

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Need: With the rise of automation in traditional manufacturing processes more companies are beginning to integrate CIM cells on their production floors. Through CIM cell integration, companies have the ability to reduce process time and increase production. One of the problems created with CIM cell automation is caused by the dependency the sequential steps have on one another. Dependency created by the previous step increases the probability that a process error could occur due to previous variation. One way to eliminate this dependency is through the use of an in process measuring device such as a Renishaw spindle probe used in conjunction with a CNC milling machine.

Overview: Western Kentucky University (WKU) utilizes a CIM cell in the Mitch McConnell Advanced Manufacturing and Robotics laboratory. The laboratory is located in the Architectural and Manufacturing Sciences department and gives students the opportunity to learn how automated systems can be integrated. The CIM cell consists of three Mitsubishi six-axis robots, a Haas Mini-mill, a Haas GT-10 lathe, an AXYZ CNC router table, 120 watt laser engraver, an Automated Storage and Retrieval System (ASRS), material handling conveyor, and vision station. The CIM cell functions throughout the curriculum as a means for applied learning and research. The researcher plans to use this CIM cell in order to determine if an in process measuring device, such as the Renishaw spindle probe, has the ability to increase final process capability over initial process capability.

Major Points:
• Use of a Renishaw 40-2 spindle probe in a CNC Hass Mini Mill
• Improvements in process capability from initial process capability to final process capability

Summary: In order to improve process capability in a CIM cell, in process measuring devices can be integrated into the cell to eliminate compounding variation. Through the use of a Renishaw 40-2 spindle probe used in conjunction with a CNC Hass Mini Mill, process capability can be improved in a CIM cell.
Manufacturing

**Environment vs. Economy – Review of Eco-Efficiency and Cost of Sustainability in Manufacturing**

Presenter:

Dr. Mehmet Emre Bahadır, Murray State University, Department of Engineering, Engineering Technology and Physics, Murray, KY 42071, 270-809-3293, mbahadir@murraystate.edu

Need: Manufacturing processes and strategies have been continuously improving for higher productivity and profitability. Today, being productive and profitable is not enough to be competitive at the global level. A sustainable approach integrating environmental, social and financial sustainability is required. However, sustainability and profitability can be two conflicting strategies. Successful adaptation of sustainable practices in manufacturing requires a better understanding of eco-efficiency and cost of sustainability.

Overview: The alarming numbers about global warming, air and water pollution, cost of energy, and dwindling natural resources have been shifting the focus from productivity to sustainability. Almost all sustainability studies depend on sustainability assessments and developing relevant metrics which have been a challenge for industries and governments. Today, a bigger challenge is to financially justify the implementation of sustainability. On two opposite sides of the financial scale there is (1) cost of sustainability practices to manufacturing companies and (2) cost of not being sustainable to the society, planet and next generations. In this presentation, sources of costs and the concept of eco-efficiency are reviewed.

Major Points:
- Sustainability assessment and metrics used in manufacturing
- Common methods applied to adapt sustainable manufacturing
- Cost of adapting and not adapting sustainable practices
- Eco-efficiency, how to evaluate and justify the sustainability in economic terms

Summary: In general, sustainability practices are considered as an opportunity for industries to become more efficient and competitive in the global market. In this presentation, cost of sustainability and concept of eco-efficiency will be discussed based on the current literature and industry practices.
Manufacturing

A National Curriculum on Medical Device Manufacturing

Presenter:

Mr. Kirk Barnes, Ivy Tech Community College – Bloomington, Bloomington, IN 47404, (812) 330-6050, kbarnes@ivytech.edu

Need: The goal is to harmonize the national curriculum on medical device manufacturing education. Currently, there is no well-defined medical device curriculum that is endorsed by the industry nationwide. Ivy Tech-Bloomington will develop the pathways for a two-year degree and specific certificates by closely working with our industry partners.

Overview: Ivy Tech Community College-Bloomington has been awarded a $1 million dollar grant from the U.S. Department of Labor (DOL) to lead national efforts in developing and expanding workforce training in medical device manufacturing over the next four years. The goal is to harmonize the national curriculum on medical device manufacturing education. Currently, there is no well-defined medical device curriculum that is endorsed by the industry nationwide, so Ivy Tech-Bloomington is responsible for developing the pathways for a two-year degree and specific certificates by closely working with our industry partners.

Major Points:
- Gaining industry support
- DACUM process
- Student Recruitment
- Curriculum harmonization with multiple colleges across the country
- Preliminary curriculum outcomes
- Developing new courses specifically tailored for medical device manufacturing

Summary: Attendees will understand the how industry Subject Matter Experts and educational leaders use the DACUM process to develop a nationally harmonized Medical Device Manufacturing curriculum.
Manufacturing

Workforce Development Challenges

Presenters:

Mr. Malcolm Bethea, Dept. of Applied Engineering Technology, North Carolina A&T State University, Greensboro, NC 27411, bethea@ncat.edu

Co-Author: Dr. Ji Y. Shen, Dept. of Applied Engineering Technology, North Carolina A&T State University, Greensboro, NC 27411, 336-285-3158, shen@ncat.edu

Need: America remains a leader in innovation, but its workforce is falling behind. Education and workforce development systems have not kept pace with the demands of the 21st century. Despite almost 13 million Americans looking for work and 8 million more settling for part-time jobs, employers continue to report that too many job seekers are unqualified for modern jobs; more than 3 million jobs continue to go unfilled despite high, persistent unemployment, leaving well-paying positions unfilled. Skills gap is especially acute in science, technology, engineering, and mathematics (STEM) and other high-demand fields.

Overview: The American workforce is missing the education that needs to compete in a global economy. We have dropped from a position of leadership to 16th globally; our 15-year-olds rank 25th in the world in math, and our elementary school enrollment is 79th internationally. As we face the retirement of the baby boom generation, we’re already seeing widespread skills shortages, and by 2018 the U.S. will need 22 million new workers with college degrees. Current workforce does not have sufficient skilled workers to meet demand at the same time many willing workers go unemployed.

Major Points:

• Hard working and determination remain vital but must be coupled with strong skills and a solid education to ensure our continued global success.

• By allowing modern jobs to sit vacant, the United States is missing crucial opportunities to grow the economy and strengthen the recovery. Global investors and major manufacturers will go where the skilled workers are.

• As a country we have to find solutions to closing the skills gap, developing a national strategy for investing in human capital, and holding onto our talent.

Summary: In the 21st century, education is a nation's economic engine. Ensuring that U.S. workers have the skills and training they need to compete in the global marketplace is a cornerstone of an economy. Right now, U.S. employers face a skills shortage that threatens our great traditions of entrepreneurship, productivity, leadership in the world economy. 25% of students aren’t graduating from high school on time. Only 45% of high school graduates are prepared for college-level work in mathematics, and only 30% can pursue college-level work in the sciences. More than one-third of four-year college students and two-thirds of community college students fail to graduate within six years. It is estimated that 86 million members of America’s workforce (about 65%) are without a degree. While the unemployment rate is at 8.2% nationally, for those with a bachelor’s degree, the unemployment rate now is 4.1%. It is becoming clearer that a strengthening economy will be dependent upon a supply of skilled and educated workers. Business and higher education working in tandem, along with adequate support from both private foundations and federal and state governments, can meet and master this challenge.
Manufacturing

An Investigation on In-Process SPC Sampling Frequency for Shaft-Bearing Turning Process

Presenters:

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Dr. Julie Zhang, University of Northern Iowa, Cedar Falls, IA 50613, 319-273-2590, julie.zhang@uni.edu

Need: The machining processes have the uniqueness of discrete production and flexible scheduling in cellular manufacturing design. To ensure the quality of machining products, control charts for Statistical Process Control (SPC) have been implemented in manufacturing companies to monitor the machining process. Sampling of data collection is an essential part for SPC control charts. There is a need to investigate how optimal sampling frequencies should be identified for discrete machining processes.

Overview: Using real data, the investigation focused on SPC sampling frequencies for a shaft-bearing turning process using the technique of Average Production Length (APL) in a local manufacturing company. The purpose of the study was to identify the proper SPC sampling frequency for the turning process. The study results provided insights on the comparison of different SPC sampling frequencies so that the management team may use it to make strategic planning in the future.

Major Points:
• Need for an investigation of SPC sampling frequency on machining processes in the company
• Explanation of the measure of Average Production Length (APL)
• Overview of the selected manufacturing process, data collection and design of the study
• Result on preferences of different sampling frequencies
• Recommendation for future studies

Summary: The study used the measure of Average Production Length (APL) to compare sampling frequencies. Study results indicated that the 100% inspection has significant shorter APL than 1/10 and 1/20 SPC sampling frequencies, and based on the study result, 1/10 is preferred over 1/20. Attendees will learn the APL approach and the result of the investigation of SPC sampling frequencies for a shaft-bearing turning process.
Manufacturing

Creating 3D Pourbaix Diagram Models

Presenters:

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Co-Author: Dr. Greg K. Arbuckle, Western Kentucky University, greg.arbuckle@wku.edu

Need: Reliability and durability are important considerations in the selection of materials for use in construction and manufacturing. Corrosion, leading to material failure, costs industries and municipalities millions in replacement and repair costs each year. Understanding how environmental factors such as pH and potential effect a specific material’s integrity is key to ensuring the selected material will last for the life of the product. Since their development in the 1920s, two-dimensional Pourbaix diagrams (E-pH diagrams) have been used to determine the thermodynamic stability of elements and the aqueous species under various pH and potential conditions for a specific element concentration. These diagrams allow researchers to determine the pH and potential conditions at which an element is passive or reactive. Historically if an investigator wished to explore a range of element concentrations, a series of two-dimensional diagrams spanning the concentration range of interest were developed and overlaid to give an image of element behavior. These pseudo-three-dimensional Pourbaix diagrams are of limited usefulness since the complexity of the diagrams often leads to overlapping lines and regions. This in turn makes interpretation of the behavior of an element and its aqueous species under various conditions difficult at best. A better approach would be to develop true three-dimensional Pourbaix diagrams in which changes in concentration are delineated along a third axis, X. The development of a true three-dimensional physical model would allow an investigator to more clearly visualize the interdependence of the three axes (pH, E and concentration) and assist in the interpretation of the diagram.

Overview: Presentation will introduce 2D Pourbaix diagrams by describing their construction and use and then outline the challenges and development of 3D Pourbaix diagram models for magnesium, aluminum and iron.

Major Points:

- Development of 3D Pourbaix diagram models to allow for a better understanding of element stability
- Application of simulations and animations pertaining to model design
- Scaling and manipulation to retain proportional integrity
- Application of 3D modeling and printing

Summary: An understanding of the interdependence of effects of pH, potential and concentration on the thermodynamic stability of an element and its aqueous species is necessary in order to make informed decisions with regard to material selection for construction and manufacturing projects.
Implementing Self-Replicating Rapid Prototyping (RepRap) into a Mechanical/Manufacturing Program

Presenter:

Dr. John L. Irwin, EdD, Michigan Technological University, Program Chair/Associate Professor, MET, Houghton, Michigan 49931, (906) 487-2525, jlirwin@mtu.edu

Need: One of the recommendations of the ASME Vision 2030 report is that Mechanical Engineering Technology programs should strive towards creating curricula that inspire innovation, creativity, and entrepreneurship (Perry & Kirkpatrick, 2012). A perfect tool for implementing just that is the RepRap 3D printer, claimed by its’ creators to be “humanity’s first general-purpose self-replicating manufacturing machine” first released in March 2007. The RepRap Project has an open design with open source software with the intent to improve on the design with each generation adding revisions to the hardware as well as software capabilities. Faculty in technology programs strive to develop projects where students experience real world examples for design, build, and test accomplished in one or two semesters inexpensively, and with tangible results. The integration of the RepRap revolution into a manufacturing curriculum can be the answer to your needs if implemented with a strategy, patience, and guidance.

Overview: The cost to build a Mendal Prusa version RepRap machine is approximately $550 in components in addition to the printing of 3D parts replicated on an existing machine. A comparable size and capability 3D printer on the market is a Stratasys Mojo which has a significantly higher price tag at around $10,000. The Mojo printer uses the same additive manufacturing process extruding the same type of plastic filament, but is delivered in the normal commercial manner with all components housed in a “black box”. The attractive element of the RepRap design is that all its components are readily accessible to help understand how the machine operates. A Prusa Mendal machine can be assembled with required tools and guidance in about 24-30 hours including the software downloads and installations on a laptop host computer. Building the printer can be accomplished by a faculty member, or could be part of a capstone student project. The process of introducing the 3D printer to students and introducing them to the world of 3D printing in the open source environment is a major benefit. Manufacturing students can design, 3D print and test project parts prior to production using traditional processes, and then files can be uploaded to a web site called Thingiverse.com dedicated to sharing digital designs with the larger community. Improvements to the existing RepRap machine can be designed, printed, installed and tested in hours not days or weeks.

Major Points:
- Analysis of RepRap Mendal Prusa machine build cost including faculty/student time invested
- Advantages to ABS and PLA material used for additive manufacturing process verses traditional machining
- Innovation, creativity, and innovation explored through open source and digital design sharing

Summary: Attendees of this session will experience a first-hand account of the implementation of a RepRap Mendal Prusa model 3D printing machine into a manufacturing curriculum including a detailed list of purchased parts, 3D parts to print using an existing machine or purchase, and links to building instructions. Student success stories, examples of student projects using the machine, and improvements to the existing design will be included. A list of courses in the curriculum that have utilized the machine with student feedback will demonstrate the level of satisfaction of utilizing an inexpensive open source digital manufacturing machine.
A Comparative Study on the Machinability of Titanium Alloy (Ti-6Al-4V) Using Conventional Flood Coolant and Minimum Quantity Lubrication (MQL)

Presenters:

Dr. Muhammad P. Jahan, Western Kentucky University, Bowling Green, KY, 42101, 270-745-2176, muhammad.jahan@wku.edu

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Need: The increased use of titanium alloys in the aerospace and medical industries has necessitated the future needs for research in the machining of these exotic materials. Traditionally, titanium has been a material that is considered to be difficult to machine. Some of the problems of machining titanium include poor conductance of heat, strong alloying tendency, low modulus of elasticity, and titanium’s work-hardening characteristics. With these added difficulties of machining, the cost of machining titanium increases the overall cost to the machine shop. The ability to apply MQL (Minimum Quantity Lubrication) to the machining process of titanium can help with both the cost and machining performance of titanium.

Overview: This study will be exploring the effects of multiple variables in the machining of titanium alloy, both for flood coolant and MQL conditions. The variables that will be studied are feed rate, depth of cut, cutting speed, cutting tool materials and cutting tool geometry. The study will evaluate the surface finish and dimensional accuracy of the finished product to optimize the operational parameters for machining Ti-6Al-4V. In addition to the surface finish the researchers will be reviewing the tool wear, cutting force, and chip morphology to ensure that the optimal parameters meets customer requirements.

Major Points:
• Effect of operating parameters on the machining performance for machining Ti-6Al-4V
• Identification of optimum parameters based on surface finish and dimensional accuracy
• Study of the tool wear
• Study of the chip formation and chip morphology

Summary: This study will evaluate the suitability of using flood coolant and MQL in machining of titanium alloy (Ti-6Al-4V). The identification of optimum parameters for machining of titanium alloy will enhance the use of this material in aerospace applications.
Manufacturing

Bench Top and Industrial Metal Lathes: Different and Similar, but Needed in Technology Education

Presenters:

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Co-Author: Dr. David Yearwood, University of North Dakota, Grand Forks, ND 58202, yearwood@und.edu

Need: The rising costs of education have forced many institutions to examine how they are using available resources. Areas of high expense, such as machine shop programs, have had severe funding cuts, or in some cases, have been eliminated due to the expensive nature of the equipment that has been traditionally used. We will present our findings from a recent study of industry as well as ATMAE accredited institutions, showing the perceptions of faculty, students, and industry representatives in regards to suitability of substituting bench top metal lathes for full size industrial versions.

Overview: Engineering and manufacturing programs may need to be cost effective to survive, but cutting costs at the expense of the quality of programs does not seem to be an acceptable solution. Using less expensive bench top metal lathes in manufacturing technology educational settings may provide a more cost effective alternative to more costly industrial lathes without impacting the quality of programs. The use of bench top equipment seems to be a viable option that is accepted by industry, faculty, and students alike and one that will still allow programs to provide hands-on experience with machine tools that many in industry feel are important for students to know.

Major Points:
• Meeting 21st century student and employer expectations
• Historical perspectives, practices of the past
• Bench top machine tool capabilities and limitations
• Faculty, student, and industry perceptions
• Conclusions, recommendations

Summary: Attendees will learn about the results of a study that suggests that using bench top metal lathes in manufacturing technology educational settings may provide a more cost effective alternative to industrial lathes without impacting the quality of programs.
Pedagogical Underpinnings of Material Science in Engineering Technology

Need: Material Science entails the study of material types, distinguishing properties, testing procedures, and applicable manufacturing processes. According to the National Center for Manufacturing Education (2011) one of the biggest challenges faced by manufacturing programs nationwide is the way material science is taught in Engineering Technology. This study aims to examine the topic areas covered in Engineering Technology programs, nationwide, that address material science from an experiential perspective. The topic areas identified will allow for the creation of a model of the pedagogical underpinnings of material science in Engineering Technology.

Overview: Material Science entails the study of material types, distinguishing properties, testing procedures, and applicable manufacturing processes. The rapid introduction of new materials into products and their associated novel manufacturing methods dictates that material science be an integral part of Engineer Technology curricula. The Engineering Technologist of today and the future must possess a basic level of competency of materials used in product manufacture. By identifying the concepts widely taught in Engineering Technology programs, nationwide, a model made up of the core concepts will be created. This presentation is based, in part, on a recent survey of the materials topics that are taught, how important those topics are, and if a laboratory experience is used.

Major Points:
• A review of the challenges faced in the pedagogy of material science
• Determination of material science core concepts
• Designing of a theoretical model of material science core concepts
• Summary of the material topics that are taught and how they are taught

Summary: This study aims to examine the topic areas covered in Engineering Technology programs, nationwide, that address material science from an experiential perspective.
Manufacturing

What Do Employers Need? An Investigation into Four Year College Skill Sets Demanded by Manufacturing Employers

Presenters:

Dr. Todd Myers, Associate Professor, Department of Engineering Technology & Management, Ohio University, Athens, OH 45701, (740) 593-1921, myerst2@ohio.edu

Dr. Zaki Kuruppalil, Assistant Professor, Department of Engineering Technology & Management, Ohio University, Athens, OH 45701, (740) 593-0258, kuruppal@ohio.edu

Need: Manufacturing drives a major percentage of the economic activity in the United States. In a press release in March 2005 the National Association of Manufacturers (NAM) revealed that the country will face a severe shortage of skilled workers if current employment and job training trends continue. The NAM is the nation’s largest industrial trade association, representing small and large manufacturers in every industrial sector and in all 50 states. NAM prediction held true even during the great recession of 2007 when employers were still finding it difficult to hire skilled people. By 2020, the shortage could be more than 10 million workers, according to the Washington trade group, which has more than 14,000 companies as members. Even though reports from various manufacturing related organization indicates shortage of skilled labor force very little information is known about the specific skill sets found lacking especially in regards to four year college degrees in Engineering and Technology related fields.

Overview: This presentation is about a pilot study that investigates the skill sets that employers demand when hiring new four year college graduates to fill manufacturing related positions and what skills they find lacking which make it hard for them to hire candidates. This study will also investigate about the fit of engineering technology program graduates in fulfilling these employer requirements.

Major Points:

• Skills employers want
• Learning outcomes lacking in ETM programs
• New ETM graduate demand
• Aligning industry need with program outcomes

Summary: At the end of this presentation attendees will understand the pilot study results and preliminary indication of learning outcomes employers seek in new ETM employees.
Manufacturing

Analyzing Stresses and Dimensional Changes in Cold Forging Using Finite Element Analysis

Presenters:

Dr. Rajeev Nair, Assistant Professor, Department of Mechanical Engineering, Wichita State University, Wichita, KS 67260-0133, 316-978-6316, rajeev.nair@wichita.edu

Dr. Hans Chapman, Morehead State University, Morehead, Kentucky 40351, 606-783-9339, h.chapman@moreheadstate.edu

Need: Cold forging is widely used in automobile and other industries towards construction of spur gears. The manufacture of these gears by cold forging depends on many variables, especially forging parameters. The dimensional tolerance of spur gear for an automobile would be within the range of several micrometers. Therefore to manufacture these gears by cold forging, dimensions should be controlled in same range. Dimensional changes by the forging variables have to be analyzed and compensated into the forging tool. A realistic finite element model that can incorporate these variables and predict the dimension of a forged part in micrometer order helps a long way in die design. Residual stresses that form in a work piece in open and closed die forging are also a very critical component in die design. These stresses can dictate the life of the work piece and its post-forging manufacturing restrictions. It is thus very vital to understand the die and work piece mechanics and outcomes during a cold forging process.

Overview: The net-shape manufacturing of precision gear has been an aim in the cold forging industry. This is especially true for spur gears in the automobile industry. Most studies on cold forging have concentrated on the forging load and die life. Dimensional tolerance of a spur gear made using cold forging needs to be within a range of several micrometers. A closed die cold forging is carried out on a cylindrical billet made of alloy steel (SAE 4140) with tool steel (AISI H-13) as the die material. Different levels of load are applied to investigate the effects of forging load on dimensional changes and residual stresses on the work piece. The loading, unloading and ejecting stages are considered which makes the FEA analysis more realistic. A in depth study of residual stresses is done on the work piece to study the effects of forging load and die-work piece tolerances.

Major Points:

• Need to understand the effect of cold forging on dimensional accuracy and residual stresses
• A cylindrical billet is modeled and studied for a closed die cold forging
• Dimensional changes for an involute curve of a spur gear can be studied from those results
• A study of work piece residual stresses is very important in die design

Summary: Finite element analysis using Abaqus® will be employed to investigate the dimensional changes and residual stresses of die and work piece during a closed die cold forging operation on a cylindrical billet that can later be used to study the effects on spur gears which are widely used in the automobile industry. The analysis will be a dynamic explicit finite element analysis and the effects of time on the process will be studied. The post processing data obtained from the FEA study could be used to modify the involute profile of a die.
Survey of Manufacturing Topics Based on the SME Four Pillars of Manufacturing Knowledge

Presenter:

Mr. Paul Nutter, Associate Professor, Ohio Northern University, Dept. of Technological Studies, 525 S. Main Street, Ada, OH 45810-1599, 419-772-2169, p-nutter@onu.edu

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 regularly evaluate their programs to ensure they are being met.

Overview: The Society of Manufacturing Engineers (SME) published detailed study of manufacturing which includes a visual representation of the key topics for manufacturing education in a graphical form designated the "Four Pillars of Manufacturing Knowledge" (previously titled the "Four Pillars of Manufacturing Engineering"). These Four Pillars were derived from the SME certification Body of Knowledge for manufacturing engineers and technologists. To assist in program and curriculum improvement of manufacturing engineering or technology programs, a survey has been conducted of managers, company owners and educators. Respondents were asked to indicate how important each topic is for graduates of these programs. This paper presents the results and analysis of this survey.

Major Points:

- Explanation of SME Four Pillars of Manufacturing Knowledge
- Process of survey development and execution
- Documentation of data received, analysis and summary
- Implications of the results for adjustments to subject matter topics, applications and technologies for manufacturing curriculum

Summary: This paper provides documentation and evaluation of manufacturing company priorities for manufacturing engineering or technology programs. Programs can benefit by assessing their effectiveness to fulfill these needs and expectations of manufacturing industries. Recommendations are also provided for appropriate curriculum revisions to enhance the job-readiness of students to better serve these 'customers' of our academic services.
Manufacturing

“Made in America” Matters!

Presenter:

Dr. Patricia Polastri, Texas A&M University - Kingsville, TX 78363, (361) 593-2125, patricia.polastri@tamuk.edu

Need: Manufacturing is the cornerstone of economic development and the only sector that can truly boost our GDP making the US a superpower again. Global consumption is rising as developing countries improve their own economies increasing demand for manufactured goods. Our deliberate transition to becoming a service-oriented nation is having repercussions that may prove irreversible for our global competitiveness if we continue the path of neglecting the manufacturing industry. Manufacturing is far more important than any other sector in the economy.

Overview: Manufacturing is the leading factor of innovation, productivity, trade and growth. The relevance of “American made” has been lost and companies continue to outsource putting our entire economy at risk. When tangible and intangible risks of outsourcing are taken into account, making it in America is still an affordable and viable option. Outsourcing continues to be an ailment in our economy and companies usually do not evaluate their true cost of ownership.

Major Points:

- Why Made in America matters
  - Outsourcing
  - Despite positive reports, less American products are on the market
  - Service industry is not sufficient to keep the US as a leading nation
  - True Cost of Ownership Tool

Summary: Attendees will be presented with viable options to keep manufacturing at home and/or bring back what was once outsourced. The cost of ownership tool will be introduced and explained so that attendees can estimate their own profit.
A Comparative Study on the Micro-Turning of Copper, Brass, and Aluminum

Presenters:

Mr. Brandon D. Staves, Western Kentucky University, Bowling Green, KY 42101, 270-313-3582, Brandon.Staves912@topper.wku.edu

Dr. Muhammad P. Jahan, (Faculty Advisor), Western Kentucky University, Bowling Green, KY 42101, 270-745-2176, Muhammad.Jahan@wku.edu

Dr. Gregory K. Arbuckle, Western Kentucky University, Bowling Green, KY 42101, 270-745-6592, Greg.Arbuckle@wku.edu

Need: Micro tools and products are used in everyday applications including electronics, automotive, medical and aerospace industries. The need to create these micro products is quickly becoming a must. Micro-turning is a way to create these tools in a cheap efficient way, by reducing voltage, wasted space, machine cost, and even material requirement. In manufacturing, aluminum is the second most used metal and copper is the third. Therefore, completing a comparative machinability study of these two materials is crucial to the optimization of manufacturing capabilities. On the other hand, as brass is rapidly becoming one of the most expensive metals, figuring out what parameters to operate a machine around this metal will end up saving a lot of money. Difficulties often occur when machining these metals as well. Copper tends to stick to the cutting tool, and must be kept under a lot of coolant in most cases. Aluminum, being a soft material, tends to break easily with the applied cutting force. Therefore, it is important to find optimum conditions for machining these materials.

Overview: This study will be exploring the differences of surface finishes when altering various parameters. Using the data found we will compare the machining performance based on dimensional accuracy and surface finish of the part produced. When the new data is presented, a comparison between the dimensional accuracy and surface finish to the parameters will be made to determine the optimum parameters for an optimum product. Based on the optimum parameters found various products will be made to compare if the parameters are as good for different designs. This process will be done on the three materials: Copper, Brass, and Aluminum. The optimum parameters for each material once found will be compared to the other materials.

Major Points:

• Optimize the machine parameters for the micro turning of Copper, Brass, and Aluminum
• Compare the machining performance of the materials based on dimensional accuracy & surface finish
• Fabrication of micro parts and components with optimum parameter settings
• Compare the machine parameters to the outcomes of the materials. (Parameters vs. product finish)

Summary: Students who graduate to a manufacturing position or in technology management field will need to have the ability to reduce cost and provide a means of creating an optimum final product. Conducting this research to create an optimum output, at different parameters, can demonstrate this ability through optimization of a machine, as well as improve this ability that any future employer will look for.
Manufacturing
Integration of Industrial Robot in Fixturing for Machining

Presenters:

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Need: Many aerospace parts have very complex geometry and require very tight geometric tolerances, high surface finish, and crack-free under surface material quality. The challenge is even more significant when machining parts with thin-wall features. The operation of turning or milling the thin-wall feature is easy to fail mostly due to unsuitable clamping and supporting forces and vibrations. The current fixture design practices for those operations are still try and error which induces difficulties in quality control and increases processing cost.

Overview: The goal of this research is to design and construct a robot assisted fixture that can accommodate parts with different dimensions and can automatically adjust the clamping and supporting forces on a part during machining process to achieve the best machining quality and efficiency. The fixture locators and clamps are configurable to accommodate parts with similar geometry but different sizes. The fixture uses a group of pneumatic cylinders as the clamping feature for cutting force compensation. Cutting forces are monitored by force sensors mounted on the fixture. The sensor data is fed back to the control unit and processed to control the motion of the pneumatic cylinders. The robotic support is to use a robot with force control capability to move a support (dead or roller) against one side of the wall to follow the cutter which is cutting the other side. Thus, the wall can be cut with secure support (preset support force from the robot) all the time. The support force is calculated based on the forces sensed by the force sensors on the fixture and on the robot.

Major Points:

- Fixture design and construction
- Robot force control programming
- Robot and fixture integration

Summary: The project is about integration of industrial robot in machining of thin-wall parts with tight geometric tolerance and complex geometries. The fixture controls the clamping force while the robot controls the supporting force following the cutting tool. Force data collected by force sensors on the fixture and the robot are used by the controller to calculate the compensation forces from the pneumatic cylinders on the fixture and the robot.
Fault diagnosis and predictive maintenance indicate an economic issue as a more efficient technique is able to continuously monitor the concerned process and trigger an alarm or compensate for the disturbance influence before critical changes in key disturbance factors have actually occurred on the process. The performance of CNC machining in terms of productivity can be maximized with the guarantee of machining safety in automated and unmanned machining. The main requirement to improve productivity in CNC machining in real environment is diagnosing tool failures and identifying the levels of tool failures in order to replace a tool in an appropriate response time. Researches on developing tool state monitoring systems have continued in earnest from the late 1980s. However, in all cases, tool failures can only be identified and compensated after the tool and the process have already been affected by disturbance factors.

Overview: The purpose of this research project is to develop and test a feedforward control system for CNC milling operation to prevent tool failures due to thermal changes. This surveillance system is hosted by a PC remotely communicating with the process through an Ethernet network. By accurately collecting temperature data from the tool tip and applying algorithms to predict potential thermal changes on the tool, the feedforward control system is able to identify the potential damage to the tool and the time that it may occur before any damage actually happens on the tool. The control system will set an alarm, and start the compensation action. Also, the system enables operators to take preventive actions based on a comparison of the process’s current temperature signature against the “healthy” signature through signature analysis based on records in the database.

Major points:
- Literature review of the research
- Introduce the procedure and system architecture
- Analyze the system performance
- Discuss of further research and study

Summary: This research project will develop and test a tool monitoring and control system to prevent tool failures due to thermal changes, therefore, reduce damages to tools which results in a longer tool life. The system will be an automated feedfoward control system which could generate alarms and start compensation actions based on collected data and programmed algorithms.
Manufacturing

An In-Process Pokayoke System Utilizing Accelerometer and Logistic Modeling for Monitoring Injection Molding Flash Due to Recycled Plastic Materials

Presenter:

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Mr. Jiaxu (Chad) Chu, University of Northern Iowa, Cedar Falls, IA 50613, 319-429-5162, chu@uni.edu

Need: Flash, the extra material squeezed out the mold cavity, is a common problem in the injection molding process. Especially in the modern injection molding industry, machines usually are set up to automatically perform large batches of production with little attention from workers. If flash occurs, it could cause a lot of re-work and production wastes. Flash can be caused by multiply reasons as many factors such as clamping force, clamping time, melting temperature, material properties, etc. impact the process. When a recycled material is added, it may significantly change the fluidity of the primary plastic resin, and then may cause flash. With environmental concerns recently, more recycled materials are used in injection molding. There is a need to develop a real time monitoring system that will provide immediate responses to avoid flash caused by recycled plastic materials.

Overview: A pokayoke system is a mistake-proofing device, method, or mechanism that is used to ensure quality and eliminate waste by means of preventing defects rather than finding them after they have occurred. A pokayoke system will be developed through logistic modeling that uses vibration signals as input collected by an accelerometer sensor. Implementing real time injection molding vibrations, this system is able to detect the flash status of parts during the injection molding process and corresponding provide warning or even shut down the production automatically.

Major Points:

• Experimental setup – accelerometer sensor installation, molding vibration signal acquisition, and recycled material concentration
• Comparison of the vibration signals in the production of molded parts with the pure plastic resin and the mixed material adding recycled plastics
• Identification of the featured vibration signal indicating flash, and logistic modeling
• Test of the pokayoke system and possible integration with modern injection molding machine tools
• Conclude the feasibility and applicability of the developed pokayoke system for the real industrial application

Summary: Adding the real time mistake-proof feature to modern injection molding machines would help assure quality and control cost for injection molding process. By applying an accelerometer sensor and logistic modeling, this research developed a pokayoke system that can monitor the injection molded parts’ flash status due to recycled plastic material. The injection molding experimental tests indicated that the pokayoke system integrating real time featured machining signal could successfully monitor inject-molded parts’ flash status, therefore help prevent defects in timely manner. The research outcome may help increase the usage of recycled plastic material to make sustainable injection molding.
Micro-Nanotechnology

**Scanning Tunneling Microscopy as a Tool for Nano-Fabrication**

Presenter:

Dr. Muhammad P. Jahan, Western Kentucky University, Bowling Green KY 42101, 270-745-2176, muhammad.jahan@wku.edu

**Need:** In recent years, there is growing need for fabricating different shaped nano-features due to the emergence of bio and nanotechnology. A significant number of nano-structures are used for different electronic and biomedical applications; such as nano-pores for DNA detection devices, nano-vias for interconnects, nano-jets for controlled drug release, next generation fuel atomizers, nozzles for nano-fluidic devices, and molecular sieves for protein sorting. Although there are existing nanotechnologies for fabricating nano-features, those processes are mainly used for polymeric and silicon based materials. Therefore, there is a need for a nano-fabrication process that will be capable of fabricating nano-features in conductive metals.

**Overview:** This presentation will show that Scanning Tunneling Microscope (STM) can be used as a platform for fabricating nano-features in conductive materials. A novel nano-fabrication process, termed as nano-electro-machining (nano-EM), has been developed by modifying the STM platform, which is capable of fabricating nano-features in conductive materials in both liquid and air medium. This presentation will cover all the aspects of the nano-EM process: fabrication method of STM tip, evaluating quality of the STM tip, fabrication of single nano-feature and fabrication of arrays of nano-features in a single step.

**Major Points:**
- Fabrication of STM tip with mechanically sheared and electrochemical etching processes
- Evaluation of the quality of STM tip by in-situ and ex-situ analysis
- Fabrication of single and arrays of nano-features
- In-situ measurement and analysis of nano-features using same STM platform
- Explanation of material removal mechanism

**Summary:** The audience will learn the step-by-step processes of fabricating nano-features using Scanning Tunneling Microscopy platform. They will also gain some insight of the physics and material removal mechanism of the nano-EM process. The attendees will also understand how the nano-EM can be used for fabricating arrays of nano-features in any desired pattern.
Micro-Nanotechnology

**Integrating Micro-Electro-Discharge Machining with Conventional Micromachining: Development of Innovative Hybrid Microfabrication Techniques**

Presenter:

Dr. Muhammad P. Jahan, Western Kentucky University, Bowling Green KY 42101, 270-745-2176, muhammad.jahan@wku.edu

**Need:** The machining of difficult-to-cut materials, at both macro and micro scale, has become an important issue in the manufacturing industries. The conventional machining processes cannot machine these materials easily due to their extreme hardness, brittleness and toughness. However, Electrical Discharge Machining (EDM) and micro-EDM are found to be capable of machining electrically conductive materials irrespective of their hardness. Conversely, micro-EDM process also has several disadvantages, such as lower machining speed, heat affected zone, higher tool wear, poor surface finish etc. Therefore, development of microtechnologies combining non-conventional micromachining with conventional micromachining processes is of prime importance. The developed hybrid microfabrication techniques should be able to fabricate micro-parts and components with potential applications in electronics, optics, biotechnology, automotive, communications and avionics industries.

**Overview:** This presentation will cover the necessity of hybrid microfabrication techniques and the research works on the process development for integrating micro-EDM with three conventional micromachining processes: micro-turning, micro-milling and micro-grinding. Hybrid microfabrication technologies have two major advantages over single micromachining process: first it overcomes the shortcomings of a single process and second it involves in-situ tool fabrication. The presentation will show the process of fabricating small diameter and high aspect ratio micro-rods by integrating the micro-EDM with the micro-turning process. Integrating micro-EDM with the micro-milling process will allow fabricating the micro-milling tools using difficult-to-cut materials and to apply those tools in machining of micro-slots in different metals. Integrating micro-EDM with micro-grinding process allows fabrication of micro-channels in glasses with smooth edges and good surface finish.

**Major points:**
- Problem statement and need for the development of hybrid microfabrication technologies
- Overview of the micro-EDM process and its varieties
- Process development for integrating micro-EDM with micro-turning and applications
- Process development for integrating micro-EDM with micro-milling and applications
- Process development for integrating micro-EDM with micro-grinding and applications

**Summary:** The attendees will understand the importance and need for developing hybrid microfabrication techniques. They will understand the process mechanism of three hybrid processes, their advantages over single processes and applications in the fabrication of micro-features.
Micro/Nanotechnology

The Genesis of a Nanotechnology Workforce: How It Impacts Manufacturing and Curricula

Presenters:

Dr. Mark R. Miller, The University of Texas at Tyler, Department of Human Resource Development and Technology, Tyler, TX 75799, 903-566-7186, mmiller@uttyler.edu

Dr. Dominick E. Fazarro, The University of Texas at Tyler, Department of Human Resource Development and Technology, Tyler, TX 75799, 903-565-5911, dfazarro@uttyler.edu

Dr. Heshium R. Lawrence, The University of Texas at Tyler, Department of Human Resource Development and Technology, Tyler, TX 75799, 903-566-7331, hlawrence@uttyler.edu

Need: As advancements in nanotechnology continue to improve products and our lives, the growth of nanomaterial manufacturers has increased exponentially. It is estimated by the year 2020 that there will be over 2 million jobs created in the United States to meet this demand. Because of the rapid expansion of this area, a well prepared workforce will be required to compete globally. ATMAE programs need to be prepared for this new type of manufacturing and its implications towards safety.

Overview: This presentation will focus on the key factors that are involved with the manufacturing of nanomaterials and how ATMAE programs can assist in preparing the workforce required by this industry.

Major Points:

• Brief overview of the impact of nanotechnology
• Description of how ATMAE programs are suited for providing nanotechnology education
• Outline of the content required for integration into existing ATMAE program curricula
• A review of effective strategies for infusing nanotechnology-related content into existing course work

Summary: As nano-based products become more and more integrated into the products we use, the need for a properly prepared workforce arises to meet this challenge. This presentation provides a brief overview of nanotechnology and its impact on our lives. In addition, it addresses the need for ATMAE programs to integrate manufacturing and safety related content into existing course work to better prepare students for careers in nanotechnology industries. Strategies for implementation will be reviewed.
Micro-Nanotechnology

Micro-Nano Industry – US Map of Companies and Hiring Trends

Presenters:

Dr. Matthias W. Pleil, Southwest Center for Microsystems Education at the University of New Mexico, Albuquerque, NM 87106, 505-272-7157, mpleil@unm.edu

Need: It is well known that the microsystems (MEMS) industry has grown at a 9% overall compound annual growth rate (CAGR) over the last 10 years and is projected to grow at 20% CAGR leading to a $21B market by 2017. Certain MEMS sectors are growing at much higher rates (BioMEMS, Inertial Sensors, consumer applications). It is also established that the United States produces approximately half of all microsystems. In addition, there are many small startup companies poised to rapidly grow which will be in need of technicians as they move from prototype to high volume production. Identifying regions where clusters of Micro/Nano industries are located and projecting hiring growth of technicians, can assist educational institutions in determining whether or not to embark on incorporating microsystems technology educational learning modules, courses or programs.

Overview: In order to identify what regions of the country are prime for starting a microsystems technician program, certificate or series of course enhancements, the SCME has embarked on our Microsystems Industry Mapping Project. This presentation will give an overview of the nations’ hot spots for Micro/Nano companies and present results from a micro/nano industry survey completed by the SCME.

Major Points:

• Microsystems and MEMS – a rapidly growing industry
• Micro/Nano Industry Clusters
• Summary of Industry Survey – Hiring projections

Summary: The SCME is a National Science Foundation funded Advanced Technological Education Center of Excellence. We are located at the University of New Mexico, Manufacturing Training and Technology Center in Albuquerque. We can help you set up a Microsystems tech program at your school and advise you on your region’s need for Microsystems Technicians.
Micro-Nanotechnology

Introduction to Nanoscience and Nanotechnology, a New Course at the University of New Mexico

Presenters:

Dr. Matthias W. Pleil, Southwest Center for Microsystems Education at the University of New Mexico, Albuquerque, NM 87106, 505-272-7157, mpleil@unm.edu

Need: Evolving STEM programs benefit by including an introductory course in nanoscience and nanotechnology. This presentation will give an overview of the introductory course developed in the University of New Mexico’s School of Engineering. This overview will include examples of modular online distance learning and hands-on classroom activities, resources for curriculum, and a “Plug and Play” model which can be “cut and pasted,” and adapted into your programs. Participants will be provided with e-resources to take back to their institutions.

Overview: Introduction to Nanoscience and Nanotechnology taught at the University of New Mexico is not only for undergraduate science, engineering and technology majors, but also K-12 educators and anyone interested in learning about new science and technology. The purpose of this course is to give students and teachers a broad understanding and a core set of vocabulary and concepts of the science and technology used in the creation and manufacturing of nano-enabled products. This course is designed to appeal to a broad audience and does not require more than an algebra level of mathematics. The course is web enhanced, includes hands-on in class labs, topics on the key concepts of Nanotechnology, Micro/Nano applications, crystals, the many faces of carbon, and career pathways for the Micro/Nano technologist.

Major Points:
- Nanoscience and Nanotechnology
- Core concepts and terminology
- Online curriculum, and the “Moodle” model
- How to develop online educational materials
- Engaging Hands-on classroom resources
- Syllabus and Learning Outcomes

Summary: Attendees will be presented with one model for an introductory nanoscience and nanotechnology course. Discussion will include examples of tying nano concepts into the real world and “classic” courses. Electronic resources will be provided to all attendees.
Safety

**Radiological Implications of Road Construction Materials to Workers**

Presenters:

Dr. Steve K. Adzanu, Alcorn State University, Department of Advanced Technologies, 1000 ASU Drive #360, Alcorn State, MS 39096, 601-877-2346, adzanu@alcorn.edu

Need: Considered as one of the major contributors to the US economy, the construction industry employs almost six million workers (Bureau of Labor Statistics). Some of the materials commonly used in this industry may contain small amounts of radioactive materials. When workers get in touch with these materials as part of their job, there is a possibility that they get exposed to radiation dose. Also, it is important to evaluate the parameters that may provide information on the hazard levels of these radioactive materials in radiological perspective.

Overview: Radiation is part of human life and human get exposed to radiation as part of various activities (primarily job related) he/she may be involved during his/her lifetime. As part of performing their duties, specific jobs may result in radiation exposure to workers. The current effort primarily focuses on understanding radiation exposure to workers in construction industry resulted from handling construction raw materials as part of their job. Furthermore, a computed assessment of parameters that may provide information on hazard levels of these construction materials is provided.

Major Points:

- NORM activity levels in construction materials;
- Radiological implications of radioactivity materials to workers

Summary: Some of the raw materials used in road construction (Concrete, Natural aggregate [sand, gravel, and crushed stone], Compacted soil) may contain naturally occurring radioactive materials (NORM) as they originate directly from the earth’s crust. Though the radioactivity levels in these construction materials may not be that significant, usage /getting in contact to these materials over years has a high probability of creating a health hazard. Considered as one of the major contributors to US economy, the construction industry comprises of approximately workers six millions and up to 10 percent of them are laborers, who may actively or indirectly handle construction raw materials. Handling these materials for a significant period of time may result in radioactive dose to the workers. In this perspective, construction materials commonly used in the industry are collected and analyzed for gamma emitting radio isotopes using gamma spectroscopic methods. Based on the obtained results, an assessment of health hazard indicating parameters like Gamma Index, Radium Equivalent, and Radiation dose is performed. Though the results may vary based on the type of rock/soil used in the raw materials, but the study would provide a template to regulating authorities to develop standards on the usage of these materials.
Safety

Weaving an Injury Reduction Net: Incorporating Preliminary Hazard Analysis into Injury Prevention

Presenters:

Mr. Charles R. Hunt, Norfolk State University, Norfolk VA 23504, 757-823-8037, chhunt@nsu.edu

Dr. Mandara D. Savage, Southern Illinois University, Carbondale, IL 62901, 618-536-3393, msavage@siu.edu

Need: In today's complex, technological manufacturing work environment, workers are frequently exposed to numerous safety and health hazards which result in injuries and other adverse outcomes. Despite the tremendous strides that have been made in recent years towards improving workplace safety, injuries continually occur. Such injuries create an increased financial burden and unnecessary risk to workers. These injuries arise from hazards which can often be recognized and corrected via appropriate hazard analyses techniques. Increasingly, however, hazard analyses techniques are elevated to high priority and employed in large, high-risk industries. Yet, the application of hazard analysis across all sectors of manufacturing is less common. Consequently, there is an urgent need for innovations in hazard analysis and deterrence to reduce worker injuries and fatalities in medium-sized and small industries. One means of reducing such adverse outcomes is by effectively incorporating preliminary hazard analysis into injury prevention efforts. Preliminary hazard analysis should focus on three domains of the work environment: work equipment; work practices; and worker-related factors. A proactive, structured approach to identifying and correcting hazards through preliminary hazard analysis can eliminate or minimize injuries, and other hazardous events.

Overview: Preliminary hazard is an integral part of proactive safety approaches designed to eliminate or minimize workplace injuries and other hazardous occurrences. This presentation will provide attendees insight on potential harmful hazards and illustrate a structured approach/model for implementing preliminary hazard analysis in mid-sized and small manufacturing industries. The presentation will also incorporate a strategy on how to protect workers from injury through the use of energy trace and barrier analysis (ETBA) as an aspect of preliminary hazard analysis. Relevant issues, strategy techniques, and examples will be shared in the presentation.

Major Points:
- Hazard risk definitions
- Rationale for incorporating preliminary hazard analysis into injury prevention
- Types of hazards/energy sources and their effects on workers
- Hazard/energy targets
- Structured approach/model for implementing preliminary hazard analysis
- Example applications of energy trace and barrier analysis (ETBA)

Summary: In highly competitive and fast changing manufacturing sectors, workplace safety and health remain vital concerns. This presentation will illustrate a structured approach/model for implementing a preliminary hazard analysis via mid-sized and small industries. It will also provide attendees insight on protecting workers and other targets/assets from potential hazardous/energy sources associated with manufacturing.
Safety Concerns for Wreckers in Houston’s Roadways

Presenter:

Dr. Aiman Kuzmar, Ph. D., P.E., Associate Professor of Construction Management and Engineering Technology, Department of Agricultural and Industrial Sciences, Sam Houston State University, Box 2088, Huntsville, TX 77342, 936-294-1228, ask008@shsu.edu

Need: Transportation is a vital component in our society. We use roadways daily for various purposes. Safety in transportation has been and will always be a major concern for all of those who use roadway systems, and all of us do. Many groups that are involved in the transportation system are more susceptible to hazards associated with roadways including construction workers, police officers, and ambulance drivers among others. Another group which is the topic of this paper is wrecker drivers. There is always a need to hear the concerns of those who are at elevated safety risks. Minimizing the detrimental effects of roadway hazards on everyone including wrecker drivers results in saving lives and protecting property for everyone among many other benefits.

Overview: This field research study explores safety concerns for the wrecker industry in Houston, Texas. The main tool is interviewing and listening to those who are at the center of this safety concern: wrecker drivers. The study is limited to selective individuals in Houston, Texas. It can be later expanded to other areas in Texas and beyond Texas to validate or dispute its findings. Wrecker drivers are laying out concerns that are addressed by transportation authorities as well as complaints about roadway hazards that are neither addressed nor even acknowledged by policy makers.

Major Points:
- Importance of Transportation
- Safety in Roadways
- Wreck Industry and Safety Concerns
- The Results of the Field Research Study
- Conclusions
- What Can be Done and Other Recommendations

Summary: This research field study investigates safety concerns as heard directly from wrecker drivers in Houston, Texas. Conclusions will be made and several recommendations are going to be offered.
Safety

Introduction of Building Information Modeling for Emergency Responders

Presenters:

Mr. Perry Moler, Texas A&M University – Commerce, Commerce, TX 75429, 903-886-5361
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Need: There is an increasing need for emergency responders to use the best technology available to them. One of the latest technologies that can be used is Building Information Modeling (BIM). These 3-D models would allow responders to visualize the layout of an environment before moving on. Many new construction and renovation projects are built using BIM models. These models are being stored onsite and available to responders. These models can be used for training programs as well in emergency situations (e.g. fires, hostage situations, and entrapments). This would have the potential for faster responses with less collateral damage.

Overview: This presentation deals with the potential benefits of using BIM models to assist emergency responders. The presentation would also entail what BIM is, how it is currently used on construction and renovation projects and how these models compare with current emergency response modeling techniques. One of the many advantages of using BIM models is that these models can be linked with various other software programs allowing for realistic training simulations. There are some future applications for outside environments by using 3-D scanning technology.

Major Points:
- Understanding BIM
- Connecting BIM models to other software programs
  - Training Simulation
  - Real word application
- Future applications

Summary: Attendees will understand potential benefits of using BIM technology in emergency situations. The presentation's topics will include current applications of BIM technology and how this technology can assist emergency responders, how these models can be connected to other software programs for training simulations and possible future applications by using 3-D scanning technology.
Safety

Measuring Worker Safety Culture in a High-Hazard Work Environment

Presenters:

Dr. Gretchen A. Mosher, Iowa State University, Ames, IA 50011, 515 294 6416, gamosher@iastate.edu

Mr. Saxon Ryan, Graduate Student, Iowa State University, Ames, IA 50011, saxon@iastate.edu

Co-Author: Mr. Aldane Greco, Graduate Student, Iowa State University, Ames, IA 50011, 615 315 0199, greco@iastate.edu

Need: Developing a culture of safety is difficult in all work environments, but it is especially challenging in a high-hazard environment. Because many of the hazards are familiar and common to the workers, educating them to take work hazards seriously can be challenging for safety professionals. The creation of a strong safety culture in high-hazard work environments is important because of the short-term and long-term risks to the workers’ health and safety, yet little research has explored the challenges of measuring and analyzing workers’ perceptions of risk in these environments.

Overview: This presentation will discuss the challenges of developing a safety culture for high-hazard work places and the importance of safety culture in these environments. Factors considered in the measurement and analysis of worker health and safety risks in high-hazard work environments will be shared. Strategies for a valid measurement of worker perceptions of health and safety risks will be discussed. Worker training implications for safety professionals will also be shared.

Major Points:

• Challenges in the development of a culture of safety in a high-hazard work environment
• Factors in measuring and analyzing worker perceptions of health and safety risks
• Strategies for valid measurement of worker perceptions of health and safety risk
• Worker training implications for safety professionals

Summary: The audience will learn about how a culture of safety can be created for a high-hazard work environment. Factors and strategies for the development of an effective safety culture will be discussed. Training implications for safety professionals will be shared.
Safety

Developing the Future Workforce to Use Avian Radar to Prevent Wildlife Strikes at Airport

Presenter:

Dr. I. Richmond Nettey, Associate Dean, College of Applied Engineering, Sustainability & Technology, Kent State University, Kent, Ohio 44242, 330.672.9476, inettey@kent.edu

Need: Between 1990 and 2007, there were 79,972 bird, 1,737 terrestrial mammal, 253 bat and 95 reptile strikes reported to the Federal Aviation Administration (FAA). Between 1998 and 2008, wildlife strikes in aviation killed more than 219 persons and destroyed 200 aircraft (Dolbeer and Wright 2009; Thorpe 2003; 2005). Wildlife strikes cost $625 million a year in the United States alone and cause 500,000 hours of passenger delays (Dolbeer and Cleary 2005). The global cost of wildlife strikes per year is $1.2 billion (Allan 2002). Some 98% of wildlife strikes involve birds; which points to the need for developing a future workforce that can use avian radar to reduce or eliminate bird strikes in the vicinity of airports. The need for effectively educating and developing the future workforce to use avian radar to eliminate bird strikes encompasses all sectors of ATMAE’s membership in academia, business, government and industry.

Overview: At least 95% of all birds struck by aircraft are protected under the Migratory Bird Treaty Act of 1918 (Dolbeer and Wright 2009) and the resident non-migratory Canada goose population in the US and Canada have increased by an average of 7.3% annually (Sauer et al, 2007). With continued growth in the volume of airline service and flight activity, this is a problem destined to get worse with serious implications for air transportation, the economy, and passengers.

Major Points
• Radars deployed during WWII could detect birds (Lack and Varley, 1945).
• Both x-band and s-band radar transceivers have been developed to track birds and aircraft (Nohara, et al 2007)
• ASR-9 and WSR-88D Doppler weather surveillance radar have also been used for bird target detection over ranges of 60nm and 124 nm, respectively (Weber et al, 2005, Larkin 2005)

Summary: The proposed session will discuss the problem of wildlife strikes in aviation and examine ways of addressing the said problem by developing the future workforce to use avian radar in an integrated approach that includes all professional sectors served by the members of ATMAE.
Safety

Summary and Statistical Analysis of Farm Work-Related Fatalities from 1994-2012

Presenter:

Dr. Ernest J. Sheldon, CSTM, Indiana State University, Terre Haute, IN 47809, 812-237-2865, esheldon@indstate.edu

Need: Although the overall trend in farm work-related fatalities has been downward for the past three decades, the rate of fatal injuries in agriculture remains six to eight times the national rate for all industries. Particularly troubling is the fact that the majority (58%) of those injuries occur to either children under the age of 18 or individuals 60 and over. This presentation will summarize results from 19 consecutive years of Indiana farm fatalities reports (>400 total incidents, 2012 data not yet available), examine differences in injury causes between various age groups, then will suggest explanations for the disproportionate numbers of youth and older farmers involved in these incidents.

Overview: Fatal farm work-related injuries were recorded in Indiana during the years 1994-2012, and average of 22.4 cases per year. Most recent Census of Agriculture data show the state with 60,938 farms. More than 45% of the recorded deaths involved individuals 60 years of age and older, and nearly half of the total incidents involved tractors. Children, often from counties with large Amish populations, were much more likely to die from injuries involving livestock than other age groups. Entanglements with farm machinery, entrapments/suffocations, falls other than from a tractor, and all other causes did not appear to affect any one age group disproportionately more than another.

Major Points:

• Individuals age 60 and above account for 45% of the fatal injuries on farms in the state, even though this group contributes a relatively small proportion of the total labor force on farms.
• Tractors were involved in 47.4% of the cases, including roadway collisions and falls from tractors. Older individuals were more likely to die in tractor incidents than other age groups.
• Livestock, primarily horses and cattle, are involved in roughly 10% of the cases, but are more prevalent among children.
• Fatal injury rates in the agriculture industry remain at least six times the rate for all industries.

Summary: Attendees will understand the scope of the problem of fatal work-related injuries among farmers and the challenges of modifying traditional behaviors and physical factors that the farm population holds so dear.
Safety

Assessment of Your Health and Safety Training Program

Presenter:

Dr. Richard A. Stempniak, Buffalo State (SUNY), Buffalo, N.Y. 14222, 716-878-6006,
STEMPNRA@BuffaloState.edu

Need: When training, the principal value of an employer’s Safety and Health training is in what an employee learns. It is therefore imperative that this training is evaluated and/or assessed following the Health and Safety training.

Overview: When presenting Health and Safety training, we can use Donald Kirkpatrick’s Four Level of Evaluation Metrics to assess your Health and Safety Training. In addition to Kirkpatrick’s Metrics this presentation will focus on the benefits of assessment, types of assessment, who assesses, when to assess and the methods of assessment and data collection.

Major Points:

- Kirkpatrick’s Four levels of Assessment
- Why do we assess?
- Who does the assessment?
- Benefits of assessment
- Conclusions and recommendations on assessment

Summary: In any organization assessment is essential to improving your organization’s Health and Safety program. Attendees of this presentation will have a basic understanding on how and why assessment is used in improving your Health and Safety Training Program.
TEACHING INNOVATIONS
Teaching Innovations

**Sustainability Curriculum Development**

Presenters:

Mr. Scott Abney, PhD Student, Purdue University, West Lafayette, IN, 859-749-3299, sabney@purdue.edu

Mr. Jeremy Johns, PhD Student, Purdue University, West Lafayette, IN, 765-479-2509, icjohns@purdue.edu

Need: Trends in industry are moving to a focus on Sustainability. A cohort of professors at Purdue University noticed this trend and are trying to get meet the market need by developing a Certification of Sustainability through the College of Technology. The certification focuses on three core courses along with a course related to the student’s educational interest. As to date, only one course has been offered as a test run to try to draw conclusions of interest based in the program.

Overview: This presentation represents the viewpoint of the development of the Sustainability Certification from the perspective of graduate assistants working to help develop the certification along with students attempting to complete the certification as it is rolled into practice. Many of the struggles of creating such a certification program are pointed out and suggestions for improvement are made from both a teaching and learning experience.

Major Points:

- The need for a sustainability program to meet market and employer demands
- The difficulty that exists between correlating a program when many professors are involved
- Marketing the program to those outside the College of Technology and why cohesiveness is necessary
- A student’s perspective of being in the program, expectations versus reality
- Recommendations for improvement from both perspectives

Summary: The increase in corporate and social awareness in sustainability is only going to continue to grow. For example, as of now it is stated 93% of CEO’s have listed sustainability as an important component of their strategic plans. From this it is important for universities such as Purdue, to offer education opportunities to students that they will be able to use in future employment.
Teaching Innovations

STEM Scholars Bridge Program for Increased Student Retentions, Internship and Career Exploration at University of Southern Maine

Presenter:

Dr. Carl N. Blue, University of Southern Maine, Gorham, ME 04038, 207-780-5391, cblue@usm.maine.edu

Need: The pilot study and evaluation the effectiveness and scalability of a NSF/USM STEM Scholarship Program as a means to improve STEM educational opportunities from entry to degree completion for 41 academically talented and financially needy incoming freshmen and community college transfer students who are interested in careers in Computer Science, Engineering, Environmental Science, and Technology Management. Students who meet the academic and financial selection criteria will be awarded up to $5,000 in scholarship funds. Students will be recruited from four feeder schools and three local Community Colleges.

Overview: In the summer of 2012, the National Science Foundation awarded the University of Southern Maine with a grant for STEM Opportunities for Academically Capable and Financially Needy Students: University of Southern Maine STEM Scholars Program. The presentation provides information on the Summer Bridge Program that was developed as well as the progress our model for blending the elements of recruitment, retention, and placement into an integrated, comprehensive but non-intrusive program that promotes student success in transitioning from high schools and community colleges to University of Southern Maine. In the terms of broader Impacts: The project provides increased opportunities for a larger, more diverse population of students, non-traditional, underrepresented and first generation, to obtain a STEM degree and to be placed in an awarding STEM job upon graduation.

Major Points:
- Overview of Summer Bridge Program
- Implementation Strategies
- Current successes
- Year One reflection

Summary: Students must demonstrate academic progress and financial need to continue the scholarships. USM’s objectives are to attain a retention rate or higher rate of graduation with assistance in placement in STEM jobs, and to establish articulation agreements with the participating community colleges. Support services include Summer Bridge Program, Advising Mentors, a Living/Learning Community, Peer Mentors and Tutors, STEM Career Awareness Seminars; Career Planning Workshops, and optional Summer Internships, Co-Ops, and Undergraduate Research Fellowships.
Teaching Innovations

The Implementation of Service Learning into Undergraduate Emergency Management Technology Courses

Presenters:

Dr. Jessica L. Buck, Jackson State University, Jackson, MS 39217, 601-979-1145, jessica.l.buck@jsums.edu

Co-Authors: Ms. Arlisa Thomas, Jackson State University, Jackson, MS 39217, 601-979-1145, arlisali@yahoo.com; Mr. Walter Hurst, Jackson State University, Jackson, MS 39217, 601-316-8111, walterhurst1@gmail.com

Need: As we transition from year to year, both natural and man-made disasters continue to rapidly escalate. To respond to the urgent need for community safety and disaster preparedness, more competent practitioners should be produced through academic programs with rigorous hands-on activities. This can be done through training opportunities based on course objectives. On integral classroom activity that will greatly assist in developing competencies for future emergency management practitioners is service learning. Service learning is a process in which students take classroom applications and experiences to assist in fulfilling a societal need. In addition to students having the opportunity to apply classroom theory on emergency management functions (i.e. mitigation, preparedness, response, and recovery), it brings awareness of emergency management careers and develop needed skills.

Overview: The Newtown, CT tragedy at Sandy Hook Elementary took the Nation by surprise in December 2012. Since then, there have been numerous outbreaks of school violence. In addition, unusual weather patterns have caused unprecedented storms that have disrupted services, and caused both property loss and deaths. The better serve the community, the nation, and the world, more emergency management practitioners are needed with distinctive skills for major disaster preparation and expedient responses. Employment projections increased with anticipated 22% grow to emergency management practitioners between 2008 and 2018 (U. S. Bureau of Labor, 2008). There has been an increase of academic programs on both undergraduate and graduate levels. However, the concept of Service Learning renders meaningful learning objectives that will help in develop and enhance skills for such a demanding area.

Major Points:
- Describe recent incidents which validates need for emergency management Practitioners
- Discuss how more academic programs are being establish, Nation-Wide
- Describe the emergency management (EM) Technology Program at Jackson State University and how service learning was incorporated into EM courses;
- Identify service learning projects implemented by EM Technology Students at Jackson State to local community organizations and discuss effectiveness; and
- Describe how service learning projects enhance student skills; bring awareness of EM careers; and how service learning projects assist with community safety and disaster preparedness.

Summary: To assist in fulfilling the need of community safety and disaster preparedness, emergency management Technology students may participate in service learning activities to enhance their awareness of societal needs and develop skills. In order for emergency management Technology students develop competency in this area; there must be research, assessment, and the evaluation technology deficiencies in a community.
Teaching Innovations

A Critical and Creative Thinking Toolkit for Manufacturing Students and Professionals

Presenters:

Dr. Vigs Chandra, Eastern Kentucky University, Richmond, KY, 40475, 859-622-1187, vigs.chandra@eku.edu

Dr. Ray Richardson, Eastern Kentucky University, ray.richardson@eku.edu

Mr. Jeff Kilgore, Eastern Kentucky University, jeff.kilgore@eku.edu

Need: Preparing manufacturing students for the global workplace requires them to have not just a strong technical foundation, hands-on skills, and appropriate professional attitudes, but also a good grasp of critical and creative thinking techniques for solving complex problems. These higher-order thinking skills such as analysis, synthesis and evaluation cannot be taught in isolation or in just one course, rather they need to be covered across the curriculum. There is thus a need for a critical/creative thinking toolkit that technology students or professionals can readily access while trying to solve problems and to understand issues at a deeper level.

Overview: The presentation will focus on techniques and strategies for fostering critical/creative thinking skills for students manufacturing programs. Each technique includes an example and an illustration explaining how it can be used in specific classes or laboratories part of a typical manufacturing program. In general, scaffolding the development of higher-order thinking skills is needed before we can expect students to perform these independently. Using the techniques suggested in the toolkit they will be able to develop effective solutions to complex problems and improve existing designs for keeping pace with advances in manufacturing technology.

Major Points:

● Inventory of workplace skills needed by manufacturing graduates including critical and creative thinking
● Identifying thinking processes independent of the context so that these can be applied for developing innovative solutions to technical problems, taking positions, or making decisions
● Examples of structured in-class and laboratories activities used in specific manufacturing classes for improving critical/critical thinking
● Impact of the classroom or lab environment on fostering higher-order thinking skills and reflective participation in a group setting
● Using analogies for making meaningful interconnections between technical topics and personal experiences in order to deepen understanding
● Suggestion from manufacturing courses for building awareness about thinking skills so students can effectively prioritize content, identify the core ideas and interconnect these effectively.

Summary: The presentation will provide information about a free, online critical/creative thinking toolkit of techniques for use in the electronics/computer technology classroom and in the workplace. Techniques such as thinking hats, reverse brainstorming, tug-of-war, compass points, among numerous others included the toolkit can be used to understand situations, to solve problems, and to effectively navigate the complexities that await them as professionals. These techniques can be used to spark interest in abstract technical topics, get students excited about learning, motivated to find answers on their own, to consistently apply higher-order thinking skills, to experiment and successively improve their work, our students will be well on their way to becoming self-regulatory learners and successful technologists.
Teaching Innovations

**Customize Laboratory Using Microcontroller for New Automotive Technology Education**

Presenters:

Dr. Phillip Cochrane, Indiana State University, Terre Haute, IN 47809, 812-237-3978 phil.cochrane@indstate.edu

Dr. Affan Badar, Indiana State University, Terre Haute, IN 47809, 812-237-39822 m.affan.Badar@indstate.edu

Need: In academia, with few exceptions, engineering and engineering technology programs have been islands, each discipline maintaining sovereignty within the context of their program. This single silo approach is contrary to the needs of industry and the best interests of students. In an emergent age of intelligent vehicles, evolving robotics, and advanced manufacturing, what is clearly needed are multi-disciplined technologists.

Overview: In September of 2012 ISU’s NSF proposal Customize Laboratory using Microcontroller for New Automotive Technology Education (CULMINATE) was approved. CULMINATE recognizes that computer engineering students lack experience in the mechanical systems that microprocessors control. Similarly, automotive and mechanical students have a low level of comfort when considering the microprocessors that will control the systems they design. Based around an automotive platform, CULMINATE will have computer engineering technology students co-design application specific board micro-controller boards that will integrate sensing, controlling, and communication in the engine microprocessor. These boards will also be used as training aids to simulate control and sensing anomalies. This is the first year of three- year program. While there are no specific results, there are lessons learned and progress reports worth sharing.

Major Points:

- Most current programs lack a multidisciplinary approach
- Industry needs multi-disciplined technologist
- ISU’s NSF sponsored CULMINATE program is attempting to cross pollinate computer, mechanical, and automotive disciplines
- This is a progress report for CULMINATE’s inaugural year

Summary: Indiana State University received an NSF grant for a cross-discipline approach to technology education. In its inaugural year, using an automotive platform, this program will have computer engineering technology students working with automotive and mechanical students to design application specific boards for engine dynamometer testing and training.
Teaching Innovations

The Changing Face of Technology Education: Shovel Ready Education

Presenters:

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Mr. Daniel Cassler, University of Houston, Houston, TX 77049, 713-743-1330, dcassler@uh.edu

Co-Author: Dr. Raymond E. Cline, Jr., University of Houston, Houston, TX 77049, 713-743-9244, recline@uh.edu

Need: Society has been changed by sweeping revolutions, agricultural, industrial, and information, and each has been disruptive and sweeping in nature. We are entering another era of revolution, the Technology Revolution. Workers are being replaced by robots, new materials make the previously impossible affordable, “science” is changing everyday life. Labor is being removed from products. These changes will create opportunity for higher education to adapt and shape the minds that will lead this revolution. Technology will be the driver of economies worldwide – how will tomorrow’s workforce be ready to lead this effort, with the skills of the past, or those of the future?

Overview: The age of technology has arrived. Changes in materials, methods, robots, 3D printers, network/intelligent enabled devices, these are just the beginning of changes. This new era will require new thought leadership, in new areas, some of which do not even exist today. Technology is becoming its own discipline, driving change with more authority than a mere multidisciplinary effort. The workforce of tomorrow will be doing tasks not even known today, and higher education must move to create the workforce that will lead this new world order. Technology as a discipline will drive the thought leaders that shape our tomorrow. This session will describe how to structure a mix of engineering, science, business on top of a foundation of the principles of technology to create a shovel ready workforce for the new era.

Major Points:

• The sweeping and disruptive nature of the technology revolution
• The role of technology degrees and curricula in a technology driven era
• Foundational elements of future worker skill sets
• The rise of a new discipline: Technology
• Course changes, conclusions, recommendations

Summary: Attendees will understand the need to adapt education efforts to meet the challenges that the leaders of the technological age will need to be successful in the new world of technology driven society. Disruptive sweeping changes will affect all aspects of society and those that are prepared to lead in the new era will be leaders of tomorrow. A new discipline is here: Technology.
Teaching Innovations

Building Better Writers: Using Technology to Enhance Feedback in Technical & Professional Writing

Presenter:

Dr. Carolyn Kusbit Dunn, East Carolina University, Greenville, NC 27858, 252-328-9661, dunnca@ecu.edu

Need: Employers consistently rate writing and communication as critical skills for the future workforce, which leaves the college instructor the task of helping students become the competent communicators and writers the workforce needs. In order to improve, student writers need more than a focus on content; numerous scholars note that improving writing also requires consistent, regular and meaningful feedback throughout the writing process. Providing this kind of feedback can be time consuming and labor intensive for the instructor. This presentation will focus on the use of a particular audio/video software to provide feedback that includes both written comment and voice/video narration. The tool allows the instructor to provide the student with feedback on each assignment that essentially becomes a “mini” one on one conference the student can keep and review at any time. I will present the results of a pilot study being done this spring on utilizing this feedback method. The presentation will include an introduction of the need for better writers in the workforce, the importance of feedback, and the results from the pilot study. It will also include a demonstration of the tool.

Overview: Teaching engineering, technology and industrial technology students how to write is considered a critical skill for future employment. The kind of writing done in a technical writing course focuses on the genres the student will reproduce in the workplace, and involves teaching students how to write particular workplace documents such as technical descriptions, proposals and technical reports. But it also requires that the instructor provide consistent and meaningful feedback, which scholars indicate is an important component of writing instruction. This presentation will focus on the importance of writing and communication in the workplace, the importance of feedback in writing instruction, and the results of a study that implemented audio/video technology to augment traditional written feedback of student writing.

Major Points:
• Need for producing proficient writers and communicators for the workplace (Advisory Councils, Industry)
• Role of feedback in teaching writing (Academia)
• Using technology to provide audio and video feedback to student writing
• Demonstration of technology
• Results of pilot study utilizing audio/video technology to provide feedback.
• Pilot Study conclusion and recommendation.

Summary: Attendees will understand the important role feedback plays in preparing student writers for the workplace, and learn specific strategies for implementing a feedback strategy in the classroom. The presentation will also explore the method, results and conclusions of a pilot study utilizing technology to add an audio/video component to augment written feedback of student writing.
Teaching Innovations

Adding Lean Manufacturing Simulation Capability to a Flexible Manufacturing Line

Presenter:

Dr. Dennis Field, Eastern Kentucky University, Richmond, KY 40475, 859-622-6781, Dennis.Field@eku.edu

Need: Many manufacturing organizations have embraced Lean methods. In order to meet industry needs, applied engineering and other technology management students must be familiar with Lean. The more realistic the training activities are that can be provided to students, the more ready they will be to immediately enter the workforce and contribute to these organizations.

Overview: The presentation will provide an overview of recent activities at Eastern Kentucky University involving the upgrade of a flexible manufacturing line to incorporate Lean Manufacturing simulation capability. These activities were undertaken by students as part of an Applied Engineering Management capstone class. The class provided an excellent learning opportunity for Capstone students as they had to be thoroughly familiar with lean principles in order to upgrade the line, while future students being introduced to Lean concepts are going to benefit from the availability of the Lean simulation capability.

Major Points:

- Knowledge about Lean Manufacturing is an important component of the skill set of Applied Engineering Management graduates
- Realistic training activities enhance the ability of students to immediately contribute to organizations as they enter the workforce
- There is a two-fold benefit in involving upper division students in upgrade efforts: Upper division student must approach the problem from an implementation perspective, while novice students are provided a realistic learning environment.

Conclusion: Given the widespread application of Lean principles, it is important that students are provided the most realistic learning experiences possible.
Teaching Innovations

**Using Conceptual Mapping to Enhance Student Learning, Planning, and Thinking Skills**

Presenters:

Dr. Tad Foster, College of Technology, Indiana State University, Terre Haute, IN 47433, 812-237-4508,  
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**Need:** It almost goes without saying that educators at all levels are still looking for ways to maximize their effectiveness in facilitating student learning. Since the 1970s, a growing number of scholars and practitioners have turned their attention to the use of conceptual mapping techniques. There is a growing and convincing body of research that demonstrates that students who employ these techniques learn faster, remember better, and are more able to apply what they know to novel situations. However, there is also evidence that teaching these techniques at the university level has achieve only modest success (i.e., it is difficult to get them to employ the techniques.

**Overview:** The focus of this session is to help university educators understand conceptual mapping and learn how to map concepts and processes using readily available open-source conceptual mapping software. They will be provided a brief summary of the cognitive science research on this subject starting with Joseph Novak’s seminal work in 1974. In addition, the participants will be provided an update on the NSF-funded Diagnostic Skills project at Indiana State University, which was first introduced at the 2012 Nashville Conference.

**Major Points:**
- A brief overview of the research base for these techniques
- An update on the NSF-funded Diagnostic Skills project at Indiana State University
- How-to instruction on conceptual mapping and its various uses using the Visual Understanding Environment software.
- Implications for technology and engineering educators

**Summary:** Research has demonstrated that conceptual mapping is an excellent tool in helping individuals learn. In practice, we have found that it is a very useful tool for teaching, evaluation, planning, and all aspects of problem solving. During this session, participants will learn about this technique and its various uses and about the open-source software packages they can adopt for their own teaching, scholarship, and service. In addition, there will be an update on the NSF-funded Diagnostic Skills project at Indiana State University, which is developing a training program that employs process mapping as a means of enhancing diagnostic skills.
Teaching Innovations

What's Happened to My Classroom? Pedagogy for the Millennial Generation

Presenter:

Mr. Gabe J. Grant, Eastern Illinois University, 600 Lincoln Ave, Charleston, IL, 61920, 217-581-3372, gjgrant@eiu.edu

Need: The majority of educators in engineering and technology education recognize that the classroom has changed. Many of the faculty do not have formal instructional and learning theory backgrounds or may not stay up to date with education and generational trends. Current conditions in secondary education have compounded the situation as pedagogical techniques used in these contexts are focusing more on standardized assessment success rather than preparation for college and career readiness. As a result, shifts in the learner population provide struggles for both the learners and faculty members when instructional and assessment strategies do not align with learner characteristics. In this presentation, the presenter will describe the characteristics of the millennial generation, conditions of secondary higher education, classroom implications of these factors, and selecting alternate instructional and assessment strategies.

Overview: The classroom has changed for higher education faculty members. Students are often criticized as less prepared, less motivated, and less knowledgeable than previous generations. Research has shown that learners entering college are more culturally diverse than previous generations. Further, this generation is passing through secondary education at a time when reform has shifted educational focus. As a result, faculty struggle to find ways to effectively deliver valuable technical knowledge to these learners. When students do not acquire technical knowledge and skills, prospective employers are left to pull from an ever-shrinking pool of qualified candidates. It is necessary that faculty use instructional and assessment strategies that provide for learners the opportunity to demonstrate knowledge, function in the workplace after graduation, and promote effective lifelong learning. Active learning and authentic assessment strategies are best paired with learners only after understanding the backgrounds of the individual and the educational methods how and environments where the learners have been previously educated. This presentation will focus on the characteristics of the millennial generation, conditions of secondary education, the impact of these factors on what faculty experience in the classroom, and selection of instructional and assessment strategies based on these factors.

Major Points:
• Description of millennial generation and cultural aspects
• Description of assessment and political conditions that exist in secondary education contexts currently
• Implications and effects of learner and secondary classroom characteristics
• Reviewing and selecting alternate instructional and assessment strategies

Summary: Attendees will understand the characteristics of the millennial generation of learners, conditions of secondary education, and impacts on higher education pedagogical practices.
Teaching Innovations

Project Based Learning and Industry Sponsored Student Competitions

Presenters:
Dr. Mitchell E. Henke, Chowan University, Murfreesboro, NC 27855, 419-575-1100, henkem@chowan.edu
Dr. Sonya R. Draper, North Carolina A&T State University, Greensboro, NC 27411, 336-285-3153, drapers@ncat.edu

Need: Industry sponsored student design and technology competitions provide potential benefits for students, faculty, programs, and industry. When opportunities for competitions are presented to students, time and budget constraints for both faculty and students can inhibit participation.

Overview: There are many opportunities for students to participate in sponsored design and technology competitions. When students enter competitions relating to their discipline the resulting recognition can be beneficial to the student, program, and, if applicable, their faculty mentor. The difficulty lies in getting students to enter submissions in addition to their other course responsibilities. By incorporating a student competition as a project in a class, participation and the quality of the entry increases.

Major Points:
• Review of project based learning.
• Student design and technology competitions.
• Benefits of using student competitions in a project based learning environment.
• Creating a culture of participation.

Summary: Using industry sponsored student design competitions can provide students the opportunity to interact with industry professionals and to evaluate their performance with peers outside of their home institution. Incorporating competitions in a project-based course allows participation with less of a time burden.
Teaching Innovations

Developing Real-World Learning Experiences through the Packet Tracer Network Simulator

Presenters:

Dr. David Hua, Ball State University, Muncie, IN 47306, 765-285-5659, dhua@bsu.edu

Need: Students majoring in information technology degree programs need a strong foundation in the theoretical underpinnings of data communications. But this is not enough when preparing students to enter into the information technology workforce. There is the need to go from theory to practice. Students need to learn the applied skills that evidence their understanding of the data networking concepts and theories. The difficulty is providing enough hardware for students to hone their applied skills. The use of network simulators like Packet Tracer provides a low cost alternative physical hardware. The problem is that the default settings of Packet Tracer create a learning experience that removes key steps that are required when working with physical hardware. Packet Tracer also has some limitations that make it vulnerable to academic dishonesty.

Overview: The presentation will identify the challenges to providing students in a data networking course with opportunities to develop the applied skills required by information technology professionals. It will be shown how Packet Tracer can be used to address this challenge. While Packet Tracer is a powerful tool in teaching data networking it does have limitations. The presentation will provide strategies to overcome these limitations.

Major Points:
- Identification of the need for simulators in information technology education
- The strengths and limitations of the Packet Tracer network simulation software will be presented
- Strategies for altering configurations of Packet Tracer to more closely reflect the experience of working on physical hardware and reduce the temptation for academic dishonesty by students

Summary: Conference attendees will leave the presentation with an understanding the strengths and limitations of using the Packet Tracer network simulator within an information technology curriculum. Attendees will learn how to modify the program configurations to create a learning experience on the simulator that more closely reflects what a student would experience when working on actual network hardware. Attendees will receive handouts with the configurations demonstrated in the presentation so that they can incorporate them into their own teaching.
Teaching Innovations

Using a Reality-Based Project to Teach Technical Subjects

Presenters:

Dr. Sudershan K. Jetley, Bowling Green State University, Dept. of Engineering Technology, Bowling Green, Ohio 43403. 419-372-2608, sjetley@bgsu.edu

Mr. Anthony Palumbo, Bowling Green State University, College of Technology, Bowling Green, OH 43403.419-372-7602, apalumb@bgsu.edu

Need: Traditionally meeting our nation’s needs for trained individuals has been the responsibility of our educational institutions. Engineering education continues to be criticized by industry for not producing students with relevant problem solving experience. Recent trend toward reducing funds to higher education requires instructors to find ways to provide relevant problem solving skills and experience for their students. Motivating students when teaching abstract concepts with assignments that have non-apparent practical application can be a challenge. Making students work under a real deadline, in a situation that applies what they are learning that provides a student with responsibility and immediate feedback is highly desirable. The presenters chose a reality based or capstone instructional strategy to provide the means to fulfill this need.

Overview: Sustainability is one of the focus areas of the College of Technology at BGSU. Hence the College offers a course ENGT 3250 Introduction to Sustainability. The national goals to reduce, energy dependence, maintain clean air and create jobs for Americans is widely known. Electric propulsion systems are being applied to vehicles in hybrid and plug-in electric configurations. Consumers must understand the sustainable advantages and benefits of owning and operating these vehicles. Consequently, the demand for trained personnel to design, build and maintain them will increase. In light of these trends, the ENGT 3250 instructors used EV Grand Prix as the laboratory component for the students. EV Grand Prix is an international competition requires students to: organize as teams, fund, design, build and race electric powered racers. The students were given individual sub-projects to design and build the racer according to specification and to conduct an out reach campaign. Student motivation and learning is high because of the racing competition. This presentation will show how these sub projects were conducted and the final results.

Major Points:
• Managing the content and the class to build the electric racer and the outreach campaign
• Procuring funds and the latest equipment for the project
• Presentation of results of the sub project and experience of the project as a whole and running the race at Indianapolis Speedway

Summary: This study serves as model for using self-funded reality based, capstone project activities as a teaching strategy. The experience of students building electric racers, working in teams and making presentations has similar merit. This strategy though used in this study to apply sustainability measures can be applied to other subject materials provided the instructor(s) keep focus on the class objectives.
Teaching Innovations

Connect Students and Industry with a Required Internship

Presenters:

Mrs. Brenda Jochum, University of Nebraska at Kearney, Kearney, NE, 308-865-8122, JochumB@unk.edu

Mr. Scott Jochum, University of Nebraska at Kearney, Kearney, NE, 308-865-8693, JochumSL@unk.edu

Need: Companies have a need for qualified employees. Without an internship, a graduate may have no relevant experience and few industry connections. A required internship fills this void; however necessary preparation and company involvement must be present to be successful.

Overview: Through a required internship program, students gain necessary experiential learning experiences and skills needed for success upon graduation. The internship program needs to include preparation on the process of securing an internship, opportunities to network with companies, and meaningful academic requirements. For the academic program to most effectively capitalize on the experiences, a framework of collaboration among the students and the academic program should be incorporated.

Major Points:

- Preparation of students prior to internship is a necessity
- Building relationships with companies and providing companies opportunities to connect with students is critical
- Involvement of faculty and staff in the process is essential to a strong program
- Academic requirements contribute to the transition of student to professional

Summary: An internship model proven to be effective in developing the future workforce will be presented. This includes a yearlong process of preparation, strong company relationships, and academic requirements that contribute to the professional growth of a student.
Teaching Innovations

Six Sigma Education and Industry Collaboration

Presenters:

Mr. Jeremy Johns, Purdue University, West Lafayette, IN 47907, 765-479-2509, jcjohns@purdue.edu

Dr. Chad Laux, Purdue University, West Lafayette, IN 47907, 765-494-0742, claux@purdue.edu

Need: Industry experience is becoming more and more required for obtaining a job. Options for college students to obtain that experience can be limited to summer internships or working throughout the semester. IT 446, Six Sigma Quality, is a course that is trying to help bridge students to industry.

Overview: Traditional lecture/lab courses are usually thought of being in relatively controlled environments and geared toward more of the hard sciences (chemistry, biology, physics, etc.). While Six Sigma is a science, it is hard to replicate the environments students will see when they finally take their place in industry. An approach to this class has been taken that involves connecting the students to industry partners and working through an improvement process. As the students do not usually have monetary ties to their partner organization, they are not required to implement changes in those organizations. Rather, the students provide their industry partner with a technical report that contains sound reasoning, based on the DMAIC process, for considering the recommended improvements.

Major Points:
• Knowledge needed for implementing and using Six Sigma effectively gained by students and project partners
• Industry experience provided to students
• Project partners gain starting ground for improvement initiatives

Summary: Attendees should understand that the benefit to both the students and industry partners by encouraging course design with projects from this perspective. Attendees should also be able to recognize the limitations of student groups working on projects in an industry environment.
Teaching Innovations

Successfully Integrating Industry Mentoring into a Senior Capstone Course

Presenters:

Dr. James W. Jones, Ball State University, Muncie, IN 47306, 765-285-1433, jwjones@bsu.edu

Mr. Mike Mezo, Ball State University, Muncie, IN 47306, 765-285-5649, mmezo@bsu.edu

Need: Technology programs constantly strive to develop assignments that replicate “real world” projects in order to simulate situations and projects their students are likely to encounter after graduation. This can be challenging, particularly in programs that are oriented towards fields that are rapidly innovating and evolving. One innovative approach is to have students work with industry mentors, who can provide their experience directly to students and act as guides and coaches in their fields.

Overview: The capstone course is a common element of many technology programs, bringing together aspects from all previous coursework. However, the industry element is often not fully integrated into this scenario, omitting a vital element. One program has addressed this omission through the use of “real world” projects and industry mentors, who provide a much-needed dose of realism and perspective to the students. This program’s innovative approach to industry involvement has developed over the years and is now an integral part of their capstone experience. Through using best practices developed over years of trial and error, faculty can implement these strategies to successfully integrate faculty mentorship into their own capstone courses.

Major Points:
• Recruiting industry mentors
• Mentorship agreements and commitments
• Mentor involvement
• Mentor grading and input
• Effects on student learning and teams
• Conclusions and recommendations

Summary: Attendees of this presentation will understand how industry mentors can be successfully integrated into a senior-level capstone course. Recruiting, commitment, and effects are explained as applicable for a faculty member in a technology program.
Teaching Innovations

**What ATMAE Programs Can Do to Address the Creativity Crisis?**

*Presenters:*

Mr. Dan Katanski, Doctoral Student in Technology, Eastern Michigan University, Ypsilanti, MI 48197, 734-482-8290, dkatans1@emich.edu

Dr. John Dugger, Eastern Michigan University, Ypsilanti, MI 48197, 734-274-1630, jdugger@emich.edu

**Need:** The term 'creativity' was coined in the 1950s, and continues to be a crucial element of economic growth. Children start out creative and creativity continues to grow until high school, then creativity levels off, and starts to decrease throughout adulthood, (Kim, 2011). Since 1990, SAT scores have continued to rise while creativity levels have declined among American students resulting in an American creativity crisis. ATMAE programs can help improve the creativity scores of program graduates to help strengthen the value of the graduate and in turn the competitiveness of employers of these graduates.

**Overview:** Creativity is at the heart of developing new and useful technological solutions. Such solutions yield new product ideas that affect America’s economic development in the development and production of computers, medicine devices and all things technical. Given the creativity crisis, the post 911 reduction in student visas, reduction in work visas, and restrictions on foreign visitors to attend technical conferences, America is no longer the focal point of technological innovation. Thus, the reduced creativity in American citizens, the limiting of foreign students who stay after graduation to become part of the creative workforce, and other foreign workers coming to America to be a part of the technology revolution, have resulted in a situation where there is inadequate human creative capital in this country.

**Major Points:**

- The focus of this presentation is to examine several ways to address the American creativity crisis.
- Recent research on creativity has shown that active learning in the class room or in extracurricular activities has resulted in increased levels of creativity among early primary, secondary, and postsecondary students.
- The use of Technology Competitions (or Academic Competitions) that present students with complex and open-ended problems requiring a number of skills that must be brought together to formulate a solution has much promise as a vehicle to improve creativity in ATMAE classrooms.
- An examination of Technology Competitions has provided some direction in improving creativity building experiences in college classrooms.

**Summary:** Sternberg stated that not being creative is a choice that is made because of the high negative cost in terms of risk of mental pain, personal and professional criticism, rejection, embarrassment, etc., (Sternberg). In a recent TED talk, Ken Robinson said that, "If you’re not prepared to be wrong, you’ll never come up with anything original… And by the time they get to be adults, most kids…have become frightened of being wrong," (Robinson, 2006).
Teaching Innovations

**Immersive Learning, Creative Inquiry Outside the Traditional Classroom**

Presenter:

Dr. Hans P. Kellogg, Ball State University, Muncie, IN 47304, (765) 285-5663 hkellogg@bsu.edu

Need: While preparing for entry into the workforce, students desire relevance from their educational experiences. Whereas traditional classrooms adequately cover content, the model is flawed when it attempts to mirror reality. With the faculty in front, the passive learning style stifles creativity and discourages descent. The student comes to class, listens, takes notes, and studies for the exams. When students pass the exams, they move on to the next portion of this highly departmentalized educational system. Research states this style of learning is inadequate. Students pass the tests but learn little of the problems solving skills required in the real world. What is desired is an alternative; a teaching style that completely immerses the student into the learning process.

Overview: The Virginia Ball Center (VBC) for Creative Inquiry originated the Immersive Learning teaching style at Ball State University. Through the VBC, this faculty was able to gain first hand experience with this teaching method. As real life film documentarians, the students described in this presentation were given the mission to create a professional quality film on the history of the Auburn Cord and Duesenberg automobiles of Northeast, Indiana and the people helped produce these world-class vehicles. With a diverse student population and the requirement for extensive travel, this student lead, faculty mentored course completed their goal and produced a profession grade film to be aired on PBS.

Major Points: Attendees will have the opportunity to learn and/or discuss the following:

- Organization of the non-traditional classroom.
- The educational model behind Ball State University’ Immersive Learning.
- The seven criteria that define Immersive Learning.
- The successes and challenges encountered in this type of “classroom.”
- Alternatives to Immersive Learning that may be in use by other institutions.

Summary: Attendees will explore the successes and challenges of Immersive Learning as an alternative teaching method at Ball State University. With a diverse student population holding a varied skill set; learn how this university course created a full-length PBS documentary film on Auburn, Cord, and Duesenberg automobiles and the people of Northern Indiana.
Teaching Innovations

**Flipped Classroom: A New Model That Is Turning the Traditional Classroom on Its Head**

Presenter:

Dr. Lynda Kenney, Department of Technology, University of North Dakota, P.O. Box 7118, Grand Forks, ND 58202-7118, 701.777.2197, lynda.kenney@und.edu

**Need:** Educators spend much of their time explaining and reviewing rather than engaging their students in the active learning process. This traditional one-size-fits-all model of education has resulted in a decline of creative, innovative students who do not meet the demands of the 21st Century workforce. The flipped learning class model inverts traditional teaching methods, delivering instruction online outside of class and moving “homework” into the classroom, thus providing students with a learning environment that is engaging, collaborative, and innovative.

**Overview:** The flipped classroom is a pedagogical model where the typical lecture and homework elements of a course are reversed. Video lectures and digital artifacts are prepared by the instructor and viewed by students outside of class before the class session, while in-class time is devoted to exercises, projects, collaboration and discussion. The notion of a flipped classroom draws on such concepts as active learning, student engagement, hybrid course design, and learning at an individual pace. The value of a flipped class is in the repurposing of class time into a workshop where students can inquire about lecture content, test their skills in applying knowledge, and interact with one another in hands-on activities. During class sessions, instructors function as coaches or advisors, encouraging students in individual inquiry and collaborative effort.

**Major Points:**
- Background of the “Flipped Classroom” pedagogical model
- What is needed to create the engaged flipped classroom
- The impact on student learning
- How “flipping” meets the needs of the 21st Century workforce

**Summary:** During this presentation, you will learn how to apply the flipped classroom model to your courses and create learning environments where students become more engaged, curious, creative, and collaborative. You will recognize how the flipped model puts more of the responsibility for learning on the shoulders of students while giving them greater impetus to experiment, and how devoting class time to the application of concepts accomplishes the development of critical and creative thinkers to meet the needs of the 21st Century workforce.
Teaching Innovations

**Developing the Future EECT Graduate: Identifying Predictors of Early and Continued Academic Success**

Presenters:

- Mr. Jeff Kilgore, Eastern Kentucky University, Richmond, KY, 40475, 859-622-1204, [jeff.kilgore@eku.edu](mailto:jeff.kilgore@eku.edu)
- Dr. Vigs Chandra, Eastern Kentucky University, [vigs.chandra@eku.edu](mailto:vigs.chandra@eku.edu)
- Dr. Ray Richardson, Eastern Kentucky University, [ray.richardson@eku.edu](mailto:ray.richardson@eku.edu)

**Need:** Identifying predictors of early academic success in EECT programs in students can be very helpful for recruiting, retaining, graduating, and placing students in the workplace. While the EECT curriculum aims to provide the structure within which academic development regarding the major can occur, it is likely that students with specific physical and mental aptitudes along with vocational interests are more likely to succeed in these rapidly changing fields. It is important to provide students with opportunities for strengthening these innate qualities, particularly reading and reasoning. With the optimal match of aptitudes, personality and EECT discipline specific competencies, the likelihood of success in the academic and professional careers can be increased.

**Overview:** Preparing EECT students for challenging professional careers in part requires them to develop a strong technical foundation along with hands-on skills and traits. By identifying the aptitudes that are conducive to success in this discipline and providing technology students with opportunities where they can leverage their innate strengths their motivation to succeed in the major can increase. The presentation will include suggestions based on ongoing research for sparking and sustaining interest in the major by drawing on students aptitudes. These activities, along with those aimed at strengthening understanding, skills and attitudes related to the EECT program, are likely to encourage students to begin explorations of electronics and computer technology and continue as lifelong learners in the profession.

**Major Points:**

- Identifying early indicators of student success in EECT programs
- Linking specific aptitudes to typical tasks, work activities, and job responsibilities of technologists
- Research of the role personality, aptitude, and motivation has in EECT-related Hi-Tech careers
- Providing opportunities across the curriculum for strengthening foundational skills and aptitudes
- Targeting recruitment of students with physical/mental aptitudes that are likely to lead to completion of EECT program and cooperative education experiences
- Motivating students to nurture specific aptitudes conducive to ongoing learning in the ever changing electronics and computer technology landscape

**Summary:** The presentation will focus on identifying aptitudes that are indicators of early and continued success in EECT program. It will provide recommendations about strategies and activities that can be used in classroom, laboratories and online for encouraging students to develop the skills and aptitudes needed in these rapidly evolving disciplines. Ongoing research in this area will be discussed targeting improvement. Specific ideas for targeting recruitment initiatives and for improving student retention based on these will be shared with the audience.
Teaching Innovations

Being Innovative in the University Classroom to Promote High Expectations, Student Motivation, and a Positive Learning Environment

Presenter:

Dr. Edward J. Lazaros, Ball State University, Muncie, IN 47306, 765-285-5647, ejlazaros@bsu.edu

Need: University faculty members often struggle to understand the factors that influence student motivation in the classroom. Faculty may need to learn more about intrinsic and extrinsic student motivational factors. Many are unaware of research that suggests faculty high expectations of students cause an increase in student achievement. When educating university students, faculty are often unaware of the positive effects of using humor to enhance the classroom climate. Furthermore, many are unaware of strategies and best practices for using humor in the classroom.

Overview: During this presentation, conference attendees will learn about how intrinsic and extrinsic factors influence student motivation in the university classroom. Recent research will be presented that suggests setting high expectations in the classroom can increase student achievement. The positive effects of using humor to enhance the classroom climate will be discussed, and conference attendees will learn strategies to use humor in their own university classroom.

Major Points:
- Intrinsic and extrinsic factors that influence student motivation
- High expectations influence student achievement
- Positive effects of using humor
- Strategies to use humor in the university classroom
- Enhancing university classroom climate

Summary: Conference attendees will leave the presentation with a better understanding of the intrinsic and extrinsic factors that influence student motivation in the university classroom. The conference attendees will be better versed in current literature that documents how high expectations can influence student achievement. Those who attend the presentation will be prepared to go back to their university classrooms and use humor to enhance classroom climate.
Teaching Innovations

Education through Games: An Exploratory Study of Construction Curricula

Presenters:

Dr. Tarek Mahfouz, Ball State University, Muncie, IN 47306, 765-285-4210, tmahfouz@bsu.edu

Dr. James W. Jones, Ball State University, Muncie, IN 47306, 765-285-1433, jwjones@bsu.edu

Co-Author: Mr. Scotty Kollwitz, Ball State University, Muncie, IN 47306, 765-285-1433, skollwitz@bsu.edu

Need: The construction industry is considered as a cornerstone for all economies. In the United States of America, this industry contributes to about 5% of the Gross Domestic Product (GDP). In 2008, its contribution was estimated at 8.5% of the United Kingdom (UK) GDP while employing over 3 million people. Inevitably, a contribution of this magnitude is constantly challenged by the quality of its practitioners. Two of the main factors that contribute to this are the quality of educational programs and the students' engagement in such curricula. Over the years, numbers of researchers, educators, and practitioners have attempted to find the best means of attracting good quality students and engaging them in the educational material. Recently, utilizing video games and 3D simulation environments have proven to be successful solutions to some extent. However, there is a little literature available about these experiences. A better understanding of the factors affecting the success or failure of these attempts is greatly needed.

Overview: A number of researchers have devoted their efforts to the development and implementation of games for educational purposes. Safety Inspector, which is an educational video game for assessing construction safety education, represents one of the most recent success stories. However, there is little literature available about other examples. To fill this gap, the purpose of this research is to investigate the construction educational curricula in the United States of America to identify (1) the extent of using games as an educational tool; (2) the rates of success or failure of such experiences from the educators' and students' point of views; (3) the challenges of such practice; and (4) the future opportunities for the use of video games and 3D simulation environments for educational purposes.

Major Points:

- The extent of using games for educational purposes in construction programs
- Successful examples and failures
- Factors affecting the success or leading to the failure of such practices
- Challenges facing the use of games for educational purposes
- Needed efforts to further nourish these practices.

Summary: Attendees will gain knowledge about successful and failed attempts of using games for educational purposes in construction programs. They will be introduced to the educators' and students' perceptions of such practice. They will be introduced to finding about the needed efforts to help expand these ongoing efforts and will be engaged in a live discussion about the topic.
Teaching Innovations

Collaborations with Campus Police Investigators to Teach Concepts for Research

Presenters:

Det. Kent Martin, Eastern Illinois University, Charleston, IL 61920, 217-581-5526, kdmartin@eiu.edu

Dr. Isaac Slaven, Eastern Illinois University, Charleston, IL 61920, 217-581-7259, islaven@eiu.edu

Need: Feedback from students in the graduate level course, Research in Technology, often refers to the lack of “interesting” topics. Because campus police investigate crimes using methodologies similar to what is taught in the graduate research classes, a collaborative effort involving the campus police investigative section and the graduate research faculty in the School of Technology can provide a positive teaching tool for the students in the Research in Technology course. Practical application of research principles can benefit both the students and the investigators who collaborate with the program.

Overview: Principles, techniques and concepts of criminal investigation are used to illustrate the application of the scientific method to research a problem. The formulation of a problem statement, investigation, methods, experiment and analysis are illustrated by applying them to the investigative process. Additionally, case studies involving an actual closed-case investigation further demonstrate practical utilization of research principles, techniques and concepts for the research course students. Furthermore, when the police investigators reassess the closed cases from a process and methodology point of view, their understanding of investigative techniques is enhanced. Using case studies, students begin to understand the appropriate ways to draw conclusions using logical reasoning.

Major Points:

• Research students work with campus police to understand application of research concepts
• Campus police work with students to enhance their understanding of how a research process relates to criminal investigations
• Case studies of closed investigations are viewed through a research perspective
• Drawing appropriate conclusions through research and how it applies to criminal investigations

Summary: Attendees will understand the benefits of a collaborative relationship between a research methods course and investigators from the campus police. The application will be illustrated using examples from actual police investigations.
Teaching Innovations

Developing Professional Portfolios for Construction Management Students

Presenter:

Professor Richard Miller, Ohio Northern University, Ada, Ohio 45810, 419-772-2463, r-miller.4@onu.edu

Need: As graduates go into industry, the need for evidence of proficiency has started to become a focal point for many employers. One way to do this is by structuring your coursework to reflect the construction process. This allows students to better understand the construction process while building a professional portfolio by completing a project from start to finish in the classroom through course matriculation.

Overview: Through a student’s program career, the design, development, and documentation of their abilities in different construction aspects can be a daunting task. Construction management programs can take advantage of course set up to maximize a student’s success in developing a portfolio while assisting faculty in developing integration of coursework from freshman to senior level. This allows the student to concentrate on a real world project from start to finish by injecting those learning outcomes from each course. Evaluations from employers in Ohio and the surrounding states have shown that they want see substantive proof of a student’s knowledge, ability, and proficiency. The development of this portfolio has led to many of the program’s students in obtaining employment.

Major Points:

• Integration of coursework from level to level.
• Ability to scaffold learning from course to course.
• Student develops a project from start to finish using a professional portfolio.
• Development of course structure to parallel the construction process.

Summary: Attendees will have the opportunity to see how structuring courses within the program can assist in the development of a professional portfolio for the student and assist in scaffolding learning to project completion for a real world project the student selects at the beginning of their freshman year and culminates during the Capstone course.
Teaching Innovations

Formation and Development of Effective Student Teams

Presenter:

Dr. Gretchen A. Mosher, Iowa State University, Ames, IA 515 294 6416, gamosher@iastate.edu

Need: The ability to work in an effective team has been identified by employers as a key skill for students entering the work force. Furthermore, a desire for a more active learning by both students and faculty has also increased the use of team-based learning in the classroom. An important component of effective teams is the process used to assemble the team and to encourage its development. Highly developed and cohesive teams allow the focus of the classroom to be on engaged and transformative learning, yet previous research has focused mostly on the learning outcomes of such teams rather than on the formation and development processes.

Overview: This presentation will discuss strategies for enhancing undergraduate student teams in introductory quality management and senior technology capstone courses. Factors considered in the selection, development, management, and evaluation of student teams will be shared. Strategies for selection of team members, management of student conflict, and creation of team-based assignments will be discussed from a technology education perspective. Implications for team development outside of the classroom will also be shared.

Major Points:

• Benefits of using team-based instruction
• Factors considered in the formation, development, management, and evaluation of teams
• Strategies for selecting team members to best enhance learning
• Creation of appropriate team-based assignments
• Implications for teamwork inside and outside the classroom

Summary: The audience will learn about strategies for effectively managing the team-based classroom in introductory and advanced technology courses. The creation and evaluation of effective team assignments will be discussed from a technology perspective. Implications for non-classroom use will be shared.
Teaching Innovations

Teaching Students How to Innovate

Presenter:

Dr. Darren Olson, MSET Program Coordinator, Department of Industrial & Engineering Technology, Central Washington University, Ellensburg, WA 98926, (509) 963-1913, olsondar@cwu.edu

Need: Attendees will learn about some core innovation principles and how to integrate these concepts into class projects, so that students can develop the ability to generate creative solutions to problems, on demand.

Overview: This presentation will be focused on the development of a term project that was created for a master’s-level emerging technologies course. The project required students to conceive of innovations within a product development context, to study the feasibility of their ideas, and to devise strategies for managing intellectual property associated with their innovations. The presenter will discuss the theoretical concepts behind generating innovations, demonstrate how the concepts were implemented in the class project, and provide examples of the innovations that students conceived. The presenter will also discuss how the principles of innovation management can be integrated into class projects in other contexts, outside of an emerging technologies class.

Major Points:

- Overview of key innovation management principles.
- Context for, and particulars of, the student term project.
- Examples of student work
- Suggestions for integrating the same principles and similar deliverables into class projects outside of an emerging technologies context.

Summary: This presentation will demonstrate that the ability to innovate can be developed. By teaching students about some key innovation management concepts and giving them an opportunity to apply these principles in a structured assignment, educators can help learners how to become innovative on demand.
Teaching Innovations

Developing Tomorrow’s Workforce through Blending Engineering Technology with Gen Ed: The Story Behind the Survey of Motorsports

Presenter: Dr. Randy Peters, Indiana State University, Terre Haute, IN 47809, (812) 237-4962, randy.peters@indstate.edu

Need: Many universities stress the need for and mandate general education courses. Students in STEM programs often dismiss general education courses as something with little or no value. The US market demand for additional graduates of STEM programs is increasing. There is a corresponding increase in recruiting efforts to attract STEM students. Engineering technology programs may benefit from increased SCH production by offering technology courses suitable for all majors. Marketing such courses may increase the number of new students and existing students (by changing majors) in these engineering technology programs.

Overview: This presentation details the development of a course focused on motorsports technology that blends the student outcomes of general education and technology. The course includes experiential learning and distance delivery.

Major Points:
• The course has Technology as the focus
• Includes significant experiential learning
• Has a community engagement component
• Has been approved by the university committee to satisfy one of the requirements in the general education program
• Is open to all students
• Has multiple sections with waiting lists
• Is delivered via distance and or face to face

Summary: The idea of blending technology and general education is not necessarily new and probably was first implemented as themed curriculum in the early 1900’s. However, this particular course was designed to engage sophomores, juniors, and seniors from across campus in an immersion of motorsports technology while understanding elements of sociology, economics, ethics, diversity issues, and business concerns of both today and days gone by. Through this immersion students gain an understanding of how to learn and ultimately think critically about a topic.
Teaching Innovations

The Burning Mind Project: Creating a Culture of Radical Innovation in Technology Education

Presenters:

Dr. Nicole Radziwill, James Madison University, Harrisonburg, Virginia 22807, 540-568-2985, nicole@burningmindproject.org

Dr. Morgan Benton, James Madison University, Harrisonburg, Virginia 22807, 540-568-6876, morgan@burningmindproject.org

Need: The pedagogical approach supported by the value system of the Burning Mind Project, adopted from the 10 Principles of the Burning Man event held annually in the desert of Nevada, addresses several key elements of training students for immediate entry into the workforce. These include self-reliance (taking responsibility for one’s own learning), communal effort, and radical self-expression as an enabler for risk-taking and innovation. Furthermore, the techniques to be discussed help to satisfy many needs of faculty who are teaching courses where the content changes rapidly, such as alleviating an overwhelming workload and ensuring the relevance, evolution, and sustainability of course materials.

Overview: The Burning Man event is an annual gathering of approximately 50,000 people in the desert of northwestern Nevada, a harsh and austere environment nearly void of infrastructure. According to http://burningman.com, its participants "create Black Rock City, dedicated to community, art, self-expression, and self-reliance... and depart one week later, having left no trace whatsoever." These are some of the characteristics of the 10 Principles of Burning Man, the community's value system. This presentation describes practical results from the first two years of the Burning Mind Project, an exploration of how the value system of Burning Man as expressed by its 10 Principles can be translated into technology education at the undergraduate level. We will share specific techniques that were applied, the successful outcomes that we observed, and the impact of the approach on achieving learning objectives while stimulating creative thinking and collaborative innovation. We will also discuss the relationship of this approach to the new Congressional STEM to STEAM initiative, which seeks to integrate Art into Science, Technology, Engineering and Math education.

Major Points:
- Current Challenges for Students and Educators in Technology
- Background: The 10 Principles of Burning Man
- How the Principles Capture the Spirit of W. Edwards Deming’s Work
- The Principles in Practice: Outcomes from Experiments
- Practical Recommendations for Educators
- Next Steps: The Congressional STEM to STEAM Initiative for Educators

Summary: This is a presentation of new pedagogical approaches for creating a dynamic learning community, focused on technology education at the undergraduate level, that models a culture of risk-taking and innovation.
Teaching Innovations

A Community College in Outer Space - Going Beyond the Average Student Project

Presenter:

Ms. Sharon Rouse, Program Coordinator / Instructor, Mechanical Engineering Technology, Mitchell Community College, Statesville, N.C. 28677, 704-878-3241 srouse@mitchellcc.edu

Need: Collaborative STEM Based Projects Reinforce Student Learning. Student STEM projects have been around for years and are an important part in understanding how to apply concepts learned in the classroom to real world problems. Cross-discipline, collaborative projects required the concepts associated with the particular discipline and reinforce the skills needed to work in a team. Sending a research-based payload to space exemplifies all of this and more.

Overview: Design and build of a research-based rocket payload. Student projects are important in that they apply knowledge gained in the classroom to real world problems. This year-long project requires many hours outside the classroom and the expertise of different disciplines such as engineering, vocational and technical skills, as well as project management and business expertise. With the help of NASA, the NC Space Grant, the Colorado Space Grant Consortium, and the generous support of the community college and other groups, these students design and build a research based payload that is launched into space.

Major Points:
- The history of projectiles at Mitchell Community College
- What it takes to go beyond the average STEM based student project
- The collaboration between the students to meet deadlines and to exceed expectations
- Teamwork with the community of supporters
- The design and build of the payload
- Testing, Testing, Testing
- Successful launch and data acquisition
- What the students get out of all this work

Summary: Attendees will understand that students in a community college are very capable of successfully completing a very large, complex, and lengthy project. It is hoped that projects like these will encourage community college leaders to challenge their students to be more than average.
Teaching Innovations

**Problem Solving Style and Team Performance: Preparing Graduates to Succeed in the Workforce**

**Presenters:**

Dr. Sophia K. Scott, Southeast Missouri State University, Cape Girardeau, MO 63701, 573-986-7383, sscott@semo.edu

Mrs. Belinda McMurry, Southeast Missouri State University, Cape Girardeau, MO 63701, 573-651-2336, blmcmurry@semo.edu

**Need:** The ever changing technical work environment requires students who can think and solve technical problems. Technology students need to be proficient in problem solving. Each individual has an approach or style he or she prefers in tackling problems. Problem solving styles are consistent ways individuals approach new ideas, manage change, and respond effectively to complex challenges. Research shows that individuals approach problems differently and this approach does have an effect on problem solving. There has been an abundance of research on distinguishing between problem solving approach and problem solving ability. Little research has been done on problem solving style and team performance.

**Overview:** This presentation will focus on the approach that students take when dealing with problems, not on problem solving ability. The proposed subjects of the research are students enrolled in a technology program at a Midwestern university. Participants will be asked to complete an instrument to assess his or her problem solving approach. In addition, the students will be given a problem to solve. The presentation will provide the results of this study.

**Major Points:**

- Identifying problem solving approaches of technology students
- Results of the study will be presented
- Tips and techniques for using problem solving approach to help students in problem solving

**Summary:** Attendees will understand how individuals approach problems and how this understanding can help them in solving technical problems. This presentation provides results of a study on problem solving approach and team performance. Additionally, tips and techniques for using problem solving approach to help students in problem solving for success in the future workforce.
Teaching Innovations

**Using Mobile Biomass Pellet-Making Equipment to Support Course Learning Objectives**

Presenters:

Dr. Isaac Slaven, Eastern Illinois University, Charleston, IL 61920, 217-581-7259, islaven@eiu.edu

Co-Author: Dr. David Melton, Eastern Illinois University, Charleston, IL 61920, 217-581-5762, dwmelton@eiu.edu

Need: As emphasis on renewable energy grows, colleges across the nation are developing energy programs and courses to prepare students to work in the industry. The use of equipment to make biomass fuel pellets in a classroom setting can provide a hands-on experience that reinforces the understanding and synthesis of the classroom materials. Since this equipment is not made to be traditionally classroom-oriented, there are few manuals or job-aids for students to use the equipment. The development of procedure manuals for the use of the equipment to align course objectives and safety can allow them to work and expand their knowledge.

Overview: This study examines the development of procedure manuals for students to run biomass pellet equipment in a classroom setting. The equipment includes a chipper, hammer mill, and pelletizer. Creating documents that outline operating procedures and hazard recognition, allow students to work with the equipment as if it were in a workplace setting and to better understand how to control the process. The documents provide students a mechanism to show how the effective use of the equipment fits into meeting campus and state renewable energy goals.

Major Points:

- Application of mobile biomass pellet production equipment in a classroom setting
- Creation of best practices, including safety protocol, of equipment
- Students use equipment that is used in settings other than a classroom
- Use and safety manuals reinforce course learning objectives

Summary: The audience will see the experience of adapting mobile biomass pellet production equipment for classroom use through the creation of procedure and safety manuals based upon the equipment and course learning objective.
Teaching Innovations

Using RFID Transponders in a Geological Application to Enhance Student Learning of Design Methodology

Presenters:

Dr. Isaac Slaven, Eastern Illinois University, Charleston, IL 61920, 217-581-7259, islaven@eiu.edu

Mr. Samuel Slaven, University of Illinois at Urbana-Champaign, Urbana, IL 61801, slaven2@illinois.edu

Need: Research has shown that students reach higher learning objectives with the application of case studies. An undergraduate level machine design class depends heavily on case studies to enhance student learning. Researchers in a geology department have been experiencing difficulty in operations to counter-bore holes in small rocks that will contain RFID tags so that the transport of sediment can be tracked. Because of this difficulty, a machine system had to be designed to produce consistent results in an inconsistent substrate. The case provides student with an unusual scenario to begin to learn a machine design methodology where brainstorming, feedback, and redesign are instrumental.

Overview: The transportation of sediment, such as gravel, in rivers and streams has been studied for nearly a hundred years. Only in the last decade have RFID tags been implanted in small rocks to map the dispersion of sediment due to water flow. One problem identified with this research is that the size of rock that can be prepared for RFID implant is limited by the process of drilling the counter-bore. The design process for creating a new mechanism and technique for drilling these rocks provides a case study that includes the stages of machine design methodology: problem definition, concept, design, prototype, redesign, testing, and analysis.

Major Points:

• Research barriers for a geology department provides a machine design opportunity
• The controlled machine design process can be used as a detailed case study for students in a undergraduate machine design course
• Students are able to experience the design process and use real data to analyze results

Summary: Attendees will see the use of an applied research project that addresses a unique research limitation. The applied research project creates a unique case study for machine design course.
Teaching Innovations

Using Digital Photography as an Innovative Teaching Approach to Engage Students in the Learning Process

Presenters:

Dr. Thomas H. Spotts, Ball State University, Muncie, IN 47306, 765-285-5913, tspotts@bsu.edu

Dr. Edward J. Lazaros, Ball State University, Muncie, IN 47306, 765-285-5647, ejlazaros@bsu.edu

Need: With a new generation of students being accustomed to fast moving images, sound, music, and other multimedia, content that is delivered by a university professor standing in a classroom is often received as static noise. An innovative approach to teaching that allows students to create meaning through their own experiences and ideas is needed. With the new generation of learners drawn to media, using photography as a tool in the classroom may be one way engage learners and get them to build visual literacy, promote advanced thinking, and get them to more effectively synthesize information.

Overview: During this presentation, conference attendees will be introduced to using digital photography as a tool to allow students to develop their own ideas about new material. Attendees will learn how to use photography to assist with teaching new concepts. Discussion on strategies to encourage students to reflect on their experiences, to develop explanations of new concepts, and engage them in learning will be presented. This presentation will differentiate between faculty delivered content and a constructive learning technique that permits students to create their own meaning.

Major Points:

- A learning process that allows students to develop ideas about new material
- Using photography to assist with teaching new concepts
- Strategies to promote students to reflect on their experiences
- Assisting learners with differentiating between given knowledge and their own comprehension and beliefs
- Assisting learners with knowledge acquisition and understanding

Summary: Conference attendees will leave the presentation with an understanding of how to capture the attention of a new generation of learners by using an innovative approach to teaching that allows students to create meaning through their own experiences and ideas. Attendees will see how to use photography to assist with teaching new concepts in the classroom. Those who attend the presentation will be motivated to go back to their university classrooms and try innovative techniques to assist learners with knowledge acquisition and understanding through the use of photographic media.
Teaching Innovations

**Smartphones: Harnessing the Power of New Technology**

Presenter:

Mr. Logan T. Tong, Department of Technology, The University of North Dakota, 10 Cornell Street, Stop 7118, Grand Forks, ND 58201, 701-203-1221, logan.tong@my.und.edu

Need: Smartphone use on college campuses is growing steadily. In the realm of technology devices, they are relatively new, but the power and portability of these devices is comparable to notebook computers. However, in spite of their popularity smartphones are largely taboo devices to have visible in the classroom, and are viewed as distracting. Students, who expect instructors to utilize technology in engaging ways in the classroom, are often far more engaged in their smartphones than the content being taught. There is a need in higher education to harness the power of these devices for teaching and learning, and to stop labeling them as a distraction.

Overview: Smartphones have incredible capabilities compared to past technologies. Current models are as powerful as the computational abilities of NASA’s Curiosity Rover on Mars, but they are often used for simple social networking and communication. A better understanding of how students use their smartphones is a crucial step in developing ways to utilize them in the classroom. Are they utilizing the full potential of their devices, or are they just skimming the capability-surface? Students may already have skills with these devices that can be highly applicable to the learning environment. Finding better uses for smartphones than Facebook and Instagram will reveal a whole new avenue for technology applications in the classroom.

Major Points:
- Capabilities and current utilization of smartphones
- Considerations when implementing new technology into the classroom
- How to engage student learning by using smartphone technology
- Benefits of integrating smartphones into the teaching and learning environment

Summary: With the ubiquity of smartphones on college campuses, their usefulness in the classroom would seem obvious. Unfortunately, smartphones are often kept out of sight of instructors during class time instead of being used as powerful and engaging teaching and learning tools. This presentation will reveal how students and educators may benefit from integrating smartphones into the teaching and learning environment.
Teaching Innovations

The Management and Struggles of a Student-Designed and Constructed Solar Car Project - Part 1

Presenters:

Dr. Jeffrey M. Ulmer, Associate Professor of Technology and Engineering Technology, G014A, University of Central Missouri, Warrensburg, MO 64093, 660-543-8337, julmer@ucmo.edu

Dr. Troy E. Ollison, Associate Professor of Technology and Engineering Technology, G014B, University of Central Missouri, Warrensburg, MO 64093, 660-543-8660, ollison@ucmo.edu

Need: Applied engineering educators are looking for ways to meld abstract topics, manufacturing processes and applied engineering technologies into a laboratory environment to reinforce student learning. Through the trial-by-success-and-error methods used by students designing, building, and managing the construction of a solar car, students are able to apply abstract classroom topics in the laboratory. This presentation will highlight project management and applied engineering issues encountered with this evolving project.

Overview: ENGT 4221 Manufacturing Problem Solving is an upper-level undergraduate course providing a micro-level look at issues directly affecting processes, procedures, and management within the manufacturing industry. As a capstone course, students receive a hands-on semester-long project that stretches their minds and provides a see-touch-smell type experience with an applied engineering foundation. The solar car project presentation will discuss issues encountered in design, manufacture and management of the following areas: problem solving, aerodynamics, car frame design (composites & metals), suspension choice, tire selection (friction concerns), regenerative braking, solar array, battery type and life, energy control system, driver safety, economic budgeting and energy management (solar fuel economy).

Major Points:
• Students need student-led projects that allow them to take abstract topics and experience it in the laboratory
• Teaching innovation utilized in the solar car project provides the presentation audience with multiple snapshots of how many different applied engineering principles can be assembled, and student-re-enforced, into one project
• Students and educators alike are able to discuss and work on real-world solar car design, manufacture & management problems and bring about value-added solutions

Summary: A solar car project that is student-designed, manufactured and managed allows a student to apply abstract topics into a real-world applied engineering product. This presentation will help technology and engineering technology educators get an idea of how they could add, or refine, a student-led solar car project to their curriculum.
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ABSTRACT

The transition of the National Association of Industrial Technology (NAIT) into the Association for Technology, Management, and Applied Engineering (ATMAE) represented, for many affiliated institutions, an ideal opportunity to investigate departmental and/or programmatic changes that might be of benefit to the institution and the students being served. Name changes for existing programs quickly became a topic for discussion with many institutions considering the use of “Applied Engineering” in program names. Several ATMAE-accredited institutions have established program name changes of some type for bachelor’s degree programs and other institutions are still debating the issue. This paper examines perceptions of “technology”, “engineering technology”, and “applied engineering” among several groups of people and explores possible ramifications for institutions considering name changes using ATMAE-accredited programs at a regional university as an example.

INTRODUCTION

The decision of the National Association of Industrial Technology (NAIT) to change its name to the Association for Technology, Management, and Applied Engineering (ATMAE) ignited almost instantaneous discussion regarding program names. For many years, graduates of ATMAE programs at a regional institution in the
southeast had been highly sought after by industry, mostly to fill positions classified as “engineering”. Almost three decades have passed since an article in the Journal of Engineering Technology contended that industry makes very little distinction between engineering and engineering technology graduates for most “engineering” positions (Grinter, 1984). Programs at institutions across the nation have continued to experience similar results with graduates being hired alongside people with traditional engineering degrees, having little or no differences in assigned duties (Land, 2012, page 32). As such, there was a natural inclination to at least consider officially changing the names of existing technology, industrial technology, and even engineering technology programs to affix the “applied engineering” label. Based on national survey information one suggestion for improving the image of technical academic programs is to create degrees with contemporary content and names that provide convincing evidence that the significant investment in such programs will result in exceptional returns for both students and employers (Weinsier and Brown, 2008, page 12). One regional institution decided to move forward with name changes and Technology degree programs were renamed as Applied Engineering in January of 2011.

WHAT’S IN A NAME?

In an effort to generate some initial analysis of the impact of the name changes, the department solicited feedback from a variety of sources. Data was collected from current high school students, high school counselors and teachers, current University students, program alumni, and employers of program alumni. Surveys were designed and distributed for each group with the exception of current University students.

Most of the survey questions utilized an ordinal scale. In order to establish mean ratings for each question, responses were assigned a number ranging from 1 to 5 with 1 representing the most negative response and 5 representing the most positive. Neutral responses were assigned point values of 3. Since an ordinal rating scale was used, the distinction must be made that the subjects taking the survey may not have felt that the difference between each step was equal but for the purpose of this comparison it was assumed that each step in the ratings scale was equal in each survey instrument. Minitab Version 16 was utilized in analyzing collected data.
HIGH SCHOOL TEACHERS/COUNSELORS

To determine how “applied engineering” was perceived in comparison to other typical program names, a group of high school teachers/counselors were asked to complete short survey instruments. Questions were customized for each survey instrument but were intended to measure the respondents' perceptions about “applied engineering” versus “technology” or “engineering technology” in terms of reputation, program appeal, association with 4-year degree programs, and association with two-year degree programs. Analysis was conducted via a one way analysis of variance and utilized the Tukey Grouping Method.

These teachers indicated no statistically significant difference (95% confidence) between “technology”, “engineering technology”, or “applied engineering” in regards to any of the questions asked with the exception of association with two-year programs. The teachers perceive “applied engineering” to be less associated with two-year degree programs than “technology”.

CURRENT COLLEGE STUDENTS

No survey data was collected regarding currently enrolled college students but a significant, indirect measure of the perception of the name changes at the current university can be taken from the students who were enrolled in a program of study at the time of the name change and have subsequently graduated. These students were given the option of keeping the degree program name for which they were initially enrolled or switching their major to reflect the new name changes. Of the twenty-two students that met this criterion, twenty (91%) chose to switch to the new program name.

ALUMNI AND EMPLOYERS

Data from similar surveys of alumni and employers of alumni indicate that these groups do perceive “applied engineering” somewhat differently from “technology” or “engineering technology”. Three questions were
common to both groups. Each group was asked to rate the reputation of each degree name, its association with 
four-year degree programs, and its association with two-year degree programs. Employers were also asked to rank 
how likely they would be to hire a person with each degree name for an open, engineering-related position within 
their companies, while alumni were asked to rank the appeal level of each program name. A total of twenty-seven 
alumni and twenty-nine employers responded. Data were again analyzed using one way analysis of variance with 
Tukey Grouping.

Both employers and alumni clearly more closely associate “applied engineering” and “engineering 
technology” with four-year degrees than they do “technology”. Results from alumni data were remarkably similar.

Employers and alumni also agree in their perceptions of how these names are associated with two-year 
degree programs. Both groups clearly distinguish “technology” as being more associated with a two-year program 
than “applied engineering”. Employers and alumni also perceive that “engineering technology” cannot be 
distinguished from either “applied engineering” or “technology” in the area of association with two-year programs. 
Again, results from alumni data mirrored those of employers.

Employers and alumni differ to some extent when it comes to the reputation of the names. Alumni perceive 
that “applied engineering” and “engineering technology” both have better reputations than “technology” as shown in 
Figure 1. Employers agree that the name “applied engineering” has a better reputation than the name “technology” 
but sense that “engineering technology” may or may not improve program reputation. This data is shown in Figure 
2.
### One-way ANOVA: rep-tec-alum, rep-ae-alum, rep-et-alum

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S = 0.7454   R-Sq = 21.05%   R-Sq(adj) = 19.03%

Individual 95% CIs For Mean Based on Pooled StDev

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<th>Level</th>
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Grouping Information Using Tukey Method

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<td>3.5185</td>
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Means that do not share a letter are significantly different.

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**Figure 1. Alumni perception of reputations**

### One-way ANOVA: rep-tec, rep-eng tec, rep-applied

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<thead>
<tr>
<th>Source</th>
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S = 0.7065   R-Sq = 11.93%   R-Sq(adj) = 9.83%

Individual 95% CIs For Mean Based on Pooled StDev

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<td>3.7931</td>
<td>0.7736</td>
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<tr>
<td>rep-eng tec</td>
<td>29</td>
<td>4.1724</td>
<td>0.7106</td>
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<tr>
<td>rep-applied</td>
<td>29</td>
<td>4.4138</td>
<td>0.6278</td>
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</table>

Pooled StDev = 0.7065

Grouping Information Using Tukey Method

<table>
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<th>Mean</th>
<th>Grouping</th>
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</tr>
<tr>
<td>rep-tec</td>
<td>29</td>
<td>3.7931</td>
</tr>
</tbody>
</table>

Means that do not share a letter are significantly different.

**Figure 2. Employers’ perceptions of reputations**
In the questions that pertained to only one group, employers were emphatic that “applied engineering” and “engineering technology” graduates were more likely to be hired for open engineering positions than “technology” graduates. Alumni were just as insistent that “applied engineering” or “engineering technology” was more appealing than “technology” as a degree program name.

HIGH SCHOOL STUDENTS

A total of 84 high school students responded to a survey. Students made no distinction as to which would be more likely associated with four-year programs but did more closely associate Technology with two-year programs. Earlier research suggests that a majority of high school students view technology as dealing with computers (Brake, Bellamy, Bertsos and Bhatnagar, 2007). An extensive study by the International Technology Education Association (ITEA) shows that two-thirds of people surveyed most associated technology with computers and the Internet (Rose, Gallup, Dugger Jr., and Starweather, 2004). A limitation of this study is that no effort was made to define the terms “technology”, “engineering technology”, and “applied engineering”. It should be noted that if the high school students in this study hold views about technology that are consistent with the above mentioned studies, these students likely perceived “technology” as being completely different from the other choices and not much can be inferred from the results.

Some interesting results emerged when these high school students were asked to identify the role that students in Technology, Engineering Technology, and Applied Engineering programs would be most likely to hold in industry after graduation. Analysis was performed using a Chi-Square test for association. The summary report is shown in Figure 3. This report reveals that students strongly associate “technology” with technician positions and strongly disassociate “applied engineering” with technician positions. Likewise, these students strongly associate “applied engineering” with the roles of engineer or engineering assistant. The summary report also reveals that a disproportionate number of students indicated that the role of an engineering technology graduate was not listed or that the student didn’t know what role the engineering technology graduate would fill. One possible explanation
might lie in the potential confusion created by engineering technology programs existing at both the associate and bachelor degree levels (Kelnhofer, et al., 2010). The scarcity of associate degree programs with applied engineering titles may be a reason for baccalaureate degree programs to favor the applied engineering title over engineering technology.

Figure 3. Summary Report – High School Students

One question whose answer was not easily discerned from the summary report was whether students perceived any difference in expected roles for applied engineering graduates and engineering technology graduates. A series of proportion tests were conducted to provide definitive answers to this question. The tests of two proportions compared student responses for the roles of technician, engineering assistant, and engineer.

Results are shown in Figure 4 and indicate that students consider engineering technology graduates more likely to
assume roles as technicians and less likely to be classified as engineering assistants. There was not enough
evidence to show that students considered one degree as more likely than the other to place graduates in roles as
engineers using the industry standard criteria of 5% significance (95% confidence). Results do indicate 75%
confidence that Applied Engineering graduates are more closely associated with engineering positions, and if the
test is executed as a one sided test, the confidence approaches 88%.

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<td>11</td>
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<tr>
<td>Engineering Technology</td>
<td>23</td>
<td>84</td>
<td>0.273810</td>
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</table>

Difference = p (1) - p (2)
Estimate for difference: -0.142857
95% CI for difference: (-0.262430, -0.0232845)
Test for difference = 0 (vs not = 0): Z = -2.34  P-Value = 0.019
Fisher's exact test: P-Value = 0.034

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<th>N</th>
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<tr>
<td>Applied Engineering</td>
<td>26</td>
<td>84</td>
<td>0.309524</td>
</tr>
<tr>
<td>Engineering Technology</td>
<td>12</td>
<td>84</td>
<td>0.142857</td>
</tr>
</tbody>
</table>

Difference = p (1) - p (2)
Estimate for difference: 0.166667
95% CI for difference: (0.0426767, 0.290657)
Test for difference = 0 (vs not = 0): Z = 2.63  P-Value = 0.008
Fisher's exact test: P-Value = 0.016

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<tr>
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<th>N</th>
<th>Sample p</th>
</tr>
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<tbody>
<tr>
<td>Applied Engineering</td>
<td>31</td>
<td>84</td>
<td>0.369048</td>
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<tr>
<td>Engineering Technology</td>
<td>24</td>
<td>84</td>
<td>0.285714</td>
</tr>
</tbody>
</table>

Difference = p (1) - p (2)
Estimate for difference: 0.0833333
95% CI for difference: (-0.0580232, 0.224690)
Test for difference = 0 (vs not = 0): Z = 1.16  P-Value = 0.248
Fisher's exact test: P-Value = 0.324

Figure 4. Proportion Tests Comparing Job Titles with Degree Name
CONCLUSION

The data suggest a gap exists in the perception of “applied engineering” as compared to “technology” or “engineering technology” that might be based on experience level. In this study, high school students and teachers noted very little difference in their perceptions of the three names. The high percentage of graduating seniors that chose “applied engineering” over “technology” as the name to be registered on their final college transcript supports the assumption that “applied engineering” is in fact perceived to be a more appealing name. Finally, alumni and employers both indicated that “applied engineering” is perceived differently.

The analysis of the high school student responses may be the most intriguing. These students' responses suggest that unless the goal of a four-year degree program was to produce technicians, Technology as a program name would be ill-advised as a marketing strategy. High school students (at least in study-region) seem to struggle with identifying the role of engineering technology graduates in industry. A program considering engineering technology as a name would do well to determine if this problem exists in its region, and if so, implement some campaign to educate the population or choose another name that is more widely identified with specific job functions for which the graduate would be qualified.

Overall, the data strongly suggest that getting engineering in the name of a program in some form would certainly improve the reputation of the program among industry professionals as both employers and alumni (working in the field) indicated a strong preference for “applied engineering” and/or “engineering technology”. The study also suggests that there may still be a need to better publicize what “technology” and “engineering” really are in the secondary education system, especially where “engineering technology” is concerned.

REFERENCES


Building Green Homes: A Comparative Analysis of Residential Green Rating Systems

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ABSTRACT

Building high performance green homes, whether new construction or rehabilitating existing homes, focuses on creating homes which are energy efficient, sustainable, economical to maintain, and create a healthy indoor environment. Many systems include elements of all of the above, but which is the best fit for a specific project? There are several green housing rating programs which will be analyzed and compared, including the NAHB National Green Building Standard ICC-700, LEED for Homes, REGREEN, and ENERGY STAR Certified New Homes. Each covers generally the same elements, yet has its own focus. This paper describes these four green rating systems, including their objectives, history, and emphases, to provide industry practitioners and construction educators the basis for decision-making and teaching.

INTRODUCTION

The international trend of sustainable or “green” construction is indisputable. In countries around the world, greater consideration is being given to efficient use of resources, increasing energy efficiency, increasing occupants’ health, and reducing waste and other sustainable factors. This consideration is also not only focused on the construction process but on the building’s entire life cycle including operations and even disposal. The increased popularity of this green movement has seen a concomitant growth in organizations providing guidelines,
certifications, credentials, and other services and information. For example, the United States Green Building Council (USGBC) was founded in 1993 and at the end of their first 20 years the organization had more than 100,000 projects participating in their Leadership in Energy and Environmental Design (LEED) program and had issued nearly 200,000 professional credentials (USGBC, 2012).

Unfortunately, the rapid rise of green building and these various organizations can make the process of considering and selecting which green program to follow a bewildering one. The profusion of organizations, guidelines, and acronyms can be challenging to differentiate for owners, technical professionals, and educators. This paper examines four of these green building rating systems used in residential construction in the United States, in order to assist professionals and educators in both decision-making and teaching.

REVIEW OF LITERATURE

Others have investigated various green rating systems for other purposes. For example, Smith, Fischlein, Suh, and Huelman (2006) compared LEED and Green Globes, a rating system popular in Canada. In 2008, Retzlaff conducted a content analysis of nine different green assessment systems to assist planners in selecting among them. Wu and Low compared three sustainable rating systems with regard to project management aspects in 2010. Proveda and Lipsett proposed a sustainability rating system for oils sands and heavy oil projects in 2011. Stephens and Siddiqi (2013) examined the challenges and limitations of using the LEED system with historical preservation projects. Clevenger, Ozbek, and Simpson (2013) reviewed six rating systems for sustainability that are commonly used in infrastructure projects.

Research has also begun to focus on the green residential segment as well. Tinker and Burt surveyed eight regional/local residential green building programs from around the country in 2002. Tinker, Burt, Bame, and Speed (2004) examined how the Austin Green Building Program, the first sustainable system for homes in the United States, impacted water consumption. In 2007, Jensen, Fisher, and Wentz explored how LEED certification could be obtained after the design was already complete for residential and commercial buildings. Reposa (2009) conducted
a detailed comparison of six factors between LEED for Homes and the National Association of Home Builders (NAHB) Model Green Building Guidelines and proposed Standard.

The need for integrating sustainable construction and education has been well established. In 2005, Kibert described how sustainability had been integrated into the construction curriculum at the University of Florida. However, Bhattacharjee, Ghosh, Jones, and Rusk (2012) found that only one third of Associated Schools of Construction member schools offered individual sustainable construction classes and noted significant differences in content and delivery. No studies were found that examined all four of the rating systems covered herein with an exclusive focus on the residential construction market in the United States, with the intent of providing information for both industry practitioner and educator.

RATINGS SYSTEMS

In order to assist those considering teaching about or using a green building rating system for a residential construction project, each system is detailed separately. These four systems are the most popular that are currently in use in the United States.

National Association of Home Builders (NAHB) National Green Building Standard ICC-700

The National Green Building Standard ICC-700 was developed through a partnership between the National Association of Home Builders (NAHB) and the International Code Council (ICC). This partnership, started in 2007, resulted in the first system developed for residential construction and remains the largest system devoted only to this market segment (NAHB, 2012). It is approved by the American National Standards Institute (ANSI) as an American National Standard, the only green rating systems with this designation (NAHB, 2013). According to the NAHB (n.d.), “High performance buildings are designed and constructed to incorporate environmental considerations and resource efficiency into every step of the home building and land development process with the goal to minimize its environmental impact” (para. 2).
NAHB's National Green Building Standard (NGBS) building rating system includes: Single-Family (or two-family units), Remodeling (single or two-family units), Multifamily and New Development. Individual rooms can also qualify as a remodeling project for certification (Home Innovation Research Labs, n.d.-b). Under NGBS, there are four certification levels: Bronze, Silver, Gold, or Emerald. Points are awarded for either following specific construction methods or for including approved green materials. Mandatory provisions must be met before the building can qualify for certification, and points are not awarded for these. Each category has a minimum point total that must be achieved for each certification level (Home Innovation Research Labs, n.d.-d). As each successive level is achieved, point totals increase for all categories. These categories are: Lot Design, Preparation and Development, Resource Efficiency, Energy Efficiency, Water Efficiency, Indoor Environmental Quality and Operation, Maintenance and Building Owner Education (Home Innovation Research Labs, n.d.-f). The NGBS focuses on developing efficient sites, selecting responsible materials, minimizing energy and water consumption, improving indoor environmental quality, and educating the occupants as to the proper operations and management of the building (NAHB, 2013).

To certify a home, the architect/builder is required to hire a NAHB Research Center Accredited Verifier. The verifier will register the project, assure that the project has completed what it claims, and examine the scoring spreadsheet supplied by the architect/builder. Verifiers will perform the required inspections before the drywall is installed and at completion. The reports are then sent to Home Innovation Labs for confirmation (Build Green, n.d). If approved and all documentation is complete, a "Home Innovation NGBS Green Certified" certificate will be issued. Only Home Innovation Lab can certify a building. The verifier merely verifies that the work was completed as stated (Home Innovation Research Labs, n.d.-e). The registration fee for single family home (new or renovation) is $500 for non-NAHB members or $200 for NAHB members (Home Innovation Research Labs, n.d.-c). There is an additional fee required for the services of the NAHB Research Center Accredited Verifier, which is determined by the verifier (NAHB Research Center, 2009).
One additional aspect of the NGBS is the Home Innovation Research Labs NGBS Green Certified Product Program. The program identifies products that are pre-approved by Home Innovation Research Labs (the same organization who handles the certification of homes for NAHB) to meet the requirements of the NGBS. Manufacturers must have each individual product certified under an approved third-party program (such as Green Seal, ENERGY STAR or Water Sense). Home Innovation Research Labs then identifies the category and points which the product satisfies. By pre-approving products, architect/builders and manufacturers are assured specific products will qualify, and Green Building Verifiers can automatically assign points Home Innovation Research Labs, n.d.-a).

The main advantage to NAHB’s National Green Building Standard (NGBS) lies in the fact that it was specifically designed for residences. Other advantages of NAHB include the minimal cost (compared to other green building rating systems) and the streamlined paperwork. The interactive Excel spreadsheet available online coordinates the points and includes a wealth of information. The point distribution ensures an equal division of the points, as the thresholds for all categories increase with each level. A project must prove green in equal parts in all categories, which is not the case in other green building rating systems.

Leadership in Energy and Environmental Design (LEED) for Homes

The U.S. Green Building Council sponsors the LEED Green Building Rating Systems. The objective/purpose for LEED for Homes is that it: “promotes the design and construction of high-performance homes – energy efficient, resource efficient, and healthy for occupants” (USGBC, n.d.-c, para. 3). When USGBC launched their LEED Green Building Rating System in 1998, all building types were included under the one system. In 2005 USGBC divided the rating system by building type, and in 2008 LEED for Homes was officially launched (ENR Mountain States, 2012).

LEED for Homes is for Single-family (or a group of single family homes) or Multifamily (multi-unit residential buildings). Homes can be either new construction or remodeling, assuming the remodeling exposes the exterior
wall cavities (USGBC, n.d.-d). If not, it will not be able to achieve certification, and the REGREEN guidelines were created in 2008 to be followed instead. The scoring system categories include: Innovation in Design Process, Location and Linkages, Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality and Awareness and Education. Categories may have mandatory prerequisites (which do not acquire points) or a minimum number of required points. The points are selected individually, and combine to reach the final point total, for the levels of Certified, Silver, Gold and Platinum (USGBC, n.d.-e). LEED for Homes focuses on efficient sites, minimizing water and energy consumption, minimizing waste, producing healthy homes for their inhabitants. The required portions include building to ENERGY STAR standards, minimizing framing waste and providing the homeowner with an operations and maintenance manual of the green features utilized with the home (USGBC, n.d.-e).

To certify a home, an architect/builder must hire a LEED for Homes Green Rater, who will ensure that the home is designed and built to meet LEED for Home standards and complete all documentation. All LEED for Homes projects require two on-site inspections: before the drywall is installed and upon completion. All Green Raters are accredited by the Green Building Certification Institute (GBCI), the same third party organization which accredits LEED Accredited Professionals (Energy Coordinating Agency, n.d.). The Green Raters work with LEED for Homes Providers to complete the verification process. LEED for Homes Providers are third party local organizations selected by USGBC (USGBC, n.d.-b). All projects pursuing LEED for Homes certification require the mandatory performance testing be completed by a Home Energy Rating System Rater (HERS Rater). The lower the HERS Index score, the more energy efficient the home (Residential Energy Services Network, n.d.).

For a single home, the registration fee is $150 for USGBC members and $225 for non-members and the certification fee is $225 for USGBC members and $300 for non-members. There are additional fees required for the services of the Green Rater, Provider Organization and Home Energy Rating System Rater (HERS Rater), which are determined by the third party (USGBC, n.d.-a). The USGBC does not pre-approve or certify any specific manufacturer’s building products, as does NAHB. They require in some instances many third party certifications,
such as Water Sense or ENERGY STAR, but do not list any products specifically. The fact that LEED Green Building Rating Systems are recognized worldwide is an advantage to using this system. LEED for Homes differs from the other systems by utilizing third party experts as part of the project team, rather than just verifying compliance.

**REGREEN**

The REGREEN residential remodeling program was created through a partnership between the American Society of Interior Designers (ASID) Foundation and the U.S. Green Building Council (USGBC) (ASID, n.d.). REGREEN is a residential remodeling “best practices guide”. It was created by ASID and USGBC in response to the need to educate homeowners and builders on green strategies for remodeling projects (ASID, n.d.).

If the remodeling does not include a complete renovation (including the exposure of the exterior wall cavities), it is unlikely to be able to achieve the number of points necessary for certification under LEED for Homes. The REGREEN guidelines were created in 2008 as a response to this situation. The REGREEN guidelines inform architects/builders and homeowners as to the methods which can be utilized to create high performance green homes (ASID & USGBC, 2008). REGREEN covers everything from installing new finishes (such as paint or floor coverings) to remodeling a kitchen or bath. The REGREEN program does not rate the project, but instead give information relevant to different types of projects. It also does not certify specific projects. The REGREEN program incorporates the principles in LEED for Homes which are applicable, including minimizing water and energy consumption, minimizing waste, shrinking the environmental footprint and producing healthy homes for their inhabitants.

REGREEN also addresses issues specific to existing construction, such as the abatement of asbestos and lead, the responsible selection of materials, and the integration of systems to reduce environmental impact (ASID & USGBC, 2008). REGREEN includes standards and certifications used by LEED for Homes, including HERS and EPA ENERGY STAR for energy savings, EPA WaterSense for water efficiency, Forest Stewardship Council wood
certification, Green Seal for materials selection and ASHRAE 62.2 for indoor air quality (ASID & USGBC, 2008). All of the information is available for free at the REGREEN website. Included are nearly 200 articles broken down by project type, such as “Kitchen Remodel,” to further inform designers (ASID & USGBC, 2008). REGREEN serves as a best practices guide for projects that want to be responsible but that do not include all of the aspects of a larger remodel or new construction.

**ENERGY STAR for New Homes**

ENERGY STAR for New Homes is sponsored by the U.S. Environmental Protection Agency (EPA) and focuses on energy efficiency, to both save money and protect our environment (EPA, n.d.-a). The goal is to “help homebuyers easily identify homes that are significantly more energy efficient than standard construction in the marketplace” (EPA, n.d.-c, para. 1). The ENERGY STAR for New Homes program was first offered in 1995. It continues to be updated to maintain a higher level of requirements over standard building codes, typically producing a 30% more energy efficient home (EPA, n.d.-c). In addition to ENERGY STAR for New Homes, the EPA certifies products, commercial buildings, manufactured housing and industrial plants. Remodeling of existing homes is not included in this rating program (EPA, n.d.-a).

ENERGY STAR for New Homes does not have different levels of certification. The guidelines allow for two paths towards certification: the National Performance Path and the National Prescriptive Path. The performance path includes a whole house approach, utilizing software to determine if each home meets the requirements. The home is then verified and field-tested by a RESNET (Residential Energy Services Network) Home Energy Rater, in accordance with RESNET Standards. A maximum allowable HERS (Home Energy Rating System) rating must not be exceeded, which vary by geographical location (EPA, 2010a). In the prescriptive path, the ENERGY STAR Builder Option Package specifies the requirements for specific components, including: the heating system, cooling system, thermostat, ductwork, envelope, water heater, lighting and appliances. The home is then verified and field-
tested by a RESNET (Residential Energy Services Network) Home Energy Rater, in accordance with RESNET Standards (EPA, 2010b).

To construct an ENERGY STAR for New Homes home, an ENERGY STAR partner builder must be selected. To maintain this partnership, the builder must build at least one ENERGY STAR certified home every twelve months. The builder then selects a Home Energy Rater to work with, and submits the construction documents to the rater for review. The builder utilizes their recommendations to select energy-efficient products and construct the home. After the Rater determines that all requirements have been met, the builder will receive an ENERGY STAR certification and a copy of the HERS report (EPA, n.d.-d). There are no fees associated with the ENERGY STAR for New Homes, but the builder and Home Energy Rater must be paid for their services.

The ENERGY STAR for New Homes is focused on new construction, but a home undergoing a complete remodeling could be certified under this system. The EPA has developed alternative compliance paths to address the specific requirements of complete remodeling (EPA, n.d.-b). The main difference of the ENERGY STAR for New Homes rating system from the other systems is that ENERGY STAR focuses completely on energy efficiency. It has only one level, showing that every ENERGY STAR certified home has satisfied all of the same standards, not chosen ones to satisfy (or not satisfy) from a list.

CONCLUSION

Sustainable or “green” construction is now a well-established practice around the world and in the United States. However, there is a bewildering amount of choices for potential green building rating systems in all types of construction, residential being no exception. This paper examined four of the most popular systems currently in use, with the intent of providing construction industry professionals and construction educators the background needed to understand, differentiate, and decide on the most appropriate system for a project.

REFERENCES


Developing Professional Portfolios for Construction Management Students

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ABSTRACT

As graduates go into industry, the need for evidence of proficiency has started to become a focal point for many employers. One way to do this is by structuring your coursework to reflect the construction process. This allows students to better understand the construction process while building a professional portfolio by completing a project from start to finish in the classroom through course matriculation. Through a student's program career, the design, development, and documentation of their abilities in different construction aspects can be a daunting task. Construction management programs can take advantage of course set up to maximize a student's success in developing a portfolio while assisting faculty in developing integration of coursework from freshman to senior level. This allows the student to concentrate on a real world project from start to finish by injecting those learning outcomes from each course. Evaluations from employers in Ohio and the surrounding states have shown that they want see substantive proof of a student's knowledge, ability, and proficiency. The development of a professional portfolio has led to many of the program's students in obtaining employment.

INTRODUCTION

Professional portfolios have been used for years to demonstrate one's works of excellence in an attempt to set them apart for employment. Heath (2002) felt that portfolios are an essential part to the success of self-assessment and an opportunity to truly reflect ones abilities while identifying potential professional growth. For years, the construction industry has not felt the need to have these professional documents as part of the interview process, but in recent years, the escalation of the profession and the heightened competition for positions of
graduates have opened the door to professional portfolios as almost a requirement for aspiring young construction professionals. Much like their architectural and engineering counterparts, the use of the portfolio has allowed construction professionals to highlight their work to potential employers, but many times for the construction management (CM) professional, the documentation for the portfolio is limited to exercises and different projects completed through their undergraduate career either in the classroom or during coop experiences. Kilgore, Turns and Sattler (2010) completed a comparative study to find the value of the portfolio and how the three dimensions of knowledge, identity, and navigation can improve success in obtaining learning goals. This paper illustrates the design, development, and implementation of the professional portfolio for undergraduate students in the CM program at Ohio Northern University using the new comprehensive assessment plan.

PORTFOLIO MODEL

The professional portfolio is about creating an experience where learning can be facilitated by use of a model that matriculates knowledge at all levels and details the different competencies required by the industry. While the terminology for the phases of a project may vary from organization to organization, the phases most commonly used are; predesign, design, pre-construction, construction, and post-construction. As construction professionals, students must understand all the details of these phases, as well as demonstrate, by hands-on application, the competencies of the components within each phase. The table below shows some of the basic elements, within each phase, of a construction project that construction management professionals must master in theory and application.
Many times for CM students, these elements of the construction process are learned or experienced in different stages of the educational process. In order to ensure students are exposed to the myriad of different types of projects, applications of theories, software programs and delivery systems, academic content courses are designed to be broad. This allows the learner to obtain the knowledge from a broad array of situations, exercises, or applications where different situational scenarios can be viewed. While all of these learning applications could be presented in a portfolio, the disjointed nature in which they appear could lead to confusion to potential employers. Thus, the faculty of the CM program at Ohio Northern felt it was necessary to produce artifacts for the portfolio that reflects the construction process using one project that reflects the new assessment plan developed this year.

**Project Selection**

Students enter the CM program with different professional aspirations and career path choices. The ability of the student to choose their project is based on their interests and career path. This allows the student to develop their skills and competencies in areas of interest while allowing them to showcase their outcomes. There are certain requirements that each student must follow when selecting their project. Some of the basic requirements are, but not limited to, that each project must follow the five phases of the construction process, must be
commercial in nature, must be published for bidding, use sustainable concepts, and must work in coordination with a local company. The integration of the local company allows the student to network with industry professionals as they develop their portfolio. The project that they select will be used through the rest of their undergraduate career. While the project, from the company’s standpoint, will be completed well before the student graduates, a partnership with these companies allow students to work with them until completion of the portfolio. For those students who transfer in sometime during the process of the portfolio, a standard project is selected at the point in which the student starts. While some the information will be completed, the student will be responsible for obtaining the artifact or outcome for that particular course.

Departmental Outcomes

The transition of the Association of Technology, Manufacturing and Applied Engineering to an outcomes based accreditation has afforded universities the flexibility to integrate elevated learning experiences into their curriculum. With this transition comes the opportunity to develop a professional portfolio that demonstrates the student’s ability in application. This transition, coupled with the ONU Technological Studies department transition to outcome artifacts, has afforded the chance for the program to develop a professional portfolio that aligns with the department’s outcomes and the new university artifact system while raising the professional development goals of the student. The professional development of students doesn’t start after graduation but must be formed during the undergraduate years. Zepeda, (2012), while targeting the importance of portfolios in education, shows that professional development today is quite different than years past as it has become the cornerstone to spiraling upward in leadership. As such, the Technological Studies department felt the need to implement outcomes based learning activities where self-reflection and assessment can elevate learning. In Appendix A, the outcomes are shown and the courses which satisfy those outcomes are highlighted or marked. As you can see, the alignment of the outcomes can produce portfolio opportunities for the student as they fulfill their artifact requirements for the university. The design of the portfolio allow for the formulation of outcomes through the student’s undergraduate career.
Course Identifiers and Artifact Development

The construction management program at Ohio Northern University involves three different colleges, College of Engineering, College of Business, and the College of Arts & Sciences, in which students take courses to obtain a Bachelor of Science in Construction Management. The bulk of the courses are delivered in the Technological Studies department. Students are required to take 120 semester hours for the B.S. degree with 76 hours dedicated to the construction management major. Within each of the construction specific courses, students are required to complete portions of their portfolio as well as artifact submissions for the university if necessary. While there is inevitably some overlap in courses when it comes to course information, the portfolio is designed to follow the construction process from predesign to post construction. Since the student is not physically involved in the construction phase of the project, all 300 and 400 level courses are designed to have this phase included through case studies, exercises, and discussions.

An example of this is during TECH 3511 Applied Soils and Foundations where the student is responsible for creating a daily schedule to follow based on the time, material, and production factors found in the RSMeans Construction Cost Data book. The following table shows a list of the courses with the construction project phase highlighted along with the portfolio requirement. The table shows some of the major requirements for the student's portfolio and some of the outcomes associated with each of the courses. Following will be a discussion, in detail, on the outcomes per year and what departmental or university outcome is fulfilled. While these 10 courses are representative of the documents contained in the professional portfolio, they are not all encompassing as some of the documentation occurs in courses not listed in the table.

Table 1 Abbreviated List of Courses for Portfolio Development

<table>
<thead>
<tr>
<th>Course Identifier/ Name</th>
<th>Construction Project Phase</th>
<th>Portfolio Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>TECH 1201 Intro to CAD</td>
<td>Predesign</td>
<td>Initial design and drawings</td>
</tr>
<tr>
<td>TECH 2211 Construction Design</td>
<td>Predesign/Design/Preconstruction</td>
<td>Feasibility, construction document set, permit process</td>
</tr>
<tr>
<td>TECH 2501 Materials and Methods</td>
<td>Design/Preconstruction</td>
<td>Selection of materials, design of materials, QTO &amp; BOM</td>
</tr>
</tbody>
</table>
PROFESSIONAL PORTFOLIO DESIGN

The design of the portfolio is to encompass an entire project from predesign to project completion and hand over. The purpose of the portfolio is two-fold for the professional as it develops the knowledge of the CM student in managing a construction project and creates a well-documented archive that supports their abilities as a construction manager. Additionally, a professional portfolio is an excellent source for programs to glean evaluative data that will assist in making the program better and more effective. The CM faculty in the program at ONU felt that the alignment of outcomes was paramount for a consistent portfolio that reflected the highest of standards and ideals found in the construction industry. Therefore, the following details the design and how each of the courses taught can be utilized as part of the professional portfolio.

Introductory Year

As an incoming freshman to the CM program, the student is exposed to the design abilities of different software packages in order to develop their design for their selected project. During their introductory courses, students learn the basics of the construction process, the design process, and the importance of integrated project delivery for construction. The focus of their coursework is laying the foundation for future courses by developing and designing a commercial construction project that meets the requirements set forth by the program. Initial work on the feasibility of design and actual design work from sketching to rough drafts are completed during this year.
Since the process of the portfolio is just starting, it is imperative that the student document the following outcomes in their portfolio from TECH 1201 Intro to CAD to start with a solid base.

**Portfolio Documents:**
- Selection of Project from Dodge Report
- Sketches of Potential Commercial Design
- Initial Feasibility Study
- Scope of Work and Construction Process Setup
- Project Delivery

**Departmental Outcomes:**
- Technical Knowledge
- Effective Communication (Technical/Graphical)
- Process Understanding

**Second Year**

Once the student has started the portfolio with their project selection, feasibility of design and initial designs, the second year allows the student to grow from a design and administrative standpoint. The emphasis during this year is to add breath to the construction process in the areas of predesign, design and preconstruction. A number of courses are completed during this year for the CM student starting with TECH 2501 Materials and Methods where the student learns the different methods employed on construction projects as well as the different types of materials utilized. During the course, the student starts to develop skills in determining logistical locations and needs, safety issues, building codes, and sustainable concepts. Based on their project needs, students produce a preliminary quantity take-off based on the material selected.

TECH 2211 Construction Design allows the student to demonstrate their competency in developing a BIM model using REVIT software to produce a construction document set minus certain section views or detail drawings which are added later in the curriculum. Students finalize their feasibility studies and go through the permitting process for their construction process. In TECH 2701 Fluid & Mechanical systems, the student utilizes their knowledge of mechanical systems obtained in TECH 2501 to select and depict the mechanical systems that will be
required for the project. Along with depicting this in the BIM model, students also register the initial capacities needed for the project along with fire protection requirements.

Portfolio Documents:
- BIM Model (Construction Document Set)
- Quantity Take-Off for Project
- Logistical Layouts and needs
- Sustainable Elements
- Initial Scheduling
- Mechanical Systems
- Permitting process

Departmental Outcomes:
- Technical Knowledge
- Process Understanding
- Effective Communication (Technical/Graphical)
- Apply and Use Current and Emerging Computer and Information Technology Systems

Third Year

At this point in the CM student’s program of study, the execution of preconstruction activities turns to the management of the project. The documents that have been generated to this point will assist in producing the type or style of management the student uses for their particular project. The main focus during this year is to develop their administrative responsibilities associated with a construction project. In TECH 3251 Construction Specifications, students finalize their schedule for the entire project while addressing the specifications needed throughout the five phases of the construction process. Students also have the opportunity to take a “Green Associate” course which coincides with TECH 3251 to obtain their LEED green associate. Students employ management concepts for all aspects of the project during both TECH 3251 and the “Green Associate” special topics course to hone their abilities.

In TECH 3511 Applied Soils and Foundations, students document testing and produce a soil analysis for their project while creating the structural steel and foundation analyses needed for their BIM model. During this course, students have the unique opportunity to dissect and troubleshoot problems that arise from these analyses pertaining to their project. Additionally, students document the value engineering opportunities with the materials
selected for their foundation plan. While the mechanical systems have been chosen during previous courses, TECH 3601 Applied Controls allow students to add schematics to the BIM model for heating and cooling systems. The final selection of the mechanical system is produced during this course along with plumbing applications that apply.

Portfolio Documents:
- Specifications Manual
- Foundation Analysis and Schedule
- Structural Steel Schedule
- Section /Detail Views for Foundation and Structural Steel for BIM Model
- Sustainable Elements
- HVAC/Mechanical System

Departmental Outcomes:
- Process Understanding
- Technical Knowledge
- Leadership, Management, and Teamwork

**Fourth Year**

The majority of this year is dedicated to optimizing the student’s ability to successfully manage a project from start to finish. In TECH 4521, students are required to produce a full estimate and bid for their project, to include all aspects from predesign through post construction. During this course students participate in various case studies involving their project to encourage advancement of their problem solving skills. In CE 4141, students manage their project through the BIM model documenting their progress from start to finish. The culmination of the fourth year comes with TECH 4991 where the student presents their professional portfolio during their capstone experience to department and university community.

Portfolio Documents:
- Finished Estimate
- Finished Schedule
- Management of project
- LEED or “Green” process

Departmental Outcomes:
- Process Understanding
- Leadership, Management, and Teamwork
• Professional Development through Lifelong learning

Assessment

The development of the portfolio allows the program to assess the contents during the senior capstone experience where the student will present their findings from the selected project. While dated, Gerrish (1993) discusses the importance of portfolios in the professional realm. While directed toward nursing, the assessment strategies employed by Gerrish show that rubric development through evaluation for portfolios can assist in raising the level of professionalism for the student. Through the course of the portfolio development, students are assessed at the end of every year pursuant to the departmental and university outcomes. Portfolio documents are kept in Taskstream system where external reviewers evaluate the artifacts based on rubrics created for each outcome. An assessment is performed during their capstone experience where they will present their results in three parts. The first part is the documentation process which is produced in the form of a written paper. The second part is a poster presentation open to the university community where the student has an opportunity to discuss their project.

The third and final portion of the experience is a formal presentation to the department student body and faculty outlining the construction process and outcomes associated with the project they selected and the presentation of their final professional portfolio. An additional benefit of assessment for this application is the evaluation of the program’s alignment with the ATMAE outcomes. This will allow faculty to make adjustments to the program’s curriculum for future success. Finally, students evaluate their own performance and substantiate their evaluation by their daily progress book which they are required to keep during the course.

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. The ability to incorporate a professional portfolio that demonstrates these competencies will assist in future successes. It is incumbent upon
the program to develop an assessment system where students can not only show their knowledge of construction but have artifacts to take with them as they enter the workforce. The development of the professional portfolio will aid students professionally and also elevate the rigors of a CM program. The ability to infuse as much real world applications into our curriculum is essential to the sustained success in the industry and academia. In closing, the professional portfolio gives students that competitive edge where they can show substantive proof of their learned knowledge as they start their careers in the industry.

REFERENCES


# Appendix A

## University General Education Outcomes:

<table>
<thead>
<tr>
<th>Outcomes for Construction Management Major</th>
<th>University General Education Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical knowledge</td>
<td>Effective communication (spoken and/or)</td>
</tr>
<tr>
<td>Construction Process understanding</td>
<td>Effective communication (written and/or)</td>
</tr>
<tr>
<td>Effective communication (technical/verbal)</td>
<td>Scientific and quantitative literacy</td>
</tr>
<tr>
<td>Leadership, management, and teamwork</td>
<td>An understanding of diverse cultures and</td>
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<tr>
<td>Applied and use of current &amp; emerging computer</td>
<td>their effects on human interactions.</td>
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<tr>
<td>and information technology systems</td>
<td>Professional development through life-long</td>
</tr>
<tr>
<td>Professional development through life-long learning</td>
<td>learning</td>
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<tr>
<td>Ethical and professional behavior</td>
<td>Ethical and professional behavior</td>
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<tr>
<td>Critical and creative thinking</td>
<td>Integration of concepts across disciplines</td>
</tr>
<tr>
<td>Scientific and quantitative literacy</td>
<td>Informed and ethical responses to personal,</td>
</tr>
<tr>
<td>Integration of concepts across disciplines</td>
<td>civic, and global needs</td>
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<tr>
<td>Informed responses to aesthetics in art and nature</td>
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</tbody>
</table>

| Required Courses Taught Outside Dept.   | Credit hours | Technical knowledge | Construction Process understanding | Effective communication (technical/verbal) | Leadership, management, and teamwork | Applied and use of current & emerging computer and information technology systems | Professional development through life-long learning | Ethical and professional behavior | Critical and creative thinking | Scientific and quantitative literacy | Integration of concepts across disciplines | Informed and ethical responses to personal, civic, and global needs | Informed responses to aesthetics in art and nature |
|----------------------------------------|--------------|---------------------|-----------------------------------|-------------------------------------------|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| TREX 1001: Freshman Transitions        | 3            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| ENGL 1221 or 1231 (Writing Seminar)   | 3            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| Extra Disciplinary Seminar             | 3            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 4091 Sr. Capstone                 | 1            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |

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<thead>
<tr>
<th>Arts and Sciences Distribution Requirements:</th>
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<tbody>
<tr>
<td>CACS 1111 (Presentational) or CACS 2251</td>
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<tr>
<td>(Interpersonal) Communication</td>
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<tr>
<td>MATH 1401: Functions for Science and Technology</td>
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<tr>
<td>MATH 1431</td>
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<tr>
<td>MATH or STAT</td>
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<tr>
<td>CHEM 1001: Chemistry in Society</td>
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<tr>
<td>PHYS 1001: Conceptual Physics</td>
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<tr>
<td>Humanity #1</td>
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<tr>
<td>Humanity #2</td>
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<tr>
<td>Humanity #3</td>
</tr>
<tr>
<td>Fine Arts</td>
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<tr>
<td>Social Science</td>
</tr>
<tr>
<td>ACTV 1001: Lifetime, Fitness, &amp; Wellness</td>
</tr>
</tbody>
</table>

| Major Courses Taught Inside the Dept.      | Credit hours | Technical knowledge | Construction Process understanding | Effective communication (technical/verbal) | Leadership, management, and teamwork | Applied and use of current & emerging computer and information technology systems | Professional development through life-long learning | Ethical and professional behavior | Critical and creative thinking | Scientific and quantitative literacy | Integration of concepts across disciplines | Informed and ethical responses to personal, civic, and global needs | Informed responses to aesthetics in art and nature |
|--------------------------------------------|--------------|---------------------|-----------------------------------|-------------------------------------------|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| TECH 1001: Technology and Society          | 3            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 1201: Introduction to CAD             | 3            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 1301: Materials Science               | 3            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 1601: Fundamentals of Electronics     | 3            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 2211: Construction Design             | 4            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 2301: Materials and Processes         | 3            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 2401: Computer Networking             | 3            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 2501: Construction Materials & Methods| 4            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 2701: Fluid and Mech. Systems         | 3            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 3421: Database Applications & Management| 3           |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 3511: Soils and Foundations           | 4            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 3611: Applied Controls                | 4            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 3801: Professional Practice           | 2            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| or TECH 4841 Internship                    |              |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 4521: Construction Estimating & Scheduling| 3           |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH 4961: Tour of Industries              | 1            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH xxx1: Technical Elective #1           | 3            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |
| TECH xxx1: Technical Elective #2           | 3            |                     |                                   |                                           |                                        |                                                                                                                                                                                                 |                                                                                                                                                                                                 |                                                |

<table>
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<th>Major Courses Taught Outside the Dept.</th>
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<tr>
<td>BIZ 2331: Behavioral Mgmt. for Bus. Plng.</td>
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<td>BIZ 3121: Business Law</td>
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<td>CE 2031: Surveying</td>
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<tr>
<td>CE 4141: Project Management</td>
</tr>
<tr>
<td>MGMT 3631: Human Resource Mgmt</td>
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<tr>
<td>General Electives</td>
</tr>
<tr>
<td>TECH 3521: Construction Specifications &amp; Doc.</td>
</tr>
</tbody>
</table>

Total hours: 123

Total Artifacts Needed with at least 2 from each area: 20
Distance and Online Learning

Fostering Social Presence through Faculty-Student Interaction for Successful Online Learning

Dr. Megan Downing
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ABSTRACT

Online learning has developed a significant presence in higher education, and the demand for online and hybrid-delivered courses continues to grow. With this sustained growth, attention to teaching practices that foster successful online learning is necessary. Instructor social presence, as established through instructor-student interaction, is a key component of a meaningful online learning experience. An understanding of online students’ perceptions of instructor-student interaction can help educators develop strategies to support and motivate online learners. This paper discusses student perceptions of faculty-student interaction and provides information for practical approaches that form authentic faculty behaviors and resonate among students’ perceptions of faculty-interaction, fostering a successful teaching and learning experience.

INTRODUCTION

Online education has an established presence in higher education. Once viewed as an avenue embraced only by students with no other option for pursuing their education, online courses are no longer seen as a last resort. Across six years of data collection, the Sloan Consortium, an organization dedicated to online higher education, recognized a steady growth in the number of higher education institutions offering online courses (Allen & Seaman, 2011). Further, the 2011 report indicates over 6.1 million higher education students integrated an online course into their Fall 2010 schedule, with over 31 percent of students completing at least one course online (Allen & Seaman, 2011). With such pervasive growth and an established presence among even traditional students’
academic schedules, it is important for faculty to develop instructional practices that foster successful online learning.

The recommended instructor practices presented in this paper are based upon the findings and recommendations from a qualitative research study that explored student perceptions of faculty-student interaction. To examine students' lived experience in the online learning environment, data were collected from students enrolled in a fully online, undergraduate bachelor's degree program at a Midwestern university via qualitative survey and interview instruments. Common themes that emerged from participant responses were examined as they aligned with the concepts of social presence theory (Short, Williams, & Christie, 1976), a communication theory that essentially reveals the degree to which communicating participants who are using an electronic means of communication feel and are perceived as real and connected to one another (Tu & McIsaac, 2002).

**ISOLATION IN ONLINE LEARNING**

In the online learning environment (OLE), students are isolated and rely primarily upon asynchronous communication with their peers and instructor (Downing, 2012). Intentional efforts are necessary to mitigate the absence of normal communication cues such as body language and tone of voice (Moore, 2005). Such efforts also serve to overcome the isolation factor that accompanies the physical separation inherent to online learning (Dennen, Darabi, & Smith, 2007; Gaide, 2004). Immediacy behaviors foster a sense of social presence by stimulating a sense of connection between communicating individuals (Mehrabian, 1969). This process decreases the social and psychological sense of distance otherwise prevalent in online learning (Myers, Zhong, & Guan, 1998).

**SOCIAL PRESENCE IN ONLINE LEARNING**

Short, et al. (1976) developed the theory of social presence in their study of person-to-person communication across telecommunications media. In their research, they incorporated early studies on intimacy
(Argyle & Dean, 1965) and immediacy (Wiener & Mehrabain, 1968) and identified the influence of perceived social presence from participants’ perceptions of both behaviors. In their research, Short, et al. (1976) concluded that the communications medium (e.g., audio only, video plus audio, etc.) directly impacted perceived social presence. Distance education researchers later recognized the value of Short, et al.’s (1976) social presence research as they studied the growing, computer-mediated, distance education environment.

Gunawardena (1995), the first to explore social presence theory in online learning research, found that online student success was directly related to instructor practices, not the communication medium as indicated by Short, et al. (1976). Gunawardena’s (1995) findings informed future research of social presence in the OLE, such as the work of Garrison, Anderson, & Archer (2000) who integrated social presence theory in their Community of Inquiry framework for effective computer based learning. Liam Rourke collaborated with these researchers and developed a Template for Assessing Social Presence through content analysis of student-to-student interaction in text-based discussion forums (Rourke, Anderson, Garrison, & Archer, 1999). Their research identified indicators of (a) Affective, (b) Interactive, and (c) Cohesive practices that fostered social presence (Rourke, et al., 1999). Later research incorporated a fourth category that recognized the (d) Functional aspect of instructor-student interaction (Tu, 2000; Tu & McIsaac, 2002). For the purposes of this study, data were reviewed in context with a modified version of Rourke, et al.’s (1999) Template for Assessing Social Presence. The template was adjusted to focus on interaction between the instructor and student (rather than student-to-student) and to include the functional category (Downing, 2012).

Affective Practices

In the face-to-face environment, tone of voice and non-verbal cues such as body-language play a significant role in affective communication behaviors (Moore, 2005). Affective practices that alleviate the absence of such natural cues in the online environment include appropriate use of humor, self-disclosure, and demonstrated caring (Rourke, et al., 1999). Of the Affective indicators, instructor practices that convey a sense of demonstrated
caring about student welfare and performance were second only to instructor feedback as important to students for generating a sense of presence (Downing, 2012). Students appreciated any communication where the instructor expressed an interest in their academic performance and personal or professional lives. To establish this connection, instructors can integrate Affective practices with their Interactive and Functional behaviors (Downing, 2012).

Incorporating humor with a lighthearted, yet appropriate, comment or image in a weekly email is an easy method of integrating Affective practices and appearing more approachable to students (Downing, 2012). For example, simple additions to the weekly announcements, such as a copyright free image, cartoon, or random scenic photo, foster a sense of instructor presence by infusing a bit of the instructor’s personality and by making the announcement seem friendly and less utilitarian (Downing, 2012).

As Rourke, et al. (1999) explained, descriptive communication that shows “closeness, warmth, affiliation, attraction, openness, all point to affective interaction” (p. 6). Simple self-disclosure behaviors such as sharing personal interests and hobbies in the course greeting email, discussion, or Wiki can foster social presence (Downing, 2012). Students also enjoy photo sharing in a Wiki or discussion board, and appreciate hearing instructors’ personal reflections on their own experiences related to course concepts (Downing, 2012). Establishing a low-stress “getting to know you” assignment that leverages asynchronous tools and incorporates ice-breaker-type activities such as photo and personal information sharing is one way to involve all students in a class-wide activity to foster social presence (Downing, 2012).

**Interactive Practices**

Interactivity encompasses all communication and learning activities within the OLE (Tu, 2002); however, interaction on its own does not always generate social presence. Short, et al. (1976) explained that “evidence that the other is attending” is necessary for interactive behaviors to be socially meaningful (p. 44). In essence, the interactive behaviors must be both noticed and appreciated for social presence to exist (Gunawardena, 1995).
Instructors who reply to discussion board threads, incorporate personal contact such as unsolicited emails or phone calls, and make themselves readily available via email, phone, or online chat tools are appreciated by students (Downing, 2012). Interactive behaviors with the most significant impact on social presence often involve feedback communication, including explicit referencing of student’s work in feedback or communication, complimenting or expressing appreciation of student work, and providing feedback that was both timely and purposeful (Downing, 2012).

Feedback has such a significant impact on student’s perceptions that it emerged as the most prevalent indicator across student responses. Due to the disconnection from the instructor and their peers, students emphasized the importance of timely feedback to reinforce a sense of connection, the perception that someone actually existed on the other end of the computer (Downing, 2012). Although feedback is an Interactive practice, students’ concerns can be addressed by considering feedback practices when developing Functional communication practices. Students’ expectations for rapid feedback may be unrealistic, and can be mitigated through Functional interaction, such as clearly communicating feedback practices as part of the syllabus and instructional design (Downing, 2012). When managing the gradebook and assignment submissions of hundreds of students, this practice may seem daunting; however, instructors who simply integrated a greeting and the student’s name or a brief quote or reference from the student’s work in gradebook feedback were seen as demonstrating an interest in student welfare and performance (Downing, 2012). This demonstrates how an instructor’s approach to feedback provides an excellent opportunity to integrate Affective and Cohesive practices, establishing a personal connection and sense of caring by adopting the simple practice of opening the online gradebook comments with the student’s name (Downing, 2012).

As with feedback, students can have unrealistic expectations regarding instructor availability; however, instructor availability is also highly regarded by students and impacts students’ perceptions of their instructors (Downing, 2012). Although an Interactive indicator, like feedback, student expectations of instructor availability can also be mitigated through Functional practices such as course and syllabus design. Instructors should include a
section in both the course and syllabus that clearly defines virtual and physical office hours and the instructor’s preferred method of contact (Downing, 2012). Instructors can reinforce their availability via a routine reminder to ensure clarity of established norms and to set realistic student expectations; further, instructors should communicate any deviation from the norm. Such instructor practices are perceived as considerate of students’ needs and influence students’ experiences in the OLE (Downing, 2012).

**Cohesive Practices**

Cohesive behaviors are “exemplified by activities that build and sustain a group commitment” (Rourke, et al., 1999, p. 8). Social exchanges, addressing students by name and communicating in a timely fashion are factors that exhibit cohesive behaviors (Rourke, et al., 1999). Instructors who communicated in a “timely manner” were described by students as providing “the best [online learning] experience” (Downing, 2012, p. 108). Practices that promote a sense of cohesiveness in the OLE include integrating salutations into all forms of written communication, including email, instant messaging, and course announcements. Personalizing discussion board replies by opening the conversation with a salutation and/or addressing the student directly by name also strengthens the Cohesive nature of the interaction (Downing, 2012). Integrating these Cohesive practices into Functional and Interactive course activities strengthens students’ perceptions of instructor social presence (Downing, 2012).

**Functional Practices**

Course design was first documented as an aspect of social presence in the OLE by Tu (2000; with McIsaac, 2002). Functional communication practices include clarity in the course syllabus, schedule, and overall course layout and design (Downing, 2012). Clarity in course design encompasses factors such as course navigation, supplements and resources, syllabus design, schedule design, assignment instructions and expectations (Downing, 2012). In addition to these obvious design practices, instructional practices related to course delivery also impact the student online learning experience. Students expressed appreciation for functional,
class-wide emails and announcements that provided a routine sense of connection with the instructor such as schedule reminders and summary or review of information recently covered (Downing, 2012). Moreover, students indicated that instructors who provided well organized and delivered content demonstrated a sense of engagement in the online learning process (Downing, 2012).

CLOSING

Although technology provides the medium for online learning, students' perceptions of the online learning experience are not driven by the communication medium, but by the “skills and techniques” of the instructor (Gunawardena, 1995, p.165). Instructors create the learning environment and impact students' learning experience through interactive behavior and design choices (Downing, 2012). With intentional planning and delivery, instructors can enrich the online learning experience for their students by adopting social presence behaviors and practices and integrating them into their online instructional routine. Social presence in the OLE generates “a sense of interaction that is essential to the feeling that others are there” (Cutler, 1995, p. 18). By incorporating practices that foster social presence, instructors generate a sense of connectedness and facilitate an interpersonal learning experience for their students in the online learning environment.

REFERENCES


Gaide, S. (2004). Community college identifies student expectations as key element in online retention. Distance Education Report, 8(15), 4-6.


Electricity, Electronics, Computer Technology & Energy Issues

Developing a Customizable Renewable Energy System Laboratory Protocol for an Engineering & Technology Curriculum

by

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ABSTRACT

In this paper the authors put forth an approach and give an example of how to produce a customizable Renewable Energy Laboratory Protocol, referred to here as a cRELP. Their intent is to assist applied engineering and technology programs with developing this type of laboratory protocol. The first half is concentrated on the author’s hierarchal approach to cRELP development. This approach is similar to an upside-down pyramid, which starts with broad deliverables and progressively steps down to more focused outcomes. The second half of the paper focuses on a case study of the cRELP, intended to be incorporated into the IET 352 Energy Systems and Sustainability course offered at the Department of Applied Engineering and Technology, Morehead State University in Kentucky. This case study includes specific lab exercises, equipment needs and safety considerations in order to give the reader an example of how to formulate a cRELP’s topics and content.

GENERAL AREA OF CONCERN

Renewable energy is currently an emerging technology both in America and the world as a whole. Specifically in the United States it has garnered increasing support by both government and private enterprises. As
applied engineering and technology programs in various universities and colleges strive to keep their course offerings relevant to current industry and technology trends, more of these academic institutions are looking to implement renewable energy courses into their course offerings. This emerging line of renewable energy course offerings is vital, according to James Elder, Director of the Campaign for Environmental Literacy, adding that universities and colleges have a critical responsibility to equip the future leaders of society to “understand the complex connections and interdependencies between the environment, energy sources, and the economy” (Elder, 2009).

In partial response to this duty, educational institutions are increasingly implementing renewable energy utility systems across their campuses. Specifically, these institutions are among the largest purchasers of wind energy in America (Elder, 2009). Moreover, to date, 672 university and college presidents across the country have signed the American College & University Presidents’ Climate Commitment, which promotes the use of renewable and sustainable energy sources in conjunction with research and education (President’s Climate Commitment, 2013). However, in order for educational institutions to effectively equip the future workforce for the multifaceted issues related to energy and sustainability, they need to move beyond campus utility issues and expose their students to renewable energy course topics (Yildiz & Coogler, 2012). Laboratory experimentation is an excellent tool to serve this purpose.

**SIGNIFICANCE OF A cRELp**

With the increased push by federal and state policy makers to advance America’s technological capabilities in renewable energy, coupled with increasing viability of this emerging technology, it is becoming more important for applied engineering and technology programs to offer courses infused with renewable energy topics (Yildiz & Coogler, 2012). As previously stated, these courses are needed to prepare future engineering and technology graduates for the energy workforce (Bari & Ferdousi, 2012). While most current course offerings have detailed curricula that emphasize renewable energy theory through lecture, many have yet to establish suitable
complementing laboratory protocols. These laboratory protocols can significantly benefit students by offering them hands-on experience, which broadens and deepens their knowledge base. Integrating both theory and hands-on application into a classroom environment prepares students for the multifaceted demands of today’s energy industry (Yildiz & Coogler, 2012).

At this point two questions may arise, “Why spend the time and exert the effort to generate a cRELP from scratch? Why not simply purchase an off-the-shelf trainer with pre-formulated lab experiments?” It would stand to reason that this approach would be easier and more cost effective. This assumption, though, according to Yildiz and Coogler can be incorrect. Laboratory equipment and manuals that are currently on the market today can be much more expensive than generating and building custom protocols and equipment (Yildiz & Coogler, 2012).

Upfront cost savings are not the only benefit of generating a cRELP. Other benefits include more effectively meeting stakeholder needs, more efficiently matching resources to laboratory protocols and more accurately marrying lab experiments to regionally applicable renewable energy technologies. When looking at an educational institution’s stakeholder needs, being able to tailor a laboratory protocol to specific student and local industry needs can have a long-term benefit. Furthermore, resource matching (as it relates to instructor experience and financial budgets) is challenging to accomplish with off-the-shelf products, as they are either too simplistic or too complex to match specific or changing resources. Lastly, customizing a laboratory protocol allows course content to effectively marry with an institution’s geographic location. This enables a successful dovetailing of course content and state-of-the-art technologies relevant in local industry. These benefits form a revolving cycle, as illustrated by Figure 1.

Figure 1: Cyclical benefits of a cRELP.
cRELp METHODOLOGY

As discussed above a “one size fits all” approach to laboratory protocol development will not yield the most benefit. In contrast, a cRELp is significantly more effective at meeting the multidimensional needs of an educational institution. In this section, a hierarchical approach to formulating a cRELp is presented. Figure 2 depicts this hierarchical approach as an upside-down pyramid of protocol deliverables. This upside-down pyramid starts with broad deliverables and progressively sharpens them at each successive level downward. In the following sections each of these steps will be presented and explained.

Figure 2: Upside-down pyramid hierarchical approach of deliverables of a cRELp.

Existing Curriculum

Looking at the hierarchy in Figure 2, the first level is to review the existing course offerings related to an institution’s proposed cRELp. This step produces a two-fold benefit: 1) it allows the instructor to understand the curricular landscape in which the proposed cRELp will be implemented in, and 2) it produces a good foundation from which to integrate the proposed protocol into the existing curriculum. This integration is important because renewable energy is an interdisciplinary topic. Integrating it across multiple degree tracks can lead to a deeper and broader experience for students, allowing them to see the multi-disciplinary connections of this technology (Elder, 2009).
Advisory Board

The next level down is the voice of an advisory board. This level is arguably the most important voice to listen to in the curriculum development process (Seybert, 2010). Advisory boards can be composed of industrial, academic, corporate or small business personnel and conversations with these individuals have significant value with a strong foundation of real-world application. Also, these advisory board members carry with them concrete job opportunities for graduates. These jobs, and the financial stability they bring, are an integral part of the education system. Listening to the voices of an advisory board is priceless, and thus should be key contributors to any curriculum content development (Seybert, 2010).

Advisory boards can give quality input into current and future renewable energy needs, which can be used to formulate laboratory protocol content. The first step in discerning these current and future needs is to communicate with board members through email, in person or with surveys/questionnaires. Whenever possible communicate with local industrial advisory board members and make it a goal to form a long-term relationship with them. Such cohesive relationships are invaluable assets that can benefit an educational institution far into the future. To this end, advisory boards are either strongly recommended or are a requirement by notable accrediting bodies such as the Accreditation Board of Engineering and Technology (ABET) and The Association of Technology, Management, and Applied Engineering (ATMAE), respectively (Seybert, 2010; ATMAE, 2013).

Strengths & Opportunities

The next level involves an analysis of an educational institution’s strengths and opportunities related to specific topics of the cRELP. This analysis starts with an evaluation of the current instructor’s background, experiences and research interests, alongside focusing the topics to include in the cRELP. The analysis also gives the faculty the ability to expand upon their research interest as well as involve students in innovative technology research.
In parallel, opportunities related to student needs should be analyzed in this step. This is accomplished with such tools as student surveys, student group decision-making and student questionnaires. These instruments are excellent at helping understand potential opportunities to service student stakeholder interests. At Sam Houston State University, professors Yildiz and Coogler employed these tools to help understand and serve their student’s interests. This process helped them solidify specific topics to include in their alternative energy laboratory protocol (Yildiz & Coogler, 2012).

Finally, an educational institution’s geographic location is a key aspect of its strengths and opportunities. Due to the fact that the abundance of renewable energy resources is different for different regions, this aspect should also be analyzed when considering what topics to include in a cRELP. Including renewable resource topics that are abundant to the region is a great starting point. Furthermore, these topics will most likely be prevalent in local industry and society. For example, when considering the applicability of Photovoltaic (PV) technology in a particular geographic area, there is a clear difference in degree from the Northeast United States to the Southwest United States, as illustrated by Figure 3. For educational institutions in the Southwest, it would make sense to focus on PV topics while those located in the Northeast may want to focus on wind, hydroelectric or other applicable renewable energy technologies.
Figure 3: Photovoltaic resource across the United States (NREL, 2012).

**Topics & Equipment**

Once an educational institution has reviewed its existing course offerings, heard the voice of the advisory board and determined its strengths and opportunities, the next phase is to formulate a framework of the cREL topics. (To aid in this process the layout of Appendix A can be referenced.) This phase can be broken into four distinct steps. These steps are presented below:

1. Breakout the cREL into broad unit sections (i.e. solar, wind, geothermal, green building).
2. Populate each unit section with specific lab topics.
3. Select a reasonable number of achievable objectives for each lab (these help to further define each lab).
4. Generate a list of equipment needs necessary to achieve each lab objective.

It should be pointed out that the above four steps are iterative. Each must be reviewed and revised as needed until a clear and focused list is formulated. Also, reviewing other institution’s laboratory protocols and equipment lists can be very helpful in working through these four steps. Additionally, renewable energy trainer product offerings are also helpful. These sources can serve as beneficial references in generating a cRELP.

Funding

The fifth step of the hierarchy in Figure 2 is to acquire funding for a cRELP. This step can be an intensive and broad-based research project on its own but determines the success or failure of the overall cRELP development. Efforts must be made whenever possible to broaden the possibilities of funding sources. To this end this section includes a handful of funding opportunities, as depicted in Table 1, some of which are for equipment only and some of which carry with them moneys to cover development time. It is worth noting that the main point to remember is this table is only a starting point. An educational institution looking to implement a cRELP should strive to apply for as much additional funding as possible.

As education budgets increasingly tighten, funding for curriculum and laboratory development becomes increasingly vital. Table 1 is a sample list of government and public funding opportunities related specifically to renewable energy education development and execution. The list in Table 1 is not exhaustive by any means, but should give the reader a springboard to start from (Constellation, 2013; US Department of Energy, 2013; US Government, 2013).
Table 1: A selection of possible funding opportunities for renewable energy education initiatives.

<table>
<thead>
<tr>
<th>Fund Name</th>
<th>Fund Code</th>
<th>Funding Entity</th>
<th>Fund Amount</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>State and local grants and funds</td>
<td>N/A</td>
<td>Various</td>
<td>Various</td>
<td><a href="http://www.dsireusa.org">www.dsireusa.org</a></td>
</tr>
<tr>
<td>Energy Efficiency and Renewable Energy Information</td>
<td>81.117</td>
<td>DoE</td>
<td>~$25,000,000</td>
<td><a href="http://www.grants.gov">www.grants.gov</a></td>
</tr>
<tr>
<td>Dissemination, Outreach, Training and Technical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analysis/Assistance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used Energy-Related Laboratory Equipment Grants</td>
<td>81.022</td>
<td>DoE</td>
<td>Various</td>
<td><a href="http://www.osti.gov/ledp/index.jsp">www.osti.gov/ledp/index.jsp</a></td>
</tr>
</tbody>
</table>

**Detail**

The final step of generating a cRELP is to design the detailed lab procedures and evaluation questions. It is important to note this step is most efficiently accomplished when the appropriate lab equipment has been acquired, installed and is available for hands-on operation by the instructor. The preliminary process of working through lab procedures should be performed on the physical equipment. This process allows for evaluation of the proposed procedures to see if they are appropriate. Then, once the procedures have been vetted, specific review questions can be formulated, which will more effectively assess students work.

**MSU’S cRELP**

Currently, the faculty and staff of the Department of Applied Engineering and Technology (AET), at Morehead State University (MSU) are in the process of implementing renewable energy and sustainability course offerings. The first of these courses is its *IET 352 Energy Systems and Sustainability* course. The course is currently offered as lecture-only sections but the AET Department is working to incorporate a cRELP into this
course. A case study example of the IET 352 Energy Systems and Sustainability cRELP is hereby presented to support the proposed cRELP approach in Figure 2 and as a reference for the reader.

**Laboratory Topics**

The AET Department’s cRELP included five unit sections: *Introductory, Solar, Wind, Fuel Cells and Green Buildings*. The *Introductory* unit includes labs focusing on safety, proper data collection and tool use. The *Solar* unit incorporates PV technologies, tracking vs. stationary installations and concentrated collectors. The *Wind* section looks at wind turbine design factors and efficiency and hybrid solar/wind systems. The *Fuel Cells* section includes a lab related to hydrogen fuel cell operation and efficiency. The final section, *Green Buildings*, looks at passive solar architecture and the effects of insulation and building materials on energy efficiency.

Each lab experiment in the five-unit sections included corresponding objectives related to each topic. These objectives were chosen to integrate with 1) topics included in the course’s lecture section, 2) local industrial advisory board input and 3) faculty and student strengths and opportunities. An outline of these topics and objectives is presented in Appendix A for the reader’s reference. It is important to note the objectives serve the purpose of focusing each lab exercise and to aid the faculty and staff in formulating appropriate assessment criteria.

**Laboratory Equipment**

In conjunction with the lab topics and objectives discussed above, the AET department’s faculty and staff also generated a list of specific equipment needs related to each lab experiment. This list was crucial for the cRELP development because it was necessary to quantify these needs in order to formalize proposals for equipment grant funding. Table 2 below is the proposed list of equipment needs produced by the MSU AET faculty and staff.

*Table 2: Proposed laboratory protocol equipment needs for the AET Department, Morehead State University.*

<table>
<thead>
<tr>
<th>Laboratory Equipment List</th>
<th>Solar Data Logger</th>
<th>Anemometer (Hand Held)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverter</td>
<td>Impulse Steam Turbine</td>
<td>Wind turbine</td>
</tr>
<tr>
<td>Deep cycle 12V battery</td>
<td>Parabolic Reflector</td>
<td>Heat box/enclosure</td>
</tr>
<tr>
<td>Pyranometer</td>
<td>Receiver System</td>
<td>Multimeter</td>
</tr>
<tr>
<td>Solar cell modules</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Laboratory Safety

Another element of the AET Department’s cRELP was lab safety. This topic should be central to any laboratory protocol and experiment. To this end it is a great practice to include an introductory lab exercise dealing specifically with laboratory safety and equipment usage. This exercise can include a review of all general safety issues (i.e. first aid, eye wash stations, personal protective equipment, exits, etc.) but also specific safety issues related to the equipment and tools used in each lab experiment. For these reasons, a safety lab at the beginning of the protocol and a short safety review must be included in each subsequent lab experiment.

When deciding what specific safety issues to include in a cRELP, a good starting point is the educational institution’s laboratory safety regulations and emergency procedures. Extending beyond this, equipment manufacture’s recommendations and local or national regulatory body’s policies can be reviewed and incorporated into the laboratory protocol literature to further strengthen the foundation of safety.

Similar to how an employee’s perception of safety is affected by management’s safety culture (O’Toole, 2002), a student’s perception of safety is shaped to a large extent by how this topic is addressed by the instructor during laboratory experiments. Therefore, incorporating safety as a keystone of each and every lab experiment will help prepare students for careers that champion safety and safe work practices.

CONCLUSION

The cRELP, if effectively implemented, can be a viable tool for preparing students in Energy Systems and Sustainability for the needs of the emerging renewable energy workforce. As shown in the pyramid hierarchical approach of deliverables for a cRELP (Figure 2) and supported with the case study, a clear step-by-step approach...
to generating a cRELPG is possible, which can be tailored to the specific faculty, students, region and local market. Also, the authors showed how their proposed approach starts with broad topics, which are systematically refined through cyclical iterations until a distilled cRELPG is generated.

Furthermore, some of the most important voices of input in this process are local advisory boards, faculty and students. Funding a cRELPG is also important. This step can be a research project on its own, which requires time and effort to accomplish. To help the reader in this process the authors gave examples of a few funding opportunities currently available, which can be found in Table 1.

Lastly, the work of developing a cRELPG carries with it multifaceted benefits. In the short term, the students are the ones to benefit from the integration of renewable energy topics into course offerings. In the long term, industry, society and our environment are the beneficiaries, which in turn affect us all.

REFERENCES


Appendix A

MSU’s cRELp Topics and Objectives

**Lab #1: Lab Safety Standards**
Objectives

1. Acquire a general understanding of all lab equipment and the safety hazards associated with each.
2. Familiarize oneself with the location of lab First Aid station.
3. Locate all fire extinguishers and exit routs.
4. Understand and be able to summarize the MSU emergency procedures.

**Lab #2: Data Collection Tools and Techniques**
Objectives

5. Familiarize oneself with each data collection tool of the lab.
6. Demonstrate the ability to measure and record data observations for each tool.
7. Distinguish and convert appropriate engineering and scientific units related to each tool.
8. Compare the contrast the different data each tool is used to measure.

**Lab #3: Solar Cells**
Objectives

1. Analyze the difference between series and parallel load resistor wiring configurations.
2. Determine the factors that affect a Solar Cell’s Isc and Voc and how temperature impacts power output.
3. Plot voltage and current observations to build a VI curve to determine Maximum Power Point.
4. Calculate the fill effect and efficiency of a Solar Cell.

**Lab #4: Photovoltaic Panels: Tracking vs. Stationary**
Objectives

1. Determine how the angle of a photovoltaic panel affects its power and efficiency levels.
2. Understand the difference between manufacture’s efficiency rating and “real-world” efficiency observations.
3. Determine whether photovoltaic power output is directly or inversely proportional to cell temperature.
4. Analyze the difference between series and parallel load resistor wiring configurations.

**Lab #5: Solar Thermal Hot Water Systems**
Objectives

1. Distinguish the difference between and understand the uses of both solar-to-electric and solar-to-thermal energy conversion.
2. Calculate the difference and net efficiency of adding solar thermal heating to a hot water system.
3. Be able to identify appropriate site locations for a solar thermal hot water system.

**Lab #6: Concentrated Solar Power (Electric Gen.)**
Objectives

1. Calculate the geometric concentration ratio between the reflector and receiver.
2. Calculate the steady state heat transferred to water at different flow rates.
3. Determine the correlation between steam temperature and turbine speed.
4. Calculate the maximum efficiency of the system, including maximum system temperatures.

**Lab #7: Analysis of Wind Turbines**
Objectives
1. Analyze the effect of wind speed on turbine efficiency and power output.
2. Understand and comment on how wind direction affects a turbine’s efficiency and power output and how a turbine’s pitch and yaw can be adjusted to compensate.
3. Determine how turbine blade diameter effects power output and why.
4. Plot the turbine voltage output based on wind speed.

**Lab #8: Hybrid Systems (Solar & Wind)**

**Objectives**

1. Realize the benefits of multiple sources of renewable energy to maintain consistent power generation.
2. Understand how to integrate different sources of variable renewable energy into one power generation system.
3. Be able to compare the contrast the advantages and disadvantages of wind and solar energy sources and how to utilize both in a hybrid application.

**Lab #9: Hydrogen Fuel Cell**

**Objectives**

1. Understand a fuel cell’s efficiency with the use of voltage, current and power curves.
2. Determine the effects of system loading on the efficiency and power output of a fuel cell.
4. Be able to describe and diagram the common components of a hydrogen fuel cell.

**Lab #10: Passive Solar Architecture**

**Objectives**

1. Distinguish the difference between active and passive solar energy.
2. Evaluate the effects of thermal convection and describe it in terms of temperature and pressure differentials.
3. Examine how window eave design effects winter and summer solar heat absorption and reflection.
4. Describe the design constrains of both winter and summer solar heating/cooling and how each can be overcome in a single buildings design.

**Lab #11: Efficient Insulation Materials/Techniques**

**Objectives**

1. Analyze the effects of insolation types and techniques and how they affect a building’s thermal efficiency.
2. Calculate the percentage of energy efficiency/savings of a well-insulated building vs. an un-insulated building.
3. Plot the thermal heat loss over time for each insulation type/technique to generate heat loss profiles.
Electricity, Electronics, Computer Technology & Energy Issues

Jet-Fuel Production from Municipal Waste Streams: Process, Concerns, and Need for Standardization in Life Cycle Analyses

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ABSTRACT

Growth in worldwide air travel has prompted concern about the influence of aviation activities on the environment. In this work, we first provide an overview of the proposed technical process for converting waste to jet fuel. Potential benefits and concerns regarding the use of municipal waste streams as feedstock are then discussed. Note that reductions in greenhouse gas emissions using this alternative fuel source are dependent on the composition of the waste stream and the total system transportation requirements, which are site-specific and require further investigation via life cycle analysis models. We conclude by examining specific areas which could improve the usability of the results obtained from the life cycle analysis models.

INTRODUCTION

Since the introduction of the commercial jet in 1960, aircrafts have experienced a dramatic improvement in fuel efficiency, and some researchers believe that next generation aircrafts will see another 15-20 percent improvement, making air travel one of the most fuel-efficient means of transportation (Daggett et al., 2006). Nevertheless, improvements in energy efficiency have failed to keep pace with overall growth in the airline industry,
resulting in a net increase in fuel consumption (Ross, 2009). Growth in worldwide air travel has prompted concern about the influence of aviation on the environment; this, along with increasing oil prices, which have contributed to the recent bankruptcies of several airlines, has driven a demand for alternative fuel sources in the airline industry. To this end, the Federal Aviation Administration (FAA) formed the Commercial Aviation Alternative Fuels Initiative (CAAFI) in 2006 to enhance energy security and environmental sustainability for aviation through alternative jet fuels (Commercial Aviation Alternative Fuels Initiative, 2013).

However, alternative energy solutions are restricted in the airline industry due to physical and system-imposed constraints. Jet fuel must be energy-dense since planes have restrictive volume and weight capacities, and fuels containing less energy would propagate a reduction in travel ranges. As a result, currently available alternatives such as ethanol and solar do not appear to be promising ventures for fueling jets (DiGeorgia, 2013; European Commission, SWAFEA, 2013). A 2009 technical report entitled, "Near-Term Feasibility of Alternative Jet Fuels," sponsored by the FAA in collaboration with MIT (Hileman et al., 2009), found that the most promising solutions in terms of reducing greenhouse gas (GHG) and other particulate emissions appear to be biofuels produced with the Fischer-Tropsch (FT) conversion process, described as follows:

*The FT process produces liquid fuels from carbonaceous feedstocks, such as natural gas, coal, and biomass. All jet fuels produced by FT synthesis have similar characteristics. In particular, they contain neither sulfur (less than 1 ppm) nor the aromatic compounds that tend to increase soot formation. Choice of feedstock does not affect fuel quality but does affect production costs and life-cycle GHG emissions. (page xvii)*

In this work we examine a particularly controversial fuel source -- municipal solid waste (MSW) streams. While not strictly considered a biofuel, paper and yard waste compose the majority of MSW (U. S. Environmental Protection Agency, 2013), which are organic-based materials. This fuel source not only shows promise for reducing GHG emissions, but could also be strategically utilized to address landfill shortages. The concept of producing energy from MSW stockpiles using incineration methods has been utilized for several decades, but such facilities have not been not widely adapted due to significant problems with air pollution. However, new technologies using the FT conversion processes appear to be a promising solution, remedying many of the pollution-control problems.
MSW-based, jet fuel production systems are currently in the developmental stages, with a pilot facility being tested in Durham, NC (Fulcrum BioEnergy, 2013) and another proposed in Bloomington, IL (Wells, 2012).

In this remainder of this work, we provide a technical overview of the FT process for converting MSW to jet fuel and further discuss potential benefits and concerns regarding these systems. This is followed by a call for further developing comprehensive and standardized methods for conducting life cycle analyses for comparing complex, alternative fuel sources, such as MSW. We then conclude with a summary and suggestions for future work.

OVERVIEW OF THE FISCHER-TROPSCH FUEL-EXTRACTION PROCESS FROM MUNICIPAL WASTE

Extensive preparation and treatment of municipal waste is required before it can be utilized post-process as a high potency fuel, as it is highly variable in composition. Typically, MSW is solid, consisting of a heterogeneous mixture of fibrous (e.g. paper), silicate (e.g. glass), polymer-based media (e.g. plastics, textiles), metallics and a magnitude of other waste materials, with variable amounts of moisture content. The proportion of these materials varies by both region and season. Figure 1 delineates the general step-wise process utilized in this study to produce the desired fuels from waste.
First, the MSW must pre-sorted to remove any inorganic (i.e. non-carbon containing) material and dehydrated. The systems used for sorting typically use a combination of size reduction, physical screening, magnetic separation, and density separation to remove the undesirables. Next a synthesis gas consisting of carbon monoxide and hydrogen is created by gasification, where the feedstock is reacted with steam at elevated temperatures and pressure. Besides the desired gaseous species, carbon dioxide and various impurities may also be present, and these need to be removed to protect the expensive catalysts used and the efficacy of the subsequent fuel synthesis.

This cleaning step is what makes gasification processes superior to incineration in regards to environmental pollution, “as all toxins that would otherwise be combusted in an incinerator must be removed from the synthesis gas. Removing the impurities from the gasified products is more effective. It is also easier to collect the precipitates and properly repurpose or dispose of them this way.” (Farver and Frantz, 2013 page 37). These
impurities are of higher abundance and variety considering the complex nature of the MSW feedstock, and still pose many technical challenges. The impurities themselves can be highly toxic, and therefore must be efficiently collected, assessed and fully remediated to minimize environmental impact.

Once impurities are removed, the cleaned reagent is brought into contact with proprietary catalysts to initiate the FT conversion; when the FT synthesis is completed, the alkane mixtures produced can be refined into liquid fuels using established techniques from the petroleum industry. FT generated fuels consist of a broad distribution of hydrocarbon chain molecules, although variations in the utilized catalyst, reaction temperature, and chamber pressure are used to produce desired fuels, which are then transported to facilities for use in air travel.
Utilizing Municipal Waste as a Jet-Fuel Source: Potential Benefits and Concerns

Pollution Control

The FT-conversion process alleviate many of the pollution-control problems posed by incineration methods, as “post-combustion emission controls are generally not as effective as pre-combustion controls” (Farver and Frantz, 2013 page 37). However, this process still produces byproducts that can be toxic and therefore must be remediated effectively. Potential pollutants are dependent on the composition of the associated feed-stock, which is highly-variable for MSW, especially in systems consuming existing stock from older landfills containing hazardous wastes. Overall, more research is needed to better assess the pollution-control requirements for the proposed system.

Greenhouse Gas Emissions

The composition of the feedstock also impacts potential reductions in GHG emissions as organic feedstocks are considered carbon-neutral, while polymer-based feedstocks derived from fossil fuels yield higher GHG emissions. Feedstock composition is site-specific, but a 2009 EPA study indicates that paper, yard-waste, food-waste, and plastics comprise over 75% of overall MWS (U. S. Environmental Protection Agency, 2010). System-wide transportation requirements also impact potential reductions in GHG emissions. However, transportation requirements are also site-specific, and therefore require a site-specific analysis to accurately estimate.

Assessing the potential reduction in GHG emissions for this system is further complicated due to the presence of two potential reference points for comparison: (1) The first point of reference is comparing emissions from the proposed MSW-based, FT jet fuel to traditional jet fuels such as Jet-A, derived from fossil fuel sources. Estimates for this reduction are not yet available, but as previously mentioned would be dependent on the composition of the waste stream. Related works appear to yield promising results, though, as a 2009 study by Shi, Koh, and Tan found that waste biomass-derived cellulosic ethanol could result in GHG emissions savings of 30 to 85% compared to gasoline consumption. (2) The second point of reference is comparing emissions from FT-
gasification of MSW as opposed to landfilling it. A 2012 EPA study estimated that gasification results in a net-carbon emission savings of 0.3-0.6 tons of carbon equivalent (TCE) per dry ton of MSW. This net savings can be attributed to the process of producing energy through gasification being much more efficient than landfill energy-recovery processes (Farver and Frantz, 2013).

*Reductions in Landfilled Waste*

Where MSW-based FT fuels appear to offer some of the biggest advantages is in reducing the amount of waste being land-filled, making these systems specifically desirable in areas where landfill space is scarce (e.g. urban and island areas). Estimates of the amount of waste that could be diverted from landfills are as high as 90% (U.S. Environmental Protection Agency, 2012). This does, however, pose concerns about the impacts the proposed system could have on recycling rates. On one hand, the systems forces separation of non-carbons in pre-processing, as this is inherent to the process, but accepts paper, yard-wastes, food-wastes, and polymers that could have otherwise been composted or recycled.

*Summary*

Compared to other candidate feedstocks such as corn or grasses, for example, MSW also had the advantages that it can be obtained at low-cost, is not depended on as a food source, and does not divert land and water resources away from agricultural interests. In summary, the proposed system offers many potential benefits, particularly in areas that face looming constraints on landfill space, but constructing this type of commercial facility is estimated to cost in the range of half a billion dollars (Farver and Frantz, 2013). This is a significant investment that ultimately competes with funding resources available for pursuing other alternative energy initiatives.

More work needs to be done to estimate the reductions in GHG emissions associated with these systems and also to further address pollution control issues needed to handle byproducts left from the FT-gasification processes. Currently the state-of-the-art method for estimating the life-cycle environmental impact of a production system (including GHG emissions) is life cycle analysis (LCA). However, this method has proven to be problematic due to a lack of standardization across studies, which has previously been associated with extreme variations in
results reported from biofuel systems (Davis et al., 2008). Problematic sources of variation in LCA are further discussed in the proceeding section, along with suggestions for future research in analyzing the proposed system.

NEED FOR STANDARDIZATION IN LIFE CYCLE ANALYSES (LCA) OF ALTERNATIVE ENERGY SYSTEMS

As both fuel sources and production processes become more diverse and complex, there is ever-increasing need for comprehensive and standardized methods that can be used for comparing systems. The most commonly used method currently is LCA, a computational tool capable of estimating the total environmental impact of a product throughout the entire production process, starting from material inputs and ending with consumption and/or post-consumption disposal, recycling, or reuse/reprocessing. The inputs and outputs for biofuel production systems are characterized in terms of material inputs, total energy requirements and yields, along with all environmental releases (pollution). The objective of an LCA typically is to evaluate the environmental impacts/benefits of the proposed system relative to a conventional or reference system. Thus, LCA provides users with a tool for selecting the best product or process for a given application, based on a pre-specified set of standards (Singh et al., 2010).

Because LCA allows for a comprehensive evaluation of an entire production system, it helps users avoid suboptimal decisions which simply shift environmental problems from one process area to another (U.S. Environmental Protection Agency, 2006). This requires users to develop comprehensive, systems-level thinking about the production process as a whole, which is beneficial in and of itself, but requires the user to specify numerous assumptions -- a complex process that requires interdisciplinary knowledge about the environmental impacts associated with the production process.

Davis et al. (2008) indicate that a lack of standardization across studies in specifying these assumptions is attributing to significant variation amongst reported results in GHG emissions from biofuel systems. They note that the main factors attributable to generating excess variation in LCA results are differences in the following items: (1)
defining a functional unit, (2) quantifying material and energy input/output estimates in the life-cycle inventory, and
(3) defining system boundaries.

Functional Unit

A functional unit needs to be specified by the user. The functional unit provides a reference to which the
total amount of required inputs and outputs can be related and sets the scale for comparison (Jensen et al., 2004).
Matheys et al., (2007) also found that the functional unit can produce significant variation in results. Functional units
considered for the proposed system of interest include the ratio of GHG emissions either per passenger for each
km of great-circle distance (great-circle distance is the shortest distance between any two points on the surface of a
sphere) or per kg of payload for each km of great-circle distance. The per-kg-of-payload-per-km-of-great-circle-
distance functional unit is used for freight aircrafts, while per-passenger-per-km-of great-circle-distance is used for
passenger aircrafts (Elgowainy et al., 2012). This difference makes it cumbersome to directly compare results even
within studies in the airline industry because there can be different assumptions about the weight of an average
passenger (e.g. the Greenhouse gases, Regulated Emissions, and Energy use in Transportation model assumes
90kg, (Elgowainy et al, 2012)).

Life Cycle Inventory

The life cycle inventory is the data collection that describes the sub-processes of the system to be
examined. The compilation of inventory is an enormous task requiring significant time, as the user must account for
all energy and material flows through each process. Process flow diagrams are used to outline the relationships
between unit processes and flows across the system boundaries. The results of the data compilation and
calculations should be checked using methods such as mass and energy balances.

Inputs include energy and raw materials. Outputs include various types of products and wastes. As
previously mentioned, the potential pollutants for fuels produced from MSW depend on the composition of the
MSW, making it difficult to comprehensively list and quantify these items. Further research needs to be conducted
towards this end. Variations in results can also be attributed to uncertainties in inventory quantities. Sensitivity
analyses should be conducted to deduce the impact of inventory uncertainty on results, but few studies consider this in their analysis.

**System Boundaries**

System boundaries define the external interfaces of the production system. Davis et al. (2008, page 5) note that different system boundaries among studies are perhaps the most complex and influential cause of variation in LCA results. For the proposed system, boundaries impact the total transportation requirements. If, for example, the system boundary is drawn at the fuel-processing site, then transportation requirements may be completely ignored. In such a case, the resulting reductions in GHG emissions would be higher than what would actually be observed in practice.

Another area of concern regards the system boundary for the reference system, which represents the status quo for comparison. In the reference systems users should account for emissions that would have been observed had the MSW been landfilled. Furthermore, if the existing landfill also has an energy recovery system, then this should be included in the reference system.

**CONCLUSION**

Technological advances in fuel conversion processes may make municipal waste streams a viable feedstock candidate in the near-future, but more work is needed to further assess the impact of waste composition and transportation requirements on reductions in greenhouse gas emissions. Waste compositions also impact pollution byproducts from the fuel conversion process, which require remediation. Potential byproducts should be further investigated, especially in feedstock from older landfills containing hazardous materials.

Life cycle analysis is currently the state-of-the-art model used for assessing the overall environmental impacts of a production process. However, these models lack standardization, which reduces the usability of the corresponding results. Particular areas of concern for these models were examined and suggestions for improvement were noted where applicable.
REFERENCES


An Investigative Study of Rapid Prototyping and Traditional Model Building in the Architectural Design Studio

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INTRODUCTION

Building architectural models is an integral part of the design studio. In architecture programs physical model building begins right in the freshman year and carries through into the design studios. Physical models can be created at each point of the design process from the conceptual phase through to the final design. The primary focus of a physical model is visualization. Models help us understand form, spatial organization, scale and proportion. Building physical models requires students to comprehend the design in its totality as they have to resolve all aspects of the design in order to be able to build the model (Day). Consequently a well-built model enables the audience to then get a complete view of the design. Through an internal grant received at Western Kentucky University, (WKU) an investigative study was conducted to examine the feasibility of using the rapid prototyping (RP) process for building models in the architectural design studio.

The goals of the study were primarily to compare the traditional architectural model building process and three-dimensional (3D) printing with regards to (1) process flow, (2) time, (3) material (variety and ease of handling) and (4) precision. Three designs were selected and physical models were made using the traditional model building methods as well as the RP process. The paper highlights the path used to arrive at the three final models and compares and contrasts the approaches. The unique setup of the Department of Architectural and Manufacturing
Sciences (AMS) proved to be a great facilitator for this project. The traditional model building process was carried out in the designs studios and RP was carried out in WKU's Mitch McConnell Advanced Manufacturing and Robotics Laboratory.

Traditional Model Building within Architecture

Physical model-making is the process of creating physical replicas of designs (Orr, 2008), at a reduced scale compared to the actual size of the object. Building models has always been a very important part of the curriculum in architecture schools. Models are used by students to understand form and space, figure out complex designs, convey design solutions and as a presentation tool. Physical models are used as visualization tools that overcome the limitations of two-dimensional (2D) images (Tucci, Bonora 2011). Students are taught the basics of model-making right in their freshman year where they create sketch models with materials such as cardboard boxes, paper and other scrap materials. The students also experiment with finer model making materials such as paperboard varieties, wood and acrylic. They are taught techniques of material selection, cutting, gluing and presentation. The skills acquired are carried forward to the design studios. In the design studio, the model building process begins with design sketches; once a design has been finalized and drawings prepared (either hand drawn or computer aided) the scale of the model is decided, materials selected to create the model and the building process begins. The building process has three main steps, (1) drafting the model outline onto the material selected to build the model, (2) cutting out the pieces, and (3) gluing the pieces together to create the desired shape.

Though model building is a very effective tool in communicating design ideas there are numerous drawbacks to building a model which include but are not limited to poor quality, human error (Agarwala et al., 2009), time constraints and disinterest on the part of the student.

Rapid Prototyping

Rapid prototyping (RP) is a manufacturing process through which the user creates a physical model directly from a computer-aided design (CAD) (Liou, 2008). It starts with the creation of the 3D CAD model which when
complete is converted to Stereo lithograph (STL) format. The STL format is used by the 3D printer to produce the physical model. Of significance is the fact that from this point on involvement by the model builder is minimal. The model build can take anywhere from a couple of hours to an entire day. On completion the model is immersed into a wash tray where ultrasonic washing dissolves the support material providing for a clean prototype. Since the model is built layer-by-layer without extraneous tools complex geometrical shapes can be modeled (Liou, 2008). There are liquid-based, solid-based and powder-based RP processes for creation of the physical model. The solid-based process which is also termed as the extrusion-based process feeds material in solid wire form and then melts it into the desired shape and the model is created (Liou, 2008). During this investigation the solid-based process with Fused Deposition Modeling was used to create models for the study.

**STUDY PROCESS**

WKU awards Faculty-Undergraduate Student Engagement (FUSE) grants to encourage undergraduate student research. The student works on a selected research topic under the guidance of their faculty mentor during the funding period. The study discussed in this paper was conducted as part of a FUSE grant received during spring 2012 and was undertaken during the fall 2012 semester. Three models typically built by students through the course of their study were used for this investigation. For the traditional modeling approach Chipboard was used as the material for building the models. Models 1 & 2 were re-built using the traditional as well as RP process. For model 3, an existing hand built model was used for this study while it was re-built using the RP process. The 3D printer used for the RP process was the Dimension Stratasys, using ABS plastic as prototyping material. The 3D printer available in the laboratory could build models to the maximum size of 8"x8"x8", and these dimensions were a factor in selecting the models being used for this study.
The first model (figure 1), involved the amalgamation of three shapes, a triangular volume, a rectangular volume and a curved surface volume; a model typically built by Architectural Science (AS) majors in their freshman year.

![Figure 1: Model 1](image1)

The second model (figure 2), involved integrating three planes into a cube to establish hierarchy, rhythm and create balance; a model built by AS students in their junior year in the design studio. The third model (figure 3),
involved the building of a single story residence, undertaken by the students in their freshman year. Models 1 and 2 required students to create design concepts before beginning the building process, on the other hand at the start of model 3 the students were provided with a set of drawings to build the model. Table 1 lists the models built, the number of iterations, the time taken to build each model and the cost of materials used to build the model.

Figure 3: Model 3

**DISCUSSION**

During observations of the traditional and rapid prototyping processes, the advantages and disadvantages in making models using these processes was noted and recorded. Figure 4 illustrates the process flow for both the traditional model building and rapid prototyping processes. Both the processes begin with the design sketches of the model to be built. With the traditional model building process the builder has the option to select materials that would be appropriate for and convey the intent of the design, while with 3D printing the material is restricted to the type of printer being used. The traditional model building process requires the builder to be involved through all the steps of the process, while in RP the involvement is up to the generation of STL files after which there is no involvement till the build is completed by the printer.
Table 1: Comparison of Traditional Modeling and RP

<table>
<thead>
<tr>
<th>Model</th>
<th>Design Sketches (hours)</th>
<th>Traditional Model Building Process</th>
<th>Rapid Prototyping Process</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Drafting (hours)</td>
<td>Building (hours)</td>
<td>Cost ($)</td>
</tr>
<tr>
<td>I</td>
<td>1.5</td>
<td>5.5</td>
<td>$10</td>
</tr>
<tr>
<td>II</td>
<td>0</td>
<td>5.5</td>
<td>$34</td>
</tr>
<tr>
<td>V</td>
<td>0</td>
<td>4.5</td>
<td>$31</td>
</tr>
<tr>
<td>I</td>
<td>6.0</td>
<td>2.0</td>
<td>$10</td>
</tr>
<tr>
<td>II</td>
<td>0</td>
<td>13</td>
<td>$31</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>0</td>
<td>15.0</td>
<td>$25</td>
</tr>
<tr>
<td>II</td>
<td>0</td>
<td>15</td>
<td>$73.5</td>
</tr>
</tbody>
</table>
To further analyze, compare and contrast the two approaches we look at table 1 above. The design sketches are common between the two approaches. Design sketches were provided for model 3 hence there is no time designated in the corresponding cell in table 1. In an academic setting, when students build a model using the traditional method it is usually a single attempt, since it is labor intensive. In contrast for a student attempting a RP model for the first time there may be several iterations of the same model as seen in table 1. The student built four iterations of model 1 using the RP process. In the first attempt (figure 5), the near infinitesimal area of the triangular tip resulted in a failure of the material to bond between the rectangular volume and the triangular volume.

![Figure 5: Model 1, First Attempt](image)

The second iteration contained flaws in scaling and the resulting model was approximately twice the desired model scale, as seen in table 1 the corresponding time required for the iteration was 17 hours. The problems encountered in the first two iterations were resolved in the third attempt. All the three iterations had surface imperfections. While the printing process for model 1 was ongoing the student started working on model 2. Three iterations of model 2 were built. In the first attempt the student made an error on the thickness of the edges making them 3/8” instead of 3/16” (figure 6). This was rectified in the second attempt but these two models also had surface imperfections. On investigation, it was found that the ABS plastic cartridge needed to be replaced. The cartridge was replaced and the fourth iteration of model 1 and third iteration of model 2 were re-printed achieving the desired result (figure 7).
The third model was printed twice. In the first attempt the walls of the house were too thin when printed and the floor did not print (figure 8). The student realized that the walls and floor were not drawn to the required minimum thickness when creating the 3D model in CAD. Horizontal planes are a particularly important detail to be checked for 3D printing since a minimum number of layers of material are need to be carried out over a relatively
large surface area (compared to the non-horizontal elements) for the floor to be printed properly. This was then corrected and successfully reprinted by the student (figure 9).

Figure 8: Model 3, First Iteration

Figure 9: Model 3, Final Iteration

For the traditional approach models 1 & 2 were re-built by the student. Figure 10 illustrates the quality and precision of model 1; considerable time was spent by the student to build the model to achieve the desired results.
Some of the visible edges of the model need to be better aligned, but on the whole the model is well executed. The traditional approach to model building allows students to build quick study iterations before attempting a serious build. While working on model 2 the student spent time on the design process and built three study models of paper (figure 11). The results of the final model can be seen in figure 11; the student did not spend adequate time in this model and as a result the edges are not well aligned due to imperfections while cutting and glue is evident on the surfaces.

Figure 10: Model 1, Using Traditional Model Building Process

Figure 11: Model 2, Study Model (left) & Final Model (right) Built Using Traditional Model Building Methods
Figure 12 illustrates the results of model 3; this model was built during a prior semester in a freshman class. The student put in considerable time and effort in the building process and this is evident in the level of detail. The model was built over three weeks with, in class time being 4 hours per week and 5 hours of time outside class in the three week period to build the model. The student had the freedom to select materials which would allow the model to have the desired finish.

![Figure 12: Model 3, Built Using the Traditional Model Building Process](image)

RESULTS

The first two models presented deal with fundamental form and shape; on comparing the models built using the two approaches RP models are more precise and have better defined edges. Using the RP process in model 1 enabled the student to integrate the model with a higher level of accuracy since it involved extrusion of material from one volume to allow the other volume to integrate. In traditional model building, extrusion is considerably tricky, difficult and is dependent on the skill of the model builder. In model 2, which should have been an easy model to build manually because of its defining geometry, the disadvantages of traditional model building are apparent. Edges are not perfectly aligned, glue is visible and the edges are not straight. Model 3 clearly shows the
strengths of the traditional approach. In the hand built model there are at least three materials used to fabricate the model. The model is well defined in terms of preciseness. Most importantly this model is completely finished and ready to present to a client or reviewer. The RP model on the other hand is a base model which requires additional work (either automated or manual) to bring it to the same level of finish as the hand built model. Model 3 indicates a potential pathway to integrate RP with the approach of traditional model making in the design studio. Students could work on a relatively complex design and create a 3D drawing to enable the production of a base RP model, which would then be augmented by traditional model making methods to produce a finish that would meet or exceed expectations. The advantages of the RP base would be precision and well defined edges and surfaces, while the benefits of using the traditional approach would be a greater selection of material and addition of detailed features that would not be easily achieved by RP.

The time spent in building the RP models comprise two components, (1) the time spent in producing the 3D CAD model and (2) the time taken by the RP system to print and wash the model. As seen in table 1, for the traditional hand built models a cumulative of 4 hours for drafting and 22.5 hours build time was used by the modeler for a total of 26.5 hours. For the RP approach a cumulative of 7.75 hours was used for drafting while build and wash time was 152.5 hours for a total of 160.25 hours. These figures account for all iterations for both approaches built. Since the build time in RP requires minimal involvement by the student builder, the time spent by the student would be the time spent on 3D CAD. Table 2 (shown below) which is a derived subset of the numbers from table 1 gives a comparative idea of student involvement in the two approaches.
CONCLUSION

Traditional model building methods are followed by most schools of architecture. They provide for good study models for students to further their designs. As observed earlier a highly detailed model requiring a wider selection of materials would benefit from the traditional model building approach. This is significant when building architectural design models showing lots of features such as building finishes and landscaping.

This study finds that while RP has the advantages of better precision and edge definition, there are factors that need to be considered for RP to be efficiently carried out.

(1) Training students in 3D CAD: This is a necessary prerequisite for RP usage. Currently students are formally trained in 2D CAD and course changes will need to incorporate 3D CAD if model making using RP is to become a part of the AS curriculum. This would also include instruction in scaling so that the iterations of the same model that were carried out can be avoided.

(2) Technology: The RP system used in this study was good for all three models but was an optimal choice for the first two models. Additional investigation is required to see how the third model could be built using RP to approach the finish achieved by hand built models.

(3) Cost: Critically, cost is an aspect where the traditional approach is clearly a more economical approach. The cost comparison and cost variance per iteration for RP to traditional model building was found to be 3.1:1 to
1. Assuming that training and preparation would reduce iterations to one per model the cost is still at least 3:1 for RP to traditional model building.

While traditional model building is a skill that is required of every architecture student, RP is an additional approach to model building that students of architecture would be well advised to add to their model building skills. As students graduate and join architectural practices, their experience with 3D printing could raise awareness and encourage practitioners to adopt the RP process for model building (Kirton & Lavoie 2005).

ACKNOWLEDGEMENTS

The authors would like to thank WKU’s Office of Academic Affairs and the Office of Research for the grant which made it possible to carry out this investigative study. We would also like to acknowledge the faculty in charge of the Mitch McConnell Advanced Manufacturing and Robotics Laboratory for their advice and assistance in the 3D printing process.

REFERENCES


Combined statistical and graphical methods are proposed to design, analyze and develop industrial
equipment HVAC componentry. A CAD/CFD-based experimental design is set up by targeting specific design
factors and studying their impact on carefully selected system response variables. Computational Fluid Dynamics
simulations are performed on 3D CAD model iterations representative of specific design factor level combinations,
and unique airflow diagrams are generated to analyze system performance. Results of the CFD analysis are further
analyzed using a multi-factorial experimental design to determine the optimal system configuration. Such an
integrated analysis approach requires minimal physical testing, thus minimizing the overall cost and time spent on
the project. This approach enabled us to not only develop a solution to the immediate problem, but also outline a
generic methodology that can be utilized in almost all CAD/CFD-based scenarios.
visualization to analyze various design iterations. Such an integrated approach can result in a more robust and optimized system design. Not only does this help improve overall system performance but also has the potential to significantly reduce time and cost spent on designing the system.

Prior to the usage of current engineering tools such as CFD, designers would have to limit their exploration into design possibilities and produce very few physical prototypes that would then be tested either in the field or during a controlled experimental run. This left many possibilities off of the table for consideration and thus severely limited the total system improvements that could be tested and possibly implemented. But with rapid advances in Computer-Aided Engineering tools including CAD and CFD, now designers are able to digitally simulate significantly more ideas and designs. This ultimately results in higher quality test scenarios since the physical tests are made up of the top percentage of the digital simulations that have shown promise.

**BACKGROUND**

*The Fundamentals of Design*

Design is formulation of a plan that satisfies a specific need or simply solving a problem. During the design process, the designer must ensure that the design meets certain predetermined criteria. The product must be functional, as well as reliable, safe, usable, manufacturable and marketable, among other things (Budynas, Nisbett, and Shigley, 2008). Design is an iterative as well as innovative process (Earle, 2000). It is also a decision-making process. All too often designers find themselves faced with decisions that must be made with either too little information, sometimes with just the correct amount of information, and sometimes with an abundance of information that partially contradicts itself. These decisions must sometimes be made tentatively, with a reservation to change at a later time as more information becomes available. Designer must be comfortable with this decision making and problem solving process. Various analysis tools from mathematics, statistics, computers, and graphics fields can be combined to formulate a plan that yields a product with desirable characteristics.
Computational Fluid Dynamics (CFD)

Computational Fluid Dynamics (CFD) is emerging as an important tool for engineering design analysis due to its innate ability to handle governing equations in their exact forms. It is not only this ability to handle the “exact”, but also its ability to function with the inclusion of detailed physical phenomena such as finite-rate chemical reactions that has boosted its popularity. CFD not only supports both the pure theory as well as the pure experiment but also it compliments their presence as well (Anderson, Degroote, Degrez, Dick, Grundmann, and Vierendeels, 2009). Today, with the recent developments in high performance computing and numerical algorithms, CFD simulations approaches are increasingly being preferred over physical testing. Particularly, CFD is being utilized in design areas that rely heavily on fluid flow, such as the aviation and automobile industries (Watson, 2012; Farouki, 1999). While the automotive and aviation industries have been using CFD for many years, the new developments in the field will surely make it available to most other industries, which until recently have seen CFD as an unattractive technology due to the amount of high skilled man power and computing power required (Ottitsch and Scarpinato, 2000). There are several examples in various industries that illustrate the versatility and usefulness of CFD.

In medical device industry, the margins for design safety are extremely tight. When designing medical devices, it is important to understand the basic flow of air, blood and even chemicals that are used in medical applications. CFD is fast becoming an important tool for medical device designers since it can simulate the internal and external flow of air, water and even blood while also accounting for heat transfer (Waterman, 2013).

Cummins, a well-known engine manufacturer, effectively uses CFD tools in early part of the product development phase. It is significantly less costly and easier to make changes in the early part of the design process. Using CFD tools, the company has been able to reduce its dependency on hardware testing and has seen significant reductions in the historically lengthy testing cycles, which has ultimately decreased the overall development cycle time. Use of virtual testing allows Cummins to bring their new designs to market faster (Stackpole, 2012).
Caterpillar is another well-known company that uses CFD to study their designs in detail prior to the cutting of any materials. They are able to analyze exact fluid flow patterns through their hydraulic circuits and understand and visualize the expansion and losses as the fluid expands. This enables them to quantify the loss and make the appropriate changes such as changing the orifice size and the resulting fluid flow (Morey, 2012; Preshner, 2010).

Experimental Design

The last part of the integrated systems analysis in this research involves experimental design or design of experiments (DOE). We see that experiments are performed in nearly every field to discover some sort of information about a particular system or process. It is apparent that experimentation plays a vital role in product realization, in which we find the activities of new product design and product improvement. The ultimate objective of this experimentation is usually to develop a component or system that is robust to the presence of outside sources of variability (Montgomery, 2012).

SIGNIFICANCE AND IMPORTANCE OF THE STUDY

HVAC systems are used to improve indoor or vehicular environment comfort. Many applications of CAD and CFD can be found in HVAC system design, but these applications have been mostly independent of each other. Very few research efforts in the past have explored the synergy between the two fields in HVAC system design optimization. Further, there exist even fewer applications where CFD and CAD are combined with experimental design. The main focus of this research is to show how these three tools can be used synergistically to optimize component designs of HVAC systems in industrial equipment while maintaining an absolute minimal requirement for prototype manufacturing or to negate the requirement altogether. A case study is presented in following sections to demonstrate the application of CAD/CFD-based experimental design for analysis of a component design in HVAC system of a typical domestic on-highway truck crane. With the synergistic use of the three tools, the total number of design possibilities to be initially explored can be increased significantly and, thus, lead to an overall more robust solution in the end. Lessons learned in this research can be generalized to explore
the use of CAD/CFD-based experimental designs to solve real-world engineering design problems. The integrated approach can help save countless hours of physical modeling, mock-ups and prototype manufacturing as well as eliminating unnecessary waste and scrap materials that would be associated with the testing of prototype components.

**METHODOLOGY**

This case study explores the effect of various design factors on the speed of air moved through the evaporator of the HVAC system of a typical domestic on-highway truck crane. The speed of air moved through the evaporator signifies the effectiveness of the heat transfer that will occur during a typical heating cycle of the HVAC system. Thus, the response variable selected for this multi-factorial experiment was the maximum air speed (inch/sec) achieved through the HVAC enclosure. The design factors chosen to vary in the experiment were the intake and output opening sizes (sq.in.), whether or not internal baffles were present, and whether or not a fresh air intake was present. Each factor is comprised of two levels, a high (+) and a low (-). These three input factors and their respective levels are summarized in Table 1 (Note: due to the proprietary nature of the design of this unit, no vital details shall be disseminated). Table 2 summarizes the factor-level combinations (treatments). Three factors, each with two levels result in 8 unique treatments.

Table 1. Summary of design factors and levels

<table>
<thead>
<tr>
<th>Design Factor</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (-)</td>
</tr>
<tr>
<td>Factor A: Intake and output opening sizes</td>
<td>One large opening</td>
</tr>
<tr>
<td>Factor B: Presence of internal baffles</td>
<td>No</td>
</tr>
<tr>
<td>Factor C: Presence of fresh air intake</td>
<td>No</td>
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</tbody>
</table>
Table 2. Factor level combinations (treatments)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Description</th>
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<tbody>
<tr>
<td>(1)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>One large opening, no baffles, no fresh air</td>
</tr>
<tr>
<td>a</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>Two small openings, no baffles, no fresh air</td>
</tr>
<tr>
<td>b</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>One small openings, baffles, no fresh air</td>
</tr>
<tr>
<td>ab</td>
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<td>bc</td>
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<td>+</td>
<td>+</td>
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<td>+</td>
<td>+</td>
<td>+</td>
<td>Two small openings, baffles, fresh air</td>
</tr>
</tbody>
</table>

Figure 1 shows the three important phases of our design methodology. The first phase involved creating three dimensional CAD models of the HVAC evaporator designs using a parametric CAD software package. These designs were based on existing HVAC evaporator box design from a typical domestic on-highway truck crane, and HVAC specification drawing, including all pertinent performance data.

![Diagram](image)

**Figure 1. Three key phases of the design methodology**

The second phase involved performing CFD analysis. The first step in any CFD analysis is to apply boundary conditions to the model. Boundary conditions are the values at the boundary of the calculation domain, such as pressure, velocity, temperature, etc. of the fluid at inlet. It is important to set appropriate boundary conditions in order to generate meaningful results. Once the appropriate boundary conditions were applied, the CFD simulations were performed on the CAD models developed in the first phase and results were collected.
The third phase involved performing analysis of variance (ANOVA) on the data obtained from the second phase. A $2^3$ factorial design with two replicates was used to examine the influence of the three design factors on the maximum air speed.

**COMPUTER AIDED DESIGN**

The eight different combinations of the factor levels and their associated CAD geometry representations are shown in Figure 2 in accordance with the standard design of a $2^3$ experimental design as documented in Table 2. Each treatment was implicitly modeled within the CAD software and then imported into the CFD software.

**CFD SIMULATIONS ON 3D CAD MODELS**

The selection of three design factors and two levels of each factor created 8 different scenarios for CFD analysis as shown in Figure 2. A mesh was applied to each scenario. Two different mesh resolutions were used in order to create two replicates for each treatment. The first of which had a mesh resolution factor of 0.99, and the second had a resolution factor of 1.00. This effectively introduced a type of virtual noise into the experiment so that we can adequately study the effect of the different treatments on the response variable.

The boundary conditions of the CFD analyses are listed in Table 3. Since the HVAC blower is rated at a volumetric flow of 425 CFM (cubic feet/minute) maximum, this was converted into a relative velocity by dividing the volumetric flow by the opening size of 0.1475 sq.ft., which yielded a blower output speed of 48 ft./second. This was subsequently converted into inches/second.
Figure 2. CAD models for 8 different factor combinations (treatments)

Table 3. Boundary conditions for CFD analysis

<table>
<thead>
<tr>
<th></th>
<th>Inlets:</th>
<th>Outlets:</th>
<th>Blower output velocity:</th>
</tr>
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<tbody>
<tr>
<td>Static pressure</td>
<td>0 psi</td>
<td>0 psi</td>
<td>2880 in/s</td>
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<tr>
<td>Relative velocity</td>
<td></td>
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</tbody>
</table>
Further, the CFD solver was set to calculate 50 iterations on the mesh of each treatment for both the replicates. Data was collected on the completed CFD analyses and the subsequent maximum observed air velocity was recorded for each replicate of each treatment of the experiment. Figures 3 and 4 show the CFD airflow velocity diagrams for each treatment for 0.99 mesh resolution factor and 1 mesh resolution factor respectively. Table 4 summarizes maximum airflow observed for each combination of factor levels.

Figure 3. CFD airflow velocity diagrams for 8 treatments at 0.99 mesh resolution factor
Figure 4. CFD airflow velocity diagrams for 8 treatments at 1.00 mesh resolution factor

STATISTICAL ANALYSIS

Statistical analysis was performed utilizing Minitab statistical software. The input worksheet was configured for a $2^3$ factorial design with two replicates. The data obtained for the maximum observed airflow at the outlet was entered into the worksheet and then the factorial design was analyzed at confidence level of 95%. Table 4 shows the ANOVA output. The P value from the ANOVA output is used to determine the significant design factors and
interactions. From Table 5, it is clear that the main effects of all the three factors as well as their interaction effects are significant, since the respective P values are less than that of \( \alpha \) value of 0.05.

Table 4. Maximum airflow observed

<table>
<thead>
<tr>
<th>Run #</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Treatment</th>
<th>Maximum airflow (in/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>(1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>+</td>
<td>-</td>
<td>a</td>
<td>5182.56</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>-</td>
<td>+</td>
<td>b</td>
<td>4525.54</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>+</td>
<td>+</td>
<td>ab</td>
<td>5517.10</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>-</td>
<td>+</td>
<td>c</td>
<td>4703.65</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>+</td>
<td>-</td>
<td>ac</td>
<td>6311.83</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>-</td>
<td>+</td>
<td>bc</td>
<td>5573.79</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>+</td>
<td>+</td>
<td>abc</td>
<td>6713.01</td>
</tr>
</tbody>
</table>

Table 5. Analysis of Variance for air speed

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Seq SS</th>
<th>Adj SS</th>
<th>Adj MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Effects</td>
<td>3</td>
<td>10921583</td>
<td>10921583</td>
<td>3640528</td>
<td>112.09</td>
<td>0.000</td>
</tr>
<tr>
<td>A</td>
<td>1</td>
<td>338259</td>
<td>338259</td>
<td>338259</td>
<td>10.41</td>
<td>0.012</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>1556905</td>
<td>1556905</td>
<td>1556905</td>
<td>47.94</td>
<td>0.000</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>9026419</td>
<td>9026419</td>
<td>9026419</td>
<td>277.92</td>
<td>0.000</td>
</tr>
<tr>
<td>2-Way Interactions</td>
<td>3</td>
<td>2140380</td>
<td>2140380</td>
<td>713460</td>
<td>21.97</td>
<td>0.000</td>
</tr>
<tr>
<td>A*B</td>
<td>1</td>
<td>332808</td>
<td>332808</td>
<td>332808</td>
<td>10.25</td>
<td>0.013</td>
</tr>
<tr>
<td>A*C</td>
<td>1</td>
<td>1187108</td>
<td>1187108</td>
<td>1187108</td>
<td>36.55</td>
<td>0.000</td>
</tr>
<tr>
<td>B*C</td>
<td>1</td>
<td>620463</td>
<td>620463</td>
<td>620463</td>
<td>19.10</td>
<td>0.002</td>
</tr>
<tr>
<td>3-Way Interactions</td>
<td>1</td>
<td>307792</td>
<td>307792</td>
<td>307792</td>
<td>9.48</td>
<td>0.015</td>
</tr>
<tr>
<td>A<em>B</em>C</td>
<td>1</td>
<td>307792</td>
<td>307792</td>
<td>307792</td>
<td>9.48</td>
<td>0.015</td>
</tr>
<tr>
<td>Residual Error</td>
<td>8</td>
<td>259825</td>
<td>259825</td>
<td>32478</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pure Error</td>
<td>8</td>
<td>259825</td>
<td>259825</td>
<td>32478</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>13629579</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The residuals from a factorial experiment play an important role in assessing model adequacy. Figure 5 shows the normal probability plot of the residuals. There is no indication of non-normality or possible outliers. Figure 6 shows the residuals versus the fitted values. This plot shows no special trends suggesting there is no relationship between the size of the residuals and the fitted values. So, based on these plots, the model appears to be adequate.
Figure 5. Normal probability plot of residuals

Figure 6. Plot of residuals versus fitted values

Figure 7 shows the interaction plots between Factors A, B, and C. The black line indicates the maximum air flow at the low levels, and the red line indicates the maximum air flow at the high levels of respective factors. The lines in different colors are not parallel to each other in any of the plots indicating that the interaction effects between the three factors are significant.

Figure 8 shows the cube plot which helps in selecting appropriate level of each factor in order to optimize the design which will generate maximum air speed. The cube plot shows that the maximum air speed possible at the outlet is 7508.97 in/sec. To achieve this speed, the current design of the evaporator should include two small openings for intake and output, and also include internal baffles as well as fresh air intake.
SUMMARY

The CAD/CFD-based experimental design discussed in this paper accomplished its objective of establishing optimal parameters for the design of the HVAC system component that yields a higher airflow than it would in a normal configuration. Design configuration “abc” with all three factors (two small openings, the presence
of internal baffles, and the presence of fresh air intake) is the optimal solution among the choices available. Further, the basic steps as outlined earlier, pose a generic empirical model that can be used for similar future design studies.

By incorporating the aspects of DOE, this research further extends the recent research effort by Watson and Joshi (2012), whereby CFD was coupled with CAD analysis methods to address a critical design issue in a vehicular HVAC system. By synergistically integrating the elements of CAD, CFD, and DOE, we are now able to virtually create multiple potential designs and analyze those designs by simulating them within the virtual environment. In the past, we would have to rely on design tools that were very subjective, such as concept evaluations. This new approach enables us to generate hard data and statistical evidence that is both objective and definitive to aid in the decision making.

REFERENCES


Management

How Six Sigma Applies in Hi Tech Companies: A Revised, Integrated Model

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ABSTRACT

As a globally influential systematic methodology, Six Sigma has been widely implemented to improve the quality of product and process and to reduce costs of lost sales and customers for various industries including manufacturing, finance and health care. Hundreds of Six Sigma projects with remarkable results prove that Six Sigma is able to change those companies by bringing them to a new level in both the short term and long term. However, in today’s dynamic and competitive market, customers’ needs are becoming more demanding than before. Innovative products and technologies are emerging every day, so high technology companies face huge challenges to produce high value products, gain more customers and increase the bottom line at the risk of high investment. Does Six Sigma work for high technology industries? This article firstly proposes to define high technology industries. Then, it aims to address how Six Sigma applies in mature high technology companies, especially discussing new product development and excavating new opportunities using DFSS and DMAIC processes. Additionally, other tools and methodologies such as TRIZ, Hoshin management could be integrated with Six Sigma to help companies solve complex problems and enhance their product life are demonstrated in this paper.
INTRODUCTION

What is Six Sigma? It is a methodology that could produce process and product improvement in an organization through data-driven measurements and leadership change over a certain time. A Six Sigma program is usually made up of a group of professional people called Green Belts, Black Belts and sometimes Master Black Belts. Several innovative companies have already had their own Six Sigma trained personnel added organizationally such as General Electric (GE), 3M, Lenovo and Samsung. To a great extent, Six Sigma supports organizational goals to obtain more market share, improved financial benefits, maintain competitive advantages, such as excellent quality of products as well as efficient and effective production process in today’s economy. Six Sigma is more than using statistical tools to improve manufacturing companies. It is a philosophy about reducing variations to meet customers’ needs in comprehensive ways, and it has been widely implemented by financial, software, and service industries.

However, how Six Sigma applies to high technology companies is still concerning for most people. High technology is defined as being highly dependent on science and technology innovation with intensive research, which needs great capital investment and Research and Development (R&D) employment (Arizona, 2008). Due to the huge investment in capital, human resources and time during the period of new product development, is it feasible for Six Sigma to be applied to help the R&D department to improve prototypical work? Can Six Sigma go beyond the bottom line to satisfy the customers of high tech companies? Suppose that a high technology product has been in development for many years, will the final products/services enter markets effectively? Will the employees of high tech companies become confused about their new products without effective input from R&D and knowledge transmission? What if the top management team leads the high tech in the wrong direction and makes decisions on their new technology or product strategies? This paper is going to provide corresponding suggestions with a Six Sigma product development model integrated with other effective methodologies and tools for mature high technology companies. Start-ups won’t be discussed in this paper, but left to future research.
NEW DIRECTIONS OF SIX SIGMA IN HIGH TECHNOLOGY COMPANIES

Six Sigma is a useful problem solving methodology, but it is not an integrated management system, especially for high technology companies (McAdam, 2004). The limit of innovation is a big deficiency for Six Sigma. Six Sigma has been designed to decrease variation and defective products instead of creating new products. Yet, with the wide deployment of Six Sigma, it now has its own new product design process, which is called Design for Six Sigma (DFSS). DFSS is considered to be a system process methodology for emerging products to meet customers’ needs. The main phases of the DFSS process are Define, Measure, Analyze, Design, Verify (DMADV), while Six Sigma’s process is Define, Measure, Analyze, Improve, Control (DMAIC). DFSS aims to replenish an inadequate process and replace the existing process or system to suit the needs of the customers and market, which provides innovative solutions that DMAIC process is not designed to do. The biggest difference between DMAIC and DFSS is that DFSS is hugely dependent on designing new products, while DMAIC is focusing on improving the current process based on the good performance of the bottom line. Six Sigma provides the maximum value for companies to produce high quality and low cost products to customers (Yang, 2007). Six Sigma makes changes to an organization, but DFSS could make an impact in, or even revolutionize to its product development system.

Jou (2010) has pointed out the inseparable correlation between new product development (NPD) and enterprise competitiveness. In order to survive, high technology companies must develop high-quality and low-cost new products for their customers so that they can gain more market share than competitors. However, many variables could influence the performance of the NPD. Companies should use both DFSS and DMAIC processes to execute projects in many ways including such tools as sustainable operation meetings, project and design review meetings, engineering data management, mass production analysis and product life cycle plan (Jou, 2010). Three problems accompany the execution of NPD that affect the performance of the process and end products. For one, the company might have a vague goal and lack of perspective of the new technology. Next, the high tech company could inappropriately utilize resources such as manpower. Finally, data management system may not work very well
as a support process (Jou, 2012). These problems could be solved using DFSS and DMAIC methodologies but standardization of processes and personnel through Six Sigma and other methods may be effective for high technology companies.

Hoshin Management, also called Hoshin Planning or Policy deployment, may support Six Sigma in resource allocation and information transmission (Yang, 2007). Hoshin Management (Hoshin) usually communicates a company’s policies, goals, and objectives throughout the business units under a hierarchy (Yang, 2007). The main purpose is to keep the focus on key activities and strategies, keeping each process holder on the same page as well. Through Hoshin, key milestones such as mission and vision, project goal, product review, mass production control, checking, implementation and annual review are all involved and clearly defined to those relevant people, which is helpful to Six Sigma deployment where personnel and top management teams establish DMAIC or DFSS projects for new product development.

However, how can high technology companies produce innovative products and technologies using these effective management systems and processes? While beyond the typical scope of Six Sigma, adding TRIZ would supplement DMAIC or DFSS. TRIZ is a Russian acronym that means theory of inventive problem solving, which can be fully utilized in the engineering design phase, technology forecasting and generating innovative solutions (Domb, 2001). When some engineering contradictions are coming together, TRIZ may be utilized to think systematically within identified constraints such as high quality, high costs and mass production. For high tech, new product development needs engineering or technology innovative solutions and TRIZ would be a good asset to support a Six Sigma team to work through technical challenges and tradeoffs, especially meeting bottlenecks during the design phase. In addition, TRIZ could be used in each phase during both the DFSS and new product development process due the comprehensive problem solving involved. Companies could use TRIZ in many ways such as training, workshops, consulting, and meetings to cultivate their employees while teaching Six Sigma knowledge (Domb, 2001). Companies like Samsung finished more than 30 TRIZ and Six Sigma projects involving 64 patents since 1998 and made great accomplishments for innovation training with a strong financial contribution.
of $65 million annually (Krasnoslobodtsev, 2006). TRIZ could be effectively connected with Six Sigma projects to produce great financial benefits and improve products and exhibiting processes efficiently.

![Diagram of Relationships Between Six Sigma, TRIZ, Innovation and NPD](image)

Figure 1. Relationships Between Six Sigma, TRIZ, Innovation and NPD

Figure 1 proposes a model of Six Sigma and its new directions that are defined by TRIZ, innovation and new product development. Figure 1 also shows the similarities and differences among methods. The new product development system, as a comprehensive business management system, connects with Six Sigma, TRIZ and Innovation. The model also enables the methods to be combined for new product development and development of new technologies. With the support of Innovation and NPD, Six Sigma could be used to analyze the incoming problems and challenges of the product design process, implementation process and the management system from the business strategy standpoint occasionally or when the organization mandates. Additionally, Six Sigma may be used to bring new products into the market and maintain organizational sustainability and competitiveness. Six Sigma, through project deployment may become more dynamic. Six Sigma could ensure that the shareholders and top management team gain investment returns in a relatively shorter time while at the same time examining existing problems and adjusting inappropriate predictions for the new technology deployment. In sum, Six Sigma may
effectively reduce the risks of the high technology companies.

INTEGRATED PROCESS MODEL OF SIX SIGMA, TRIZ AND NPD

When Six Sigma (DFSS) is integrated with TRIZ and NPD, it is important to think systematically for high technology companies. In most cases, what high tech needs is not innovative products, but the systematic innovation process to support innovation. Table 1 presents a way to think differently about the new product development process. DFSS leads the main process of the new product development system. First, the top management team finds opportunities to create a new product or new technology, from the market such as compelling competitors and Voice of Customers (VOC). After companies use TRIZ to forecast the future technology and communicate frequently with the marketing and business development departments, management could use DFSS to define the current situation and resources. During this “Define” period, conveying the vision from top management to R&D and to marketing people is essential. The new product concept should be consistent with the company vision. Mature high technology companies have their own culture and technology trends. If mature companies change their vision away from previous work, the company may lose inherent customers. As a result, this vision change to pursue the new technology is not beneficial. During the “Measure” phase, companies could use tools like Quality Function Deployment to transfer customers’ thoughts into the company process and technology, in the problem definition stage. After definition, analysis of all data may be difficult with a new product concept, due to the tendency of the organization to discover how to commercialize new products while working with limited time, resources and budget. R&D people should participate in all meetings and utilize the information management system so that their design is in touch with both the market and top management team. During the “Analyze” and “Design” phases, the DFSS process is more flexible in support of new product development. If design problems are found by R&D, TRIZ and Six Sigma tools used for defining innovative solutions such as using Feasibility analysis, design review, Concurrent engineering, Design of experiments and Errorproofing could be utilized (Krasnoslobodtsev, 2006). The key tools are also shown in Table 1.
<table>
<thead>
<tr>
<th>DFSS</th>
<th>Process</th>
<th>Key Factors</th>
<th>Process Holders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define</td>
<td>Strategic Planning</td>
<td>Value Chain, Technology Roadmap, Market Forecasting, System Engineering</td>
<td>R&amp;D Dept &amp; Top Managers &amp; Business Dept</td>
</tr>
<tr>
<td>Define</td>
<td>Marketing</td>
<td>VOC, Survey, Interviews</td>
<td>Marketing Dept</td>
</tr>
<tr>
<td>Measure</td>
<td>Requirement Review</td>
<td>QFD, Data Information Management System</td>
<td>R&amp;D Dept &amp; Top Managers &amp; Marketing Dept</td>
</tr>
<tr>
<td>Analyze &amp; Design</td>
<td>Idea Generation</td>
<td>Brainstorming, Concept Design, Benchmarking Search, Technology Forecasting, TRIZ</td>
<td>R&amp;D Dept &amp; Business Dept</td>
</tr>
<tr>
<td>Analyze &amp; Design</td>
<td>Idea Review</td>
<td>Feasibility Analysis, Pugh’s Concept Selection, Ideal Function, Concurrent Engineering</td>
<td>R&amp;D Dept &amp; Top Managers &amp; Business Dept</td>
</tr>
<tr>
<td>Analyze &amp; Design</td>
<td>Project Initiation</td>
<td>Goal Setting, Milestone Planning, New product Development, Resources Allocation</td>
<td>R&amp;D Dept &amp; Finance Dept &amp; Business Dept</td>
</tr>
<tr>
<td>Verify &amp; Control</td>
<td>Project Execution</td>
<td>Hoshin Management, Performance Measurement, Technology Transformation</td>
<td>All</td>
</tr>
<tr>
<td>Control</td>
<td>Production Control</td>
<td>Statistical Tools, Kaizen, Risk Reduction, Future Planning</td>
<td>All</td>
</tr>
</tbody>
</table>

Table 1. Integrated Process Model of Six Sigma, TRIZ and NPD

Table 2 illustrates the different tools between DFSS and TRIZ during the whole high tech process. Finally, the new product development loop is coming to the “Verify” phase, in which DMAIC can offer great support by decreasing variation and defects in the new product production process and future development. DMAIC process is an effective tool to help high technology companies develop and sustain the new technology while at the same time
increasing the quality and service of the product to meet customers’ needs. During the period of the DFSS process, those process holders such as top managers, R&D department and marketing department, and finance should communicate closely and frequently share information about the new product process. Otherwise, the product development system may result in increased performance variation and accrue future risks.

<table>
<thead>
<tr>
<th>New Product Development Process</th>
<th>TRIZ Tools</th>
<th>DFSS Process</th>
<th>DFSS Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idea Generation</td>
<td>- Technology Forecasting&lt;br&gt;- Guided Evolution&lt;br&gt;- Functional Analysis&lt;br&gt;- System Operator</td>
<td>Define</td>
<td>- Project Charter</td>
</tr>
<tr>
<td>Idea Screening</td>
<td>- Conflict Resolution&lt;br&gt;- Ideal Final Result&lt;br&gt;- Development of measurement methods</td>
<td>Measure</td>
<td>- QFD(VOC) &amp; Kano&lt;br&gt;- Functional Process Map</td>
</tr>
<tr>
<td>Conceptual Development</td>
<td>All</td>
<td>Analyze &amp; Design</td>
<td>- Axiomatic Design&lt;br&gt;- Pugh&lt;br&gt;- FMEA</td>
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<tr>
<td>Product Testing</td>
<td>- Conflict Resolution&lt;br&gt;- Trimming&lt;br&gt;- Problem Solving</td>
<td>Analyze &amp; Design (Improve)</td>
<td>- Robust Engineering&lt;br&gt;- Designed Review Based on Failure Mode</td>
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<tr>
<td>Technical Implementation</td>
<td>Validate &amp; Implement</td>
<td>Verify &amp; Control</td>
<td>- Accelerated Testing&lt;br&gt;- Test to Failure&lt;br&gt;- Design Review Based on Testing Results</td>
</tr>
</tbody>
</table>

Table 2. Key TRIZ Tools and DFSS Tools during the NPD and DFSS Process

How this model should be implemented for commercialization of new technology successfully is a key issue for high technology companies. Main aspects to consider include communication, leadership roles, R&D project control and external forces (as shown in Figure 2). Large, multicultural high technology companies face language obstacles and culture shocks in working together to develop new technology. Language and professionalization
through Six Sigma training provides a common vocabulary to support an advanced information sharing system and could be established for high tech process performance. Also, the knowledge transmission from R&D to each business unit in the company such as sales, manufacturing and top management could improve. Strong leadership impacts the business unit capabilities for the goal of equal importance. Without the support of effective leadership, the model above is unable to operate smoothly. Resource deployment such as capital, plant, workforce, and project planning should be planned in advance and function dynamically to change according to unforeseen situations. Yet, an effective Six Sigma leader is one that is able to balance resources and manage projects to make changes in the organization. The R&D team could produce many Six Sigma project charters and support implementation of DFSS and TRIZ to make sure the new design and testing results satisfy future customers. High technology means the difficult challenge for R&D is the transferring of knowledge to business units and customers through the form of a new product. The model above could improve this transmission. Finally, it is important to analyze the external forces such as suppliers, competitors, customers and government regulations, especially for top management. These external factors could change the new product or technology. For instance, China is now increasingly developing advanced technological industries. The Chinese government has created a beneficial environment in which high tech operates. Before these high technology companies develop the new products, it is necessary for organizations to apply for patents to protect their inventions and innovative technologies. Otherwise, the competitors may quickly encroach on the market. Therefore, all of these key factors are of importance to a successful new product development system and make Six Sigma attractive to high tech companies operating in China. Effective implementation of Six Sigma and other methodologies supports business strategies and should be considered. In this case, these high technology companies could go beyond China and find their customers in the competitive market.
CONCLUSION

In conclusion, this paper points out that Six Sigma and DMAIC/DFSS could work for most high technology companies to establish and improve their new product development system by integrating with other tools like TRIZ and Hoshin Management. Through the process model proposed above and the key factors of successful implementation, R&D people should work with top management team and marketing department throughout the DFSS process. For top managers, it is also essential to establish some programs to make all the employees connected with each other strongly so they can share the same level of information, especially for R&D. In this way, their new products and technologies would have greater market acceptance rate. Certainly, customers are always the most critical factor.

Six Sigma in high technology companies is still a new topic in the business process and strategy field. The
new integrated model introduced in this paper may not be suitable for all mature high technology companies. Yet, the general idea and key factors could work for those companies who want to know what is important and what is good for the organization when they begin to start their new product development. On the other hand, emerging challenges not discussed are still available to generate future research on this topic. (1) For high technology companies, different industries have different speed of Returns of Investment (ROI). (2) It is hard to find TRIZ expertise across different fields. (3) There will be big gaps between language and knowledge as R&D becomes more globalized. (4) Companies tend to have inappropriate perspectives of their target customers. (5) Methods on how to extend the new product life cycle should be studied in the future. To sum up, it is not an easy thing to apply Six Sigma in high technology companies, but it is good to see a bright future.

REFERENCES


Manangement

Realistic Overdraft Projection Using a Stochastic Methodology

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ABSTRACT

For the contractors it is essential to know the realistic maximum overdraft required for the life of project to avoid the disruptions for completing the activities due to delayed payments and unplanned cash flow deficits. Analyzing the cash flow is critical for the contractors to the success of any project. Traditional overdraft projection models have shortcomings in accounting uncertainties in cost and duration. Realistic budget and schedule planning dictates focus on more than just deterministic scenarios, i.e., focus on uncertainties in the project. In this paper, the Monte Carlo Simulation technique, the stochastic tool, has been applied to an existing deterministic model to achieve realistic schedules and their related overdraft projections considering uncertainties in the project life.

INTRODUCTION

Overdraft is an extension of credit from a lending institution when an account reaches zero. Overdrafts from bank accounts are the most common form of construction financing. Overdraft is illustrated in the graph shown in figure 1.
Contractors would receive periodic payments from the owner as construction proceeds. However, a contractor may have a negative cash balance due to delays in payment and retainage by the owner. When payments from project owner are not sufficient then contractors will look for overdraft. In the graph, Contractor’s expenses which occur continuously for the project duration are illustrated by a piecewise continuous curve. The payments received from the owner are represented by a step function. The owner's payments for the completed work are assumed to lag one period behind as compared to contractor’s expenses, resulting in overdraft shown as shaded region.

Contractors are mainly dependent on bank overdrafts to finance projects and to proceed with project activities. Bank imposes the maximum limit on the overdraft account based on expected expenditures and receipts produced for the specified duration of construction (Hendrickson 1998). Therefore it is important for contractors to understand how much maximum overdraft they would be needed for the undertaken project.

There are several time scheduling techniques are available to estimate overdraft. Developing a good overdraft projections/model with the help of available time scheduling techniques is very important because poor planning and management of transactions will cause a major failure in construction industry (Navon, 1996). Overdraft model will
determine cash inflow and cash outflow transactions over a project’s duration. Overdraft projections should be such that cash requirements at any period should not exceed the allocated maximum overdraft limit (Elazouni and Metwally, 2005). Unrealistic overdraft projection causes financial failure (Chen et al, 2010). One of the important factors to be incorporated in overdraft model to improve the accuracy of overdraft projection is to account for uncertainties associate with project.

This paper studied the shortcomings of existing overdraft projection models. This paper also proposed an overdraft projection model for contractors. The proposed model considered many factors like retainage, financing cost and uncertainties both in cost and duration of activities. Paper also suggested guidelines for implementing proposed model and provided managerial implications by focusing on how contractors can benefit by using the proposed model.

OVERDRAFT PROJECTION MODELS AND THEIR SHORTCOMINGS

Currently there are several models that are widely used to calculate overdraft in the construction industry. Many researchers studied cash flow forecast and developed different models to preview fund-related requirements. These models can be used to manage the fluctuations in the project cash balance. However there are some shortcomings in these models. Some of such models are discussed below.

The Forecasting Model Using Moving Weights of Cost Categories

Park et al. (2005) introduced moving weights of cost categories. The moving weight is calculated by subtracting the actual cost from the initial budget for each month. The calculated moving weight is then applied to the next month. Applying weight to individual cost category changes the budget every month. It is highly depended on managing the cost and earned value every month. In order this model to be reliable the estimates of both the cost and earned values have to be accurate. This model works better in construction phase rather in planning phase and this model has not considered any uncertainties associated with the project.
The Dynamic Cash Flow Forecasting Model

Kaka and Lewis (2003) presented a model to effectively plan and manage the cash flow of individual projects at a company level. The authors showed the relationship between 30% and 50% of project completion on one hand, and 50% and 70% completion on the other. The results showed that 50% and 70% completions of a project could be predicted from the actual cost of that project at the 30% and 50% completion levels, respectively. This model also did not consider the uncertainties involved in the project execution.

The Resource-Based Model for Automatic Cash-Flow Forecasting

Navon (1995) automatically integrated the bill of quantity (BOQ), cost estimate, and the schedule associated with a lower level of resources. However, if either BOQ or the schedule is altered due to various changes, integration is likely to be more complicated and time consuming. Moreover, the main obstacle to automating the integration process is compatibility between cost associated to BOQ and activity associated to schedule.

The Assessment of Activities’ Criticality to Cash-Flow Parameters

Marwa (2012) model considered the randomness of the activity start times to identify critical activities in the project. Critical path of the project schedule is developed and random distribution functions are framed for the activity start times to run Monte Carlo simulation. The main disadvantages of this model are the integration of project schedule with cash flow calculations is too complex for contractors to be applied to all the project schedules. A new set of complex functionalities need to be developed for every project. As the number of activities in the project increases the complexity of this methodology also increases. In this model, uncertainties cannot be applied to the duration of a particular activity. Additionally this model does not consider the uncertainties associated with the cost of activities.

THE PROPOSED OVERDRAFT PROJECTION MODEL

An effective model considering the aspects of cash flow and uncertainties in the project is proposed to overcome the shortcomings in existing deterministic models. Overdraft in the proposed model is based on several aspects of cash flow such as direct cost, indirect cost, and duration of activities, payment period, payment delays,
retainage, and financing cost. Contractors develop project schedules that include direct cost and duration of activities.

From the project schedule point of view indirect cost which is also known as overhead cost, is estimated as a proportion of direct cost. As contractors work extended working days to cover more projects in a year the proposed model is developed so as to accept any number of working days per payment period. Owner holds a percentage of a payment(s) as retainage from periodic payments as security for the contractor’s performance until specific number of periods. These retainage and payment delays lead to borrow the overdraft amount from the bank. Model is proposed to account for retainage, variations in payment delay and financing cost involved in lending overdraft from external source. Along with these cash flow aspects, overdraft is affected by many unforeseen factors.

Factors Affecting Overdraft

Overdraft projection model is proposed to include the effect of factors that affect cash inflow and cash outflow to achieve a realistic accuracy. The impact of affecting factors increases the periodic cash outflow and decreases the periodic cash inflow. In the Table 1, factors that affect cash-in are denoted by (I), that affect cash-out are denoted by (O), and that affect cash-in and cash-out are denoted by (I&O).
Table 1: Factors that affect project cash flows (AlIssa and Zayed 2007)

<table>
<thead>
<tr>
<th>Suppliers:</th>
<th>Sub-contractor:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sup1-Delay of making payments (O)</td>
<td>• Sub1-Decisions to sub-contract (O)</td>
</tr>
<tr>
<td>• Sup2-Procurement problems (O)</td>
<td>• Sub2-Over/under measurement (O)</td>
</tr>
<tr>
<td>• Sup3-Delay in delivery (I&amp;O)</td>
<td>• Sub3-Failure of sub-contractor (I&amp;O)</td>
</tr>
<tr>
<td>• Sup4-Financial Management:</td>
<td>• Sub4-Renting vs. buying equipment (O)</td>
</tr>
<tr>
<td>Financial Management:</td>
<td></td>
</tr>
<tr>
<td>• F1-Change of progress payment duration (I)</td>
<td></td>
</tr>
<tr>
<td>• F2-Change of progress payment conditions (I)</td>
<td></td>
</tr>
<tr>
<td>• F3-Receiving front payment (I)</td>
<td></td>
</tr>
<tr>
<td>• F4-Large retention percent (I)</td>
<td></td>
</tr>
<tr>
<td>• F5-Delay in releasing retention (I)</td>
<td></td>
</tr>
<tr>
<td>• F6-Financial position (O)</td>
<td></td>
</tr>
<tr>
<td>• F7-Loan repayment (O)</td>
<td></td>
</tr>
<tr>
<td>• F8-Payments of material (before/after arrival)(O)</td>
<td></td>
</tr>
<tr>
<td>• F9-Over work measurement (I&amp;O)</td>
<td></td>
</tr>
<tr>
<td>• F10-Under work measurement(I&amp;O)</td>
<td></td>
</tr>
<tr>
<td>• F11-Change of labor and staff wages (O)</td>
<td></td>
</tr>
<tr>
<td>• F12-Bank interest (O)-Price change (O)</td>
<td></td>
</tr>
</tbody>
</table>
| Sub-contractor: 
• Sub1-Decisions to sub-contract (O)
• Sub2-Over/under measurement (O)
• Sub3-Failure of sub-contractor (I&O)
• Sub4-Renting vs. buying equipment (O)

Prior to Construction:

• P1-Poor design (O)
• P2-Inaccurate bid items (I&O)
• P3-Estimating strategies (O)
• P4-Cash flow forecasting (O)
• P5-Competitors (I)

Others:

• O1-Weather condition (I&O)
• O2-Positive change order (addition work) (I&O)
• O3-Negative change order (I&O)
• O4-Inability to manage change orders (I&O)
• O5-Number of claims (I&O)

Project schedule and cash flow aspects together with effect of factors affecting overdraft will help in realistic projections. The integration between the project schedule and the overdraft calculation needs to be established in order to study the impact of the cash flow aspects.

Integration of Project Schedule with Overdraft Calculations

Integration was implemented to derive total direct cost for each day. Activities’ daily direct costs are assumed to be associated throughout the activities’ durations from their start times to their finish times. To represent the activities’ daily direct costs along with their durations, the integration used functions for all of the activities’ durations throughout the total project duration. The equation used for a single day of activity is shown below.

\[
f(x) = \begin{cases} 
1 \frac{\text{Direct Cost}}{\text{Duration}}, & \text{if } x > \text{Start time and } x \leq \text{Finish Time} \\
0 & \text{otherwise}
\end{cases}
\]

Equation 1

The value of the variable x can range from one day to the total duration. This equation has been defined for each day in the project duration, for each of the project’s activities. After the representation of the direct cost of each
activity’s day, the total direct cost of each day can be calculated. The total direct cost of each day is calculated as the sum of the direct costs of all the activities ongoing that day. The total direct cost of each period is calculated as the sum of the total direct cost of the number of days comprising the period. Total direct cost from integration helps in developing overdraft calculations.

Overdraft Calculations

The calculation of overdraft depends on the activities’ cash outflow and inflow. The cash outflow depends on the total direct cost and indirect cost of the activities. Total direct cost is the cost of all the activities ongoing during the period. An integration calculation, Equation 1.0, helps in identifying ongoing activities in a period. Indirect cost is a proportion of direct cost. Indirect cost and cash outflow for a particular period can be represented by following equations:

\[ \text{Indirect Cost} = \text{Direct Cost} \times \text{Overhead}\% \]  
\[ \text{Equation 2} \]

\[ \text{Cost}(t) = \sum_{i=1}^{n} (\text{Direct Cost} + \text{Indirect Cost}) \times \text{Cout} \]
\[ \text{Equation 3} \]

Where \( n \) = number of days comprising the payment period; \( t \) = payment period; \( \text{Cout} \) = weight of cash outflow factors’ impact based on all the affecting factors considered.

Project contract is for cost plus fees. The total bill is the plus the markup. Markup at the particular period is a proportion of the cost of activities performed during that period. Markup and Total bill can be represented by following equations:

\[ \text{Markup}(t) = \text{Cost}(t) \times \text{Markup}\% \]
\[ \text{Equation 4} \]

\[ \text{Total Bill}(t) = \text{Cost}(t) + \text{Markup}(t) \]
\[ \text{Equation 5} \]

Where \( t \) = payment period.

This model considers owners withhold a part of payments as retainage. The withheld retainage will be paid at the end of the project. Project payments are made with some payment delay. Most of the time, contractor receives payments for previous period. Retainage withheld and payment received can be represented by following equations:
Retainage withheld(t) = Total Bill(t) * Retainage%  \hspace{1cm} \text{Equation 6}

\text{Payment received(t)} = \sum_{i=1}^{n} \left(1 - \text{Retainage Withheld} \ (t - d) * \text{Cin} \right) \hspace{1cm} \text{Equation 7}

Where Cin = is the weight of cash inflow factors’ impact based on all the affecting factors; d = payment delay in number of payment periods; n = total number of payment periods in the project.

When the payment from the owner is not sufficient or payment received is a negative value, the contractor looks for overdraft from banks. Contractors deposit the payments into the credit-line accounts to continually reduce the outstanding debit. The overdraft and interest at the end of each period is calculated using following equations:

\text{Overdraft(t)} = \sum_{i=1}^{n} \left(\text{Payment Received}(t) + \text{Fin}(t - 1) - \text{Payment Received}(t - 1)\right) \hspace{1cm} \text{Equation 8}

\text{Interest}(t) = \text{Overdraft(t)} * \text{rate of interest}. \text{ If } \text{Overdraft(t)}>0 \hspace{1cm} \text{Equation 9}

\text{Total amount financed(t)} = \text{Overdraft(t)} + \text{Interest(t)} \hspace{1cm} \text{Equation 10}

Where t = payment period;

Overdraft for each period is calculated and maximum overdraft in the project is determined without considering uncertainties in project. Monte Carlo simulation is proposed to study uncertain environment in the current model.

\textit{Monte Carlo Simulation}

Monte Carlo simulation is a method for iteratively evaluating a deterministic model using sets of random numbers as inputs. This method is often used when the model involves uncertain parameters. A single simulation can involve thousands of evaluations of the model, a task which in the past was only practical using super computers. These simulations are more reliable and realistic.

Model is allowed to specify minimum, maximum and most likely limits for cash flow aspects. Monte Carlo simulation is employed in choosing random distributions that specify values within these limits. For each simulation run, the Monte Carlo simulation specifies different values for inputs and observes variations in the overdraft. Upon
completing the specified number of runs, the probability distribution of the overdraft is obtained. Sensitivity analysis can be carried out to see the impact of input details on the overdraft.

IMPLEMENTATION OF PROPOSED OVERDRAFT MODEL

The proposed model is implemented in spreadsheet environment and automated using visual basic macros. A commercially available @risk tool is used to import the project schedule to the spreadsheet. Changes made to project schedule will be reflected in the model and changes made in the model will be reflected back in the project schedule. Additionally the @risk tool helps in: (1) choosing and applying random functions to the uncertain inputs; (2) choosing output parameters; (3) setting number of iterations per simulation; (4) running Monte Carlo simulation; (5) generating output graphs and correlation graphs. Conceptual steps in the model are shown in figure 2.

@Risk Monte Carlo simulation module is loaded to Excel spreadsheet using ‘Load Palisade @Risk’ macro button shown in the figure 3. Project schedule is imported to the model using ‘Import MPP File’ link in Palisade @Risk tool shown in figure 3.
Input details for overdraft calculation can be entered in the spreadsheet as shown in figure 4. Model is incorporated with the yes/no questions whether to include or not to include the effect of a particular factor in overdraft calculation. Based on the selected affecting factors total weight of affecting factors is calculated.

These input details and imported project schedule helps in creating integration calculations and overdraft calculations in the templates. Calculation templates are created automatically using ‘Create Templates’ macro button shown in the figure 5. Macro uses visual basic and excel formulae to generate calculation templates.

Macro will read cost of activities, start time and finish time of activities from project schedule and produce integration calculations in the spreadsheet. Macro reads payment period provided in input details and produces excel formulae in the spreadsheet to calculate direct cost per each payment period. Similarly, macro produces all the formulae in the spreadsheet to calculate overdraft. Using direct cost from the project schedule, indirect cost is calculated and eventually overdraft for every period is calculated automatically in the calculation templates. Calculation templates will provide the overdraft value without considering any uncertainties.
Figure 4: Overdraft calculation inputs in excel model

As macro produces formulae within the spreadsheet, cash flow aspects can be varied any time to observe the variation in the overdraft. Following the steps shown in figure 5, uncertainties can be applied to cash flow aspects for specific or all the activities in the project. Thousands of iterations can be run per simulation using @Risk tool to observe the maximum overdraft value in the project considering all uncertainties.
EXAMPLE OVERDRAFT CALCULATION BASED ON DEVELOPED MODEL

A sample project is used to illustrate the proposed methodology and spreadsheet model. A simple project schedule with 6 activities is created in MS project as shown in figure 6. @Risk tool is loaded using ‘Load Palisade @Risk’ macro button. Sample schedule is imported into the spreadsheet model.
Input details required for overdraft calculation are provided as shown in table 2:

<table>
<thead>
<tr>
<th>Indirect Cost: 15%</th>
<th>Retainage Period: 2</th>
<th>Pay period (days): 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mark up: 20%</td>
<td>Payment Delay: 2</td>
<td></td>
</tr>
<tr>
<td>Retainage withheld: 1%</td>
<td>Interest on overdraft: 0.19%</td>
<td></td>
</tr>
</tbody>
</table>

Overdraft calculation and integration templates (table 3) are created automatically using the ‘Create Templates’ macro button. Cash inflow, outflow and overdraft details for each period are generated automatically and validated with manual calculations.

To consider the uncertainty, triangular distribution function with 20% variation is applied to the cost and duration of all the activities in the sample project. Monte Carlo simulation is run for 1000 iterations per simulation to observe the variation in project duration and maximum overdraft. Output results and graphs are generated using @risk tool.
### Table 3: Overdraft calculations

<table>
<thead>
<tr>
<th>Details</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outflow</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct Cost</td>
<td>7000</td>
<td>6000</td>
<td>5000</td>
<td>3000</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Indirect Cost</td>
<td>700</td>
<td>600</td>
<td>500</td>
<td>300</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>7700</td>
<td>6600</td>
<td>5500</td>
<td>3300</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Markup</td>
<td>1540</td>
<td>1320</td>
<td>1100</td>
<td>660</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total Bill</td>
<td>9240</td>
<td>7920</td>
<td>6600</td>
<td>3960</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Inflow</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retainage Withheld</td>
<td>92.4</td>
<td>79.2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Payment Received</td>
<td>0</td>
<td>0</td>
<td>9147.6</td>
<td>7940.8</td>
<td>6600</td>
<td>4131.6</td>
<td></td>
</tr>
<tr>
<td><strong>Overdraft</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overdraft at end of the Period</td>
<td>7700</td>
<td>14307.7</td>
<td>19822.01</td>
<td>13994.23</td>
<td>6157.424</td>
<td>-425.409</td>
<td></td>
</tr>
<tr>
<td>Interest on overdraft balance</td>
<td>7.7</td>
<td>14307.7</td>
<td>19822.01</td>
<td>13994.23</td>
<td>6157.424</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total amount financed</td>
<td>7707.7</td>
<td>14322.01</td>
<td>19841.83</td>
<td>14008.22</td>
<td>6173.591</td>
<td>-425.409</td>
<td></td>
</tr>
</tbody>
</table>

**Output Results**

Project duration in the deterministic model is fixed; in the sample project, project duration is 16 days (from the figure 5) before considering uncertainties in the duration. After considering uncertainties, the stochastic project duration varied between 14-17 days (shown in figure 7). Maximum overdraft observed in the sample project before applying uncertainties is $19,822.01 (from the table 2). After applying uncertainties and running Monte Carlo simulation for 1000 iterations, Realistic maximum overdraft value is observed between $20,631.14 and $26,440.52 values with 90% confidence (shown in figure 7).
Figure 7: Maximum Overdraft & Project Duration after running 1000 iterations per simulation

Correlations of activities are automatically generated after running Monte Carlo simulation. From figure 7, duration of activity B is 50% and cost of activity F is 18% positively correlated to the maximum overdraft.

**IMPLICATIONS**

A company can survive a transitional period without a profit, or even with a loss. However, it may fail due to lack of cash during the operation even if it has a good financial statement. Inadequate overdraft projections to a certain project may drive a corporation into a crisis of financial situations. If contractors rely only on judgment based on
their experience without the use of any mathematical forecasting techniques, they may not make a good decision to forecast overdraft.

In real world construction industry, complex and unexpected situations such as design changes, payment delays are inevitable thus causing liquidity problems without prior warning affecting the cash flow of contractors. A good forecasting model needs to consider uncertainties for overdraft projections. The estimation of the cash outflow and inflow transactions is crucial to realistically forecast cash flow. Unrealistic cash flow forecasting is the main cause of financial failure for contractors. To improve the accuracy of overdraft projections, the impact of factors that influence the cash inflow and outflow transactions should be incorporated.

The proposed model suggests a practical and easy approach for contractors who are generally not familiar with finance knowledge of forecasting overdraft using the regular reports. In addition, this model helps the experienced contractors for overdraft projections under totally uncertain situations. The proposed fast and simple overdraft projection model allows contractors to support and to save time for decision making strategy of cash management to the projects.

CONCLUSION

Accurate overdraft projection is vital for any contractor in the construction industry for successful operation. Overdraft forecasting benefits contractors for having necessary cash flow to run their project and deal with unforeseen circumstances successfully. Realistic overdraft projections and schedule planning model should focus on uncertainties in the project.

The proposed model was designed to determine the overdraft projections in the project considering the uncertainties in the cost and duration of the activities. The @RISK software for Monte Carlo simulation technique was used in the model to generate random values for the cost and duration of the project activities to run thousands of iterations in order to calculate realistic maximum overdraft. The simulation outputs include the probability distributions for the project duration and maximum overdraft.
The major contribution of this model can be summarized as: (1) integration between project schedules with the overdraft calculation model is automated such that any project schedule can be imported to get overdraft calculations; (2) overdraft calculations are automated for any number of working days per period; (3) owner retainage and financing cost are considered for overdraft projections. Ultimately, the overdraft projection model was designed to be a simple, accurate and reliable forecasting tool for general contractors.

REFERENCES


ABSTRACT

This research presents an approach of gauging levels of workforce developmental change as it relates to organizational initiatives. The method of applying such changes is through the application of a system of managing projects and processes which attempts to improve transparency and accountability across six different organizations where the varying events of change are measured. The change model itself consists of an interdisciplinary approach which emphasizes education of advanced organizational measurement techniques as fundamental drivers of converging change (Kashiwagi 2008). The observations of the change process are documented in the real-time observed cased studies of the organizations as they progressed through the developmental change process. The findings of the research introduce a scaled metric which can be used to determine levels of developmental learning as they occur based on the observation and analysis of the six groups observed. This work is considered to be foundational in that the data is collected across several subjects in a real-time study known as Inaugural Model Observation Point (IMOP). It is anticipated that future additional contributions would further elaborate on the phenomenon of prescribed organizational change.
INTRODUCTION

Within the realm of workforce development, much has been written on the broad topic of change management as it relates to organizational learning and growth (Armenakis & Bedeian 1999, Kerber & Buono 2005). A common goal for leadership in such organizations is the ability for organizations to institute and administer group learning along the lines of intended progressional path (Kotter & Schlesinger 1979). Additionally, it should be noted that such organizational terms as learning, development, transformation and change are considered synonymous in such studies, as they help to define the intended progress of supervising groups (Brown & Posner 2001, Senge 1990, Shein 1996, Rolls 1995, Mezirow 2000, Eisenbach, Watson & Pillai 1999).

However, while there are several well-known authors who have researched and tested change management theories in various workforce organizations (Todnem 2005, Stanleigh 2008, Bennis 2000, Burns 2004, Beckhard 1969), there are few, if any, standards for measuring developmental change that have been both established and standardized which could be used in further longitudinal studies (Lines, Kashiwagi & Sullivan 2011, Pettigrew 1990). Table 1 demonstrates a list of various organizational change researchers and their approaches to empirical observations of change models. The essential elements that are lacking in such research can be summarized in the following list of limitations:

- Lack of empirical studies of organizational change using real subjects
- No known compatible data standards that can be applied to varied settings and subjects
- Observation and collection of data in real-time vs. historical investigation

Also worth noting from Table 1 is the number of studies that had data collected in a post-event sequence. This typically meant that the information of the changes that occurred were obtained from historical documentation and interviews. Though useful and effective at outlining events that took place in the observed groups, Figure 1 was assembled by the authors to demonstrate various levels of empirical strength in change model observations. At the lowest level, theories are presented and analyzed without any human case study to test its validity. Further up the pyramid, a change model can have greater strength in validation by applying its steps to a post-change
observation and historically investigate the developmental change process. It is worth noting that all authors analyzed in Table 1 apply this level of empirical strength. As shown in the pyramid setting out to observe changes at the beginning of the empirical case study would have greater validity because the information gathered is easier because it is observed in a current and real-time dimension. Additionally, applying multiple case study tests of diverse groups attempting to apply similar initiative goals would give the research even greater validity due to its repetitious test results. It is with this understanding that the authors propose a new perspective of observing and collecting change model data to be called Inaugural Model Observation Point (IMOP) where the viewing of the changes is done simultaneous with the change efforts.

Additionally, within the varied studies of change management, there is little specific literature on the management of change in the built environment where empirical data is generated from the real-time testing of actual events involving real people (Stone 2012). For this reason, the scientific shedding of light on what could be considered standardized indicators of change within the workforce of the built environment would be beneficial in helping to better understand how management can facilitate and influence the development of workforce members.

For this reason, it is anticipated that such findings here could be applied in a broad spectrum of development efforts where change, learning and development would be the intent of the organizational leadership. Examples of such would be curriculum development and validation in education (Schmuck 1977, Moore 2005), manufacturing process training and modifications, general employee training (Plenert 2000, Bass 1994, Banks & Wheelright 1979) or corporate and government initiatives.

**METHOD**

The tests of such developmental change was conducted in the form of a pilot-initiative where the introduction of a new project management system was to be learned, practiced in application and institutionalized by each of the six groups. Such a system, generally known as Best Value, was introduced by a research group out of Arizona State University which had been developing and testing the process since the mid-1990’s. This process (which
involved various related fields within project management, procurement, facilities management, construction
management and vendor-buyer relationships), included education and training to all subjects individually as outlined
in the following steps:

1. Formalized education - Initialized education sessions of the initiative process
2. Interactive measurement systems training - Scheduled intermittently between the formalized sessions are
   smaller scale interactive modules where more hands-on activities of learning take place. These session,
   which last anywhere between 5 - 90 minutes
3. Facilitated Learning/Teaching Meetings - Meetings where the members of the initiative-appointed team
   conduct and carry out the assigned duties in implementing and administering the measurement systems
   being applied (Kashiwagi 2008).

Table 2 displays a brief summary of each organization as they vary by industry, time period of observation and
other helpful information. Each of the six groups, which are coded according to their actual organization names,
were strongly tied to the Project Management-related responsibilities regardless of whether they were as a client,
vendor or internal management team. In all six subjects the common goal of the project management team is
centered on the achievement of the planned goals of the initiative.

Data Collection

During both the training and education sessions of the initiative, the researchers were present either face-
to-face or via phone conference to record both the events of the meeting discussions as well as the progressive
acts of behavior modification of the subjects as they adapted to the newer system of management. Records of the
events over the months of observation were taken by hand in real-time observation and entered into a cloud-based
data management spreadsheet for later review. Table 3 shows a summary of the data that was collected at each
meeting. It consists of a mixture of both finite numerical metrics of time, attendees, and dates along with prose-
written progress data of individuals attending as they adapted to the system changes that were being administered.
Observational Summary

In total, there were six organizations observed over approximately a 21 month period. Individually, the observation periods varied between 7.8 and 21.3 months. During this period of time, 282 education sessions were conducted and recorded where various levels and related characteristics of change were recorded in a real-time basis where an IMOP time frame was applied. Average length of each session totaled 1.1 hours per session and individual subject groups varied in session time from .7 to 1.5 hours per session. Total session in actual time was 223.8 hours. Attendees to the session’s averaged 4.4 people per session giving a total person-hours invested time of the research to be 1,268 hours of face to face, phone conference and email meeting sessions. Written information of the discussion, key and action items consisted of 123 pages of prose wording in a 12 point font which included 5,593 lines of text posted by the authors. These notes were the primary source of the qualitative data and the derived quantitative events.

ANALYSIS AND FINDINGS

As the extensive review of occurred data was conducted, it became evident that common levels of group practices were adopted by the members of the groups which were then formally noted and codified by the authors in an attempt to initiate a stratification of levels of behavior. Table 4 summarizes the number of events that occurred during the progressive change process as members of the groups developed the learning and institutionalized changes within their initiatives. These behavioral acts, as they were measured, are proposed to be common across various subjected groups. Additionally, it is proposed that these “levels” of change create a unique and unprecedented measurement in that they are observed in real-time documentation, across varied subjected groups which are applying the same initiative and are classified by scaled levels of behavioral complexity, effort and longevity. Table 5 shows specific behavioral examples of observed actions while an analytical summary of such levels between the six groups is listed below.
Level I. Perspective Transformation

Counted as the lowest level of change, this type of behavior modification draws from Mezirow's definition of an internal transformation at an individual level of perception to an altered understanding of an environment (Kitchenham 2008; Taylor 2000). Individuals or groups of individuals perceived and believed that specific aspects of their environment were one way and subsequently had their newly learned awareness gives them an altered understanding which theoretically should lead to altered behavior (Taylor 1997). For the sake of the collection of data, the perspective transformation is assumed to take place during the initial meetings with supervising parties as they learn of the process and take steps to initiate a contracted agreement with the Best Value research team.

Level II. Behavior Introduction

Building on the perspective transformational change, the behavior introduction involves the activation of new behavior, both from a change in perspective and from other factors, where there was no pre-existing observation of the behavior. This change must also correlate with the desired intent of the initiative.

Level III. Applied Process Sequencing

As a series of Behavior introductions are implemented, the sequential adherence to such introductions as learned individually or from an educating source for optimized results outlines a higher level of change. The cognitive exertion moves from a singly focused modification in behavior to a more metacognitive approach of learning in that the members of a group now think ahead of what they are doing in an effort to understand logic in what the next step is.

There is also an assumed further expansion of perspective transformation that is achieved as subjects follow a newly learned sequence in behavior where a heightened understanding is reached solely from the
adherence to and practice of multiple acts in a set order. It is this heightened set of actions coupled with the perspective change which makes progression to the next level of change more likely and possible.

**Level IV. Distributive Transformation**

A natural progression in organizational change processes is the raising of capabilities from student to teacher were applied changes in acts as well as thought processes lead to an ability of subjects to facilitate others through the same change pattern that has recently been experienced. This is where the momentum of change initiative begins to be carried on the shoulders of the early movers of the supervising group who now begin to focus their initiative-related efforts to educate others on the process of transformation, behavior introductions and sequencing (Cortese 2005).

**Level V. Proactive Application**

This level of organizational change is observed where the subjects are able to successfully internalize the intended purpose of the change process with all of the below four levels achieved. At this point, the initiative could be considered an implemented success at a single project level and change within the constraints of the project goals goes into a state of flux where restricting issues can be addressed and mitigated without changes in the management process. It is at this point that the subjects broaden their perspective beyond the intended scope of the supervising members behind the initiative and begin to search for other applications and innovations to further the movement towards improved environments.

**Level VI. Transferred Application**

As a part of the compiling of the changes observed, two assumptions are made in the accounting and collection of the instances. First, such levels are deemed as having occurred when two or more members of the group take part in the change whether separately or linked in their behavior. Second, it is assumed that change
CONCLUSION

Though a pioneering effort, this study attempts to demonstrate a further approach to the method of studying and understanding developmental change by documenting real-time data across various groups and compiling its common occurrences. This newly contributed perspective on organizational change, known as Inaugural Model Observation Point, has helped to shed light on six levels of behavioral development that occur amongst workforce members as they seek to learn, apply and institutionalize changes in their environment. It is hoped that such an outlook on organizational studies will help to raise the level of empirical strength in the search for truth in human growth as well as give greater insight to those that oversee the development of workforce members.

REFERENCES


# TABLES AND FIGURES

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<tr>
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<th>Standardized Data Set Used</th>
<th>Relative Case Study Use</th>
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<th>Author Experience Used to Develop</th>
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Table 1: Analysis of Various Organizational Change Models by Author
Figure 1: Hierarchy of the Strength of Case Study Research in Organizational Change

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<th>Organization Code</th>
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<th>Core Team Size</th>
<th>Observed Duration (months)</th>
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<td>Municipal Facilities Management</td>
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<td>15</td>
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<td>FE</td>
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<td>10</td>
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<td>OR</td>
<td>Facilities Management</td>
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<td>6</td>
<td>10</td>
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<tr>
<td>AMK</td>
<td>FM Vendor (Food Services)</td>
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<td>22</td>
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<td>Facilities Management (Utilities)</td>
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Table 2: Summary of Observed Subject-O rganizations
### Recorded Items from Initiative Education Sessions

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<tr>
<td>Attendees</td>
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<tr>
<td>Duration of meeting</td>
<td>Minutes and man-hours</td>
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<td>Key subject matter discussed (measurement, finance, etc.)</td>
<td>Frequency of occurrences</td>
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<tr>
<td>Progressive levels of observable change behaviors</td>
<td>Scaled levels of change</td>
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<tr>
<td>Reported Risks to the progress of maintaining the initiative</td>
<td>Issues and rankings</td>
</tr>
<tr>
<td>Levels of the relationship quality (Supervisor/Subordinate)</td>
<td>Number Ranking</td>
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<tr>
<td>Points of Friction between team members</td>
<td>Frequency of occurrences</td>
</tr>
<tr>
<td>Collaborative changes that occur due to the initiative</td>
<td>Frequency of occurrences</td>
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<tr>
<td>Notes and summaries of initiative acceptance progress</td>
<td>Prose documentation</td>
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**Table 3: Education Session Recorded Data Session Types**
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<th>FE</th>
<th>OR</th>
<th>AMK</th>
<th>SRP</th>
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<td>L4 Distributive Transformational</td>
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<td>L6 Transferred Application</td>
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<tr>
<td>Total Session Changes Observed</td>
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<td>23</td>
<td>20</td>
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Table 4: Levels of change data compilation across six observed organizations
<table>
<thead>
<tr>
<th>Levels Observed</th>
<th>Examples of Learning, Development, Behavior Modification and other Change</th>
</tr>
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<tr>
<td>I.</td>
<td>This initial taking of steps is accounted for as a Level 1 change. However, due to the focus of this research being on actions of change as compared to perceptions, further compilation and assessment is not taken of Level 1 changes. This is further deemed as ignorable due to the existing research which has been conducted on such events. Questioning of the presented material, Insights (Initial &quot;aha&quot; moments), Enthusiasm demonstrated, Request for further education and contracted agreement achieved, Comprehension of risks, Discussion of new material</td>
</tr>
<tr>
<td>II.</td>
<td>Personal study of materials, Returning for further education, Agreeing to be in core team, Consolidation or simplification of environmental elements, New autonomous self direction, Preparation for initiative-related events, Acting out a single step of the weekly risk reporting process</td>
</tr>
<tr>
<td>III.</td>
<td>Initiative-related planning and coordinating Carrying out sequences of BV PIPS process steps including completion or administration of: PPI’s, Risk Plans, Interviews, Modeling of data, Choosing a vendor based on modeled measurement, Other related events, Other sequencing of steps to measure organizational environment</td>
</tr>
<tr>
<td>IV.</td>
<td>Answering team questions (teaching members), Self training meetings with others (formal and informal), Teaching back to educators what has been learned from initiative experience, Presenting findings related to BV in quarterly or conference meetings, Friction points between members due to measured misalignment (transparent errors), Formally disagreeing with a superior's command or suggestion based on expertise, Risk reporting-related steps in sequence</td>
</tr>
<tr>
<td>V.</td>
<td>Risk Mitigation (through subordinate-directed innovation) where a formal solution is found which reaches cooperative agreement between supervisor and subordinate parties, Change process begins a state of flux in terms of adaptive change within the initiative goals, Excitement or enthusiasm of wanting to apply process elsewhere, Actively educating other team members on areas of the initiative</td>
</tr>
<tr>
<td>VI.</td>
<td>- Transferring concepts and principles to other environments at work, personal life, etc. - Increasing the initiative into another unrelated area for replication of process - Momentum of change increases to a flux environment of change</td>
</tr>
</tbody>
</table>

Table 5: Examples of Organizational Change observed in Levels Analysis
Implementing Self-Replicating Rapid Prototypers (RepRaps) into a Mechanical/Manufacturing Program

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ABSTRACT

The cost to build a Prusa Mendel version of a self-replicating rapid prototyper (RepRap) is approximately $550 in components, including the 3D parts printed on an existing machine. A comparable size and capability 3D printer on the market is a Stratasys Mojo, which has a significantly higher price of about $10,000. The Mojo printer uses the same additive manufacturing process extruding similar types of plastic filament, but is delivered in the normal commercial manner with all components housed in a “black box”. An attractive element of the RepRap design from an educational perspective is that all of its components are readily accessible, making it much easier to understand how the machine operates. A Prusa Mendel RepRap can be assembled by a single person in about 24-30 hours, including installation of open-source software on a host computer. Building the printer can be accomplished by a faculty member, or could be part of a capstone student project. The process of introducing students to the world of 3D printing in the open source environment is a major benefit. Manufacturing students can design from scratch or build on existing open projects, 3D print and test parts prior to production using traditional processes. Students can join and contribute to the open source community by uploading their design files to various web sites dedicated to free sharing of open source digital designs. In addition, improvements to the existing RepRap machine can be designed, printed, installed and tested in hours, not days or weeks.

INTRODUCTION

The opportunity arose in November 2013 with a project organized by various University faculty and research staff to assist in developing a workshop for high school teachers to build and commission an open-source
The plan to invest in a rapid prototyping machine for the School of Technology (SoT) to integrate into the Mechanical Engineering Technology (MET) curriculum for product design realization has been a long time goal.
within the Department. The curriculum needs of the manufacturing focus in the MET program significantly influenced the decision to invest in rapid prototyping technology, and by unanimous consensus, faculty in the program agrees that all phases of the MET program will benefit. Administration and faculty are convinced that prototyping technology will add to the capabilities of the already well equipped fabrication laboratory. The Department machine shop/assembly fabrication laboratory currently utilizes CNC plasma cutting, CNC milling, CNC lathe, and EDM capabilities, as well as welding and manual metal finishing. Without the benefit of a plastic molding laboratory, access to the use of plastics in design realization is often left to outsourcing. A company that produces prototypes for commercial industries, C-Ideas, located in Crystal Lake, Illinois in the past has been generous in their donation of prototypes for senior project students in need of a part in their design, although relying on outside sources for donations is not sustainable over time (C-Ideas, 2013).

In planning for the purchase of a rapid prototyping machine the MET Program Chair and School Dean attended the SME Rapid conference in May 2012 to investigate vendors and costs of various rapid prototyping systems. Following an exhaustive search of several vendors and suppliers covering a range of prices from the Stratasys Mojo at $10,000 to Statasys Fortus 400mc with a price tag between $100-200K depending on the extra capabilities, the latter was ordered in June of 2013 having been partially funded through an alumni donation (Stratasys, 2013). The system is scheduled to be operational in the SoT Machining/Fabricating facility during the 2013 fall semester. This long lead time encouraged evaluation of the Prusa Mendel for its prototyping capabilities, applications and possible limitations.

PRUSA MENDEL REPRAP

One of the recommendations of the ASME Vision 2030 report is that Mechanical Engineering Technology programs should strive to create curricula that inspire innovation, creativity, and entrepreneurship (Perry & Kirkpatrick, 2012). A perfect tool for implementing these goals is the RepRap 3D printer, claimed by its' creators to be "humanity’s first general-purpose self-replicating manufacturing machine", and first released in March 2007. The
RepRap has already demonstrated utility in a wide range of educational environments (Kentzer, et al., 2011; Gonzalez-Gomez, et al., 2012). The RepRap Project has an open source hardware design using open source software with the intent to improve on the design and software with each future generation (RepRap, 2013).

Commercial versions of fully-assembled open-source 3-D printers are available in the range of $800 to $2,200 from companies like Trinity Labs, LulzBot-Aleph Objects, Type A Machines, and Printrbot LC (2013). The Prusa Mendel model is less expensive than all of the proprietary machines and even these open-source variants and can be employed academically as an application project for students, e.g. assembling and commissioning a printer.

Tasks involved in the assembly of the Prusa Mendel design include cutting of steel components, filing and deburring of printed parts and steel components, mechanical assembly of threaded components, soldering, routing and connection of wiring, and various other cutting and measuring steps. Commissioning of the machine includes tasks such as downloading and configuring software and firmware, troubleshooting electronics, making adjustments to components on the circuit board, fine tuning travel and extrusion and leveling of the printer build platform.

Learning opportunities can be easily linked to the academic preparation of manufacturing students in almost every facet of the SME recommended Four Pillars of Manufacturing, from materials and manufacturing processes to manufacturing competitiveness (Mott et al., 2012). The purchased components necessary to build the RepRap are largely available at hardware stores and also from several suppliers listed on the RepRap.org Prusa Buyer Guide page (RepRap, 2013). A complete bill of materials was produced that includes the parts that were purchased for the 3D printer assembled in the build workshop. (See Table 1)
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<tr>
<td>20</td>
<td>Metric 18-8 Stainless Steel Threaded Rod</td>
<td>90024A080</td>
<td><a href="http://www.mcmaster.com/#standard-threaded-rods/+qjwbc">http://www.mcmaster.com/#standard-threaded-rods/+qjwbc</a></td>
<td>6</td>
<td>$8.31</td>
<td>$49.86</td>
<td>$304.00</td>
</tr>
<tr>
<td>22</td>
<td>1/8x1/4 PTFE tubing</td>
<td>554D3X31</td>
<td><a href="http://www.mcmaster.com/#standard-ptfe-tubing/=knxad">http://www.mcmaster.com/#standard-ptfe-tubing/=knxad</a></td>
<td>2</td>
<td>$3.73</td>
<td>$7.46</td>
<td>$421.04</td>
</tr>
<tr>
<td>24</td>
<td>Stepper motor</td>
<td>U21N17MTR</td>
<td><a href="http://ultimachine.com/content/kysan-1124090-nema-17-stepper-motor">http://ultimachine.com/content/kysan-1124090-nema-17-stepper-motor</a></td>
<td>3</td>
<td>$16.50</td>
<td>$49.50</td>
<td>$551.80</td>
</tr>
<tr>
<td>26</td>
<td>Glass</td>
<td>Local</td>
<td><a href="http://www.graphite.com/">http://www.graphite.com/</a></td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td>$525.59</td>
</tr>
</tbody>
</table>
PRUSA MENDEL 3D PRINTED PARTS

The 3D printed components (See Illustration 2) can be purchased from various suppliers such as Charlie’s 3D Technologies, eMAKERshop, and A2APrinter, or even on Ebay for as little as $50 for a complete set, although with access to another 3D printer, parts can be printed for just the cost of about 500 grams of filament. Commercial filament ranges from $19-$122/kg (http://www.3ders.org/pricecompare/) but most users purchase filament in the $35-55/kg range. In addition, open-source Recyclebot's provide the potential to produce filament from recycled waste plastic for less than $1/kg (Baechler, et al., 2013).

The 3D printer extrudes either polyactic acid (PLA), which most of the parts for the printer are made from, or acrylonitrile butadiene styrene (ABS) used for parts requiring high heat resistance. Replicating an additional prototyper requires approximately 24 hours of printing (time dedicated to preparing the 3D file for printing/slicing, running the print and removing the part from the heated bed). The RepRap parts can be printed in approximately 21 hours (See Tables 2-4), but a print failure rate of 20% on a new printer leads to the additional time (Wittbrodt et al., 2013).
### Table 2. Days 1 & 2 - 3D printing Prusa Mendel parts

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Start Time</th>
<th>End Time</th>
<th>Time elapsed - minutes</th>
<th>Result</th>
<th>Total Time</th>
<th>Total Time</th>
<th>Part images</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame vertex foot1 -</td>
<td>10:30 AM</td>
<td>11:15 AM</td>
<td>45</td>
<td>Good part</td>
<td>45</td>
<td>45</td>
<td><img src="image1.jpg" alt="Frame vertex foot1" /></td>
</tr>
<tr>
<td>estimated time=52</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame vertex foot2 -</td>
<td>11:16 AM</td>
<td>12:00 AM</td>
<td>44</td>
<td>print stopped, possibly due to virus scan software, part was 90% complete</td>
<td>45</td>
<td>90</td>
<td><img src="image2.jpg" alt="Frame vertex foot2" /></td>
</tr>
<tr>
<td>estimated time=45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame vertex foot3 -</td>
<td>12:30 PM</td>
<td>1:15 PM</td>
<td>45</td>
<td>print stopped, problem with 3D offset and heated printer bed</td>
<td>45</td>
<td>75</td>
<td><img src="image3.jpg" alt="Frame vertex foot3" /></td>
</tr>
<tr>
<td>estimated time=30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame vertex foot4 -</td>
<td>1:16 PM</td>
<td>2:16 PM</td>
<td>60</td>
<td>Good part</td>
<td>82</td>
<td>112</td>
<td><img src="image4.jpg" alt="Frame vertex foot4" /></td>
</tr>
<tr>
<td>estimated time=60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame vertex 1 -</td>
<td>2:00 PM</td>
<td>2:45 PM</td>
<td>45</td>
<td>Good part</td>
<td>45</td>
<td>75</td>
<td><img src="image5.jpg" alt="Frame vertex 1" /></td>
</tr>
<tr>
<td>estimated time=45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame vertex 2 -</td>
<td>3:00 PM</td>
<td>3:45 PM</td>
<td>45</td>
<td>Good part</td>
<td>50</td>
<td>75</td>
<td><img src="image6.jpg" alt="Frame vertex 2" /></td>
</tr>
<tr>
<td>estimated time=45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hingebone gears -</td>
<td>1:30 AM</td>
<td>2:45 PM</td>
<td>75</td>
<td>Good part</td>
<td>75</td>
<td>105</td>
<td><img src="image7.jpg" alt="Hingebone gears" /></td>
</tr>
<tr>
<td>estimated time=90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 tooth T5 gear1 -</td>
<td>2:25 PM</td>
<td>3:15 PM</td>
<td>45</td>
<td>Good part</td>
<td>55</td>
<td>80</td>
<td><img src="image8.jpg" alt="12 tooth T5 gear1" /></td>
</tr>
<tr>
<td>estimated time=45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 tooth T5 gear2 -</td>
<td>3:15 PM</td>
<td>4:00 PM</td>
<td>45</td>
<td>Good part</td>
<td>55</td>
<td>80</td>
<td><img src="image9.jpg" alt="12 tooth T5 gear2" /></td>
</tr>
<tr>
<td>estimated time=45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>buda mount -</td>
<td>1:30 PM</td>
<td>2:30 PM</td>
<td>30</td>
<td>Good part, but found out this part needed to be made from ABS not PLA material</td>
<td>33</td>
<td>63</td>
<td><img src="image10.jpg" alt="buda mount" /></td>
</tr>
<tr>
<td>estimated time=30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prusa extruder mount,</td>
<td>2:30 PM</td>
<td>3:30 PM</td>
<td>30</td>
<td>failed possibly due to turning off fan and bed temp rose too high</td>
<td>33</td>
<td>63</td>
<td><img src="image11.jpg" alt="Prusa extruder mount" /></td>
</tr>
<tr>
<td>estimated time=30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>prusa extruder mount</td>
<td>3:30 PM</td>
<td>4:30 PM</td>
<td>30</td>
<td>parent quality for the final 25%, reserved 2 and removed filament, moved location to 72F room &amp; extruded 400mm of material to clear nozzle</td>
<td>33</td>
<td>63</td>
<td><img src="image12.jpg" alt="prusa extruder mount" /></td>
</tr>
<tr>
<td>estimated time=30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>z motor mount -</td>
<td>4:20 PM</td>
<td>5:20 PM</td>
<td>60</td>
<td>Good part, possibly due to 60F temperature in room, moved location to 72F room &amp; extruded 400mm of material to clear nozzle</td>
<td>33</td>
<td>63</td>
<td><img src="image13.jpg" alt="z motor mount" /></td>
</tr>
<tr>
<td>estimated time=60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Day 1 -**
- three good prints and two failed prints - printing time 122/152 = 80% efficiency

**Day 2 -**
- six good prints and three failed prints - printing time 211/256 = 82% efficiency
Table 3. Day 3 - 3D printing Prusa Mendel parts

<table>
<thead>
<tr>
<th>Part</th>
<th>Start Time</th>
<th>End Time</th>
<th>Duration</th>
<th>Status</th>
<th>Part Time</th>
<th>Total Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z motor mount</td>
<td>9:00 AM</td>
<td>9:55 AM</td>
<td>55</td>
<td>Good part</td>
<td>388</td>
<td>528</td>
</tr>
<tr>
<td>Z's motor mount</td>
<td>10:00 AM</td>
<td>10:55 AM</td>
<td>55</td>
<td>All parts were scrap due to y axis shift in layers</td>
<td>388</td>
<td>528</td>
</tr>
<tr>
<td>Bar clamp x 8</td>
<td>11:17 AM</td>
<td>12:09 PM</td>
<td>52</td>
<td>Good part, mounted and programmed fan for cooling,</td>
<td>413</td>
<td>553</td>
</tr>
<tr>
<td>Bar clamp x 9</td>
<td>12:11 AM</td>
<td>12:55 PM</td>
<td>44</td>
<td>Good part</td>
<td>499</td>
<td>639</td>
</tr>
<tr>
<td>Parametric coupling 1</td>
<td>12:11 AM</td>
<td>12:55 PM</td>
<td>44</td>
<td>Good part</td>
<td>499</td>
<td>639</td>
</tr>
<tr>
<td>Parametric coupling 2</td>
<td>12:48 PM</td>
<td>2:08 PM</td>
<td>20</td>
<td>Good part</td>
<td>559</td>
<td>699</td>
</tr>
<tr>
<td>C_rod_Y_axis</td>
<td>2:23 PM</td>
<td>3:12 PM</td>
<td>49</td>
<td>Good part, but one of the Carbon rod holders came loose from the heated bed so one part failed</td>
<td>488</td>
<td>748</td>
</tr>
<tr>
<td>Wades Plate</td>
<td>3:15 PM</td>
<td>5:54 PM</td>
<td>159</td>
<td>Good part</td>
<td>767</td>
<td>907</td>
</tr>
<tr>
<td>C_rod_holder</td>
<td>5:54 PM</td>
<td>6:15 PM</td>
<td>21</td>
<td>Good part</td>
<td>788</td>
<td>928</td>
</tr>
</tbody>
</table>
### Table 4. Days 4-6 - 3D printing Prusa Mendel parts

| Part name | Start Time | End Time | Print Time | Part Status | Quality
|-----------|------------|----------|------------|-------------|--------|
| X end plate | 11:36 AM | 12:20 PM | 44 minutes | Good part | 983/1123
| Y motor bracket | 12:20 PM | 12:52 PM | 32 minutes | Good part | 1027/1167
| Belt clamp | 1:10 PM | 1:15 PM | 5 minutes | Good part | 1064/1194
| Belt terminator1 | 1:15 PM | 1:26 PM | 11 minutes | Good part | 1075/1215
| Belt terminator2 | 1:28 PM | 1:37 PM | 9 minutes | Good part | 1084/1224
| Belt terminator3 | 1:37 PM | 1:48 PM | 11 minutes | Good part | 1095/1235
| Belt terminator4 | 1:48 PM | 1:58 PM | 10 minutes | Good part | 1105/1245
| Extraversion direct | 1:58 PM | 2:23 PM | 25 minutes | Good part, but found out later this part needed to be a different part with a nut trap | 1131/1270
| Prusa extruder mount | 2:23 PM | 3:11 PM | 60 minutes | Part failed, top portion was sparse due to not enough material extruding, slippage | 1142/1342
| Z mounter mount2 | 3:11 PM | 4:11 PM | 62 minutes | Retracted filament and cut off grooved section - Poor quality part | 1142/1404
| Wireholder1 | 10:53 AM | 11:03 AM | 10 minutes | Good Part | 1152/1414
| Wireholder2 | 11:03 AM | 11:13 AM | 10 minutes | Good Part | 1162/1424
| Shim | 10 Good Part | 1172/1434
| Spacer_w_insert | 25 Good Part | 1197/1459
| Z-motor mount part | 60 Good Part | 1257/1519
| Buddha Mount | 26 Good Part | 1283/1545
| 3 x end stop holder | 30 Good Part | 1313/1575

#### Day 4 -
Ten good prints and one failed print - 86% efficiency

#### Day 5 -
Two good prints and one failed print - 24% efficiency

#### Day 6 -
Five good prints and zero failed prints - efficiency of 100%

**Totals**

- 21 hours and 52 minutes for printing good prints
- 26 hours and 15 minutes total time spent printing
- Forty-one good prints and eight failed prints
- Overall = 1313/1575 = 83% efficient
The 3D printed parts for a Prusa Mendel RepRap were produced by the 3D printer constructed during the workshop and another completely assembled printer (See Illustration 3) was ready to roll out to the SoT faculty, staff and students for use by February 2013.

![Illustration 3. Replicated Prusa Mendel RepRap](image)

**OBSERVATIONS**

In the remaining portion of the 2013 spring semester the 3D printer was in nearly constant use in the machining/fabricating facility. This was due to both the high utility of a RepRap for prototyping, but also its relatively low operating costs. A student employee working as a machinist’s assistant operated the prototype machine partially for performing tasks related to his job function, but also to assist other students with their senior projects. Parts were also printed to improve the performance of the 3D printer, for example an improvement to the original design that was implemented is a hinged accessible extruder to facilitate changing filament and clearing of jams. The advantage of this 3D printer being open source is that 3D models are freely available for modification and improvement. Components are free to download from a number of online sources. The student employee simply downloaded the part designed by another user to solve this filament accessibility issue, printed the part, and
installed it on the machine. Additional designs have been uploaded by University research staff members assisting in the 3D printer workshop, such as a Double Whammy Prusa that uses a “Push-me-pull-you extruder drive” (http://www.thingiverse.com/thing:46800) along with a pair of “Acarius10’s Minimalistic J Head X Carriages” (http://www.thingiverse.com/thing:45883) to make two copies of the same print at once. (See Illustration 4)

Illustration 4. Double Whammy Prusa Modification

The extruder hot end can be a problem spot with plugging of the 0.50mm nozzle the most significant issue. The small orifice is difficult to clear if foreign, high glass temperature plastic or non-plastic material plugs it. Clearing protocols have been developed, but this issue is the bane of 3D printer operators and great care is taken by filament manufacturers and printer operators to avoid it. A second issue is related to the design of hot ends. The goal of the hot end is to heat filament to its glass temperature immediately prior to deposition while keeping the filament before the nozzle as cool and stiff as possible since that filament serves as the piston driving the heated plastic through the orifice. Incoming filament keeps the temperature before the hot end at a sufficiently low temperature, but interruption of feeding for long periods of time can lead to the filament heating to its glass temperature and deforming. This leads to kinks within the hot end that can be difficult to extract.

Attempts to machine the nozzle parts from more durable brass material and PEEK stock to replace the purchased nozzle have proven unsuccessful, although this offers a continuous opportunity for MET students to
explore design alternatives and create possible solutions to one of the limitations of the RepRap 3D printer. Several extruder hot end variations inevitably lead to design, build and test scenarios in order to optimize the 3D printer performance.

**ORIGINAL DESIGNS**

To assist in implementation of the use of 3D printers a tutorial was created, providing guidance to students who wanted to make 3D prints of their designs. The tutorial introduces the student to Cura, software for creating the code necessary to run the print, PronterFace printer host software, and finally how to operate the printer as far as powering up, eliminating jams, setting the Z height, and leveling the bed. The tutorial can be found in the Appendices section.

The high school teacher involved in the initial build workshop created a similar tutorial for students. The RepRap at the high school was under heavy use by students to realize their novel creations. For example a student at the local high school created a key chain in the shape of the upper peninsula of Michigan published on Thingiverse on February 5, 2013 (See Illustration 5).

Illustration 5. Upper Peninsula Key Chain Thing

Many other original designs and 3D prints were created by the high school students, but notably as far as improvements to the 3D printer itself, the students made a fan holder and an on/off switch holder which are very
useful parts for safety considerations. The popularity of the RepRap can have unintended consequences. For example, a high school student was caught attempting to break into school in the middle of the night – not to vandalize – but to get extra time on the RepRap to improve his self-directed class project. This level of student enthusiasm for extra school work is generally uncommon.

In a recent graduate level engineering fundamentals course for Applied Science Education majors a “potting box” was designed and printed for housing an electronic circuit board for a mini wind generator (See Illustration 6). Similar electronic circuit board containers are available to purchase for five to ten dollars each, but none were available to fit the exact measurements of this circuit board. As explained by Wittbrodt et al. (2013), the RepRap is an economically attractive investment for the average U.S. household based on the life-cycle economic analysis, but as illustrated by this example alone it can at the same time save students time and money for engineering related projects requiring custom parts. This remains true for much more expensive components such as those used for research-grade scientific equipment, where a RepRap can easily pay for itself saving thousands of dollars for labs printing custom designs (Anzalone, et al., 2013; Pearce, 2012; Zhang, et al., 2013).

Illustration 6. Circuit Board Potting Box (without Lid)

CONCLUSIONS AND RECOMMENDATIONS
Faculty in technology programs strive to develop projects where students experience real-world examples for design, build, and test all during one or two semesters. Expense is a significant consideration but so is production of tangible results. The integration of the RepRap into a manufacturing curriculum can be an answer if implemented with a well thought out strategy, patience, and guidance.

Strategically thinking, it is recommended to utilize the RepRap machine as a low-cost alternative or supplement to comparable 3D printers, (commercially costing anywhere from four to twenty times the cost to build a Prusa Mendel), not only to rapid prototype parts, but also as an ongoing project for students to tweak the open-source design making improvements in performance. Patience is necessary to build and operate the 3D printer; it requires 24-30 hours to construct and commission, and until it is tuned nearly constant monitoring while running prints. Regular maintenance is required to keep the printing bed level and to keep printing material from jamming in the extruder. Lastly, guidance is required from those who have fine tuned the build process and usage of 3D printers in the form of well planned out instructions like the “MOST RepRap Build” page created for the Additive Manufacturing Workshop (MOST RepRap Build, 2013), including 3D printer assembly, software installation, and 3D printer operation and maintenance procedures. It is also recommended to have a live consultant on hand who has the experience of having built and operated a RepRap 3D printer to ask questions when the answers are not available through online references. For those without access to an experienced user locally, the RepRap IRC channel maintained by the international RepRap community is active and can be helpful (http://www.reprap.org/wiki/IRC).

Additive manufacturing has come a long way from the early generations of rapid prototyping machines that were only affordable for large corporations to purchase and operate. The RepRap 3D printer has made it possible to implement a design-build-test scenario for students from high school to higher education. It has made it possible to literally see a design produced in hours, not days or weeks while costing only pennies, not dollars.
REFERENCES


3D Printing using the Prusa Mendel (developer, Josef Prusa) Rapid Prototyping Replicator (RepRap)

1. Model a part in any CAD software, download a part from the internet, (thingiverse.com is a site that features parts designed for RepRap machines) Files can be downloaded as .stl file format.

2. Export the model from NX or other CAD software as a STerioLithography (.stl) file format. After selecting the part error warning will show if the part has negative coordinates, but the part will still export.

3. Open Cura software for slicing and generating G-code for printing.

4. Load the Model, and the model can be scaled, flipped or rotated using these tools. Then, generate the G-code by choosing, Prepare print.

5. Cura software has two stored print config files, one is for Polyactic Acid (PLA) and the other is for Acrylonitrile butadiene styrene (ABS) material. The PLA has a lower melting point than ABS so the setting for the nozzle and the bed temperature are higher. Printing speed and filament diameter can be changed on the fly to adjust for accuracy of prints. To change the print config file choose Open Profile from the File pull-down menu.

6. The profile file for PLA is named c:/program files/cura_12.11/cura/preferences.ini and for ABS is named c:/program files/cura_12.11/cura/Cura_greenABS_profile.ini

7. The G-code file is automatically saved to the same location as the .stl file with the same name.
8. The layers of slicing can be viewed using the arrows up and down here.

9. Turn on Power supply. Open the Printer Interface software (Pronterface)

PLA = Set Heater temp to 210 and Bed Temp to 60

ABS = Set Heater temp to 235 and Bed Temp to 115

10. Connect to the printer through the USB cable and choose Connect. Status will indicate that the printer is connected. (The COM port may have to be changed or USB cable reconnected if it does not connect.)
11. Load the .stl file into Pronterface and set the heater and bed temperatures. Checking Monitor Printer will show the current temperatures in the Graph area.

12. Home the printer bed and make sure that the bed is level and the Z height of the nozzle is about a paper thickness from the glass surface. The level can be adjusted using the nuts under the bed to raise or lower, and the Z height of the bed can be adjusted using the screw above the Z limit switch.

13. Material must be inserted into the extruder and tension can be adjusted using the nuts compressing springs to increase tension on the filament. There should be no screeching sound otherwise the tension is too tight.
14. When the Hot end is at the correct temperature, raise the Z height 10 mm, change the extrude value to 10 and pick **Extrude** to make sure material is flowing through the nozzle.

15. Select **Print** to start the printer and watch to make sure part is adhering to bed surface, if it fails pick pause, clean the surface, **Home** the machine, pick **Reset**, and then select **Print** again.

16. When print is complete, turn heater and bed off, choose **Disconnect**, clean build surface, and turn off power supply.
Teaching Innovations

Building Better Writers: Using Technology to Enhance Feedback in Technical & Professional Writing

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INTRODUCTION

For a number of years both the academic research and general news media have recognized and emphasized the importance of so called ‘soft skills’ in gaining employment. One soft skill that appears on list after list, year after year, is the ability to communicate effectively both orally and in writing (Association of Technology, Management and Applied Engineering, 2013, National Association of Colleges and Employers, 2013, Robles, 2012). Preparing students to meet this particular need for the future workforce naturally means emphasizing writing skills in the college curriculum. But research on writing and the teaching of writing indicates that requiring students to write is not equivalent to making students good writers. Research on writing repeatedly emphasizes the importance of feedback in developing student writers. The longtime Harvard Study of Undergraduate Writing indicates that students view feedback on their writing as “central to their learning experience” (Walk, 2000). Writing instructors therefore, must not only require appropriate writing exercises, but provide the kind of meaningful and comprehensive feedback that will improve student writing. As anyone who teaches writing intensive classes will tell you, it takes a considerable amount of time and labor to respond to student writing. As a result, there are many different techniques instructors use to give feedback that is comprehensive for the student, yet efficient for the instructor. This paper examines the role of feedback in developing better writers, and discusses the use of a particular audio-video technology to enhance feedback in a university technical writing course.

LITERATURE REVIEW
While many instructors are experts with advanced degrees in their particular area of study, they may not be experts in evaluating and teaching writing specifically. The literature review will therefore focus on writing research, and the role and importance of feedback in improving writing.

The process of commenting on student writing – and its subsequent effectiveness – has been much debated and questioned. The title of the introduction to the book *Key Works on Teacher Response* best expresses it: “The Emperor (Still) Has No Clothes – Revisiting the Myth of Improvement” (Straub, 2006, p. 1). Among writing scholars, the question over how best to give feedback and how much that feedback actually improves student writing is still open to exploration and research. Scholars have opined that early studies of writing feedback may have been flawed in design (Knoblauch and Brannon, 2006, p. 71). Subsequent studies have indicated that instructor feedback, along with the opportunity to revise writing before it becomes a final, graded product, does lead to better student writing (Knoblauch and Brannon, 2006, p. 74, Hillocks, 2006). Other texts indicate that students feel the same. In 1990, Harvard University Professor Richard Light conducted a study that focused on what undergraduate courses were considered ‘effective’ by undergraduate students. Light found that students preferred (and did better in) courses in which the instructor provided rapid, frequent feedback on work – which naturally lends itself to courses that are writing intensive (Light, 1990). Light’s work has been built upon by *The Harvard Study of Undergraduate Writing*, which studied the writing of 400 undergraduate students from 1997 to 2001. The study mirrors and expands Light’s assumptions. According to the *Harvard Study of Undergraduate Writing*, students utilize feedback to not only improve writing, but to discern instructor expectations, understand the content and interpret their own performance (Walk, 2000, p.1).

Scholar Nancy Sommers has also studied and written about the qualitative benefits of instructor comments – the more or less “soft” aspects of feedback. Providing comments, Sommers posits, makes audience real for students, and reminds them that their writing must communicate to a reader other than themselves. (Sommers, 2013, p. xi). Sommers goes on to suggest that reminding students that there is someone reading their work allows students to become “thoughtful readers” (Sommers, 2013, p.xi) themselves and contributes to both critical thinking
and improved learning. Light and Sommers’ assumptions about the importance of feedback to student performance has become an accepted foundation of writing pedagogy.

How students interpret comments from instructors is also an avenue of study. Thomas Gee noted that students often assign a tone to instructor comments that the instructor did not intend. Gee suggests that students often take comments such as “awkward” or “poorly written” personally (Gee, 2006, p. 38). Sommers notes that as a result, instructors must be cognizant of the tone of their comments: “To develop authority as writers, students need guidance and specific advice, always phrased in an encouraging tone” (Sommers, 2013, p. 6).

The study of student writing is vigorous and ongoing, and any scholar teaching a writing intensive class would find the literature on writing interesting and helpful. The overview presented here is meant to provide a foundation for this particular study on the use of technology to provide feedback.

THE STUDY

This study was designed to examine how audio-video feedback using a tool called Tegrity could be used to provide more complete feedback to student writers. The most common form of feedback is written (or typed, if using a word-processing program) comments in margins or within the body of a student paper (Moore and Filling, 2012). Researchers have also utilized various types of technology to provide feedback, most notably audio or video recordings in which the instructor ‘reads’ a student paper and provides oral commentary that is then sent to the student via various technologies, such as podcasts (Moore and Filling, 2012). Strictly oral feedback, while allowing an instructor’s true tone to show, does not allow the student to ‘see’ what the instructor is referring to in the actual writing assignment, unless the student has a copy of the paper in front of him or her while listening to the audio feedback. Even then, the oral recording could become cumbersome and confusing if the student loses his or her place, or if the instructor moves ahead in the document without saying so out loud. This study was designed to combine written comments with oral feedback so that students could ‘see’ their paper on screen, along with seeing the instructor and hearing the instructor’s feedback.
The Tegrity audio-video feedback tool was deployed for the first time in Spring, 2013 in one face to face section of an upper level, writing intensive technical writing course at a four year university. The course enrolled 24 students. It is a required course for all students in computer science, technology and construction management programs, as well as being an acceptable equivalent for business writing for students in other majors. The tool itself, Tegrity, was chosen because it is compatible with the university course management system Blackboard, and because producing videos via the tool is simpler and less time consuming than with other tools because there is no FTP involved, and the time it takes for the videos to ‘render’ is minimal. The tool works with a standard web-cam and microphone, and anything on the user’s desktop computer can be pulled up and shown in the recording. The tool also allows the instructor to show themselves in a corner of the video.

The Course

Each week during the semester, students write a paper that applies the lessons learned that week. Students write four foundational assignments in the first month of the course: a technical document analysis, an ethics analysis, an audience analysis and a research assignment. The remainder of the course focuses on writing specific workplace documents: a graphics assignment, a page design assignment, a business letter, a technical description, a resume and cover letter, a memo with embedded instructions, a proposal and a technical report. The students turn in each of these documents as an assignment. The instructor grades the assignment, gives feedback, and returns the graded assignment with the feedback to the student within a week of submission. At the end of the semester, the student revises the nine workplace documents based on the instructor feedback, and compiles the documents into a portfolio, which is then submitted as the final project. The documents the students write throughout the semester and the final portfolio constitute all of the graded work for the course – there are no standard tests or quizzes.

Prior to the Spring of 2013, feedback was provided to students who submitted papers digitally using the ‘highlight’ and ‘track changes’ functions of a word processing software. Students that turned in hard copy assignments received written comments directly on the paper. As noted, students received graded work back within
a week so that they could utilize the feedback on subsequent assignments. For this study, students in one section of the course received a recorded video that showed the instructor in one corner of the video, and the student’s paper in another, larger window. The instructor used the highlight and track changes function to mark the paper while narrating the changes being made orally. When the video was done, the instructor uploaded it to a special section of the course site, where each student could only see his or her own work. The videos were also completed within one week of the assignment being submitted and remained on the student's particular area of the course site for the entire semester. Figure 1 is a ‘screen grab’ of what the videos looked like, although for FERPA reasons, the document being shown in Figure 1 is not actual student work.

Figure 1: Screen Capture Sample of Tegrity Feedback Video

Two other sections of the same technical writing course, taught by the same instructor in the same semester, received typical written feedback with no audio-video augmentation. It should be noted that the feedback given to both the Tegrity and standard sections is fairly lengthy. Instead of one word notes such as ‘wordy,’ for instance, the sentence is actually edited and rewritten with an explanation of why. This kind of feedback ensures that students understand instructor comments and also shows them how to edit needless words from a sentence;
something they clearly needed help to do if the sentence was wordy in the first place. This kind of sentence level issue is addressed in the feedback, in addition to ‘larger’ concerns such as coherence, structure, lack of evidence or detail and organization.

Technical Discussion

The tool itself, Tegrity, is relatively easy to use. From a production standpoint, the instructor, wearing a microphone and using a webcam, opens the Tegrity window, clicks on an icon to start the video recording and from there can pull up and record anything that appears on the instructor’s desktop computer – in this case, the assignment being reviewed. The instructor can then begin pointing out particular problems with the assignment using the track changes and highlight functions of a word processing software to make the changes, while also narrating the changes and making suggestions orally. The oral narration allows more involved discussion of the ‘why’ for the changes – drawing on what was discussed in class, for instance. Thus, the student can physically see what is being changed on the assignment, in addition to hearing the instructor narrative and seeing the instructor’s facial expression. Once the instructor is finished, he or she clicks on another icon to stop the recording. Another icon click automatically uploads the finished recording.

One of the primary concerns initially was the security and confidentiality of individual videos. Each video had to be viewed by only the student in question. To ensure this, once the video is finished and uploaded, the instructor accesses a control panel and turns ownership of the video over to the student, and marks the video itself as never publishable. This places the completed video into the individual student’s secure area, where it can only be viewed by that student. The videos also remain in the instructor’s control panel. As more videos are added, the old videos stay in the student’s secure area, so that at the end of the semester, the student has all of the videos produced over the course of the semester for review before the portfolio is due.

Initially, the instructor had a ‘learning curve’ to master both creating the videos and depositing them in the student’s secure area. After that, however, the process was fairly streamlined. The instructor started by opening the assignment and reviewing it briefly to see what aspects needed to be addressed and explained in the video. Then
the instructor started the recording and created the narrated video. Depending upon the length of the assignment and the number of issues that needed to be addressed, videos ranged from two minutes to twelve minutes in length. Once uploaded and turned over to the student, the student could access the course website to view the video, download it to his or her computer and/or access it on a mobile device or tablet via an app. The videos could be paused, speeded up or slowed down just as most online/computer videos. At the beginning of the semester, the instructor showed the class how feedback would be delivered and how to access the Tegrity videos. Each week, the instructor would remind students about using Tegrity to view feedback, and asked if anyone was having problems with the tool. None of the students ever expressed having any problems utilizing the tool.

On the last day of class, students in the Tegrity section and the standard sections of the course were given a questionnaire to fill out about their experience in the class. Completion of the questionnaire was voluntary and anonymous; once students were done, they placed it face down in a folder near the door to the classroom and left. The instructor did not handle the questionnaires until the class was finished. A number of the questions on the survey dealt with non-feedback related items such as how they felt about the course assignments and the class attendance policy. Several questions focused exclusively on feedback given in the class. Those questions are listed in Table 1.

Table 1: Questions Regarding Feedback in Tegrity and Standard Courses

<table>
<thead>
<tr>
<th>Class</th>
<th>Survey question</th>
</tr>
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<tbody>
<tr>
<td>Standard Feedback</td>
<td>1. Did you feel the level of feedback you received from your instructor was adequate? If not, what would you have liked to see in terms of feedback on your papers?</td>
</tr>
</tbody>
</table>
Of the 24 students in the Tegrity feedback section of the course, 16 students filled out the questionnaire in varying degrees – one student answered only one question in the whole survey, which was question 3 in Table 1. Of the 48 students in the two standard feedback sections, 23 students filled out the questionnaire. The results of the completed questionnaires are detailed below.

**RESULTS AND FINDINGS**

Both the Tegrity and Standard feedback sections of the course were asked whether or not they felt the feedback from the instructor was adequate, and if not, why. All 23 respondents in the standard feedback sections responded that they felt the feedback was adequate. Fifteen of the 16 respondents in the Tegrity feedback section felt the feedback was adequate, with the lone remaining respondent declining to answer the question.

This homogeneity would indicate that regardless of how the students received feedback, they felt it was ‘adequate.’ None of the respondents in either section indicated any dissatisfaction with the feedback they received, and if students chose to add additional answers above and beyond a simple ‘yes’ the comments were positive. This would indicate that the student expectation regarding the level of feedback was met regardless of the delivery method.
Students in the Tegrity feedback section of the course were asked additional questions about their experience with feedback. First, students were asked if they liked receiving feedback via Tegrity better than standard written feedback. Eleven of the 16 respondents wrote that they preferred the feedback via Tegrity over written feedback. Three respondents wrote that they preferred to receive feedback in written form. One respondent expressed a neutral opinion – writing that both forms of feedback were acceptable. The final respondent did not answer this particular question in the survey.

The students were also asked to explain their preference for either the Tegrity or standard written feedback. The three students who noted a preference for standard written feedback noted that they preferred to have an actual paper to refer to as opposed to viewing the Tegrity video. One student who expressed a preference for the Tegrity feedback also noted that getting a hard copy of the paper in addition to the Tegrity video would be helpful. One of the respondents chose not to answer this particular question at all. The remaining respondents, who wrote that they preferred the Tegrity feedback, gave reasons that can be organized into three characteristics: more detailed feedback, better understood feedback and convenience.

Once the surveys were gathered, each ‘reason’ for the Tegrity preference was noted in a list. Once that list was compiled, it was studied to determine if any of the answers could be grouped together under an overarching description. The 11 students that preferred the Tegrity feedback, in addition to the one student who liked written and Tegrity feedback equally, all explained what they liked about the Tegrity feedback. Those explanations fell into three categories as noted in equal numbers. Four respondents felt the Tegrity feedback was more detailed than standard written feedback. Four respondents noted that they understood the Tegrity feedback better than standard written feedback. Three respondents preferred the Tegrity feedback because of its convenience; for instance, it could be accessed from any computer and reduced hard copy papers that needed to be saved. One respondent noted that the Tegrity feedback was both better understood and more convenient. Overall, then, the majority of the 16 respondents in the Tegrity feedback survey preferred Tegrity feedback to standard written feedback because they felt it was more detailed, easier to understand, and more convenient.
The final question asked of the students in the Tegrity feedback section of the course was designed to find out how the students utilized the feedback. Students were asked how they used the Tegrity feedback and were given four choices to choose from. Students were told to choose as many of the four that applied. The choices were:

a. I listened/watched the video, then revised my paper.
b. I revised my paper while listening/watching the video.
c. I listened/watched the video on each assignment as soon as it was posted to Tegrity
d. I listened/watched the videos at the end of the semester before turning in my portfolio

Responses a and b were meant to discern how students used the feedback while revising assignments for the final portfolio. Responses c and d were designed to determine when the students viewed the feedback – as soon as the Tegrity videos were posted, or at the end of the semester before turning in the final portfolio. All 16 of the respondents in the survey answered this particular question – this was the only question the 16th respondent answered in the whole survey.

In terms of how the students used the feedback while revising, six respondents noted that they revised their work while listening to/watching the video, as opposed to four who noted that they watched and listened to the video and then revised. In terms of when students used the feedback, six of the respondents noted that they listened to/watched the videos as soon as they were posted throughout the semester, while seven noted that they listened to/watched the video at the end of the semester before turning in the final portfolio. One respondent noted that he/she listened to/watched the videos both as soon as they were posted and at the end of the semester, but that individual was the only respondent that did so. This indicates that while a fair number were watching/listening to the feedback throughout the semester, a bigger number waited until the end of the semester to view the feedback. This is concerning in the sense that feedback is designed to help a student become a better writer, and students that wait until the end of the semester to view and therefore implement early feedback miss the opportunity to work that feedback into subsequent assignments.

Overall, this admittedly small sample does lend itself to some observations. First, students that did not receive audio/video feedback via Tegrity apparently did not feel shortchanged, because all of the respondents in the
standard written feedback sections of the course responded that they felt the feedback from the instructor was adequate. However, the respondents in the standard sections did not have the opportunity to choose which kind of feedback they would receive, and if the responses from the Tegrity feedback surveys are any indication, the standard written feedback students might have felt differently had they been offered the choice. The majority of the respondents in the Tegrity feedback section of the course noted that they preferred the Tegrity feedback to written feedback because it was convenient, more detailed, and better understood. The one concern from the data is the indication that a number of students waited until the end of the semester to view the feedback, which is problematic in the sense that as the literature review indicated, regular feedback is necessary to improve writing. If this tool is implemented in the future, that issue will need to be addressed often and regularly with students to ensure they are getting the most from the feedback they receive.

CONCLUSION AND FUTURE RESEARCH

This particular study was a pilot, and the data gathered statistically small. The emphasis was on launching the tool, and collecting preliminary data on its reception by students. Any solid conclusions, therefore, can only be drawn after similar studies are undertaken in the future, and an effort is made to solicit more responses from students. However, the study does suggest that audio/video feedback of student writing is worth studying, and that students at least feel it benefits them for a variety of reasons. If, as noted in the literature review, understanding instructor feedback is an issue, then this form of feedback might be helpful in solving that problem. Interestingly enough, none of the students commented on the tone of the feedback in their surveys; that may also be a future avenue of study – do students perceive audio/video feedback as more positive and encouraging than written feedback? Do they feel more ‘connected’ to the instructor as a result of this type of feedback?

Another potential area of study is whether universal videos could be created for view by all students in a course. The reality is that the audio/video feedback did not save the instructor time in terms of grading papers, which may discourage some from utilizing it. However, creating general ‘sample’ videos for student viewing may be
an alternative. For instance, if an instructor examined a sample document and explained what was ‘good’ about the writing and what needed attention, could that video be posted to the general course site before an assignment was due to aid students in judging their own work? This, along with the individual audio/video feedback may be especially helpful in online courses, where the student never sees the instructor face to face. It would be interesting to discover if this type of feedback would help build community in online courses and strengthen the connection between students at a distance and the instructor.

The study of this particular tool in face to face technical writing tools will continue in the 2013-2014 academic year, with more emphasis on accumulating additional data and a focus on collecting additional information beyond how and when students utilize the feedback.

REFERENCES


Teaching Innovations

Teaching Students How to Innovate

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ABSTRACT

The ability to innovate can be developed. By teaching students about some key innovation management concepts and giving them an opportunity to apply these principles in a structured assignment, educators can help students learn how to innovate on demand. This paper is focused on use of a term project that was created for a master’s-level Emerging Technologies course. The project requires students to conceive of innovations within a product development context and to study the feasibility of their ideas. This paper highlights some theoretical concepts behind generating innovations, describes how the concepts were implemented in the class project, and provides some insights about future developments.

INTRODUCTION

One aspect of developing new products is innovation, which in turn may involve Technology Management. According to Shane (2009), potential product development projects should be identified and their relative merits should be examined by comparing planned outcomes to company strategic objectives, examining the feasibility of projects, and selecting the most promising projects for further development. Innovation and the management of technology, within a framework of product development, are essential components of Shane’s conception of managing technology strategy.

Shane’s (2009) text is used as the basis for a graduate-level Emerging Technologies course, which is focused on the strategic management of technology. A central component of the course is a term project that requires students to conceive of potential product innovations and evaluate these ideas using Technology
Management principles. The project is conducted in three phases. Students identify candidate technologies, propose some possible innovations, and conduct technology assessment activities.

The purpose of this paper is to describe how students learn to innovate as they complete the project. The following sections highlight core principles, provide an overview of the project, and present insights about future improvements to the project.

**CORE PRINCIPLES**

During the early weeks of the Emerging Technologies course, students are introduced to some fundamental concepts about innovation. For example, the working definition of innovation for students to use in the course is that innovation is the use of ideas, tools, materials, and processes to achieve a desired outcome. Students also learn about the difference between incremental and radical innovation; namely that incremental changes are “small improvements to existing technologies (Shane, 2009, p. 21)”, and that radical changes are “a fundamentally new way of solving a problem (Shane, 2009, p. 21).”

It is important to note that the context for this project is radical innovation and the strategic management of technology within a product development framework. Within this context, radical innovations are improvements that fundamentally change a product, based on stakeholder needs. This is not the same thing as imagining something that has never been thought of before.

According to Adner and Levinthal (2000), the source of a radical innovation often lies outside the domain (field of application) in which the innovation occurs. For example, they cited the development of radio technology. Heinrich Hertz invented a device to verify the existence of electromagnetic waves. Later, the technology was adopted for use in wireless telegraphy, then for broadcast radio, emergency services transceivers, and wireless telephony. In each case, radical innovation was preceded by adoption of the technology into a new domain. After each transfer, radio technology followed a new development trajectory and radically changed the domain it was transferred into.
Adner and Levinthal (2000) coined a name for the process of importing a technology into a new domain. Borrowing from evolutionary science, they called it speciation. They advocated that organizations should intentionally induce speciation by consciously searching other domains for technologies that can be considered for incorporation into their own products. This process is the key to innovating on demand, and it is a central theme of the term project.

OVERVIEW OF THE PROJECT

The project is conducted in three phases: Project configuration, concept development, and technology assessment. Students in the master’s program take a product development class based on Ulrich and Eppinger’s (2012) text, so at the start of the Emerging Technologies course they are already familiar with the product development process. Ulrich and Eppinger’s process provides the conceptual framework for the project’s phases.

Phase One: Scenario Development and Project Configuration

Students begin the project by defining a scenario to be used as the context for the innovations they will conceive of. To begin with, they define the product to be improved and describe the company that makes it (either real or hypothetical), the market for the product, and the industry the company operates in. They are encouraged to select products from a variety of industries, even if the products might be considered low-tech and/or mundane. For example, one student selected dog feeding dishes for his scenario. On the other hand, students are counseled away from products that are so complex that the project’s scope would be too large. When necessary, the instructor provides help with narrowing the scope to a sufficient level. Students complete the scenario by identifying key stakeholders and determining their needs, defining product performance specifications and design parameters, and defining project constraints.

In addition to defining explicit stakeholder needs, students are required to discover some latent needs. According to Day (2000, p. 143), a latent need is “evident, but not yet obvious.” Understanding explicit customer
needs can lead to ideas for radical innovations, but discovering latent needs is often a better source of inspiration because it may not be possible to meet previously unarticulated needs by making incremental improvements. The intentional discovery of latent needs is a precursor to seeking ideas in other domains, and it is essential to the process of planned innovation.

Day (2000) suggested that evidence of latent needs can be discovered by becoming immersed in the stakeholder’s world, which requires using ethnographic marketing research methods. Students are required to use a variety of these techniques. They employ methods such as observing people in person, perusing the mass media, conducting internet searches, drawing from their own experiences and the experiences of people they know, etc. As they employ these methods, students look for signals like user frustrations, product failures, the use of products for unintended purposes, social and environmental problems caused by new technologies, societal trends, emerging standards, and changes in legal and regulatory environments.

Once students have defined stakeholder needs, they are required to express those needs in abstracted terms. This means they must state the needs primarily in terms of product benefits and functions, rather than in terms of product features. The purpose of this requirement is to establish a well-defined problem without using prescriptive terms. Onahreim (2012) found that properly constraining a problem can enhance the creativity of those who are trying to solve it. Yet stating requirements in prescriptive terms can preclude the conception of some possible solutions. Ficalora and Cohen (2010) suggested that stating stakeholder needs in abstract terms can help to properly constrain a problem without using prescriptive terms.

The engineering algorithm called TRIZ supports the notion that defining a problem in abstract terms can lead to the formulation of innovative solutions. According to Altshuller (trans. 2007), Users of the TRIZ method define a problem, abstract the problem to its root elements, and select from among a catalog of tried and proven, abstracted methods for solving the problem at hand. The catalog of solution methods was developed by analyzing the solutions to thousands of engineering problems. In the case of this term project, students seek out solution
ideas by looking in other product domains, rather than by selecting them from a catalog of methods. In both cases, the process of abstracting a problem’s root elements is the key to matching problems with solutions.

The final step in this phase of the project requires students to define product performance specifications, product design parameters, and project constraints. They are given some latitude in conceiving these parameters, as long as the parameters they define correspond logically with their scenarios. For example, they are encouraged to consider whether their parameters would be feasible given factors such as the historical uses of the product, its expected price range, the capabilities of the organization and its ability to develop new capabilities, the maturity level of the technologies involved, the maturity of the market, the sophistication of users, etc.

Phase Two: Concept Generation

Phase two of the project requires students to generate innovative product design concepts. They conduct searches for technologies that can be imported into the domain of their chosen manufacturer and incorporated with the product as potential innovations. This phase of the project requires students to identify candidate technologies, describe each technology and its provenance, generate ideas for potential innovations, and create system-level design concepts.

To start the second phase, students conduct a search for technologies that could potentially be used to enhance their product by meeting stakeholder needs, searching outside of the domains in which their product is used. The technologies they find might be cutting-edge, but they could also find technologies that are well-established in some other domain. A candidate technology might be complex, but a simple technology could also be useful. Within these realms of possibilities, many technologies could potentially lead to radical innovations. For purposes of the project, the search process is called scanning the periphery, a term borrowed from Day and Schoemaker (2000).

The approach to peripheral scanning involves sensing signals among a lot of noise that exists in the market. The key to differentiating between signals and noise lies with knowing what you are looking for. Day and
Schoemaker (2000) suggested that signals can be amplified by defining stakeholder needs in terms of benefits and functions, prior to conducting a search.

According to Doering and Parayre (2000) and Day and Schoemaker (2000), both the signals and the noise can be in the form of market trends, fledgling technologies, the emergence of new firms and new corporate alliances, patent filings, internal developments from other divisions of the firm, parallel discovery in separate domains, etc. Students are required to use multiple methods, such as searching technical and trade literature, conducting patent searches, scanning the web, perusing mass media resources, visiting retailers or other locations where products of interest are being sold or used, and interviewing knowledgeable people.

Once students have discovered between three and five candidate technologies they are required to provide an overview of each and include this in their written report. The overview must describe the technology, what domain(s) it exists in, how it is currently being used, what its current level of development is, and how it might be beneficial for the product they are improving. They must also create correlation matrices and rate the strength of the relationships between each candidate technology and each stakeholder need they identified.

Finally, students are required to generate product concepts that incorporate the new technologies. They must describe how the technologies can be integrated into the product and provide the desired benefits and functions. They must also provide details about how this would integrate with the product at the system-level of design.

Phase Three: Conducting Technology Assessment

The third phase is focused on technology assessment. Even though the primary purpose of this paper is to highlight how the project helps students learn to innovate, the broader context for the Emerging Technologies courses is about strategic Technology Management. This section of the paper is intended to provide an overview of the Technology Management activities that students perform for the term project. After students create their design
concepts, they are required to conduct a market analysis, analyze factors affecting strategic choices, and use a decision matrix to determine commitment strategies.

**Conducting a Market Analysis**

Students begin their market analysis by mapping the value chain and identifying their organization’s intended position in that chain. After mapping the value chain, they examine each technology's maturity level using S-curve theory and using the Abernathy-Utterback (2004) model, to discern where the opportunity for profitable development is likely to occur. This model suggests that during the early stages of a new technology’s life, the opportunities for profitable advancement are primarily in the area of product innovations. Late in the lifecycle of a technology, the opportunities for profitable advancements are primarily in improving related processing technologies. During the transition period between the early and late stages, there are opportunities for both types of advancements. Ultimately, each student’s decision about placement in the value chain must be informed by these analyses, as well as by considerations such as the firm’s core competencies, its access to key resources, which economies of scale the company can exploit, whether the product is likely to yield opportunities for increasing returns, and whether there are opportunities for networked effects with accessories and with compatible products. Students summarize all of these considerations by mapping them using a strengths, weaknesses, threats, and opportunities (SWOT) analysis, and justify their decisions accordingly.

Once they have determined where the company should position itself in the value chain, students analyze the competition using a tool based on Porter’s five forces model (as cited in Shane, 2009, pp. 251-252). This model is used for categorizing competitive forces according to buyer power, supplier power, the threat of new entrants, the threat of substitutes, and the degree of rivalry among competitors. Information is presented using a diagram with rivalry represented in the center, and the remaining competitive forces pushing in from the margins.

Students also perform a risk analysis for each technology. Using their best judgment, they consider all of the information they know about the product, the market, and the candidate technologies to create a risk profile.
This is accomplished via the method presented by Doering and Parayre (2000); each technology’s risk level is rated in three categories (market risk, technological risk, and organizational risk) using a low/medium/high scale.

**Analyzing Strategic Considerations**

Students are required to analyze a variety of factors and determine how their planned innovations fit the company’s strategy. These are summarized in Table 1.

<table>
<thead>
<tr>
<th>Issue</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core competencies</td>
<td>Do the product and the technologies match the company’s core competencies? Will it be necessary to form alliances and partnerships?</td>
</tr>
<tr>
<td>Technical feasibility</td>
<td>In addition to feasibility issues considered elsewhere, students must use the technology envelope method proposed by MacMillan and McGrath (2000) to determine which market segments can be served by incorporating the new technologies at their current levels of development vs. which segments can be served by advancing the levels of these technologies by various degrees and in various combinations.</td>
</tr>
<tr>
<td>Resources</td>
<td>Does the company have needed facilities, equipment, and human resources?</td>
</tr>
<tr>
<td>Early market entry</td>
<td>Will the timing of market entry allow opportunities for capturing a large portion of the market? Is it possible to establish a dominant product design, or to set and control de facto standards? Will early entry allow the company to lock-up critical resources?</td>
</tr>
<tr>
<td>Intellectual property</td>
<td>How can the company appropriate the gains from intellectual property? Consider patent and trademark protection, licensing opportunities, trade secrets, enhanced reputation, proprietary-system compatibility, etc.</td>
</tr>
</tbody>
</table>

**Making Commitment Decisions**

The project’s technology assessment activities culminate with students committing to a technology strategy for each proposed innovation. They are required to choose from among four strategies described by Doering and Parayre (2000). Watch and wait refers to a noncommittal strategy. Position and learn refers to a strategy in which
the company decides to conduct some exploratory research, so that it will still be in a position to enter the market at a later date, if conditions are right. Sense and follow refers to a strategy in which the technology has already emerged, justifying development and integration with products. Believe and lead refers to a strategy in which the technology is promising and the company will enter the market early as a lead innovator.

At this point in the project, students have gathered and analyzed a lot of information and have considered many variables related to the adoption of several technologies. To make their strategic selections, they must devise and use a weighted decision matrix. At a minimum, the decision matrix must account for the results of the correlation matrices matching technologies with stakeholder needs, the contents of the risk profiles, and the results of SWOT analyses.

To conclude their project work, students describe how the product’s development will continue, based on the technologies that they determined are worth immediate development. This includes the technologies for which students selected either the sense and follow strategy or the believe and lead strategy.

EXAMPLES OF STUDENT WORK

The term project has been conducted twice in the Emerging Technologies course. The project was recently created and has only gone through two iterations, so its structure and its requirements are likely to significantly evolve over the short term, with fine tuning occurring continually as time provides more insights. Table 2 provides a sampling of the results from two completed projects.
Table 2.
Examples of student work

**Project 1: Modular PV Solar Panel Systems, 10MW or Greater (1st year project)**

**Stakeholder Needs:** Simplify installation, reduce installation time, make the system easily scalable, simplify maintenance

**Technologies:** Mechanical quick-connects, integrated track wiring with quick-connects, standardized wire routing systems, integrated test points, self-healing membranes

**Innovations:** A PV panel system that can be easily scaled-up due to construction methods that are analogous to plug-and-play technology, with self-healing materials and with built-in check points for electrical troubleshooting to facilitate upkeep and maintenance during its lifetime.

**Project 2: Two-Piece Optical Discs for Data Archiving (2nd year project)**

**Stakeholder Needs:** Inexpensive system for backing up large amounts of data; ability to partition the media; heat resistance; robust and durable; bio-degradable

**Technologies:** Interlocking inner- and outer-sections, with partition data on inner section and interchangeable outer sections for data archiving; Bluray-RW; corn-based polymers; self-cooling polymers, scratch-resistant coatings

**Innovations:** A data backup system with inexpensive components, the ability to scale up capacity via inexpensive add-on modules (simply re-write the partition data and add more outer rings), a reasonable degree of robustness, environmentally-friendly media materials

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The student work summarized in Table 2 was chosen because it represents good work and because it illustrates an important distinction between the first-year and second-year results. During the first year, students were given a higher degree of latitude in choosing products for their scenarios, they had more freedom to choose from among available theories and methods, and the report formats were less prescriptive. They tended to choose more complex products, with technologies that they could not entirely grasp due to limitations in expertise and the time available to gain deeper understanding. There was also considerable variability in the quality of results, due in part to a lack of specificity in exactly which theories and methods must be applied, and in what quantities the results must be produced.
During the second year, project requirements were tightened up. The instructor provided guidelines and helped students select less complex products. Requirements were more prescriptive regarding which theories to reference and which methods to use. Ranges were given for the numbers of needs to identify, the number of technologies to evaluate, and the number of potential innovations to generate. Finally, MS Word tables and Excel matrices were provided that could be used as guidelines or as templates, embedded in a sample report created by the instructor.

As might be expected, the second-year results were more focused and the quality of student work was better, but there were tradeoffs. During the first year, there was a distinct difference in quality of project work as differentiated by historical achievement levels within the master’s program. During the second year there was less variability between individual students in the quality of their work, and there was better idea generation in general. However in the second year, some of the work mimicked the instructor’s own style more closely than desired. It is possible that the higher-achieving students could have been stifled to some extent.

In the future the instructor will take some steps that should help produce results with sufficient quality and consistency, while encouraging more independent thought. Additional theories and methods will be included a-la-carte style, with students being required to select a few from among multiple options. Also, the instructor’s sample reports will be supplemented using additional material, borrowed with permission from former students, which illustrates alternative means for satisfying requirements. Finally, grade incentives will be provided, encouraging students to produce less derivative work. Interested readers are welcome to contact the author in the future, to inquire as to whether results have improved.

REFERENCES


