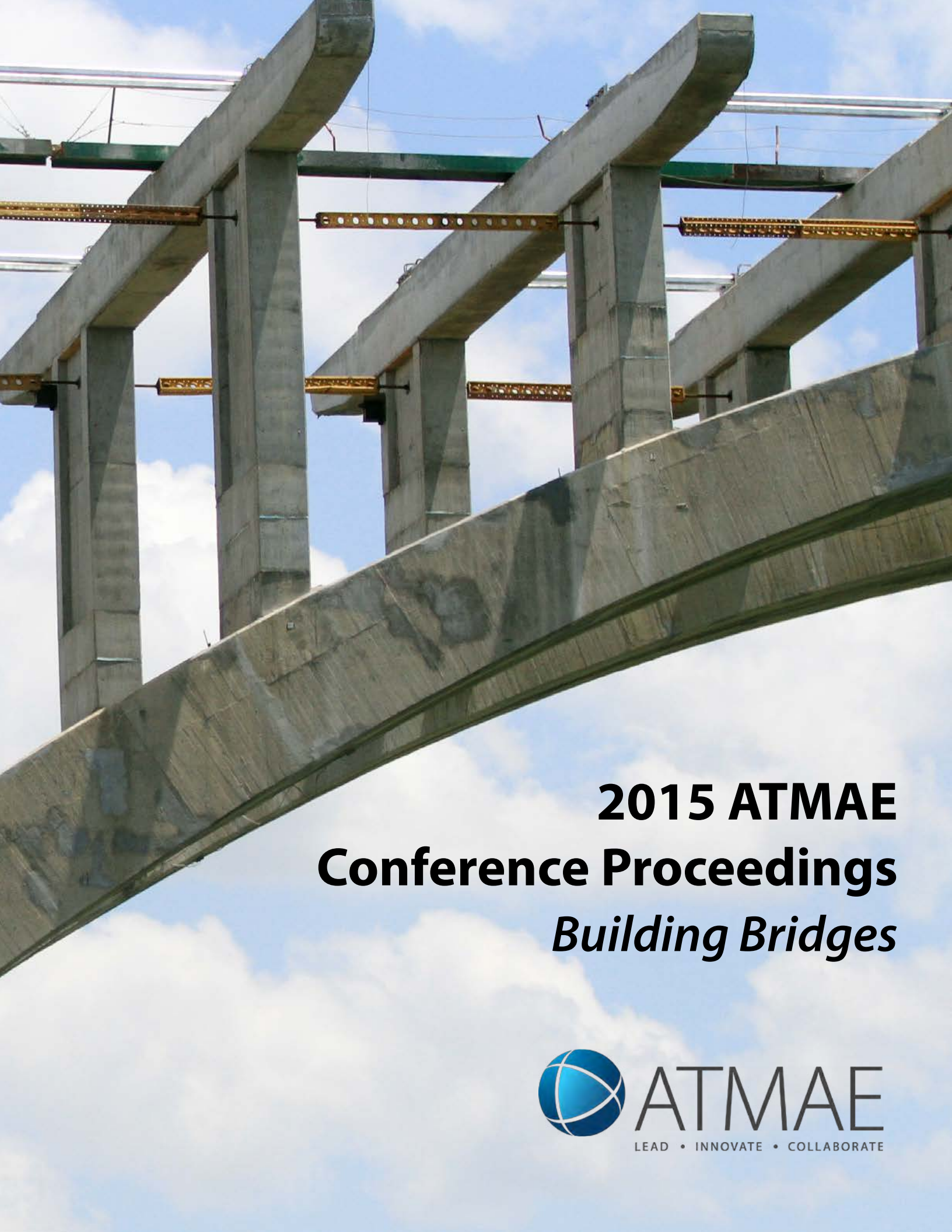


2015 ATMAE Conference Proceedings

Building Bridges

ATMAE

LEAD • INNOVATE • COLLABORATE

Review Process and Acknowledgments

The ATMAE 2015 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 2015 Annual ATMAE Conference in Pittsburgh, Pennsylvania November 11-14, 2015. 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 by a panel of ATMAE members with expertise in the topical area in a double-blind process. 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.

Many ATMAE members and leaders dedicated their time and expertise to review of all the Conference Presentation Proposal Abstracts, Conference Proceedings Papers, Student Research Competition Abstracts and Best Papers for the ATMAE 2015 conference. Without their time and efforts, ATMAE could not provide a thorough double-blind peer-referee process. Our thanks go to all of those dedicated ATMAE members:

Conference Presentation Abstracts (by track):

- ***Administration:*** Erik DeVito, Dominick Fazarro, Michelle Surerus, John Wyatt
- ***Construction:*** Richard Boser, Denise Gravitt, James Jones, Perry Moler, Andrea Ofori-Boadu, Clair Roudebush
- ***Distance & Online Learning:*** Hope Carroll, Don Gladney, Vahidhossein Khiabani, Neil Littell, Richard Miller, Gretchen Mosher, Simon Sultana, Linda Wanless
- ***Electrical, Electronics, Computer Technology & Energy Issues:*** Wutthigrai Boonsuk, Derrek Dunn, David Hua, Ognjen Kuljaca, James Maxwell, David Yearwood
- ***Graphics:*** Isaac Chang, Doug Koch, Neil Littell, James Maxwell, Argie Nichols, Charles Weiss
- ***Management:*** Shweta Chopra, Don Gladney, David Hua, Vahidhossein Khiabani, Ekaterina Koromyslova, Brian Lancon, Patricia Polastri, Erik DeVito
- ***Manufacturing:*** Wutthigrai Boonsuk, Stephen Dunn, Vahidhossein Khiabani, John Irwin, Ekaterina Koromyslova, James Maxwell, Nilmani Pramanik, Patricia Polastri, Chuck Steltenpoh, John Wyatt, Kuruppalil Zaki
- ***Micro / Nanotechnology:*** Dennis Field, Matt Pleil, Walt Trybula
- ***Safety:*** Steve Freeman, James Jones, Paul Kinsey, Charles Schwab
- ***Teaching Innovations:*** Dominick Fazarro, Janet Fick, Michelle Surerus, Mike Ulmer

Best Conference Proceedings Paper Review Process:
Carolyn Dunn, Dennis Field, Rod Flanigan, John Wright

Best ATMAE Conference Proceedings Paper Award:
"Design Refinement by Iterative Virtual Experimentation (DRIVE): A Methodology for Solving Engineering Problems"
Mr. Charles M. "Matt" Watson, Link-Belt Construction Equipment and
Dr. Nilesh Joshi, Morehead State University

COPYRIGHT 2015 ATMAE: The ATMAE 2015 Conference Presentation Abstracts and Proceedings Papers are copyrighted by the Association of Technology, Management, and Applied Engineering. The submission, review and publication process for the 2015 Conference Presentation Abstracts and Proceedings Papers was organized, coordinated and administered by the ATMAE staff at the offices of Apex Management in Elmhurst, IL. If you have questions about the ATMAE 2015 Conference Proceedings, the Annual ATMAE Conference or any of ATMAE's programs, please contact the ATMAE office.

Presentation Abstracts - Table of Contents

Presentation Papers - Table of Contents (page 209)

Construction

A Formal Analysis of Public Projects in the Construction Industry 19

A Framework for the Implementation of Service-Learning Projects for Construction Management Courses 35

An Exploratory Study of the Characteristics Quality of Residential Contractors Green Building in the United States 32

Building Information Modeling and Construction Education 37

Challenges of Obtaining Surety Bond for Construction Contracts 25

Changes in Construction Trends Due to Chaos: Economical, Social, Technological, and Legal Analysis 21

Community Service Based Energy Efficiency Construction Course Development 31

Competitive Bidding: The Good, The Bad, and The Ugly!! 30

Construction Management Projects: Relational Database Design and Development 28

Cost and Life Cycle Analysis using LEED Certification for MSU Building 23

Impact of Lease Lease-Back (LLB) Method in Construction Today 24

Implementing Solar: Conducting Student/Faculty Research on Renewable Energies for a "Greener" Campus 18

Managing Subcontractor-Related Challenges on LEED projects: the U.S. Green Contractors' Perception 33

Modularization in the Construction Industry: Practices and Challenges 17

Nanotechnology Applications for Thermal Insulation in Construction Projects 27

On the Health and Productivity Benefits of High-Performance Green Buildings 20

Parametric Analysis for Building Sustainability Rating Systems using LCA 22

Preparing AET Construction Technology Students for the 21st Century Construction Industry Through Studying Dubai's Booming Construction Technology 29

Race to Zero: Exciting Students about Energy Efficiency and Net-Zero Homes 16

Residential Construction: Fall Protection Analyzed 36

Strengthening Academia and Industry Connections Boosts Construction Materials and Equipment 26

The Use of Radio Frequency Identification (RFID) Technology in Construction Industry 34

Using Live Project Cameras to Teach Construction Materials and Methods 15

Distance Learning

A Virtual Learning Community: Supporting Advanced Technical Education 49

Addressing Lost Instructional Days through Online Learning 45

All Online Learners Are Not the Same: Effective Principles and Concepts for Teaching Adults Online 48

Analysis of Asynchronous Supplemental Course Modules in Statistical Process Control 47

Augmented Reality Technologies in Supporting and Enhancing the Effectiveness of Distance Education 51

Building Bridges and Blurring the Lines between Distance and Face to Face Learning 44

Designing a Structured and Organized Internet Class - Leading Students to Organization and Consistency On-line 38

FERPA Implications on Online Student Collaborative Learning 46

Improving Student Outcomes in Online Courses 41

Incorporating Multimedia into Online Courses 39

Known Unknowns and Unknown Unknowns: Developing a Strategic eCampus Infrastructure to Support Institutional Priorities 52

Making Online Classes More Personal 43

Marketing Online Programs 42

Perspectives and Expectations of Students in Online Courses 40

The Hybrid Program: The Key to Unlocking the "Glass Ceiling" 50

Electricity, Electronics, Computer Technology & Energy Issues

A Study of Effect of Surface Condition on Energy Production of Photovoltaic Solar Arrays 66

A Temperature Alarming System based on HCS12 Microcontroller 76

Affordable Laboratory Exercises in Wind Energy 74

Application of Online Gas Analyzer to Monitor Quality and Quantity of Syngas Production for Renewable Energy 53

Application of Piezoelectric Transducers in Vibration Suppression in Flexible or Micro-Electromechanical Systems (MEMS) 75

Arduino Board and Arduino Integrated Development Environment 62

Bilayer Graphene Field-Effect Transistors - Analytical Modeling and Applications 58

Bridges to the Cloud: Technologies for Integrating Security in the Development of Online Systems 65

Design and Development of a Data Acquisition System to Test Heat Transfer through Building Envelopes ... 55

Designing and Implementing LabVIEW & Arduino Control in a Solar Tracking System 69

Developing a BYOD Deployment Strategy in an Enterprise Environment 67

Internet Access Cost and Bandwidth in Rural and Urban Settings 64

Key Factors Towards Customer Satisfaction in PV Solar Manufacturing and Related Market 56

Life Cycle Assessment (LCA) for Renewable Energy Centre at Eastern Illinois University: Energy Production and Environmental Impacts 54

Natural User Interface Using Kinect Sensing Technology for Motion-Controlled Deployment 57

Optimization and Simulation of Vacuum Cannon System 73

Practical Loop Tuning – How to Tune a PID Loop! 61

Proportional-Integral-Derivative Controller Implementation Using Field Programmable Analog Arrays for Liquid Level Control System 70

Pulse Width Modulation and its Applications 71

Study of Biomass Gasification as a Renewable Energy Technology Using Feedstock of Arundo Donax and Switchgrass 59

Teaching Challenges in Embedded Systems Design 60

Technology and Developing Platform for Humanoid Robots 63

Third Party User Authentication and Authorizations with OAuth 2.0 68

Graphics

3D Mockups - The Responsible Way of Designing Flexible Packaging 83

Application of ANOVA in Colorimetry Computation to determine the Device Reliability (Spectrophotometry) 77

Bridging the Gap between Businesses and Customers through the Web Technology 80

Cars and People of Cuba; Challenges of Teaching Photography during a Study Abroad within a Communist Country 89

Color Printer Resolution Adjustment for Different Screening Technologies in Multicolor Digital Printing 78

Design Refinement by Iterative Virtual Experimentation (DRIVE): A Methodology for Solving Engineering Problems 88

Does Digital Printing Impact Traditional Binding/Finishing Operations? 82

Fostering a Problem Solving Approach in Graphic Communications Curriculum 92

Green Design: Lighting for 3D Scanning, Converting 3D Scan Data into Solid Models and 3D Printing with an Emphasis on Green Design 81

How could Knowledge of Forest Stewardship Council (FSC) Certification and Rainforest Alliance Certification Enhance Student Learning and the Marketability of Graphic Communication Students upon Graduation? 93

Is it Possible or Practical for a Graphic Communication or Printing Program to Earn Forest Stewardship Council (FSC) Certification or Become Rainforest Alliance Certified? 94

Optimizing Part Design for Consumers using Open Source AM Technology 86

Portable Virtual World: Using Unity 3D to Package Virtual Models and Spaces 84

Service Learning: Designing a Mobility Device for Child with Disability 85

The Interaction of Students Online to Collaborate the Development, Design, and Completion of CAED Group Based Projects 87

Which Comes First: Print or Digital? The Role of Print in a Cross-Media World 90

Management

A Comparison of Organization Development Theories 96

A Dynamic Simulation-Based Hybrid Model for Optimization of Billet Manufacturing Plant Layout 99

A Model to Harmonize China-US Standards for Improved Trade 106

Adoption of Food Safety Modernization Act: A Six Sigma Approach to Risk Based Preventive Controls for Small Food Facilities 98

An Overview of Working Capital Management and Its Impact on Profitability of U.S. Manufacturing Industry 341

Assessing Quality Climate and Understanding the Organizational Quality-Tendency 100

Effective Leadership of Contingent Technical Workers 97

Enhancing Quality and Management Decisions with Stochastic Risk Methods 104

Hospital Process Management - A Case Study 110

Improving Universities and Colleges through the Adoption of the Malcolm Baldrige National Quality Award Criteria for Higher Education 95

Lean Six Sigma Big Data: A Higher Education Institution Study 108

Mapping Service Quality Problems to Their causes Using a Taxonomic Framework of Causal Candidates: A Diagnostic Tool for Facilitating Root Cause Analysis 107

National Cultures Impact on Quality Management: Building Bridges Towards Globalization 102

Predicting Suppliers' Behavior on Changing of Quality Requirements in Supply Chain 105

Supply Chain Technologies in Northern Minnesota 103

Sustainability Metrics Maturity 101

To the Last Drop: Project Based Learning for Quality Assurance 109

Use of Kanban at an International Airport 111

Manufacturing

A New Way of Looking At Shear Angle from the Standpoint of Tool/Chip Engagement Time 121

Aligning the ATMAE Accredited Manufacturing Engineering Technology Curriculum Content with the Society of Manufacturing Engineering (SME) Four Pillars of Manufacturing Knowledge 131

Comparing Particle Swarm Optimization and Simulated Annealing for optimization of machining parameters in wet machining of AISI 1040 Steel 123

Current Nano Scale Manufacturing Processes and their Capabilities 117

Discrete-Event Modeling and Simulation for Continuous Improvement in Manufacturing Systems 118

Evaluation of Stereoscopic Vision for Manufacturing Applications 130

Eventorbot: An Open Source 3D Printer Manufacturing and Improving 126

Implementing 3D Modeling in Packaging Industry 129

Improve Global Competitiveness: A Software Development for Fast and Accurate Cost Estimation of Machined Parts 125

Investigating the Surface Quality and its Effect on Biocompatibility during Micro-Electro-Discharge Machining of Titanium Alloys 116

Manufacturing and Non-Manufacturing Students' Perceptions on the Applicability of the Four Pillars 114

Micro-milling Machinability of Aluminum, Copper and Brass 113

Model for Conducting Process Improvement Projects Using Concepts of Lean Six-sigma at the Green Belt and Black Belt Levels 115

Opportunities in Manufacturing of Renewable Energy Components in Central Kentucky 127

Optimization of Machining Parameters Using Simulated Annealing in Sustainable Wet Machining 122

Redirect Focus of Industry and Academic Relationships 132

Safe Production in Industry 4.0 112

Simulated Manufacturing Company Class Case Study—The Good, the Bad, and the Useful 128

Teaching Innovation: Imagination, Conceptualization and Innovating, Utilizing 3D Printing Technology in a University Setting 120

The Effects of Performance and Longevity of AISI 4141 Steel in the Firearms Industry 124

Workers' Perception of Night-Shift Schedule 133

Zero Positional Tolerance at Maximum Material Condition: A Workforce Development Priority 119

Micro/Nanotechnology

Classroom Ready Micro–Nanotechnology Multidisciplinary Resources 135

Design and Manufacturing on a Head of a Pin-Enhancing Engineering Education with a Project-Based Microsystems Design Course and Competition 137

International Skill Standards for Micro-Nano Workforce Education 134

Leveraging Your Equipment and Facilities for Program Development Utilizing Remote Access and Control .. 136

Safety

A Mixed-Methods Investigation of Safety Leadership 141

Development of the Nano/Advanced Materials Safety Certification 138

Employing Hazard Recognition and Control: Effective Techniques to Reduce Accident and Injuries 144

Evaluating Employees' Perceptions of Trust and Safety Climate in the University Research Laboratory Environment over Two-Levels of Management 139

Identifying and Evaluating Leading Indicators to Measure Safety and Manage Industrial Risks 140

Monitoring UV Exposure in Synthetic Life-Safety Equipment..... 142

Probabilistic Design Analysis (PDA): Prospects and Pitfalls 143

School Administration

A Comparative Analysis of Faculty Salaries between Management, Engineering and ATMAE Related Disciplines: The Need for Establishing a Benchmark and Enhancing Visibility in a Market Driven Economy .. 159

A Credible Model for Strategic and Operational Planning in a University Department of Technology 160

A National Study on the Current and Evolving Characteristics of Today's Applied Engineering College-Level Educator 146

A Systematic Methodology to Improving Literature Review Results 168

Academic Rigor in Higher Education Institutions: Pros and Cons to Faculty, Students, and Administrators ... 154

Accommodating Accessibility Issues for Faculty 153

Adjunct Faculty: Bridges to Success 149

Analysis of Critical Thinking Skills of Upper Division Technology Students 171

Applying a Business-Level Strategy Perspective to Technology Department Administration 162

ATMAE Alumni: A Trends Analysis and Demographics of 2009 ATMAE Accredited Programs Alumni 163

ATMAE Certification and Training: What Does Training Bring to the Table? 157

ATMAE Faculty Demographics and Salaries: Trends and Characteristics of the ATMAE Faculty in 2015 156

Closing the Gap—Building the Bridge for Female Success in STEM Programs 164

Current Enrollment Trend Data for 4-Year Technology Programs in ATMAE Accredited Universities 166

Degree Completion Programs: Enhancing Community Colleges, Universities, and Economic Development 151

Developing a One Year Organizational Leadership Capstone Experience 152

Developing Sustainable Minds in 21st Century Students 155

Enhancing Student Learning Using a Problem Based Learning (PBL) Approach in Engineering and Technology 158

Hosting a Regional Technology Fair: Opportunities for STEM, Student Recruitment, & University Service 165

Increasing Student Awareness, Enrollment, and Retention at Underrepresented Minority Institutions in Nuclear Related Subject Areas or Programs: A Case Study at Alcorn State University 147

Increasing Student Engagement Through Seminar Series and Plant Tours 169

Mentoring New Faculty Members in Technology Programs 150

Partnering with Industry: Discussion of the Partnership Leading to, and the Applied Research Of An Analysis of Reaction Times in NHRA E.T. Bracket Racing Classes 173

Plagiarism: Graduate Student Awareness, Perceptions, and Cultural Attitudes 167

Projects as Learning Bridges: Interlinking Projects for Building Connections Across the Technology Curriculum 170

The ATMAE Lean Six Sigma Exam: First Year Status Report 161

Utilizing Rubrics, Certification Exams, and Surveys Keep Program Assessment Plans Simple and Effective ... 148

What is "Technology, Management, and Applied Engineering"? 145

What Midlife Crisis? Encouraging and Retaining the Nontraditional Student 172

Teaching Innovations (TI)

An Undergraduate Energy Systems Track for Engineering Technology 191

Bridging Engineering Technology with General Education: Faculty Lessons Learned from the Survey of Motorsports 184

Building International Bridges with Courses Abroad to Europe and Asia 186

Conceptual Art as an Agent in Furthering Technological Progress 203

Creating and Sustaining High-Quality Senior Capstone Experiences 182

Developing and Sustaining High Quality Academic Advising with Technology Undergraduates 179

Development of a Master's Project Option Focused on the Entrepreneurial Development of Technical Innovations 189

Development, Implementation and Reflection of Sustainable Manufacturing Modules for Manufacturing Program at UNI 175

Does Work Experience Influence the Decision Making Ability of College Students? 206

Effect of Industry Engagement on Students Learning in the Undergraduate Program 208

Engineering Problem Solving, Engaging the Imagination, Paper Airplanes, College Students, and 5th Graders 178

Fluid Power Laboratory Modes versus Resource Utilization Effectiveness 197

From Student to Practicing Engineer: Preparing Future Engineers for Industry Via a Capstone Course Project 207

Green Campus Experience: Developing a USGBC LEED® Lab™ Course 190

Identification and Validation of Competencies Expected of the Graduate Programs in Renewable Energy ... 174

Impact of Instructional Strategies in the Classroom ... 204

Impact of Learning Style on Success in Team Problem Solving ... 195

Impact of Thinking Style on Team Decision Making ... 199

Implementation of Rapid Prototyping Technologies in Multidisciplinary Coursework and Research Applications ... 177

Impression Management through Interdisciplinary Collaboration ... 187

Mobile Technologies for Engineering Technology Education – Impact and Case Study ... 176

Motivation and Learning Strategies of Students in Turkey ... 201

My Dear Watson: Imparting Clinical Reasoning Skills to the First-year Medical Students ... 193

Perceptions of Technical Communication among Students, Faculty Members and Industry Personnel ... 200

Providing Real World Experiences for Students Through a Long-Term Collaboration with Habitat for Humanity ... 202

Student Engagement in Data Networking Labs ... 194

Student Mentoring Through Group Leadership ... 192

Student Training and Professional Development: How Community Emergency Response Teams (C-CERT) in Technology Programs Develop New Emergency Management Practitioners ... 188

Teaching Communication in a Technical Field: Focusing on the Soft Skills ... 180

Teaching Engine Diagnostics and Monitoring via Customized Microcontroller Board ... 205

Team Learning in Technology: Replicating Industry's Problem-Solving Approach ... 196

The Electric Guitar: Design, Production and Testing ... 185

The Need for Incorporating Geometrical Dimensioning and Tolerance in Engineering Technology Undergraduate Curriculum ... 183

To Be More Than a Student: Case Study of Undergraduate Research on Addressing Food Security ... 181

Presentation Abstracts - Author Index

Dr. Eli K. Aba 111, 204
Mr. Scott Abney 101, 127
Dr. David K. Addae 71
Mr. Sailesh Adhikari 54
Dr. Sanjeev Adhikari 23, 24, 25
Dr. John Adjaye 71
Dr. Steve K. Adzanu 71, 147
Dr. Junyong Ahn 31
Dr. Nicholas O. Akinkuoye 158
Dr. Mahmoud A. Al-Odeh 34, 103
Dr. Gregory K. Arbuckle 113
Dr. Sherif Attalah 19, 21, 22, 27, 150
Mrs. Tange D. Awbrey 110
Mrs. Roya Azimzadeh 48
Dr. M. Affan Badar 111, 204, 205
Dr. Rendong Bai 57, 62, 66
Dr. Bill Bailey 44
Miss Linsay Bartle 201
Dr. David L. Batts 151
Mr. Brent C. Baumer 149
Mr. Jermiah Billa 147
Mr. Gary R. Birk 27, 37, 153, 187
Mrs. Valerie Birk 153, 187
Dr. Wutthigrai Boonsuk 57, 130
Dr. Richard A. Boser 15, 16
Mr. Brandon Bostater 170
Dr. Timothy M. Brockman 34, 178
Mr. Caleb Burns 208
Ms. Marietta Byerline 167
Mrs. Hope Carroll 83
Dr. Paul A. Cesarini 52
Dr. Vigs J. Chandra 65, 170
Dr. Yi-hsiang Chang 109, 193
Dr. Hans Chapman 174, 191, 341
Dr. Austin C. Cheney 162
Dr. Robert A. Chin 119, 145
Ms. Rohini Chitlam 199
Dr. Shweta Chopra 98, 106, 169, 181, 208
Mr. Brendan Clary 126
Mr. Joseph Cleary 16
Dr. Jerry Cloward 53, 56, 59, 126
Dr. Phillip Cochrane 197, 205
Dr. Charles Coddington 159
Dr. Keith L. Coogler 55
Mr. Michael Alec Cooper 23
Dr. John Craft 83
Mr. Emmanuel Dada 133
Dr. Ulan Dakeev 177, 201
Ms. Fatemeh Davoudi Kakhki 99, 131
Dr. H. Naik Dharavath 77, 78
Ms. Shimi Didla 147
Dr. Caiwen Ding 73, 76
Dr. Mark Doggett 114, 167
Ms. Shaun L. Dudek 92
Mr. Steve R. Easterling 23, 24, 25
Mr. Ernest Echefu 53
Mr. Robert K. Ehrmann 134, 135, 136
Mr. Don Ewert 138
Dr. Bankole K. Fasanya 132, 133
Dr. Dominick E. Fazarro 138
Mr. Daniel Feinberg 203
Mrs. Janet Fick 22, 190, 202
Mrs. Casey Fitch-Randolph 188
Ms. Stephany Fonseca 142
Dr. Steven A. Freeman 139
Mr. David Freet 65
Ms. Geethanjali Gaddam 195
Ms. Ria N. Gasaway 181
Dr. Jess Godbey 165
Dr. Mehmet Goksu 74, 177
Dr. Kimberley A. Gordon 172
Mr. Andrew Graham 84, 120
Dr. William R. Grise 58, 75
Mr. Abhay K. Grover 98
Mr. Michael C. Harruff 113
Mr. Matthew E. Harvey 47, 100, 143
Mr. John R. Haughery 47, 168, 174
Dr. Michael A. Hayden 148, 173
Dr. Farzin Heidari 129
Dr. Harvey F. Hoffman 207
Dr. David M. Hua 39, 40, 45, 46, 194
Mr. Charles R. Hunt 144, 160
Dr. Andrew C. Hurt 152, 192
Mr. Almir Ibragimov 51
Dr. John L. Irwin 86
Dr. Muhammad P. Jahan 113, 114, 116, 117
Mr. Arif Ali Jalbani 56, 66
Dr. Feng Jao 28, 166
Dr. James W. Jones149,150, 153, 154. 180, 187, 190, 196
Dr. Nilesh Joshi 76, 88, 99, 174, 191, 341

Mr. Jon L.P. Judge 141
Ms. Pegah Kakavand 116
Mr. Hans P. Kellogg 89
Mr. Kevin Kenyon 190
Dr. Nir Keren 100, 143
Mr. Seyedramin Ramin Khalilinejad 59
Mr. Jeff B. Kilgore 65, 170
Dr. Doug Koch 48, 146
Dr. Sri R. Kolla 70
Dr. Alton L. Kornegay 132, 133
Dr. Ekaterina A. Koromyslova 105
Dr. Zaki Kuruppalil 183
Mr. Joseph W. Lampinen 97
Dr. Dawn Laux 49
Dr. Chad M. Laux 49, 106, 108
Dr. Heshium R. Lawrence 157, 161
Dr. Edward J. Lazaros 39, 40, 41, 42, 43, 45, 46, 82
Dr. Sanghyun Lee 69, 73
Dr. Jack Li 60
Mr. Haizhou Li 126
Dr. Yuetong Lin 205
Dr. Zhisen Lin 20
Mr. Scott Livengood 205
Mr. Bradley C. Logsdon 116
Ms. Jing Lu 106
Mr. Daniel L. Lybrook 152, 192
Mr. Earl D. MacLeod 100
Dr. Tarek Mahfouz 17, 19, 21, 22, 150, 154
Dr. Gary S. Mahoney 185
Mr. Terry Marbut 165
Ms. Pam A. McGee 164
Ms. Belinda McMurry 195, 199, 200
Dr. Devang P. Mehta 80
Dr. Merwan Burjor Mehta 95, 115
Dr. David W. Melton 87, 124
Dr. Brian Mennecke 49
Mr. Lyle Meulebroeck 84, 120
Mr. Michael M. Mezo 19, 21, 30, 37, 196
Dr. Mark R. Miller 138, 157, 161
Dr. Richard F. Miller 18, 28, 166
Dr. Alan Mills 203
Mr. Perry J. Moler 96
Dr. Gretchen A. Mosher 98, 104, 139, 140, 141, 169, 179, 182, 206
Mr. Nedom C. Muns 55
Dr. Jessica L. Murphy 188
Dr. Oliver J. Myers 121
Mr. Brian Nakayama 181
Mr. Paul Nutter 128
Mr. Michael R. O'Donnell 100
Dr. Tim Obermier 64
Dr. Olusegun Odesina 158
Dr. Andrea N. Ofori-Boadu 32, 33, 35
Dr. Troy Eugene Ollison 146
Dr. Darren C. Olson 107, 189
Dr. Randell W. Peters 148, 173, 184, 197
Dr. Peter Ping Liu 53, 56, 57, 59, 62, 66
Ms. Rajasri Pingili 62
Dr. Matthias W. Pleil 135, 137
Dr. Patricia Polastri 155
Dr. Nageswara Rao Posinasetti 122, 123, 175
Dr. Nilmani Pramanik 118, 175
Ms. Lin Qian 102
Mr. Sai K. Ramaswamy 47, 140, 143, 206
Dr. Paul J. Resetarits 125, 186
Dr. Rukmini Srikant Revuru 122, 123
Dr. Ray E. Richardson 170
Mr. Sean T. Roberts 87
Dr. Trevor Robinson 166
Dr. David L. Rouch 85
Dr. Clair J. Roudebush 112
Dr. Sharon M. Rouse 119
Mr. Saxon J. Ryan 104, 206
Mr. Sahith Sanike 200
Mr. Arush Saxena 108
Prof. Dianna Schuster Stair 38
Dr. Charles V. Schwab 104
Dr. Sophia K. Scott 195, 199, 200
Dr. Jeenson Sheen 144, 160
Dr. Musibau A. Shofoluwe 33, 133
Dr. Shinming S. Shyu 20
Ms. Phondie Simelane 193
Mr. Stephen A. Simpson 139, 143
Dr. Isaac S. Slaven 66, 124, 142
Dr. Sara B. Smith 90, 92
Dr. Mark Snyder 78
Dr. Michelle Soupir 169
Dr. Evelyn Sowell 32
Dr. Thomas H. Spotts 43, 82
Dr. John Springer 108
Dr. James J. Stein 36
Mr. Daniel T. Stock 124

Dr. Shawn Strong 34
Mr. Munir Sulaiman 144
Mrs. Teje Sult 165
Dr. Michelle L. Surerus 93, 94
Dr. John Sutton 156
Mr. Donald Thomas 85
Mr. David R. Towley 178
Dr. Walt Trybula 138
Dr. Jeffrey M. Ulmer 146, 156
Dr. Shahram VarzaVand 31
Mr. Jerry Visser 105
Dr. Todd C. Waggoner 81
Dr. Wafeek S. Wahby 26, 29
Mr. Christopher Waldron 85
Dr. Lewis S. Waller 32, 33, 35
Dr. Haoyu Wang 125, 186
Dr. Ni Wang 73, 88
Ms. Jennifer A.Warrner 30, 180, 196, 202
Mr. Charles M. Watson 88
Mr. Craig D. Wilson 37
Mr. Doug Wilson 27, 202
Dr. John R. Wright 61
Dr. John E. Wyatt 50, 121
Dr. Baijian Yang 67, 68
Dr. Faruk Yildiz 55, 74, 177, 201
Dr. Yuqiu You 73, 76, 131, 163, 341
Mrs. Angelia M. Yount 38
Dr. Pao-Chiang Yuan 188
Dr. Ahmad Zargari 131, 156, 159, 163, 174, 191
Dr. JulieZhang 118, 175
Dr. Jin Zhu 63, 176

Thursday, November 12, 2015 - 11:30am - 12:15pm

Construction

Using Live Project Cameras to Teach Construction Materials and Methods

Author: Dr. Richard A. Boser, Illinois State University, Normal, IL

Need: An understanding of construction materials and methods is predicated upon being able to visual what is actually happening on a project site. Textbooks can provide excellent topical background and various media can illustrate step by step methods and the equipment and materials commonly used. However, there is no substitute for real-world observation of a the activities on a building site in order to understand not only the materials and methods, but actual task sequencing, productivity and impact of weather, site logistics, and other variables. Instructors try to inject this real-world element through field trips; however, this is not always practical given class sizes and the absence of readily available access to appropriate projects. Using webcams makes a wide range of virtual construction projects readily available for a host of instructional opportunities.

Overview: This presentation will illustrate how webcams were used in an entry-level, lecture-based construction materials and methods course. The goal was not only to assist students in developing a deeper understanding of construction materials and methods, but to also "flip the class" and increase engagement through active learning. Throughout the course, student teams regularly observed the progress on a specific building by monitoring project webcams and documenting in the format of a superintendent's daily log. Consistent with the daily log requirements, students documented the (a) key materials/systems installed, (b) equipment used in the installation, and (c) construction sequencing and productivity. Students were also asked to note activities that they didn't understand for addition discussion by their team and/or the class at large. Details on the instructional procedures and impact on student learning will be shared.

Major Points:

1. Details on how to bring construction projects into the classroom through the regular use of webcams.
2. The benefit of "flipping the class" activities to increase student engagement with the content and enable topics to arise organically through direct observation of building projects.
3. Naturally expand connections among construction topics by breaking down the typical course silos to help students understand not only the materials and methods, but task sequencing, productivity, and impact of weather, and site logistics.
4. Use of student teams to allow relatively in-depth investigation of the construction activities on multiple project sites.

Summary: This presentation will illustrate how webcams were used in an entry-level, lecture-based construction materials and methods course to increase active learning through regular observation and documentation of real-world building construction projects.

2015 Conference Proceedings

Thursday, November 12, 2015 - 11:30am - 12:15pm

Construction

Race to Zero: Exciting Students about Energy Efficiency and Net-Zero Homes

Authors: Dr. Richard A. Boser, Illinois State University, Normal, IL
Mr. Joseph Cleary, Illinois State University, Normal, IL

Need: There have been significant changes in the materials and methods utilized in residential construction in recent years as a result of federally mandated energy code compliance that resulted from the American Recovery and Reinvestment Act of 2009 and the associated goal of improving energy efficiency in buildings by an additional 15% with every three-year cycle of the International Energy and Conservation Code (IECC). To support this initiative the Department of Energy (DOE) in 2014 instituted a Race to Zero (RtZ) Student Competition to engage and encourage university students and faculty to become "part of a new leadership movement to achieve truly sustainable homes." This presentation will overview how our university responded to the RTZ challenge and designed an award winning home in conjunction with Habitat for Humanity that will be built in 2015.

Overview:

- Overview of DOE Race to Zero (RtZ) competition and requirements.
- Connections to sustainability and green building.
- Selecting and motivating the RtZ team.
- RtZ design results for a production ready net-zero home.
- Benefits of participation in the RtZ competition for students, faculty, and the construction management curriculum.

Major Points:

- Disseminate information about the RTZ competition and the benefits for construction management students, faculty, and curricula.
- Provide an example of how one construction management program participated in the first RTZ competition in 2014 by collaborating with Habitat for Humanity to design and build a home with off the shelf technology.
- Utilizing a competition to engage and excite students' about sustainability and building science.

Summary: The DOE Race to Zero competition is an ideal vehicle for engaging students in the real-world challenges of sustainability in the built environment and the practical design and construction issues involved in building residential structures. The competition requires that the home be site specific. Therefore the active learning experience goes beyond an academic challenge and has implications for the community at large. The presentation will overview the nuts and bolts of the RTZ competition as wells as the benefits for all stakeholders.

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Construction

Modularization in the Construction Industry: Practices and Challenges

Author: Dr. Tarek Mahfouz, Ball State University, Muncie, IN

Need: The contribution of the construction industry to the U.S. Gross Domestic Product (GDP) in 2011 was estimated by the U.S. Bureau of Economic Analysis at 3.4%. This contribution is negatively impacted by the loss of quality, productivity, and/or efficiency in construction projects. After the industrial revolution a number of principles have been introduced to enhance production processes and increase efficiency. What initially started as a principle of "Standardization" has quickly evolved into "Modularization" methodologies. It has been adopted by the construction industry at different levels ranging from onsite preassembly to offsite prefabrication and preassembly of fully integrated multi trade units. The literature and practical experience in this domain illustrate that successful implementation requires key factors including but not limited to genuine coordination, early inception into the project design, availability of fabrication and storage facilities, ... etc. This research endeavor provides a much needed conceptual plan for integrating Modularization practices into construction companies based on lessons learned.

Overview: Over the years, modularization concepts have been implemented at construction projects at different forms and levels. The literature in this domain indicates the superiority of modular construction to conventional method in regards to reducing construction time, improving safety and quality, and balancing resources. However, there are a number of factors that has hindered its full adoption, some of which are project size, time of introducing modular methodology, weather conditions, availability of skilled labor, and remoteness of the site location. The current study aims at defining parameters leading to successful implementation of modularization, providing a conceptual plan for such realization, and lessons learned from previous endeavors.

Major Points: Definition of Modularization; Case studies of construction projects; Factors contributing to the success and failure of modular construction; and Framework of a conceptual plan for the implementation of modular construction.

Summary: Attendees will gain knowledge about different techniques of modular construction; its benefits to contractors, owners, and designers; factors leading to its successful implementation; and expected financial, schedule, safety, and quality benefits. They will be introduced to the current status of its practices and the expected challenges.

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Construction

Implementing Solar: Conducting Student/Faculty Research on Renewable Energies for a "Greener" Campus

Author: Dr. Richard F. Miller, Ohio Northern University, Ada, OH

Need: Renewable energy opportunities continue to gain momentum in the building industry ranging from geothermal heating/cooling and wind/solar energy production. As such, CM programs have seen the need of developing coursework that exposes students to the world of sustainability and renewable energies. In light of this movement, this study was conducted to engage students in a university sponsored research project on the viability of adding solar energy to the campus grid.

Overview: Students have been engaged to participate in practical research applications concerning the benefits, costs, and sustainability of developing a total solar grid or grid stations on the campus. The aim of this research is twofold:

1. Present the university with research results to assist in making decisions toward a "greener campus"
2. Immerse students in a relatively new sector of the building industry. As the need for qualified or knowledgeable people continue to grow in the sustainability sector of the building industry, the research will assist students in garnering the knowledge needed to conduct project studies upon graduation.

Major Points:

- Development of a research databank for costs associated with solar integration into an energy grid.
- Elevate awareness of sustainable concepts in the building industry within the CM program.
- Reporting of results from the study to include forecasted payback and costs.

Summary: Attendees will have the opportunity to see the results of the solar research conducted and the methodology utilized for repeatability at their location. Additionally, curriculum development will be shown as to how the faculty integrated parts of the research into different CM coursework to support instruction on sustainable and renewable concepts.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Construction

A Formal Analysis of Public Projects in the Construction Industry

Authors: Dr. Tarek Mahfouz, Ball State University, Muncie, IN
Dr. Sherif Attalah, Ball State University, Muncie, IN
Mr. Michael Mezo, Ball State University, Muncie, IN

Need: Within the current dynamic and economically challenging construction domain, risks associated with public projects are assumed by governments under traditional construction approaches. However, the success of these projects have tremendous impact on the public. Over the years, governments have realized the need to share risks associated with construction processes and operations, financial management, funds generation and allocation, safety, energy efficiency, etc. This has yielded different approaches for construction projects that integrates and requires collaboration between governments and stakeholders. From Build Operate Transfer (BOT) to Public Private Partnership (PPP) to Public Engagement (PE) multitude of models and examples within the world exist. However, limited research was dedicated to formalize the characteristics that determine the success and collaboration structure between project stakeholders. With the growth of these models, a better understanding of the involvement and role of each party in a well designed and structured modeled is needed.

Overview: Since the Suez Canal project in Egypt, the first BOT project, to some of the most recent PE projects by the Minnesota Department of Transportation (MnDOT), a number of researchers attempted to define formal guidelines for these projects. Although their contributions have paved the way for better project performance, the construction industry and the public are in ever growing need to better understand the associations between the different parameters of these projects as well as the involved parties and their roles. To fill this gap, the current study defines the different approaches of performing public projects, identifies variations among these approaches, and formalizing a model for their performance.

Major Points: Characteristics of public projects; Different models for performing public projects including BOT, PPP, and PE; Analysis of these models in relation to involved parties responsibilities and challenges from a financial, performance, and legal perspectives; and Illustrations of multiple case studies.

Summary: Attendees will gain knowledge about BOT, PPP, and PE through formal analysis and case studies. They will be introduced to the current status of the aforementioned models and the expected challenges. Furthermore, they will be engaged in a lively discussion about the topic.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Construction

On the Health and Productivity Benefits of High-Performance Green Buildings

Authors: Dr. Shinming S. Shyu, Eastern Michigan University, Ypsilanti, MI
Dr. Zhisen Lin, Fuzhou University, Fuzhou, China

Need: While alleviating the environmental impacts by building activities, the construction and operation of high-performance green buildings have been demonstrating effectiveness in reducing energy and water consumptions, which can be measured and translated into actual savings in dollar to reflect the performance-based economic advantage. Nonetheless, recent studies showed the emerging edge of high-performance green buildings lies in the benefits associated with occupants' health and productivity via quality indoor environments. Quoted in ASHRAE's publication HPB in fall 2013, HVAC&R Research noted: "the highest return on the construction dollars is human productivity in the designed space." Hence, to explore and materialize these latent benefits of high-performance green buildings, the design and construction professionals are to comprehend related measures in order to deliver healthful indoor environmental quality (IEQ).

Overview: A survey conducted by EPA found that the average American spends approximately 90 percent of their time indoors. Poor indoor environmental quality related to HVAC system, indoor pollutants, lighting quality, noise level, thermal conditions, humidity, vibration, etc. has been identified as the cause of sick building syndrome (SBS) and building-related illness (BRI). A study by Fisk and Rosenfeld estimated the annual cost of SBS at $10-100 billion, while productivity and performance at $ 20-200 billion (Kibert, 2008). In addition to air change per hour method (ACH), this study will examine and analyze related provisions in International Green Construction Code (IgCC) and ASHRAE 62.1- Ventilation for Acceptable Indoor Air Quality, that contribute to ensure the health and productivity benefits of high-performance green buildings.

Major Points:

- Health and productivity benefits of high-performance green buildings
- Indoor pollutants
- Sick building syndrome (SBS) & building related illness (BRI)
- ACH – Air Change per Hour method
- ASHRAE 62.1 – Ventilation for acceptable Indoor Air Quality
- International Green Construction Code (IgCC)

Summary: IEQ has been considered one of the most critical human-related issues in building operation, as it directly affects occupants' conditions and performance. Built environments constructed with problematic materials, products, or systems may cause SBS, BRI, as well as huge economic loss of employers and the society. Thus, to ensure occupants' health, productivity, and associated synergetic benefits, high-performance green buildings provide workable solutions.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Construction

Changes in Construction Trends due to Chaos: Economical, Social, Technological, and Legal Analysis

Authors: Dr. Tarek Mahfouz, Ball State University, Muncie, IN
Dr. Sherif Attallah, Ball State University, Muncie, IN
Mr. Michael Mezo, Ball State University, Muncie, IN

Need: Construction is considered one of the most lucrative industries in developing countries. Similar to all other industries, construction trends are greatly affected by natural disasters, labor strikes and political events among others. However, recent political tensions in the middle east had more dramatic consequences on construction projects. The resulting chaos has hampered the progress of large construction projects, but also has given the chance for unmonitored smaller ones specially in the residential sector. Such practices took advantage of loop holes in the implemented laws. Although these projects are scattered, they represent a phenomenon that needs analysis. It is an undeniable fact, that they have damaging effects on the infrastructure of these countries. Little if any research exists in the literature about these trends and their long term economic, cultural, technological, and legal ramifications.

Overview: Over the last five years, countries in the Middle East have seen a turmoil of political events. These have resulted in multiple damages to structures and infrastructures. It is expected that the construction industry undergoes a hold at this time of tension. It is also understandable that it gets a boost after circumstances are settled as the rebuild process starts. However, multiple unexpected changes in construction trends have been noticed including unpermitted building, code violations and destruction of agricultural lands. These violations have put excessive unplanned loads on countries' infrastructures, deteriorated living standards and technological developments, caused cultural challenges, initiated legal problems, and introduced further financial and economical constraints. Thus, the current study attempts to analyze and characterize these trends in developing countries as well as to highlight their effects.

Major Points: General characteristics of the construction industry in developing countries; Changes in construction trends due to recent political tension in these countries; Identification of cultural, financial, and legal effects of changes in construction projects due to chaos; and Discussion of case studies.

Summary: Attendees will gain knowledge about unexpected changes in construction projects and their damaging effects on the industry, technology, infrastructure, economy, and culture. They will be introduced to different case studies as well as be engaged in a lively discussion about the topic.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Construction

Parametric Analysis for Building Sustainability Rating Systems using LCA

Authors: Dr. Sherif Attallah, Ball State University, Muncie, IN
Dr. Tarek Mahfouz, Ball State University, Muncie, IN
Mrs. Janet Fick, Ball State University, Muncie, IN

Need: Sustainability rating systems like Leadership in Energy and Environmental Design (LEED) have proven to be an effective ways to reduce the potential negative environmental impacts of construction projects. However, there is a need to optimize the results of implementing different approaches or credits through use of proper quantification methods like Life Cycle Analysis (LCA).

Overview: The construction industry has a significant negative impact on resource consumption and the environment. To reduce this effect, sustainability rating systems like LEED have been introduced to evaluate the performance of buildings from sustainability perspective. This evaluation is carried through a merit/credit system where each credit addresses a specific sustainability concern and is assigned a certain weight. Although LEED version 4 has included some points that adopt the concept of life cycle analysis (LCA), one further way to optimize utilization of LEED credit system is to perform an objective analysis of the credit weights through quantification of the potential positive impact associated with each credit. This study covers a simplified parametric analysis using LCA technique to assess different approaches that can be pursued to achieve the target credits. The parametric analysis helps to identify the optimum approaches that, while achieving the target scores, lead to maximum saving of environmental impact.

Major Points:

- Sustainability rating systems
- Achieving scores in credit systems
- Need for optimization
- Life cycle analysis
- Performing simplified parametric analysis
- Results and conclusion

Summary: Attendees of this presentation will understand how life cycle analysis is a powerful quantification technique that can improve the use of rating systems for construction projects.

2015 Conference Proceedings

Thursday, November 12, 2015 - 4:45pm - 5:30pm

Construction

Cost and Life Cycle Analysis using LEED Certification for MSU Building

Authors: Mr. Michael Alec Cooper, Morehead State University, Morehead, KY
Dr. Sanjeev Adhikari, Morehead State University, Morehead, KY
Mr. Steve R. Easterling, Morehead State University, Morehead, KY

Need: Morehead State University needs LEED Certification to improve its sustainability in ways such as reducing its environmental impact and saving energy, water, and money. Most of the changes would involve lighting and water fixtures which are the main usage/wastage points for energy and water. These changes would make MSU more environmentally and financially stable as well as set a positive example for other universities.

Overview: This work is aligned with the increasingly popular trend of "going green" of an entire university campus. The objectives are to determine the costs and requirements of achieving Leadership in Energy and Environmental Design (LEED) Certification for Morehead State University. Some of MSU's buildings are slated for renovation or remodeling and some are slated for demolition and rebuilding or replacement. To achieve LEED Certification, MSU needs to employ Green Building techniques in any new construction or remodeling efforts. These techniques will be intended to reduce the amounts of energy and water used by MSU. Current use of energy and water will be compared with projected use of energy and water using LEED techniques. Life cycle cost analysis will be determined on proposed MSU Buildings. The benefits of being a LEED certified university will be discussed as well.

Major Points: LEED certification requirements and benefits Affected buildings are O+M and BD+C Current overall cost of energy and water usage Cost of implementation using time for savings to offset cost of implementation.

Summary: By implementing green building practices, MSU can not only become LEED certified by the U.S.G.B.C., but can reap the benefits of these rewards, such as LEED online, customer service, and professional infrastructure. This study concerns MSU buildings being renovated, remodeled, or built new with LEED certified. For those building being renovated or remodeled, the current lighting needs should be brought into consideration so that we may decide on the amount of energy efficient lighting to use to achieve a satisfactory level of illumination. Current types and amounts of water fixtures should be taken into account as well, since these may be replaced with water saving alternatives. For the buildings being demolished and rebuilt or replaced, care should be taken that green building practices are included in the designs of new construction.

2015 Conference Proceedings

Thursday, November 12, 2015 - 4:45pm - 5:30pm

Construction

Impact of Lease Lease-Back (LLB) Method in Construction Today

Authors: Mr. Steve R. Easterling, Morehead State University, Morehead, KY
Dr. Sanjeev Adhikari, Morehead State University, Morehead, KY

Need: The Lease Lease-Back Method, an unconventional method in Construction Management, is on the rise. Newly practiced by some municipalities it needs no formal introduction, for some time now it has been practiced without much regulation, and has yet to become a proven efficient method of construction. Fundamentally, the comprehension of the Lease-Leaseback approach is essential to the understanding of its viability, and in order to use the lesson-learn approach in order to establish best quality standards for its use. Any viable qualified construction management technique should first and fore-most ensure smooth delivery of the product in collaboration with improving owner satisfaction and owner profits.

Overview: Currently in California, this construction delivery method has been used by school districts throughout the State to deliver school facilities on time, on budget, and with a reduced level of public agency risk associated with issues related to the low-bid method of construction delivery.

Major Points:

- Generally, public construction requires competitive bidding to award construction contracts
- In a lease-leaseback agreement, a school district leases its property to a developer for a nominal amount and the developer constructs the construction project and returns the property back to the school district.
- A significant number of lease-leaseback agreements in the past are entered without competitive bidding.
- There is opportunity to offer many benefits and challenges for customers and management.

Summary: Whatever the outcome, quality and safety of construction projects will still be job one for Professional Construction Managers! Lease Lease-Back is still yet to become a proven efficient Quality Construction Management technique for ensuring smooth delivery of products and processes, while improving owner satisfaction and profits. We will be observing this new method in construction management Time will tell if the Lease Lease-Back Method will maintain reliable dimension while becoming an alternative to the traditional methods of solving recurring problems and, ensure high quality and safety standards for future building projects.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Construction

Challenges of Obtaining Surety Bond for Construction Contracts

Authors: Mr. Steve R. Easterling, Morehead State University, Morehead, KY
Dr. Sanjeev Adhikari, Morehead State University, Morehead, KY

Need: A surety bond is a three-party agreement whereby the surety assures the project owner (obligee) that the contractor (principal) will perform a contract in accordance with the contract documents. When a contractor requires its subcontractors to obtain bonds, the contractor is the obligee and the subcontractor is the principal.

Overview: Most surety companies are subsidiaries or divisions of insurance companies, and both surety bonds and traditional insurance policies are risk transfer mechanisms regulated by state insurance departments. However, traditional insurance is designed to compensate the insured against unforeseen adverse events. The policy premium is determined based on aggregate premiums earned versus expected losses. Surety companies operate on a different business model. Surety is designed to prevent a loss. The surety prequalifies the contractor based on financial strength and construction expertise. Since the bond is underwritten with little expectation of loss, the premium is primarily a fee for prequalification services.

Major Points:

- Challenges
- Some Contractors Find Challenges Obtaining Bond Needed
- Contractors Fail to Meet Demands
- Benefits and Challenges for Contractors and Owners
- Pre-Qualification Checklist may include:
  - An Organization Chart of key employees; detailed resumes of key employees and their responsibilities
  - A Business Plan
  - A Continuation and Completion Plan
  - Evidence of a bank line of credit
  - Letters of recommendation and references

Summary: In view of the fact that most surety companies distribute surety bonds through an agency system, the first step is introduction to a professional agent or broker, also known as a surety bond producer, who specializes in contractor surety. The surety bond producer will most likely send the contractor a per-qualification checklist to gain an understanding of the firm's business and needs before their first live encounter. This initial meeting with the contractor is more than a simple meet and greet; the surety bond producer needs to develop in-depth understanding of the firm's business, and helps tailor the contractor's submission for the specific requirements of the surety company underwriter.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Construction

Strengthening Academia and Industry Connections Boosts Construction Materials and Equipment

Author: Dr. Wafeek S. Wahby, Eastern Illinois University, Charleston, IL

Need: The ever-increasing need for collaboration between academia and industry has never been more indispensable as it is now. The 21st Century shall witness even more innovative applications within the construction industry that require the introduction of new building materials, equipment and methods, as well as qualified and well trained personnel.

Overview: This paper explains how the technological progress in the construction industry depends on two elements, namely: innovation and resources. Resources, in turn, are introduced as PAMITEMS—an acronym that stands for People, Administration, Materials, Ideas, Time, Equipment, Money, and, Site—without any of which a project cannot be started or completed. Joint Ventures between industry and academia—which lead research and development -- inevitably result in better materials and equipment for improving the construction industry.

Major Points:

- Examples on problems facing the construction industry—including manufacturing, maintenance and repair—that were solved through innovative materials, equipment, methods, and qualified professionals.
- Composite materials: lighter, stronger, and cheaper

Summary: Academia and industry—together—can achieve a much greater and faster progress of the construction industry than can be achieved should they operate apart from each other. The challenges expected during the 21st Century in the construction industry necessitate more collaboration between academia and industry to arrive at better construction materials, equipment, and personnel.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Construction

Nanotechnology Applications for Thermal Insulation in Construction Projects

Authors: Dr. Sherif Attallah, Ball State University, Muncie, IN
Mr. Gary R. Birk, Ball State University, Muncie, IN
Mr. Doug Wilson, Ball State University, Muncie, IN

Need: Construction projects are responsible for a high percentage of total energy consumption in any country. This energy consumption of buildings, especially in cold areas, is highly dependent on the R value of the insulation materials used in the different envelope systems. Therefore, there is always a need for improving the thermal properties of these insulation materials in an affordable way so that project owners are encouraged to invest additional capital in the construction phase.

Overview: Nanotechnology looks into applications that utilize improved properties of different materials as they get processed at the nan-scale. One of these important applications is developing more efficient insulation materials for building envelops that are characterized with high thermal resistance values. The main obstacle that hinders adoption in the construction business is the high initial cost of these products compared to traditional insulation used in the market for decades. Therefore, this study aims at exploring the insulation products with enhanced resistance based on nanotechnology that are introduced to the USA market (with a focus on the residential sector), the market position of these products and potential growth.

Major Points:

- Nanotechnology
- Thermal insulation
- Thermal resistance
- Residential projects
- Market penetration

Summary: Attendees of this presentation will get insights on the thermal insulation products with enhanced nano-properties and the challenges facing adoption in the USA market.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Construction

Construction Management Projects: Relational Database Design and Development

Authors: Dr. Feng Jao, Ohio Northern University, Ada, OH
Dr. Richard Miller, Ohio Northern University, Ada, OH

Need: When students are placed in their internship/co-op jobs, many of them have the opportunities to experience the database systems used in the company. The scope of construction projects varies. Large corporations usually invest and purchase software which tailored to their specific project needs. However, small companies in general have limited resources to improve and manage their projects. Construction management students utilized their skills and knowledge learned in a database class and created tailored database projects based on their work/internship experiences to improve the cost, project, and human resource management.

Overview: This presentation will focus on design and development of database projects in construction field. Students designed projects based on their Internship/work experiences, and tailed the design for the specific needs in the company. Relational models were used to create objects such as tables, forms, and reports. Queries were created to analyze the data. In addition, user interface and macro were developed to increase the accessibility for all users. Final projects were published as an executable file and can be installed in a client's computer.

Major Points:

- Overview of Relational Database Design Concepts
- Overview of Object function in MS Access
- Example 1: Construction Projects – Roofing Company
- Example 2: Construction Projects – Human Resource Management

Summary: This presentation will provide an overview of creating database projects in construction related field. Sample projects designed and developed by students majored in Construction Management will be introduced.

Friday, November 13, 2015 - 9:00am - 9:45am

Construction

Preparing AET Construction Technology Students for the 21st Century Construction Industry Through Studying Dubai's Booming Construction Technology

Author: Dr. Wafeek S. Wahby, Eastern Illinois University, Charleston, IL

Need: The ever-increasing need for studying innovative applications within the construction industry is an excellent bridge to improving students' classroom experience, as well as the construction industry and the many other industries that are associated with it at large. The introduction of new building materials, equipment, and methods, as well as preparing qualified and well trained personnel are foundational for an efficient and progressive construction industry in the 21st Century.

Overview: During his visit to Dubai in February 2014, the author discussed with professionals and documented in picture and video the latest trends in the construction industry manifested in the ever-changing skyline of Dubai. This paper reports on the main features of the phenomenal boom of Dubai's construction technology, where there are almost no two buildings that are similar. Realizing that this progress was achieved in only 40 years, observers can expect to find a wealth of useful information on the myriads of challenges that confronted this remarkable progress, and how they were overcome.

Major Points: Analysis of the driving force behind the booming construction industry in Dubai. The technologies adopted and/or developed to build uniquely designed buildings. Examples of remarkable buildings and the challenges encountered in design, manufacturing, maintenance and repair—that were solved through innovative materials, equipment, methods, and qualified professionals. A different classroom experience through different wave of construction technology.

Summary: Studying the Dubai modern model of construction technology helps understand how to overcome challenges and achieve unprecedented success for construction technology students as they prepare to join the workforce in a competitive job market.

2015 Conference Proceedings

Friday, November 13, 2015 - 9:00am - 9:45am

Construction

Competitive Bidding: The Good, The Bad, and The Ugly!!

Authors: Mr. Michael M. Mezo, Ball State University, Muncie, IN
Ms. Jennifer Warrner, Ball State University, Muncie, IN

Need: A classroom based (real-world) Bidding Exercise is relevant to the majority of CM students, and the associated anxieties & nuances of Bid day! This classroom based, "Competitive" Bidding exercise creates real bid requirements, the bid day process, and the process of evaluating & selecting the "best" Subcontractors bid for a prescribed scope of work.

Overview: Includes most parameters & aspects for a real-world Bid exercise; Subcontractor bids are created, issued, administered, and compiled, and final submitted Bids are opened and read aloud! For a real project on campus, 25 work packages (or scopes of work) are created, and used for students teams to bid as an "agency CM". To create bid day stress, approx. 20 bids are issued for each Bid Package, or scope of work, that's 500 Bids are issued for the entire project. This is not realistic, but it does help create the anxieties of Bid Day, and the selection of the best bid for each scope of work.

Major Points: Student teams receive approx. 500 Bids for 25 different Work Scope or Bid Packets. Coordination of issued Addendum & other Bid Form Supplement information. Coordination of multiple Subcontractors, their scope of work, and their submitted bids. Use of a prescribed Bid Bond. Complete the Bid Form. Create a Bid Bond, and submit the required percentage. Application of Bidding "Caveats" (or real world bidding situations). Submit Bid on time, and at a 'remote' location on campus (away from the classroom). Bids are publicly opened, and real aloud. The "best, responsive" Bid wins the Project !! Grades are awarded based on level of responsiveness (or completion), the selection of the correct bid for the scope of work, application of a set Overhead rate & Profit rate, and other specific requirements. Late Bids are returned, un-opened, and a score of zero is applied.

Summary: Students gain a quick understanding of the stresses, affects, confusions, panic, and the end results of the Bid Day process! In competitive bidding, 2nd place pays the same as last place!

2015 Conference Proceedings

Friday, November 13, 2015 - 9:00am - 9:45am

Construction

Community Service Based Energy Efficiency Construction Course Development

Authors: Dr. Junyong Ahn, University of Northern Iowa, Cedar Falls, IA
Dr. Shahram VarzaVand, University of Northern Iowa, Cedar Falls, IA

Need: Energy for heating and cooling of small towns in Iowa are generally supplied by a cooperative or conglomerate utility companies. Access to information such as energy efficiency rate of each residential buildings may not be available to town residents.

Overview: The first goal of this research course development is to conduct a pilot study, to educate, and to assist Iowa's small town to become more energy efficient. Energy consumption and energy loss by residential buildings in the town will be analyzed by various tools and methods such as infrared thermography both at street level and overhead (Aerial). Energy consumption and thermal imageries will be analyzed to ascertain energy efficiency. The other goal of this research course development is educating the students of construction management programs regarding sustainability. The students will involve in every aspect of the research including literature review, small residential town selection, data gathering, data analysis, and so on. The construction management graduates are the potential future builders, educators, and construction leaders. Their participations in the energy efficiency, sound environmental design/construction, and sustainability research are essential to future success of energy efficiency of state of Iowa and that of the nation.

Major Points:

- Need for an energy efficiency construction course development
- Outcome based curriculum development
- Course logistics
- Community engagement

Summary: The design of energy efficiency construction course has the goals of providing community with energy loss analysis and educating students to encourage research and learn about energy efficiency concepts.

2015 Conference Proceedings

Friday, November 13, 2015 - 10:15am - 11:00am

Construction

An Exploratory Study of the Characteristics Quality of Residential Contractors Green Building in the United States

Authors: Dr. Lewis S. Waller, North Carolina A & T State University, Greensboro, NC
Dr. Andrea N. Ofori-Boadu, North Carolina A&T State University, Greensboro, NC
Dr. Evelyn Sowell, North Carolina A & T State University, Greensboro, NC

Need: The issue of global warming has resulted in an outcry of the environmental impact of current housing patterns and practices. According to National Association of Home Builders (NAHB), their members build more than 80% of the homes in the United States, and it was estimated that half of those incorporated some form of green practices into their development, design, and construction . Some residential contractors are not sure about the applicability of green construction practices as recommended by NAHB guidelines. Therefore, it is significant to grasp the concept that green building entails a holistic approach to avoid unplanned environmental, social, or economic cost that may result from applying only one element of a building. This paper will present data on involving experienced professionals such as NAHB green residential contractors in the green building based on their knowledge and decision making in green construction project . Also, this study will shed light into the quality practices often used by select contractors to attain NAHB project certification.

Overview: This presentation will provide data on the characteristics of residential contractors in the United States regarding green building. This consists of addressing green building practices as it relates to carbon dioxide,emissions, waste, energy and other problems related to the usage of non renewable resources. This presentation will also provide insight regarding contractors knowledge of Leadership in Energy and Environmental Design (LEED) which is one of the most popular green building standards. While focusing on Green Building Design, the emphasis is to aspire contractor to attain green certificate through NAHB.

Major Points:

- Overview of the Study
- Purpose of the Study
- Methodology
- Characteristics of NAHB
- Residential Contractors
- Results
- Conclusion

Summary: This paper presents findings on the top ten quality characteristics of residential contractors as it related to their knowledge regarding LEED, green quality improvement practices, and productivity. The results can help enhance contractors chances of a achieving a successful green building project.

2015 Conference Proceedings

Friday, November 13, 2015 - 10:15am - 11:00am

Construction

Managing Subcontractor-Related Challenges on LEED Projects: The U.S. Green Contractors' Perception

Authors: Dr. Andrea N. Ofori-Boadu, North Carolina A & T State University, Greensboro, NC
Dr. Lewis S. Waller, North Carolina A & T State University, Greensboro, NC
Dr. Musibau A. Shofoluwe, North Carolina A & T State University, Greensboro, NC

Need: In addition to the already established stringent building regulations, U.S. General Contractors (GCs) need to also comply with the green requirements for projects seeking certification with the U.S. Green Building Council (USGBC) – Leadership in Energy and Environmental Design (LEED) Program. LEED requirements present higher levels of risks to project success. In particular, there are several challenges associated with subcontractors on LEED projects. Since subcontractors play critical roles in the achievement of LEED objectives, GCs need to implement practices that will enhance the success of their LEED projects. Effective management practices that address key challenges associated with subcontractors are addressed.

Overview: Whereas initially only a few high profile corporate clients and public agencies were interested in green building, in recent times the demand for green projects has increased. Due to the shift to green construction, General Contractors have had to adopt green building practices in order to provide green or sustainable buildings to their clients. Professionals in the construction industry remain uneasy about the transition from conventional to green building practices. The purpose of this research study was to explore the major challenges associated with managing subcontractors on LEED projects. Qualitative methodologies were used to obtain research data from top General Contractors engaged in green building projects, specifically LEED commercial building projects.

Major Points:

- Background and purpose of study
- Methodology
- Findings and discussions
- Conclusion and recommendations

Summary: Attendees will know and understand the challenges associated with managing subcontractors on LEED projects. In addition, effective subcontractor management practices for LEED projects will be highlighted. When implemented by General Contractors, these practices could improve the success of future LEED commercial building projects. With the increased global emphasis on green building, it is critical that General Contractors aggressively pursue specific management practices to remain competitive and successful in the green building industry.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

Construction

The Use of Radio Frequency Identification (RFID) Technology in Construction Industry

Authors: Dr. Mahmoud A. Al-Odeh, Bemidji State University, Bemidji, MN
Dr. Shawn Strong, Bemidji State University, Bemidji, MN
Dr. Timothy M. Brockman, Bemidji State University, Bemidji, MN

Need: The industry environment faces different management and operational challenges such as: locating material quickly, managing workers, securing assets, and ensuring that expensive assets are being fully utilized. Advanced technologies have helped organizations implement solutions to overcome these challenges. Radio Frequency Identification (RFID) is currently being used in areas such as agriculture, athletics, manufacturing, security and law enforcement, and transportation. There is a need to investigate the current studies and previous literature of using RFID in construction industry. Also, challenges that may prevent adopting this technology will be explored. Finally, the future interest in using RFID for construction industry should be summarized.

Overview: This research aims to review the literature studies of using the Radio Frequency Identification (RFID) technology in the construction field. The result of this research will be based on the available literature and on recent or on-going studies. This research will explore the need for using this technology in construction. It will identify the major challenges with adopting RFID. Experts' opinions will be highlighted on advantages of using RFID such as: reducing risk management, increasing the availability for assets on site, improving efficiency and identifying assets locations. A comparison between RFID and other technologies such as GPS will be investigated. Visual instructions will be used to engage audience.

Major Points:

- Using advanced technologies will help constructors to improve profit, reduce waste, and increase the assets utilization.
- The successful use of RFID technology in other areas encourages constructors to use it on their construction projects.
- Summarizing best practices from the literature is essential for bringing RFID technology to the construction industry.
- Identifying the major challenges and advantages for adopting RFID will help construction administrators to make the best dollar value decisions.
- Comparing RFID technology with other technologies such as GPS will ensure a wise investment.

Summary: Attendees will gain a better understanding of the issues involved with implementing RFID technology in the construction industry. Attendees will be exposed to best practices and strategies of using RFID technology in construction.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

Construction

A Framework for the Implementation of Service-Learning Projects for Construction Management Courses

Authors: Dr. Andrea N. Ofori-Boadu, North Carolina A&T State University, Greensboro, NC
Dr. Lewis S. Waller, North Carolina A & T State University, Greensboro, NC

Need: Employers stress the crucial need for Construction Management graduates who have not only gained academic knowledge, but have also been exposed to real world experiences. While teaching strategies implemented within the confines of classroom settings are valuable, they lack the capacity to accurately capture the dynamics associated with real-life construction projects. Engaging Construction Management students in service learning projects contributes to bridging the gap between academic knowledge and real life construction practices. Beyond technical skills, these projects enhance student attributes associated with civic responsibility and charity.

Overview: Service-learning partnerships between universities and community-based organization are beneficial because students gain knowledge and real world experiences, while providing assistance to low-income populations and non-profit organizations. The plans, processes, partnerships, documents, and evaluation methods utilized during the engagement of Construction Management undergraduate students in a service learning project will be reported in this presentation. This project did not occur without challenges. The difficulties faced as well as the lessons learned will be discussed. The capacity to effectively deliver these unique opportunities to all stakeholders in a time and cost efficient manner, requires effective planning and implementation. This study is unique as it presents a framework for minimizing obstacles and obtaining multiple benefits from service learning projects.

Major Points:

- Background and purpose of service learning project
- Framework for the implementation of a service learning project
- Lessons learned from a service learning project
- Conclusion and recommendations

Summary: Attendees will be provided with a framework for developing and implementing a service learning project for Construction Management students. The challenges faced, as well as the lessons learned will be beneficial to the success of future service learning projects. In the long term, graduates with real life experience can better meet the challenges faced in industry, as well as the expectations of their employers.

2015 Conference Proceedings

Friday, November 13, 2015 - 2:00pm - 2:45pm

Construction

Residential Construction: Fall Protection Analyzed

Author: Dr. James J. Stein, Eastern Michigan University, Ypsilanti, MI

Need: Construction is an inherently dangerous business and accounts for more workplace fatalities than most other industries in the United States. Statistically, most deaths on construction sites are caused by fall incidents. In recent years, many commercial, industrial and civil contractors have taken effective measures to improve worker safety. However, the residential industry has been notoriously lax on safety, especially with fall protection. Due to increased pressure from OSHA and industry leaders, a new approach for fall protection in the residential sector is being emphasized. Improved attitudes combined with enhanced OSHA standards are changing business as usual.

Overview: The researcher will review pertinent OSHA standards that impact fall protection requirements specifically for residential construction. Moreover, three residential fall protection safety programs will be compared as possible models to follow featuring effective policies and strategies. In addition, new fall protection technology will be analyzed. Data will be presented from literature searches, vendor literature and residential contractor interviews. This presentation will emphasize the positive changes that have been happening and offer new approaches that can improve fall protection in the residential construction industry. Both technical aspects of fall protection and proper planning will be emphasized.

Major Points:

- Historically, many residential construction contractors have a poor record of providing adequate fall protection.
- There are unique challenges for residential contractors regarding fall protection.
- Newer OSHA and industry standards for fall protection in the residential sector have been promulgated and must be followed at a minimum.
- Effective strategies and policies for residential fall protection will be explained.
- Newer fall protection technologies are available to facilitate effective fall protection for residential builders.

Summary: This research centers on the positive changes that have been happening in regards to fall protection in the residential construction industry. Emphasis is placed on new requirements, policies, strategies and technologies that are available today.

2015 Conference Proceedings

Friday, November 13, 2015 - 2:00pm - 2:45pm

Construction

Building Information Modeling and Construction Education

Authors: Mr. Craig D. Wilson, Ball State University, Muncie, IN
Mr. Gary R. Birk, Ball State University, Muncie, IN
Mr. Michael M. Mezo, Ball State University, Muncie, IN

Need: There is a great deal of information on how to teach Building Information Modeling that involves creating three dimensional models. But what impact does this have on the overall teaching of construction management and how might that impact the development of other courses.

Overview: Teaching Building Information Modeling does not just address developing a three dimensional model. It also involves an understanding of the Level of Development, Integrated Project Delivery, and the construction process. The interest is in how BIM impacts student's impressions and understanding of the construction management process, estimating, scheduling, and pre-construction planning. This information could impact how BIM will integrate into other CM courses.

Major Points:

- The BIM process
- Level of Development
- Integrated Project Delivery
- Developing Models
- Lessons Learned

Summary: Attendees will gain an understanding of how Building Information Modeling is taught with an emphasis on materials, methods, the construction process, scheduling, and pre-construction planning. Construction management faculty will leave with the perspective from one program, and prepared to be able to adapt it in their own organizations.

Distance Learning

Designing a Structured and Organized Internet Class - Leading Students to Organization and Consistency On-line

Author: Mrs. Angelia M. Yount, Ball State University, Muncie, IN
Prof. Dianna Schuster Stair, Ivy Tech Community College, Lafayette, IN

Need: Having attended several conferences, and sitting through many presentations, we feel a large point is being missed. All the "bells and whistles" in the world built into an internet class will not make up to the student for lack of structure and organization. The structure of the class is the most important comfort area for a student. Appropriate structure is the section of the class where the students feel that they have control. Through the use of on-line student surveys and conversations from two institutions, we will share with the group the prime areas of concern about Internet classes from the students' point of higher education.

Overview: Education is spending millions of dollars each year to reach Internet students. Success or failure of a class generally hinges on the first three weeks of the class. This is the time the student will use to get acquainted with the structure and the teaching style of the instructor. Through the structure and organization that the student will feel in control of their education or lost and abandoned. If a student can maneuver through an internet course with a feeling of consistency, and recognize the paths they must follow, they are more prone to succeed than if they are constantly looking for and trying to locate material. Organization and structure become very important in this setting; learning to build consistency into a class is not difficult however, it is something most tend to overlook. We have instigated a plan to design all our classes with the same structure and organization, so after taking the first class in our discipline the student will know what to expect from the next class. We did not always do this and learned the hard way that students need consistency and organization if we want to succeed and remain in the on-line course. Through surveys done by the students, and personal conversations we have had with them. We will present the class design areas that the students find most difficult generally for on-line classes.

Major Points:

- Consistency and Structure
- Organization
- Comfort and Easy Access to Material in Course
- Success and Engagement
- Student Surveys of Online Courses

Summary: Attendees will gain thoughts and ideas of how to create a structured and organized Internet course. They will understand the importance of students will spend less time working to find material and more time actually learning. This expectation of organization in the on-line course will help student navigate through all courses within the department.

Thursday, November 12, 2015 - 11:30pm - 12:15pm

Distance Learning

Incorporating Multimedia into Online Courses

Authors: Dr. Edward J. Lazaros, Ball State University, Muncie, IN
Dr. David M. Hua, Ball State University, Muncie, IN

Need: Because of the increasing popularity of online classes, teachers need to have a look at how their class currently uses multimedia (Mandernach, 2009, p. 1) and improve if they do not meet satisfaction. Instructors need to design their classes to meet a number of objectives, and multimedia integration can help (Miller, 2013, p. 242). Instructors need to know what kinds of multimedia to use for different learning situations.

Overview: This presentation will cover the different types of multimedia and how to incorporate them into online classes. The main multimedia elements will be discussed and some of their possible uses will be explained. Then, information about the use of multimedia in teaching and the benefits of multimedia to students will be related. Then the multimedia principle will be explained, and the different origins of multimedia will be talked about. Next, supplemental multimedia and linked multimedia will be talked about. Then the personalization principle and how it relates to instructor created multimedia will be explained. The concepts of multimedia projects for students and of micro-level design will be explained. Finally, other principles related to the design of multimedia in online courses will be explained.

Major Points:

- The different elements that can compose multimedia.
- Why multimedia is useful in online classes, and the benefits that students receive from multimedia in online classes.
- The multimedia principle and how it affects online course design.
- The uses of supplemental and linked multimedia.
- How the personalization principle relates to instructor created multimedia.
- Micro-level design of multimedia and other principles that guide the making of multimedia.

Summary: During this presentation, participants will learn about the various kinds of multimedia that can be incorporated into online classes. Strategies for using multimedia in the teaching process will be explained. Research findings relating to the student benefits of multimedia will be discussed. The origins of multimedia will be highlighted. Supplemental multimedia and linked multimedia will both be presented so that participants can fully understand these concepts. Strategies for incorporating multimedia in online classes will be shared.

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Distance Learning

Perspectives and Expectations of Students in Online Courses

Continued on next page

Authors: Dr. Edward J. Lazaros, Ball State University, Muncie, IN
Dr. David Hua, Ball State University, Muncie, IN

Need: There is a need to study what students expect from online courses, and how various factors of online courses affect their learning ability, because the number of students enrolled in online courses has been growing, and will continue to grow. All of these online students have different expectations as to what an online course will be like, and educators need to take into account the expectations and needs of online students so the students can get all that is possible from the course.

Overview: This presentation will cover the expectations and the factors that student perceive to affect their satisfaction and learning in online courses. The expectations will be broken down into the categories of before the class begins, during the class, and when the student is experiencing technology problems. Information will then be related about the perceptions of students regarding online classes, which will be broken down into the categories of course content, interactions with teachers, and interactions with other students. The perceptions section will focus on how discussions help students learn, how students perceive their communication with classmates, and communications with teachers. Finally, information about how students compare online courses and regular courses will be related.

Major Points:

- The expectations of students relating to before the class has started, when the class is in session, and when they are experiencing technology problems.
- Student perceptions about course content.
- Student perceptions about the benefits and problems of discussions and group projects.
- Perceptions about communication with classmates, with teachers, and the problems with using text communication.
- How students compare online courses to regular courses.
- How much students feel about online courses in general.

Summary: During this presentation, participants will learn about the factors that influence student satisfaction in online courses. Student expectations of an online course will be discussed in detail. Specifically, student expectations prior to the start of class and expectations during the class. Student expectations relating to resolving technology problems will be shared. Research findings will be presented to show how students

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Distance Learning

Improving Student Outcomes in Online Courses

Author: Dr. Edward Lazaros, Ball State University, Muncie, IN

Need: The number of students taking online classes continues to grow, with one third of all higher education students taking at least one online class in 2011. Even though research has shown that students in online classes have similar learning outcomes to students in traditional classes, instructors still need to make sure that their students have high learning outcomes when taking online courses, and adapt their courses to improve outcomes if necessary.

Overview: This presentation explains how to improve student outcomes in online courses. First, a definition of course outcomes will be given, and the Quality Matters and Community of Inquiry rubrics of grading online courses will be explained. Then, the effects of how a course is designed and the way that the homepage is set up will be explained. The importance of how students interact with the course will be explained next. The use of discussion boards, and how they can effect low achievers, will be discussed, followed by instructions on how to improve quiz design. The use of journals, and rubrics will then be discussed. The benefits of turning a course into an online game are explained. Finally, how communication effects student outcomes will be discussed.

Major Points:

- Course outcomes
- How to use the Quality Matters rubric and the Community of Inquiry rubric to improve online courses
- How the course design and homepage can effect course outcomes
- How students interact with the course and with course content
- How to use discussion boards to increase student outcomes, particularly the outcomes of low achieving students
- How to design quizzes that work as a study tool. How to use a journal to improve retention of materials
- Why it is important to use a rubric when grading student's assignments
- How turning a course into an online came can improve student outcomes
- The effects of communication and social interaction with other students improves outcomes
- How to improve the outcome of student satisfaction, and how this outcome effects other outcomes

Summary: During this presentation, participants will learn about how to improve student outcomes in online courses. Course outcomes will be defined, and Quality Matters and Community of Inquiry rubrics of grading online courses will be explained. The importance of understanding student interaction in online courses will be discussed. The benefits of discussion boards in online courses will be highlighted. Integrating journals and rubrics into online courses will be explained. Findings relating to the relationship between communication and student outcomes will be shared.

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Distance Learning

Marketing Online Programs

Author: Dr. Edward J. Lazaros, Ball State University, Muncie, IN

Need: Because of the increasing amount of people trying to get an education, having distance learning opportunities is a major goal of many universities. However, the rapid expansion of online programs has lead to the quality of these programs often being suspect. To build the brand of the program and to get the word out about the quality of the program, it must be marketed.

Overview: This presentation will discuss why marketing is important for online programs, and then will talk about how online programs are commonly marketed). The topics of who to target marketing towards, and how to market for a younger audience is discussed. The idea of allowing trials of online programs is covered, followed by how to build a brand. Next, the importance of focusing on the product and reducing risk is explained. Then the topic of planning a long term marketing strategy is discussed, followed by the importance of focusing on outcomes. The importance of using marketing materials that are not on the internet and using social media is then covered. Next, the use of ads is discussed. Then, how to play up the advantages and the accreditation of the program is covered. Marketing programs to foreign students is talked about, followed by how to get better search engine results. Finally, the problems that result from exaggerating in marketing are explored.

Major Points:

- Why is marketing important and how are online programs usually marketed?
- Who to target with marketing and how to address the concerns of the younger audience. Allowing students to try online programs.
- How to build a brand by focusing on the product and outcomes.
- How to use non-internet materials and social media to market online programs.
- How to use ads to market online programs. The importance of emphasizing the advantages the program can offer.
- How to market to foreign students.
- How to get better search engine results. The problems that arise from false marketing, or exaggerated marketing, as shown by for profit universities.

Summary: During this presentation, participants will learn why marketing is important for online programs. Common strategies for marketing online programs will be discussed along with the need for a brand, focused product, and a long-term plan. The importance of targeting specific markets and audiences will be shared. The use of social media and ads will be presented. Search engine optimization will also be highlighted.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Distance Learning

Making Online Classes More Personal

Authors: Dr. Edward J. Lazaros, Ball State University, Muncie, IN
Dr. Thomas H. Spotts, Ball State University, Muncie, IN

Need: The amount of people taking online classes is growing, and with the growing online population, the amount of social interaction between teachers and students is going down. Online students tend to feel more alienated from their instructor than students in a traditional class do. Because of this it is important to learn how to increase the social presence and personalization of online courses.

Overview: This presentation will discuss why personalization in online courses is important, and the relationship between personalization and social presence. Then, the factors of social presence and how to increase your social presence will be discussed. Next, information about text based online communication and how to personalize it will be discussed. The topic of how privacy effects personalization will be covered, followed by how to make online conversations more personal. The use of video and synchronous communication will be then be covered. Then, the presentation will talk about how to personalize feedback given to students, and how to use tablets to give this feedback. Next, the topics of encouraging and rewarding students will be covered, followed by allowing students to control the discussion of the class. Finally, the topics of how to be familiar with your students, and how to personalize classes for many different cultures is discussed.

Major Points:

- Why personalization is important.
- What social presence is and what influences it.
- How to communicate effectively using text.
- How to use videos and synchronous communication to personalize classes.
- How to create personalized feedback using tablets.
- How to encourage and reward students.
- Allowing students to take control of discussions.
- How to use multimedia to personalize courses
- How to become familiar with students.
- How to personalize courses containing students of multiple cultures.

Summary: During this presentation, participants will learn why personalization of online courses is important. Strategies for enhancing a social presence will be identified. Examples of how to personalize text based communication online will be shared. Using video for synchronous communication in the online classroom will be discussed. Strategies for personalizing student feedback will be highlighted. Information on how to appeal to different cultures through personalization will be shared.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Distance Learning

Building Bridges and Blurring the Lines between Distance and Face to Face Learning

Author: Dr. Bill Bailey, Kennesaw State University, Marietta, GA

Need: Institutions face multiple challenges due to the growth of distance education, demands for greater accountability, and increasingly diverse needs of students. How can we meet the demand for distance learning, and provide the benefits of both face to face and distance formats?

Overview: This presentation will describe a framework that blends face to face and distance education in a way that provides the best of both approaches, and improves the utilization of institutional resources.

Major Points:

- The model described in this presentation:
- Provides flexibility for students
- Includes the best of online and face to face instruction
- Includes interaction between online and face to face students
- Optimizes the use of institutional resources
- Results in comparable outcomes for face to face and distance learning students

Summary: Attendees will gain knowledge of a model that combines face to face and distance learning students, providing real time interaction between the two groups, maximum flexibility in achieving student goals, and results in similar outcomes for the two groups.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Distance Learning

Addressing Lost Instructional Days through Online Learning

Authors: Dr. David M. Hua, Ball State University, Muncie, IN
Dr. Edward J. Lazaros, Ball State University, Muncie, IN

Need: Inclement weather is frequently the cause of lost instructional time due to school closings. School districts prone to these weather related closings will typically factor in a few "snow days" into their calendar to makeup the lost instructional time. If the number of snow days exceeds the days built into the schedule, the school year is extended to recover the lost time.

Overview: When inclement weather causes a school district to cancel classes, the district is required to makeup that lost time. There is a growing trend towards the use of e-learning to meet this requirement. There are concerns, however, among parents and school boards concerning the efficacy of e-learning. There can also be confusion concerning the expectations placed on school districts by state departments of education related to the use of e-learning days. This presentation will address these concerns and provide strategies for meeting state requirements in the use of e-learning to recover lost instructional time. This will address policy, logistical, and pedagogical issues.

Major Points:

- Identify the issues surrounding the use of e-learning in K - 12 school settings.
- Discussion of the state policies that impact the use of e-learning to recover lost instructional days.
- Best practices for implementing an e-learning policy in K - 12 school districts.

Summary: This presentation will discuss the issues associated with lost instructional time due to inclement weather in the K - 12 school setting. The use of e-learning is increasingly used as an alternative to canceling school. This presentation will provide strategies for meeting common state guidelines on the use of e-learning to recover lost instructional time.

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Distance Learning

FERPA Implications on Online Student Collaborative Learning

Authors: Dr. David M. Hua, Ball State University, Muncie, IN
Dr. Edward J. Lazaros, Ball State University, Muncie, IN

Need: The processes through which business is conducted are changing. The days of people having to always come together in a single physical location to meet and work together are a thing of the past. The time, cost, and difficulty of bringing together a busy group of professionals can be prohibitive. This is especially problematic as businesses scale out to national or global operations. The advent of cloud services has provided organizations with a wealth of tools that provide synchronous communication and collaboration. Students must be prepared for the dynamics of these modern business practices. The prevalence of asynchronous online learning environments does not provide students with the opportunity to develop the skills that will serve them as virtual work environments continue to become more prevalent.

Overview: Cloud services have provided a wealth of tools that allow for synchronous communications and collaboration. The ability to use these tools will become an increasingly expected skill by employers. These skills, however, are not the topic of courses. To address this shortcoming, educators can embed the use of these tools into their courses, regardless of the topic of the course. Incorporation of these tools, while important, should be done with a certain amount of care. Without consideration of how these tools work and their default settings, an instructor can inadvertently be exposed to potential FERPA violations. This presentation will highlight several online collaboration tools, the potential FERPA vulnerabilities, and steps to protect against violations.

Major Points:

- Strategies for increasing student engagement through online collaboration services.
- Presentation of the tools used in these strategies.
- Discussion of the FERPA issues associated with online collaboration.

Summary: The dynamic, virtual work environments that students may encounter upon graduation require skills in synchronous online communications and collaboration. Instructors can foster these skills in students by incorporating these types of activities into their courses. This presentation will discuss resources to help online instructors increase collaborative learning among online students. With the learning opportunities that these resources provide, they can also leave the instructor open to potential FERPA violations. Strategies for avoiding these violations will be highlighted.

2015 Conference Proceedings

Thursday, November 12, 2015 - 4:45pm - 5:30pm

Distance Learning

Analysis of Asynchronous Supplemental Course Modules in Statistical Process Control

Authors: Mr. Matthew E. Harvey, Iowa State University, Ames, IA
Mr. John Haughery, Iowa State University, Ames, IA
Mr. Sai Ramaswamy, Iowa State University, Ames, IA

Need: Over the past decade an increasing number of ATMAE affiliated programs have developed online or hybrid (face-to-face and online content) courses focusing on Statistical Process Control (SPC). These courses were administered to meet several goals, that included bolstering access, reducing university costs, providing schedule flexibility, and increasing curriculum offerings. In recent years there has been much discussion regarding the value and benefits of these hybrid courses., However , very little research has attempted to empirically measure the benefits of these courses.

Overview: The intent of our presentation is to build on previous work towards extending the learning environment outside of the classroom. Our research focuses specifically on asynchronous supplemental material relegated to SPC content within a total quality improvement course. We evaluated the perceived helpfulness that these modules hold for a diverse group of undergraduate students from technology and engineering degree tracks.

Major Points:

- Content used in asynchronous supplemental course modules
- Methods used to disseminate modules and track module completion
- Results of student surveys of perceived helpfulness of supplemental modules

Summary: Methods and content used to present supplemental SPC content asynchronously in a total quality improvement course will be presented. Additionally, the perceived helpfulness of this pedagogical approach is analyzed towards improving student learning across a diverse undergraduate population.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Distance Learning

All Online Learners Are Not the Same: Effective Principles and Concepts for Teaching Adults Online

Authors: Mrs. Roya Azimzadeh, University of Central Missouri, Warrensburg, MO
Dr. Doug Koch, University of Central Missouri, Warrensburg, MO

Need: As the prevalence and demand for online instruction continues, the diversity of the population receiving that instruction continues to grow. The adult population is a group that finds online learning appealing due to the flexibility often afforded. As the number of high school graduates levels off or in some regions declines slightly, many programs and institutions are looking at continued growth by offering continuing education and advanced degrees to the adult population. In order to appropriately address and instruct this population we must understand and utilize effective principles and concepts for their demographics and learning styles.

Overview: The goal of this presentation is to provide participants with an understanding of the characteristics of adult learners and to provide them with some tools to better engage and educate adult learners. The presentation will focus on characteristics of adult learners, andragogy, the importance of communication, and engaging the learners. The presentation will demonstrate interesting online tools and techniques to foster these important concepts.

Major Points:

- Characteristics of Adult Learners
- Adult Learning Theories and Andragogy
- Facilitating Online Learning Guidelines
- Useful Online Tools and Techniques
- Discussion and Conclusion

Summary: Attendees will learn innovative and effective ways to reach and better educate adult learners in an online environment. Upon completion of the presentation the participants will know characteristics of adult learners and adult learning theory. They will also have an understanding of some basic online tools and resources for effectively engaging adult learners.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Distance Learning

A Virtual Learning Community: Supporting Advanced Technical Education

Authors: Dr. Dawn Laux, Purdue University, West Lafayette, IN
Dr. Chad M. Laux, Purdue University, West Lafayette, IN
Dr. Brian Mennecke, Iowa State University, Ames, IA

Need: The 21st century requires a workforce that is skilled in advanced technology. As demographics change, higher education requires more varied pathways to continue to meet national workforce needs. As the definition of traditional college student changes, more effort by higher education institutions towards attracting and retaining non-traditional students are sought.

Overview: This presentation is based upon a NSF funded grant in Advanced Technical Education (ATE) to create a pathway from Associates to Bachelors for commuting students. To support these students, a virtual learning community (VLC) was created. The results of this study demonstrate that an experimental concept such as a VLC requires a different framework than traditional learning communities.

Major Points:

- Introduction Engineering Technology Pathways
- Review of the learning communities models
- The Virtual Learning Community concept
- Results and adaptations for commuter student model

Summary: Attendees will learn about efforts to adapt the learning community model based upon the social model for student persistence to meet the needs a non-traditional, commuter college student dispersed across a wide number of locations.

Distance Learning

The Hybrid Program: The Key to Unlocking the "Glass Ceiling"

Author: Dr. John E. Wyatt, Mississippi State University, Mississippi State, MS

Need: More and more high tech companies are moving to the southeast, especially the automotive industry. The demand for a more highly trained workforce has led to a great shortfall in employees with the necessary technological and educational sill sets. Community colleges are undertaking a large amount of work in preparing entry-level employees and the 4-year universities are working on entry-level management and supervisory employees. The problem is there are great many current employees who have the experience to advance through the company but today lack the educational component that a 4-year degree offers. They have hit the "glass ceiling".

Overview: Currently there are many Interdisciplinary Studies programs that a student can take online to gain a 4-year degree, but in Mississippi there are no online Industrial Technology programs that can give the laboratory experiences that make such program both popular and unique. Several years ago Industrial Technology at Mississippi State University looked at a program where the students took classes led by Mississippi State University faculty at their local community college. This turned out to be a logistical minefield and the idea was dropped. However, over the years Mississippi State University began to develop lecture only courses for online delivery, ad also investigated the possibility of using simulation software to do laboratories, but financial restrictions have put this on hold. Currently, we are exploring the hybrid program with the lectures, quizzes, exams etc. being delivered online and the students coming to campus 5 times a semester to undertake the lab portion of the class.

Major Points:

- The need for highly trained and qualified technical employees
- The "glass ceiling"
- Past ways of dealing with non-traditional students
- New program design
- Issues with new program design

Summary: Attendees will see how there is an enrollment base for working students, and that as educators we are missing out on an opportunity to give both these potential students the possibility of career advancement while staying employed. While their employers will have the advantage of internal promotion which is good for employee morale.

2015 Conference Proceedings

Friday, November 13, 2015 - 9:00am - 9:45am

Distance Learning

Augmented Reality Technologies in Supporting and Enhancing the Effectiveness of Distance Education

Author: Mr. Almir Ibragimov, University of Northern Iowa , Cedar Falls, IA

Need: Online education has become a popular method of learning for many people. There are several benefits to online education, such as availability and flexibility. Along with the advantages there are several disadvantages, such as lack of practical work in fields like healthcare and engineering, and lack of exciting educational materials. These challenges can be partially solved by using the modern technology - Augmented Reality. Popularity of these tools is rapidly growing. They are being used in many areas, such as construction, manufacturing, education, medicine, and art. Augmented Reality technologies can be used to support learning, and enhance the effectiveness of distance education.

Overview: This presentation aims to describe Augmented Reality technologies in improving distance education. The presentation is mostly based on analysis of case studies of using Augmented Reality in education, expert publications and interviews. Augmented Reality technologies and their applications will be presented in addition how they can be used to enhance the effectiveness of online education.

Major Points:

- Weaknesses of Online Learning
- Introduction to Augmented Reality
- Augmented Reality technologies in online education
- Applications of Augmented Reality
- Conclusions, recommendations

Summary: Positive impact of Augmented Reality on distance education is evident. The use of Augmented Reality technologies can improve many online courses.

Distance Learning

Known Unknowns and Unknown Unknowns: Developing a Strategic eCampus Infrastructure to Support Institutional Priorities

Author: Dr. Paul A. Cesarini, Bowling Green State University, Bowling Green, OH

Need: As the number of traditionally-aged students decreases in certain parts of the country, due to populations shifts and other factors, many institutions are considering new approaches to attract nontraditional students in online degree or degree-completion programs. While there is no "on size fits all" model toward this end, there are numerous best practices we can glean from public and private institutions that have demonstrated success in this area.

Overview: Former Defense Secretary Donald Rumsfeld once famously stated, "There are known knowns. These are things we know that we know. There are known unknowns. That is to say, there are things that we know we don't know. But there are also unknown unknowns. There are things we don't know we don't know." While his statement focused on national security issues, the general idea of what he said can also be applied to developing a cohesive distance learning strategy in higher education. Current institutional practices and policies -- or, "known knowns" -- can be examined and assessed by way of task forces and related committees charged with examining what internal obstacles or roadblocks exist that inadvertently hinder students in online degree programs. Gaps in these policies, or gaps in infrastructure such as the lack of a modern learning management system (LMS) or the lack of some key technological platform or component might then be uncovered. Along with these, there could well be significant resistance or reluctance from key institutional stakeholders, at the department, school, or college levels, from faculty and/or administration. These could all be framed as "known unknowns". On the opposite end of the spectrum would be the "unknown unknowns": the unintended consequences of developing such a supporting infrastructure for online degrees. Such consequences might include unforeseen impacts on faculty workloads, intellectual property, campus culture, and host of related areas and issues. Evolving regulations relating to state authorization for distance education -- a topic which is not limited to strictly online degrees -- might also fall into this category. This presentation and discussion will focus on the many challenges associated with developing and implementing a centralized eCampus unit at a university. Active audience participations will be required, as much of this session will involve group work and collaboration.

Major Points: In this session, we will: • Discuss institutional hurdles that may inhibit the growth of online degree programs. • Explore different solutions other institutions have implemented to address these hurdles. • Identify certain types of degrees program that may be more or less well-suited for online delivery. • Examine potential institutional culture issues that may need to be addressed in order for such a plan to succeed. • Leave with at least two actionable items to take back to your institution, from a business operations perspective, toward this end.

Summary: Developing a comprehensive, strategic eCampus solution to attract new, nontraditional students is no small task. Yet, the result may open up new opportunities and a way of reaching a untapped student population that was previously unreachable due to a variety of work, family, or geographic reasons. It can only begin with a great deal of deliberation and hard work from a wide variety of parties, with the way forward filled with "known unknowns" and "unknown unknowns".

Thursday, November 12, 2015 - 11:30am - 12:15pm

Electricity, Electronics, Computer Technology & Energy Issues

Application of Online Gas Analyzer to Monitor Quality and Quantity of Syngas Production for Renewable Energy

Authors: Mr. Ernest Echefu, Eastern Illinois University, Charleston, IL
Dr. Peter Ping Liu, Eastern Illinois University, Charleston, IL
Dr. Jerry Cloward, Eastern Illinois University, Charleston, IL

Need: The Renewable Energy Center at Eastern Illinois University (EIU) was designed to have two biomass gasifier-heated boilers. The purpose is to provide heat and steam for the entire campus using biomass, with the aim of powering up approximately 10 percent of the electricity needed by the university. One of the experimental studies being conducted at the Centre for Clean Energy Research and Education (CENCERE) at EIU, is aimed at using the inline gas analyzer to monitor the quality and quantity of the syngas produced from the gasifier after converting woodchips to syngas. The technology allows us to measure the syngas composition including CH4, CO, H2, CO2, and O2 simultaneously.

Overview: Experimental studies show that the net total production of the electricity generated from biomass feedstock, through combustion is commonly low in ranges from 20 - 40%. The amount of biomass burnt in existing combustors is usually limited to 5 – 10% of the total feedstock (wood chips and switch grass) due to the concerns about plugging of the existing feed systems. Pyrolysis converts biomass to bio-oil in the absence of oxygen. Biomass undergoes the process of thermochemical conversion of feedstock through drying, pyrolysis and gasification, in a typical gasification process. Gasification converts biomass through partial oxidation into a gaseous mixture of syngas (synthesis gas) consisting of hydrogen (10 –20%), carbon monoxide (15 – 30%), methane (2 – 4.5%), carbon dioxide (5 – 15%), nitrogen (45 – 60%) and water vapor (6 – 8%). This paper gives an insight to the application of the inline gas analyzer (Gas board) being used in monitoring the quality and quantity of syngas production using a solid fuel of 50% woodchips and 50% switch grass for renewable energy.

Major Points: 1. Introduction: Why measuring the composition of syngas? 2. Basic ability of GasBoard – online measurement and monitoring of syngas composition. 3. Basic principle of sensing devices; 4. Instrument setup, including gas conditioning and filtering; 5. Operation procedure; 6. Data acquisition (computer interface) 7. Typical results (composition of syngas)

Summary: As a part of renewable energy production, it is important to know the composition of syngas produced from a biomass gasification process in order to understand the conversion efficiency and energy value of gas being produced. This presentation will introduce the audience to an online monitoring instrument used to measure the syngas composition, including carbon monoxide, hydrogen, and methane. Experiments show the online monitoring is fast and effective in measuring the gas composition simultaneously.

Electricity, Electronics, Computer Technology & Energy Issues

Life Cycle Assessment (LCA) for Renewable Energy Centre at Eastern Illinois University: Energy Production and Environmental Impacts

Author: Mr. Sailesh Adhikari, Eastern Illinois University, Charleston, IL

Need: Two of the major environmental problems that people are facing include air pollution and global warming. Every new invention of this period are majorly focused on reducing environmental impacts and furthermore how to be more sustainable. One of the solutions is to use natural sources that has low environmental impact. To reduce and control emission from the product or processes, it is essential to measure the quantity of emission and threat to the environment. For a particular product, it is necessary to analyze the overall production process (e.g., raw material extraction, production, inventory, transportation, and waste to landfill) to quantify actual amount of emission. Life-cycle assessment (LCA) is the modern approach and an useful tool of sustainability practice to evaluate individual procedure and component for its degree of acceptability in terms of emission, reusability and proper disposal ability. To be sustainable in practice, Eastern Illinois University with its Renewable Energy Centre (REC) had switched from coal to biomass and natural gas as fuel for heating campus facility and supplying hot water. Theoretically, it is assumed that the process is renewable and sustainable with its operation and sources used but scientific world believes on numerical values. To evaluate and promote sustainable sources used at REC in future, it is critical to monitor overall energy production process and waste management practice through Life Cycle Assessment.

Overview: Audience will be informed about different renewable biomass energy sources as inputs of biomass gasification, basic biomass gasification process, atmospheric emission, and solid waste management. Simultaneously audience will be able to understand how the supply chain of Renewable Energy Center works. The research will offer brief knowledge on biomass utilization and its importance to greenhouse gas reduction in first stage. To promote sustainability, this research also explains, how cradle to grave approach of natural source utilization can be modified to Cradle to Cradle (C2C) in biomass gasification process. Finally, audience can be aware of emission control practice and ash utilization from biomass gasification.

Major Points: • Energy and fuel consumption for a university campus; • Assessment of emissions from Renewable Energy Center • Discussion of possible approaches to reduce greenhouse gas emissions • Promotion of renewable energy sources • Discussion of how to extract high energy from biomass with low air emission • Utilization of biomass by-products

Summary: The Life-cycle Assessment of the Renewable Energy Center on campus of Eastern Illinois University assess the emission from biomass gasification process and compares the result with natural gas and coal firing process. Also audience will be informed about the variation of emissions and approaches to reuse the byproduct of gasification process. This research will explain how to make the supply chain of REC more sustainable.

Electricity, Electronics, Computer Technology & Energy Issues

Design and Development of a Data Acquisition System to Test Heat Transfer through Building Envelopes

Authors: Dr. Faruk Yildiz, Sam Houston State University, Huntsville, TX
Dr. Keith L. Coogler, Sam Houston State University, Huntsville, TX
Mr. Nedom C. Muns, Sam Houston State University, Huntsville, TX

Need: The continuing popularity of green and sustainable buildings and energy efficient design ideas made attractive alternatives to dimensional wood-frame wall constructions. During the last era, increased popularity was observed for insulating concrete forms, low-density concrete masonry, structural insulated core panels, engineered wood wall framing, concrete blocks with insulated cores, steel framing, and a variety of hybrid wall systems. The comparison of a variety of materials that form building walls research are already available. There are testing equipment available for the people who are in building inspection field. However, there are not many laboratory and training infrastructure available to test different type of materials forming the building walls for academia.

Overview: A group of students and faculty in engineering technology program developed modular wall and roof panels of common residential design such that panels can be assembled into a complete "boxed envelope" to compare thermal transfer characteristics of the envelope on site. The panels have embedded temperature sensors at each material interface throughout the panel. Sensors are connected to a data logger for recording temperature variations throughput the day on a seasonal basis. This system is used in construction and instrumentation related courses and research.

Major Points:

- Green building technology
- Comparison of construction material reliability in various seasonal temp. variations
- Modular wall construction techniques
- Instrumentation and related equipment
- Thermal energy
- Undergraduate student learning and project involvement

Summary: With the increasing importance of green building technology in present and future energy scenarios, an ability to design and analyze green building systems is essential for educators and students in engineering and technology programs. All students in the project showed improved learning and understanding of concepts about green building technology vs. construction materials by complementing theory-based lectures with hands-on experimentation. All the project steps and student outcomes will be detailed in the paper.

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Electricity, Electronics, Computer Technology & Energy Issues

Key Factors towards Customer Satisfaction in PV Solar Manufacturing and Related Market

Authors: Mr. Arif Ali Jalbani, Eastern Illinois University, Charleston, IL
Mr. Jerry Cloward, Eastern Illinois University, Charleston, IL
Mr. Peter Ping Liu, Eastern Illinois University, Charleston, IL

Need: Customer satisfaction is one of the critical goals in green power generation not only for renewable energy markets but also for establishing a green culture across the country. Particularly, PV solar technology is one of the fastest-growing markets in the United States that needs special focus on customer expectations in order to shape a trustful market for future demands and related services. Basically, financial benefits, energy independency and carbon offsetting are the major targets in PV solar market to build the desired trust and related satisfaction among the customers. Technically, system selection is the essential step towards the final targets in PV solar projects that should be executed based on customer energy demands and related costs. Therefore, comparing the PV solar manufacturers in terms of materials, manufacturing, efficiency and durability would give energy consultants the key indicators for selecting the best systems based on customer expectations and budget.

Overview: Center for Clean Energy Research and Education (CENCERE) in Eastern Illinois University has conducted a research on two pilot PV solar arrays equipped by two different PV solar manufacturers in order to compare their products in terms of the desired targets in solar power generation. Basically, each of the arrays consists of six separated 240W PV solar modules manufactured by Sharp Corporation (south array) and Canadian Solar (north array). Technically, the comparison is based on continuous monitoring of the daily, monthly and lifetime power generation from each of the modules in a same condition in terms of solar radiation. In addition, based on the U.S. EPA Clean Energy Equivalencies Calculator, the total carbon offset achieved by each of the modules is calculated in order to compare each of the products in terms of carbon footprint and related life cycle analysis. Furthermore, inspection practices as essential tasks in PV solar customer services are considered by the research team in order to study the effect of monthly and seasonal inspections on power generated by each of the products.

Major Points: - An experimental study on essential factors in PV solar operation and efficiency; - Studying the key indicators for selecting the best PV solar systems; - Discussing the customer needs and expectations from PV solar market.

Summary: Basically, the paper would try to end up with an applicable guideline for PV solar operation and related power monitoring based on a practical study. Furthermore, the basic factors for selecting the best PV solar arrays from different manufacturers with different technologies and specifications would be introduced. Eventually, the paper would discuss the technical issues in PV solar manufacturing in order to suggest possible solutions towards customer satisfaction as the key element for developing a successful Total Quality System (TQS) in the market.

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Electricity, Electronics, Computer Technology & Energy Issues

Natural User Interface Using Kinect Sensing Technology for Motion-Controlled Deployment

Authors: Dr. Rendong Bai, Eastern Illinois University, Charleston, IL
Dr. Wutthigrai Boonsuk, Eastern Illinois University, Charleston, IL
Dr. Peter Ping Liu, Eastern Illinois University, Charleston, IL

Need: The fusion of a camera, a directional microphone system, and a depth sensor into a single, mass-market device provides an opportunity for software developers to implement better computer interaction. Kinect is transforming how people interact with computers, kiosks, and other motion-controlled devices. For example, in retail environments, Kinect applications enable customers to interact with products more naturally before they purchase. Retailers will have a deeper engagement with their customers. In healthcare, Kinect-enabled solutions are being developed for use in operating rooms, for physical therapy at home and in clinics, and for patient monitoring. Kinect can be applied in a variety of healthcare scenarios for patients and physicians, and thus offers potentials for lower cost and better treatments. During the process of learning Kinect development, students will explore the fundamentals of signals being processed – how video, audio, depth, and 3D skeleton information can be represented in a program. Students can also understand programming issues that are highly relevant to the creation of programs that deal with large streams of data from sensors, including memory allocation, creating unmanaged code to improve performance, and multi-threading.

Overview: In this presentation, we will give an overview of how Kinect sensor works and how Kinect for Windows software development kit (SDK) exposes each of the data sources. We introduce each of the sensors in the context of solving a well-defined problem. From healthcare and physical therapy to retail, education, and training, Kinect is making it possible for computers to work for human instead of the other way around. Businesses worldwide are using Kinect sensor with Kinect for Windows SDK to develop and deploy novel solutions, where we have the ability to interact naturally with computers by simply gesturing and speaking. The Kinect sensor bar contains two cameras, a special infrared light source, and four microphones. It also contains a stack of signal processing hardware that is able to make sense of all the data from the cameras, infrared light, and microphones. By combining the output from these sensors, a program can track and recognize objects in front of the sensor, determine the direction of sound signals, and isolate them from background noise.

Major Points:

- Overview of Kinect Sensor How Kinect sensor generates data about the world around it
- How to write software use Kinect SDK
- Kinect development examples

Summary: In this presentation, we will explain how Kinect sensor works and its potential applications. We will explain the development and deployment of Kinect solutions, which enable us to interact naturally with computers by simply gesturing and speaking. We also plan to demonstrate a few Kinect application examples.

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Electricity, Electronics, Computer Technology & Energy Issues

Bilayer Graphene Field-effect Transistors - Analytical Modeling and Applications

Authors: Dr. William R. Grise, Morehead State University, Morehead, KY

Need: Electronics instructors at all levels are frequently expected to incorporate the latest electronic device into their teaching. Graphene, which is basically a single layer of carbon, has been used to create Field-Effect Transistors (FET's) that replace silicon with carbon as the conducting element. From 2008 onwards, these devices have shown maximum frequencies of operation well into the millimeter-wave region (~ 100GHz), with electron mobilities as much as ten times that of silicon. Because of their expected importance for radio-frequency (RF) electronics, it is time to present some simple enough device descriptions and circuit models so that instructors and students in upper-level electronics and communications courses, as well as other users, can make sense of the potential of this new device technology. This presentation will update one submitted by the same author in 2013, but not presented due to illness. In this presentation, the focus will be on developing analytical models for a more recently proposed field-effect transistor (FET) based on graphene bilayers, as opposed to single layers. The use of two (or more) layers has been proposed as a way to create a cleaner separation between ON and OFF states in the FET, thus bringing this new technology on par with present Silicon-based FET's. Furthermore, the presentation will examine the question of how, and with what materials, one can "attach" the graphene layers to a substrate so as to improve performance.

Overview: Graphene is the single sheet of carbon atoms one gets if one were to "unroll" a carbon nanotube. As mentioned above, grapheme has interested many device engineers, and the wider community of semiconductor device users, due to its high electron mobility, and consequent very high frequency of operation. Devices have been developed already that use graphene sheets as the active element. This presentation will explain for the non-expert how a two or more layers of carbon atoms can act like a conventional FET, the limitations of this new device technology, and the efforts being made to overcome those limitations. Most important, the presentation will develop some relatively simple analytical (closed-form) device equations, for current, voltage, and capacitances that can serve instructors as they decide to introduce discussion of this new transistor technology into their upper level electronics classes.

Major Points: Need for simple analytical and circuit models for a new device technology, the graphene FET. Analysis of device operation and limitations, as well as advantages of the graphene FET in RF communications circuits. Focus on newer bilayer technology and its advantages. Development of device equations, suitable for classroom instruction that describes main modes of operation of the graphene bilayer FET.

Summary: Those who attend will obtain an understanding of the behavior and applications of this new device. Attendees will be provided with materials that can be used to incorporate the graphene FET into upper-level electronics courses.

Electricity, Electronics, Computer Technology & Energy Issues

Study of Biomass Gasification as a Renewable Energy Technology using Feedstock of Arundo Donax and Switchgrass

Authors: Mr. Seyedramin Ramin Khalilinejad, Eastern Illinois Univrsity, Charleston, IL
Dr. Jerry Cloward, Eastern Illinois University, Charleston, IL
Mr. Peter Ping Liu, Eastern Illinois University, Charleston, IL

Need: Generally, majority of solid biomass resources include virgin wood, energy crops, agricultural residues food waste, industrial waste and co-product and blends and mixture. Particularly, according to the US Department of Agriculture (USDA), 10-12 million ha of herbaceous energy crop could produce over 455 million metric tons (Mg) of biomass annually. Notably, Illinois has a remarkable agricultural capacity in terms of soil and water resources that can be widely used for dedicated crop farmlands in order to harvest energy for local energy consumption in residential and commercial applications. Thus, reliability of using local energy crops such as Arundo donax and switch grass for local energy production is one of the missions of research and development projects conducted by Center for Clean Energy Research and Education (CENCERE) in Eastern Illinois University.

Overview: A downdraft gasifier is considered as a pilot setup for Arundo donax and switch grass pellet as the gasification feedstock. Basically, quality and quantity of syngas production and related conversion efficiency are the major target values in the experimental data analysis. Particularly, operating temperature and pressure are the variables to compare the target values as functions of temperature and pressure for each of the feedstock. Then, based on the target values, electrical power supplied by a 10 KW generator equipped with an internal combustion engine fed by the produced syngas is predicted to compare each of the feedstock in terms of power generation and biomass consumption rate. Eventually, regarding the fact that households in Illinois use 129 million Btu of energy per home, annual working hours and feedstock consumption of the 10 KW generator as the only energy source for a household in Charleston are estimated and compared. Therefore, the predicted annual demands (tons) of the local feedstock are discussed as the key factors for future agricultural strategies in energy crop farmlands such as harvesting sequences and carbon offset inventory in the region.

Major Points: · Basic concept of biomass gasification and its application for renewable energy; · Comparing the quality and quantity of syngas derived from two energy crops; · Providing useful data for future pilot energy crop farmlands such as switchgrass

Summary: The present paper illustrates biomass gasification technology and related experimental instruments as well as basic calculations for syngas production analysis. In addition, the methodology used in the paper can be used for future experiments to form a comprehensive data base of the local energy crops. Finally, discussions presented in the paper are conducted towards alternative solutions for common challenges in practical biomass applications from energy crop farmlands to syngas production and related power generation.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Electricity, Electronics, Computer Technology & Energy Issues

Teaching Challenges in Embedded Systems Design

Author: Dr. Jack Li, Southwestern Oklahoma State University, Weatherford, OK

Need: There is a big change in microprocessor field. Recently, 8-bit CPUs are being replaced by the advanced 32-bit CPUs, such as ARM CPUs at the same price. 8-bit CPUs are normally used in microprocessor classes while markets ask to use new 32-bit CPUs. Because there are so many functions added to the new CPUs, program designing becomes so complex that it is hard to design software from low level to application level. Using operating systems, such as Linux or Android, in an embedded system is a common way to solve these problems. Operating systems design is very complex, especially for 8-bit systems. Even an embedded operating system is used, there are still more hardware and software designs, such as driver or Board Support Packages (BSP) design. All these design methods are normally hardly covered in one class. It is so important introduce these new changes to students in order to help them to face to new market.

Overview: An ARM development board will be used, which includes commonly used hardware, such as a touchscreen, SPI, I2C, Ethernet, flash memory card etc. Students will learn hardware design, software development environment setup as well as software design.

Major Points:

- This proposal suggests to introduce these general processes rather than detail teaching in specific topics.
- Let students touch related hardware design and software design in real products, such as a tablet.
- A proper setup should make all these topics fit to one class.

The material should include:

1. Setup development system
2. Read and design basic interface circuits
3. Driver/BPS design
4. Operating System Integration
5. Application Software Design

Summary: The students should get a whole idea about different topics in embedded systems design by this introduction. They can pick up special topics in further studying according to their interesting. The hardware is setup according to market products, which will motive students in studying.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Electricity, Electronics, Computer Technology & Energy Issues

Practical Loop Tuning – How to Tune a PID Loop!

Author: Dr. John R. Wright, Millersville University of Pennsylvania, Millersville, PA

Need: "PID controllers have been at the heart of control engineering practice for seven decades. In process control, more than 95% of the control loops are of the Proportional-Integral-Derivative (PID) type" (Raut & Vaishnav, 2015). With more than 200 different algorithms available on how to tune a control loop, tuning a loop can be daunting, if not confusing. Many controls professionals even consider the process of tuning a loop a black art due to the complexity involved. Applied engineers need to understand the basics of PID closed loop control and how to practically tune a loop in the field as they are often faced with this challenge as process, manufacturing, and controls engineers.

Overview: The purpose of the presentation is to provide step-by-step instruction on how to practically approach tuning a PID control loop.

Major Points:

- Defining the elements of PID (Proportional, Integral, and Derivative)
- Understanding Your Process Type (Self-regulating versus Integrating)
- Understanding Your Controller Type (Series/Classical, Parallel, and Ideal/ISA)
- Practical Tuning for Self-regulating Processes (Using Zeigler-Nichols & Pessen Methods)
- Tuning a Cascaded Loop

Summary: Tuning a process control loop is one of the most highly regarded skills by successful applied engineers. The process of tuning a PID loop in the field is often done by trial and error. This presentation emphasizes a practical method that will ground applied engineers with the practical theory needed to tune a loop thus saving time and increasing the effectiveness of closed loop control systems.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Electricity, Electronics, Computer Technology & Energy Issues

Arduino Board and Arduino Integrated Development Environment

Authors: Ms. Rajasri Pingili, Eastern Illinois University, Charleston, IL
Dr. Peter Ping Liu, Eastern Illinois University, Charleston, IL
Dr. Redong Bai, Eastern Illinois University, Charleston, IL

Need: Arduino is an open source hardware which means that all the design files for the Arduino board are made public. So anybody can go and make clones of the Arduino. Lots people have made clones of Arduino and sold them and lots of the clones are really good. That's kind of idea that open source hardware is your opening step so people can share. Arduino is an interface board which provides efficient and effective technology with low cost in order to create micro controller related projects. Arduino programming is quite simple and easy to understand, circumvent the difficulties and challenges of uncooperative coding. Arduino consists of Universal Serial Bus and micro controller board which are plugged in to computer using external electronics. The design of Arduino board is open source so anyone can use it. Arduino is best and reliable choice for people who are passionate to develop electronic projects. Arduino is connected to electronics using its pins to control the things such as turning on and off motors or lights and sensing temperature and light.

Overview: The Arduino Uno is the most recent innovative and mostly used as well as by far the best and well known series of Arduino boards. The major difference between older Arduino boards and Arduino Uno is the usage of different kinds of USB chip attached to their respective controllers. This difference of using different kind of USB chips primarily helps their users in terms of easy installation of Arduino software and allowance of higher speeds of communication with respective computers. Micro controller is the core component in the Arduino board. One of the best things about the Arduino platform is how easy it is to get started. The software that gets installed in the computer is completely free and it is designed specifically for ease of use. Integrated Development Environment runs like a text editing program on the computer connects to Arduino. Now with any software installed you may have particular things working on your computer that could hinder a smooth installation.

Major Points:

- Arduino board major hardware and software components.
- Importance of micro controller in Arduino.
- How to connect Arduino board and Arduino IDE
- Flow the process of uploading and executing the sketch from Arduino IDE to board

Summary: Arduino is an open source environment and it is very easy and available to everyone. This presentation introduces the audience to Arduino hardware, and its integrated development environment (IDE) interface tool for software development. A simple example will be demonstrated on how to program an Arduino controller.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Electricity, Electronics, Computer Technology & Energy Issues

Technology and Developing Platform for Humanoid Robots

Author: Dr. Jin Zhu, University of Northern Iowa, Cedar Falls, IA

Need: Robotics in industry, education, and personal is a very active field worldwide. It has become an outstanding part of our lives. Bill Gates argued in 2007 that there are similarities between the 1980's computer market and today's and today's service robot market. It is expected that the humanoid robots will become an indispensable component in our day-to-day lives in a near future, just like the roles of computers and Internet today. For this reason it is becoming increasingly interesting and important to study the available technologies and platforms for development in humanoid personal robots, also their usage in STEM education.

Overview: Robotics technology has been considered as a key economic enabler as pointed out in a report on US robotics road map published by Computing Community Consortium sponsored by NSF recently. Advancements in robotics technology have made new applications emerging in a diverse areas, including medicine, healthcare and education. Humanoid service robots are one of them. According to the International Federation Robotics, service robots are robots that operates semi or fully autonomously to educate, assist, or entertain human beings. Humanoids are defined as machines that have the form or function of human. Humanoid service robots may provide a friendly interface and various services, such as housework, education, rehabilitation, elder care, and rescue tasks. The emergence of humanoid service robots will have enormous economic and social impact in the future. We will discuss the current status and trend in the development of humanoid robots and also the technical challenge on its development. The study will focus on the application of humanoid robot in STEM education.

Major Points:

- Current status in the development of humanoid robots in US and other countries
- Physical human-robot interaction of humanoid service robots
- Humanoid robotics platform and examples
- Humanoid robots in STEM education

Summary: Robotics technology has been considered as a key economic enabler in the near future and will eventually affect our daily lives just as what the computers and Internet do today. The trends and emerging technologies in the development of humanoid robots and key challenges will be discussed. Application scenarios and examples will also be shown.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Electricity, Electronics, Computer Technology & Energy Issues

Internet Access Cost and Bandwidth in Rural and Urban Settings

Author: Dr. Tim Obermier, University of Nebraska Kearney, Kearney, NE

Need: Congress stated in the 1996 Telecommunications Act that advanced telecommunications and information services should be provided in all regions of the Nation. Rural and high cost areas are required by Congress (USC 254(b)(1-7) to have access to the Internet with bandwidth and cost that is similar to that provided in urban areas. Although Internet access plans are typically similar in price points, what differs between urban and rural residents is the available bandwidth causing significant differences in per-Mbps cost for Internet access.

Overview: This presentation will cover the major findings of a research project to determine the per-Mbps cost of Internet access in a largely rural state with only one metropolitan area. Five classifications of cities as defined by statute were used to compare the cost and speed of service for terrestrial wireless, fiber optic cable, television cable, and digital subscriber line Internet access. The study results holds significance for community leaders, telecommunications regulators and Internet service providers so they may develop policies to provide equitable services required by law to both rural and urban locations. The methodology of the study is easily applied to other states.

Major Points:

- What is the methodology needed to effectively study and compare Internet cost and speeds?
- What is the per-Mbps cost for terrestrial wireless, fiber optic cable, television cable, and digital subscriber line Internet access?
- What is the per-Mbps cost for the various Internet access platforms by city classification?
- How do rural and urban residents compare in regard to Internet speed and cost?

Summary: This presentation will review the results of a study to determine and compare the per-Mbps cost of Internet access platforms between five classifications of rural and urban cities in a rural mid-western state. The study results holds significance for community leaders, telecommunications regulators and Internet service providers so they may develop policies to provide equitable services to both rural and urban locations.

Thursday, November 12, 2015 - 4:45pm - 5:30pm

Electricity, Electronics, Computer Technology & Energy Issues

Bridges to the Cloud: Technologies for Integrating Security in the Development of Online Systems

Authors: Mr. Jeff B. Kilgore, Eastern Kentucky University, Richmond, KY
Mr. David Freet, Eastern Kentucky University, Richmond, KY
Dr. Vigs J. Chandra, Eastern Kentucky University, Richmond, KY

Need: The recent security breaches in large organizational databases containing sensitive personal information–medical system providers and credit card companies–highlight the need for increased awareness about and integration of security technologies. With an estimated 80 million users affected by the 2015 Anthem security breach, this matter clearly requires closer consideration and action by IT professionals. Crucially, EET curricula need to build awareness in technology students about the potential impact their network design decisions have on security of the overall system. Internet surfing habits need to be changed as well, such as while connecting to the Internet using a conveniently located hotspot for free Wi-Fi access with low or no security. There is also a need for using appropriate open-source and proprietary equipment as well as technologies for improving the security of operating systems, applications, and network links, regardless of manner in which the information is accessed.

Overview: With new technologies being integrated into existing enterprise-level computer systems continued vigilance on the part of network professionals is needed for maintaining security while ensuring ease of access and 24/7 availability. Organizational leaders should take note that the security of their computer systems are continuously being probed for vulnerabilities and every effort should be made by networking personnel to increase confidentiality, integrity, and availability of the information. While the growth of network-aware devices and appliances at the office and home provide us with a tremendous opportunity for automation and mobile access, it also opens up the system for unauthorized access over the network. The presentation will emphasize the use of security tools and strategies across the curriculum. Examples of activities drawn from courses in databases and Linux for improving security will be discussed.

Major Points: · Highlighting need for comprehensive software systems that can offers secure high-availability access · Need for maintaining continuous access without compromising confidentiality or integrity of the information regardless of the modality through which the data is transmitted or received. · Sample in-class and laboratory activities, online research, and projects emphasizing security, with special consideration to various database systems · Introducing and reinforcing software and hardware security tools in the networking curriculum · Strategies for securing integrated systems that use databases and other services · Building a big picture view of the comprehensive security strategy along with the specific details needed · Why good design of networks matters and the need for strengthening the weakest links in the network

Summary: Always-on, mobile, and more recently wearable technologies that interface with database driven applications for fitness or banking are making demands that many systems were not originally designed for. The presentation will increase awareness of the vulnerabilities in computer and network systems, along with providing ideas for using appropriate technologies for securing network systems. They will learn about the challenges faced while trying to provide secure access and why this continues to be an elusive goal. Participants will learn about increasing the resiliency of online systems to unauthorized access by embedding security into the design of computer systems and applications, particularly in online systems.

Thursday, November 12, 2015 - 4:45pm - 5:30pm

Electricity, Electronics, Computer Technology & Energy Issues

A Study of Effect of Surface Condition on Energy Production of Photovoltaic Solar Arrays

Authors: Mr. Arif Ali Jalbani, Eastern Illinois University, Charleston, IL
Dr. Rendong Bai, Eastern Illinois University, Charleston, IL
Dr. Isaac S. Slaven, Eastern Illinois University, Charleston, IL
Dr. Peter Ping Liu, Eastern Illinois University, Charleston, IL

Need: Solar is one of the best renewable energy resources. Data from field on energy losses due to surface soiling of PV (photovoltaic) plants are scarce. The study of type of dirt and its accumulation on surface of solar panels varies from one location to other. The characteristics of climate (rain fall, amount of dirt in the air etc.) are important factors and are site specific. This presentation will focus the field measurement of dirt energy losses (dust) and irradiance incidence angel losses since inception to date on a Solar PV plant located at Center for Clean Energy Research and Education, Eastern Illinois University. This study will help us understand the performance of solar panels and the variations in energy production of each sub panel. This study will also help us understand daily, monthly and annual production of each panel, and to estimate annual energy losses due to dirt and irradiance incidence angel. This paper will further suggest techniques to be implemented to mitigate such energy loses.

Overview: Surface soiling is the 3rd most important PV performance factor, after insolation and temperature. This study has been designed to study the effect of soiling on energy production. Typical factors of soiling will be studied in detail during this research project. The most important factors include site characteristics (vegetation, traffic air, pollution), ambient temperature and humidity, PV system tilt angle and orientation (including exposure to sun and wind), dust properties (include type, shape, size and weight), wind velocity, glazing characteristics (texture and coating). After identification of factors that impact soil accumulation, we will study the percent of energy loss due to each factor. This research will evaluate and measure the impact of soil accumulation on the existing PV system installed at Center for Clean Energy Research and Education, Eastern Illinois University, as well as will predict soiling impacts on future PV plant energy generation.

Major Points: Solar is one the best sustainable energy resources in the world. Factors influencing energy production by a solar panel; Soiling impact and measurement of variability on the PV system Estimated and actual energy loses due to soiling and methods to avoid these energy loses. High cost and low cost cleaning methods, labor intensive, manual vs automated cleaning methods and their availability and impact on energy losses and gains. Impact of operational cleaning solar panels (trolley vs Broom) on the energy production of PV plant.

Summary: Solar as a renewable energy source, is expected to help reduce the nation's dependency on foreign oil or other fossil fuels. The world is moving towards more solar energy, and the pace is improving day by day. It is important to study factors that influence the performance of solar PV systems. This study will help identify impact of dust accumulation on efficiency of PV plant. This study will further identify suitable methods to reduce these energy losses of this PV plant and other PV plants to be installed with similar environmental conditions.

Friday, November 13, 2015 - 8:00am - 8:45am

Electricity, Electronics, Computer Technology & Energy Issues

Developing a BYOD Deployment Strategy in an Enterprise Environment

Authors: Dr. Baijian Yang, Purdue University, West Lafayette, IN

Need: With the ever-increasing cost of telecommunication, Bring Your Own Device (BYOD) has shown its promise to reduce financial burden to many organizations. For companies who are tempted to make the switch, they need to understand what does it really means to implement BYOD; what are the possible deployment strategies; and what are the best practices.

Overview: Bring your own device (BYOD) is a policy of sanctioning employees to bring personally owned mobile devices to the workplace, and allowing those devices to access privileged information and applications. In this presentation, we will introduce a case study of a fortune 500 company to demonstrate 1) how to perform cost analyses on BYOD projects; 2) what are the possible deployment plans; and 3) what are the Dos and Don'ts.

Major Points:

- What is Bring Your Own Device (BYOD)?
- How does BYOD impact the industry and what are the benefits and concners.
- Background information of fortune 500 company with its costs on telecommunication
- The need to investigate BYOD for this company
- Cost Analyses
    - o What is the cost structure in BYOD environment?
    - o Under reasonable assumptions, would BYOD make sense to this organization?
- What are the deployment strategies?
    - o Should iOS and Android be supported at the same time or one at a time?
    - o Should additional platforms need to supported, such as WP8 and Blackberry
    - o Should a small a percent of users pilot testing the BYOD or the entire organization make a switch at one time
    - o What the countermeasures for BYOD concerns, such as information security and privacy Lessons learned in this case study

Summary: Faculty, students and industry experts will learn real world lessons on 1) determine if BYOD is the right policy for an organization; 2) what are the possible deployment strategies; and 3) what are the best practices.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Electricity, Electronics, Computer Technology & Energy Issues

Third Party User Authentication and Authorizations with OAuth 2.0

Author: Dr. Baijian Yang, Purdue University, West Lafayette, IN

Need: More and more Social Apps begin stepping into people's daily life. This creates both challenges and opportunities for people to manage their social life. People often find it difficult to remember every single sets of user IDs and login credentials for an app an Internet forum. As a result, there is a growing trend in industry that enable users to link an existing social app account to a new set of service. One such popular solution that enables third party user authentication and authorization is OAuth version 2.0. This presentation will introduce what is it; how it works; and what are the security concerns.

Overview: It is not uncommon nowadays that a web site or an app (whether it is on iOS or Android) allows users to link an exiting account to log in their sites. Backed by industry leaders, such as Facebook and Google, OAuth 2.0 is an open standard for user authentication and authorization. In this presentation, we will first introduce this standard followed by a brief example of how to use oAuth 2.0 APIs on Android Platform to integrate social apps. We will then compare OAuth 2.0 to other competing Identity Management approaches, such as OpenID. At last, we will examine the security risks and privacy concerns in current implementations of OAuth 2.0.

Major Points:

- The need for 3rd party user authentication and authorizations.
- Introduction of OAuth
  - What is it
  - Version history
  - Available APIs from Facebook
- An working example of using Facebook OAuth2.0 API
  - How the authentication process works at code level
  - What information is exposed to network sniffers
  - What information is exposed to OAuth2.0 Server and Client
  - What information is vulnerable to other Apps located on the same device
- Comparisons of OAuth2.0 vs OpenID and other user authentication and authorization techniques
- Security and privacy risks in OAuth2.0
- Best practices and recommendations

Summary: Faculty, students and professionals will learn how third party user authentication and authorization is used in theory and practice. They are also informed about the security and privacy concerns when using OAuth2.0, and how does it compares to the other similar technologies or standards.

2015 Conference Proceedings

Friday, November 13, 2015 - 9:00am - 9:45am

Electricity, Electronics, Computer Technology & Energy Issues

Designing and Implementing LabVIEW & Arduino Control in a Solar Tracking System

Authors: Dr. Sanghyun Lee, Morehead State University, Morehead, KY
Dr. Ni Wang, Morehead State University, Morehead, KY
Dr. Yuqiu You, Morehead State University, Morehead, KY

Need: Since energy crisis is the most important issue in today's world, renewable energy resources are getting priorities to lessen the dependency on conventional resources. Solar energy system is becoming the major renewable system to replace the conventional energy resources due to the inexhaustible resource and its environmental advantages. In a solar energy system, solar panels are used to directly convert solar radiation into electrical energy. Solar panels are made from semiconductor materials which has a maximum efficiency of 24.5% in energy conversion. Unless a new material or technology is invented and applied in making solar panels, the most cost-effective method to improving the efficiency of solar panels is to increase the light intensity. Automatic solar tracking systems have been designed and studied by many researchers, but the high initial investment and low system efficiency still prevents a wide implementation of such type of systems. Fixed solar panels are still the major implementation for solar energy systems, especially for small-scale household systems.

Overview: The purpose of this research project is to design and implement an integrated control system with LabVIEW and Arduino in an automatic solar tracking system. A prototype of the system will be designed and built with solar panels, stepping motors, motor drives, photosensitive sensors, LabVIEW system, and Arduino microcontroller. The mechanical design, hardware setup, component interfacing, software design, circuit wiring will be examined and demonstrated. The efficiency of the system will be evaluated by comparing with a fixed household solar system.

Major Points:

- Literature review of the research
- Introduce the procedure and system architecture
- Analyze the system performance.
- Demonstrate the cost analysis of the system
- Discuss of further study

Summary: This research project will design and implement an integrated control system – LabVIEW and Arduino controller on an automatic solar tracking system. The design and construction of the system will demonstrate an application of mechatronics in solving a real world problem to people from industry as well as academia.

Friday, November 13, 2015 - 9:00am - 9:45am

Electricity, Electronics, Computer Technology & Energy Issues

Proportional-Integral-Derivative Controller Implementation Using Field Programmable Analog Arrays for Liquid Level Control System

Authors: Dr. Sri R. Kolla, Bowling Green State University, Bowling Green, OH
Mr. Brandon Bostater, Bowling Green State University, Bowling Green, OH

Need: Field Programmable Analog Arrays (FPAA) can be used as analog equivalents to the Field Programmable Gate Arrays (FPGA) to implement complex analog signal processing functions. One of the main advantages of using analog circuits over their digital counterparts is that they do not require analog-to-digital converter and digital-to-analog converter thus reducing the cost and quantization errors. Configurable Analog Blocks (CABs) made of switched capacitor arrays are used in FPAA to provide these benefits. There is a need to educate our students about these devices and use them in process control applications. This presentation will demonstrate the use of FPAA for the Proportional-Integral-Derivative (PID) controller implementation for a liquid level control system and show their efficacy through test results for set point and other changes.

Overview: The PID controller is implemented using AN221E04 FPAA to control level of liquid in a tank. The controller accepts a set point voltage and an input voltage corresponding to the level of the liquid to produce an output voltage which controls the speed of a motor to pump the liquid into the tank from a reservoir. Using AnadigmDesigner 2 software, the PID controller is first created and simulated with different values for gains KP, KI, and KD. Once the proper values are found, the program is downloaded to the FPAA. Using a transistor based circuit, the FPAA voltage output is able to control the speed of the pump motor to change the liquid level. The implemented system is tested and its performance to control the level of liquid in the tank is evaluated.

Major Points:

1. An overview of FPAA is presented
2. Analog PID controller implementation is explained
3. Implementation of PID controller on FPAA using AnadigmDesigner 2 is described
4. Details of FPAA based PID controller application for a liquid level control system are presented
5. Test results of a liquid level control system using FPAA based PID controller are discussed

Summary: This presentation will provide ATMAE professionals an understanding of FPAA and their advantages in implementing analog PID controllers. An application of AN221E04 FPAA based PID controller, designed using AnadigmDesigner 2 software, for a liquid level control system will be presented with test results.

Friday, November 13, 2015 - 10:15am - 11:00am

Electricity, Electronics, Computer Technology & Energy Issues

Pulse Width Modulation and its Applications

Authors: Dr. John Adjaye, Alcorn State University, Alcorn State, MS
Dr. Steve K. Adzanu, Alcorn State University, Alcorn State, MS
Dr. David K. Addae, Alcorn State University, Alcorn State, MS

Need: Pulse width modulation (PWM) is an important electrical/electronic engineering technique used to control various electrical and electronics devices and systems, particularly electric motors used in electric cars and other machinery for speed control. PWM is also used in servomotor controls, which are extensively used in such applications as robotics, radio-controlled vehicles such as airplanes, cars, and boats. PWM is also used in circuit design such as switching power supplies to ensure constant output voltage. Thus pulse width modulation is ubiquitous but many people are unaware of its presence. This presentation seeks to enlighten attendees of how PWM signal is generated and its applications.

Overview: This presentation deals primarily with the use of the pulse width modulator PWM) circuit as a servomotor controller, although it can also be used in all sort of motor speed control applications. A servomotor can be connected to the steering column of a vehicle and used as the steering actuator for the vehicle. In the servomotor an electrical input signal determines the angular position of the motor armature. The electrical input signal is a periodic rectangular pulse train with a variable pulse width. Thus the angular position of the armature is determined by the duty cycle (pulse width) of the periodic rectangular pulse train. The variable pulse width periodic rectangular pulse train is generated from a variable DC voltage source using pulse width modulation (PWM) techniques. The duty cycle and hence the pulse width of the rectangular pulse train is determined by the DC voltage level. In this presentation, the building blocks and the design of the servomotor controller (PWM) circuit that will convert the variable DC voltage source to a periodic rectangular pulse train with variable duty cycle (pulse width) will be laid out.

Major Points: The following bullet points describe the function of each component of the pulse width modulation (Servomotor controller) circuit

- The 555 Timer: The 555 timer is connected as an astable multivibrator to generate a periodic square wave with a frequency of 100 Hz and duty cycle as close 50% as possible.
- The J-K Flip-Flop: The J-K flip-flop is used to produce a square wave with a duty cycle of exactly 50%. The frequency of the square wave generated by the JK flip flop is one-half of the output frequency of the 555 timer, since a frequency of 50 Hz (i.e. a period of 20 ms) is desired for the servomotor.
- Comparator 1: Comparator 1 is used as a level shifter and will be implemented with a 741 op-amp. The comparator 1 is used to shift the voltage levels from 0 V and 5 V to –VCC (–5 V) and +VCC (+5 V) of the op-amp. This creates a square wave which is symmetrical around 0 V ground line with the same frequency as the input signal (i.e. output signal from J-K flip flop).

Continued on the next page

Electricity, Electronics, Computer Technology & Energy Issues

Pulse Width Modulation and its Applications

- The Integrator: The integrator is implemented with a 741 op-amp The square wave signal with voltage levels of –5 V and +5 V from the output of comparator 1 is the input to the integrator. The output of the integrator is the integral of the input signal. Hence, since the input signal to the integrator is a square wave, the output voltage signal is a triangular wave.
- Comparator 2: Comparator 2 is the final stage of the PWM circuit (servomotor controller), which is implemented with one of the 741 op-amps of the LM324 Quad Op Amp IC. The variable DC voltage source is the reference voltage (VRef2) of comparator 2 and it is applied to the inverting input of the op-amp. The triangular wave output voltage from the integrator is applied to the non-inverting input and compared with DC input, VRef. The output of comparator 2 is the pulse width modulated periodic rectangular pulse train which is applied to the control input of the servomotor.

Summary: Attendees will gain insight into the basic design and implementation of PWM (servomotor controller) circuits and their applications.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

Electricity, Electronics, Computer Technology & Energy Issues

Optimization and Simulation of Vacuum Cannon System

Authors: Dr. Ni Wang, Eastern Kentucky University, Richmond, KY
Mr. Caiwen Ding, Morehead State University, Morehead, KY
Dr. Yuqiu You, Morehead State University, Morehead, KY
Dr. Sanghyun Lee, Morehead State University, Morehead, KY

Need: This presentation will address the optimal parameters for Ping-Pong ball "gun" system and simulate it using CFDs. This research results could be applied for commercial use.

Overview: Ping-Pong ball "gun" has been demonstrated in experiments by other academic researchers capable of shooting through a Ping-Pong bat or plastic cup. This occurs as a Ping-Pong ball is placed inside a PVC tube with both ends of the PVC tube are sealed, then the tube is evacuated, one end of it is punctured and the incoming air propels the Ping-Pong ball through the tube to the opposite end. Despite their lack of mass, the featherweight balls are approved to be able to pack a lot of energy. This project seeks to continue the development of such devices with an emphasis on optimization and simulation of Ping-Pong "gun". The current work will model the experiment in CAD software and look for the optimized parameters for tube size and ball size to gain the maximum speed of ball or maximum strength of force. The goal of this proposal is developing a device of Ping-Pong gun system, which could be portable with strong strength to help self-defense and crime prevention after scaling down based on optimization results. The results will be simulated in CAD software and tested in lab experiments.

Major Points:

- Modeling Ping-Pong Ball system
- Flow simulation of system using CAD
- Optimization of system
- Validation CAD results in lab experiments

Summary: Ping-Pong ball "gun" has been approved to be able to pack a lot of energy. This project will work on optimization and simulation of Ping-Pong "gun" to gain the optimized parameters for tube size and ball size to gain the maximum speed of ball or maximum strength of force. The goal of this proposal is developing a device of Ping-Pong gun system, which could be portable with strong strength to help self-defense and crime prevention. The results will be simulated in CAD software and validated in lab experiments.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

Electricity, Electronics, Computer Technology & Energy Issues

Affordable Laboratory Exercises in Wind Energy

Authors: Dr. Mehmet Goksu, Millersville University, Millersville, PA
Dr. Faruk Yildiz, Sam Houston State University, Huntsville, TX

Need: Renewable energy production is one of the most important topics in energy today due to increasing global energy needs and global warming. Today, as fossil fuel reserves continue to diminish, scientists try to make wind turbines a more viable and cost-effective method of generating electricity to partially fulfill world's energy needs. Over the last several years, many courses have been developed to train students to meet the needs of a rapidly emerging national green energy workforce. Although, these courses are well- planned, many of them still suffer from offering hands- on activities that will help students to gain better understanding of concepts in renewable energy. This presentation provides cost-effective laboratory exercises in wind energy that can easily be implemented by institutions.

Overview: We will present a series of experiments in wind energy in which students will learn the basics of wind turbines and investigate the optimal condition to obtain maximum power from a small scale wind turbine. Also, students will design their own wind turbines based on observations of suggested activities. These experiments are mainly developed to demonstrate the effects of important elements in designing wind turbines.

Major Points:

- Basics of wind turbines
- Cost effective hands-on exercises in wind turbines
- Design and analysis of wind turbines
- Determining the effect of number of blades, pitch angle, blade length, and solidity of the blade on the wind turbine output
- Laboratory manual for the suggested hands-on activities
- Conclusion and suggestions

Summary: This presentation is focused on hands-on activities, especially designed for students taking renewable energy courses. The integration of these activities will strengthen curriculum in the department. All of the information including the laboratory manual of the activities will be shared with the academia so they can be implemented easily at different institutions.

2015 Conference Proceedings

Friday, November 13, 2015 - 2:00pm - 2:45pm

Electricity, Electronics, Computer Technology & Energy Issues

Application of Piezoelectric Transducers in Vibration Suppression in Flexible or Micro-electromechanical Systems (MEMS)

Authors: Dr. William R. Grise, Morehead State University, Morehead, KY

Need: Piezoelectric transducers, along with their supporting circuitry, have been developed that are able to suppress deleterious vibrations in many flexible mechanical systems. The reason that piezoelectric devices, integrated with feedback controllers, are finding increasing application in the vibration control area is because these devices can be embedded in a composite structure as both sensors of undesired mechanical movement, and as actuators that can be configured to damp the sensed vibrations as well. The need for vibration suppression becomes more acute as structures are formed of more flexible materials, or whose performance could otherwise be seriously affected by vibrations. Many advanced applications, such as control of precision positioning devices, controlling and damping vibrations of aerospace surfaces, or reducing feedback vibrations in sporting equipment, now rely on embedded piezoelectric vibration sensing and damping systems, in preference to more traditional passive vibration control techniques.

Overview: The presentation will focus first of all on an improved mechanical analysis of the vibrations experienced in flexible structures. The aim in this portion of the presentation will be to present in simplified form the "how" of the higher-order modes of unwanted vibration in flexible structures. Secondly, a review of the best piezoelectric materials available for transducers, e.g., piezoceramics vs. quartz or lithium niobate crystals, and the basic design of transducers, will be presented. Finally, the interaction between the vibration suppression requirements of flexible structures, with their many higher-order modes of vibrations, and the design of more realistic, advanced piezoelectric transducers capable of dealing with the whole spectrum of vibration modes supported by these flexible components, will be discussed, and solutions will be presented.

Major Points:

- Types and modes of vibrations in modern, flexible structures
- Using the piezoelectric effect to sense vibration, and suppress vibration.
- Design and integration of feedback controllers with piezoelectric transducers to achieve desired vibration damping and/or suppression.
- Review of current applications and performance of piezoelectric vibration damping transducers.

Summary: Attendees will understand the physical principles animating the most recent design of piezoelectric transducers for vibration suppression, and will also gain insight into the overall systems design, i.e., including the feedback circuitry, of these transducers.

2015 Conference Proceedings

Friday, November 13, 2015 - 2:00pm - 2:45pm

Electricity, Electronics, Computer Technology & Energy Issues

A Temperature Alarming System based on HCS12 Microcontroller

Authors: Dr. Caiwen Ding, Morehead State University, Morehead, KY
Dr. Yuqiu You, Morehead State University, Morehead, KY
Dr. Nilesh Joshi, Morehead State University, Morehead, KY

Need: Temperature is an important parameter to be monitored and controlled in many production systems including process control and discrete control systems. An efficient, accurate, and cost-effective temperature control system is required for production systems in which temperature needs to be controlled. This research project is to develop a real-time temperature alarming system using HCS12 microcontroller, temperature detector chip, and Axiom's CMD-12DP512 board.

Overview: The performance of a temperature monitoring and control system is based on the detecting device, data processing, data conversion, and data display. The purpose of this research project is to design, build, and evaluate a real-time cost effective temperature alarming system based on HCS12 microcontroller. The HCS12 reduces interrupt latency and has a high performance– Instructions execute faster while remaining deterministic. The system will be tested for water temperature process control. HCS12 microcontroller is a typical data processing system. The temperature monitoring and control system includes detector chip—LM35DT to automatically detect water temperature so as to provide an alarm signal through LEDs when water temperature reaches the predetermined range. Following the rising of water temperature reaches the predetermined range; the temperature sensor will send the corresponding voltage to the A/D converter. In this project, the Axiom's CMD-12DP512 Board is used for A/D conversion. The performance of the system will be evaluated based on response time, accuracy, and control range.

Major Points:

- Literature review of the research
- Overview of the system architecture with hardware components
- Interfacing and programming of software
- Analyze and evaluate the system performance based
- Demonstrate the cost analysis of the system
- Discuss of issues and further study

Summary: This research project will design, build, and study the performance and cost of a temperature monitoring and control system. The demonstration of the hardware components, system interfacing, programming, and system evaluation will provide information and experiences for professionals who are interested in temperature sensing and control. The cost of the prototype system will also be studied and compared with the average market prices of similar temperature detecting systems.

Thursday, November 12, 2015 - 11:30am - 12:15pm

Graphics

Application of ANOVA in Colorimetry Computation to determine the Device Reliability (Spectrophotometry)

Authors: Dr. H. Naik Dharavath, Central Connecticut State University, New Britain, CT

Need: There are several color measuring hand-held devices (spectrophotometers) available in the market for the color quality management, but the reliability and accuracy of these devices have not been thoroughly investigated. The purpose of this study was to determine the colorimetric deviation of multiple types of spectrophotometers. A total of five types of instruments were used in the experiment. In seeking to empower our students to better understand the color deviation (DE), this work examined the use and operation of multiple spectrophotometers in a laboratory environment, similar to, upon entering into the workplace, a student would encounter. Hence for a student to consistently deliver a quality print, managing and controlling color from the input device to a multicolor output device is a major concern for the graphic arts educator. Applying these devices with our students will heighten their recognition as to the importance of proper color managed workflow (CMW).

Overview: A spectrophotometer takes the subjective judgment out of how a printed image looks. This device makes color imagery a science. There are three main categories that determine the quality of an image: the light source, the colored object that is reflecting the light, and the observer. Spectrophotometers only determine light, not how the observer is going to interpret the light spectrum. Images are still up for interpretation to the end viewer, but we can consistently measure the color image to achieve objective and quantifiable numbers. Color measurement variation can stem from the substrate, such as paper, and how spectral reflectance data are collected. The experiment was focused on the measurement of color prints, printed by using cyan, magenta, yellow, and black (CMYK) dry-toners on a digital color printing device which uses a color laser digital printing technique (color electro-photography). Color measuring devices used were considered as five independent groups (K = 5). Since the K = 5, a one-way Analysis of Variance (ANOVA) with equal n's method (at a = 0.05), was used to determine the significant differences that exist between the (K = 5, n = 80, and N = 100) group means (averages) color deviations (DE) of the various devices. The objective was to study the device response variation in a CMW. With five devices (groups, K = 5), a one-tailed, non-directional hypothesis was established. The data from the ANOVA test revealed that there were significant differences in the spectral response to a color among these multiple devices.

Major Points: Purpose, limitations and methods applied for the experiment. - Need for having reliable color measuring devices and their effect on the color printing production quality. - Use of ANOVA for evaluation of reliability and accuracy of device measurement. - Data analysis, summary and finding.

Summary: The presentation will be based on the outcome of the experiment. Attendees will understand the importance of having a reliable color measuring device for the CMW. Presentation will enable educators to make changes in the existing color management curriculum and teach students to apply scientific methods in printing and evaluating color reproduction. The findings of the study cannot be generalized to other CMW. However, other graphic arts educators, industry professionals, and researchers may find this study meaningful and useful. For example, educators can implement similar or the presented model (or method) to teach color management modules. The colorimetric data of this experiment led to the conclusion that the selection of a reliable device to measure the color is an important step in a CMW in order to evaluate colors more accurately.

Graphics

Color Printer Resolution Adjustment for Different Screening Technologies in Multicolor Digital Printing

Authors: Dr. Naik H. Dharavath, Central Connecticut State University, New Britain, CT
Dr. Mark Snyder, Millersville University, Millersville, PA

Need: Over the past two decades, the printing (or graphic arts) industry has been revolutionized. Technologies, workflow systems, management strategies, markets, and customer expectations have changed. Due to advancements in computer networking and digital printing technologies, print media has become a powerful multi-channel marketing and communications tool. Modern printing has evolved from a craft-oriented field toward color management science. This demands greater color reproduction control among the devices used in the print and imaging industry. The objective of this research is to determine the use and effect of printer resolution and digital screening applications to enhance the quality of digital color printing to satisfy the end-user of print media.

Overview: The purpose of this experimental research project was to identify the "Effect of printer resolution adjustment on Amplitude Modulated (AM) vs. Frequency Modulated (FM) screening of multicolor (CMYK) digital printing". Digital front-end platforms (raster image processor or RIP) of digital printers (or presses) offer opportunities for the user (or press operator) to manipulate the output color quality to meet the expected demand of the customer. In order to print a quality halftone image, the user must carefully manage several print parameters, variables, and attributes which are associated with the digital printing process. For this experiment, printer resolution was reduced to 600 dots per inch (DPI), because one screening option (FM screen) in the front-end platform (RIP) was limited to only setting the resolution at 600 DPI. This is due to random micro-dot placement, without use of screen angles, for the dot reproduction of FM screening. However, the AM screening option offered the ability to set printer resolution at 600 DPI, 1200 DPI, and 2400 DPI. In order to test the resolution effect on the screening technologies, only the 600 DPI resolution was selected for both screening technologies to keep the parameters/variables consistent throughout the experiment. The "print attributes" are individual characteristics within the printing process that can be monitored during the production process so as to maintain the color consistency. Only the attributes of dot gain (DG), gray balance (GB) and print contrast (PC) were tested to determine whether printer resolution had an effect on the two screening technologies, since these were the attributes measured by patches made up of halftone dots or screened tint percentages. This presentation will outline the study, explain the concepts, provide background, describe methods used, and then summarize the findings of this study.

Continued on next page

Thursday, November 12, 2015 - 11:30am - 12:15pm

Graphics

Color Printer Resolution Adjustment for Different Screening Technologies in Multicolor Digital Printing (Continued)

Major Points: Adjustment of the printer resolution on the screening technologies will have a direct impact on the print attributes. As such, the following questions were the focus of this research project due to resolution adjustment.

1. Is there a difference in the print contrast (PC), dot gain (DG), and gray balance (GB) of (CMYK) between the AM vs. FM screened, digitally printed images due to resolution adjustment?
2. Is there a difference in the overall color reproduction of (CMYK) between the AM vs FM screened, digitally printed images due to resolution adjustment?

Summary: The presentation will be limited to colorimetric and densitometric data only. This presentation is based on the outcome of a research experiment. Session participants will learn about the influence of digital screening technologies (AM vs. FM) on digital color printing. For this research, the print attributes of dot gain, gray balance, and print contrast were analyzed to examine the effect of significant differences that exist in the two screening technologies due to printer resolution adjustment. Graphic communication educators, industry professionals, and researchers may find this information meaningful and useful, however the colorimetric and densitometric data collected in this study may not be generalizable to all digital printing systems. Additional studies using similar systems (dry-toner), screening methods applied, and substrates is recommended.

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Graphics

Bridging the Gap between Businesses and Customers through the Web Technology

Author: Dr. Devang P. Mehta, North Carolina A&T State University, Greensboro, NC

Need: The Web is one of the versatile technologies. Companies can use the Web technology as a business tool for various purposes, such as, to publish the information about their products and services, to market and sell their products and services, to communicate with their customers and vendors, to offer technical support, to do market research, and to receive payment. An empirical research study was conducted to investigate the relation between the performance of commercial printing companies and conducting the number of e-commerce activities.

Overview: A questionnaire survey was conducted to determine the correlation between the performance of commercial printing companies and conducting the number of e-commerce activities. The commercial printing companies were asked to select various e-commerce operations. The performance was broken down into three categories, financial, non-financial, and overall. The financial performance was measured using four financial indicators: sales, profits, costs, and return-on-investment (ROI). The indicators used for measuring the non-financial performance were number of customers, merchandise return rate, and sales and marketing productivity. The overall performance was measured by combining both financial and non-financial indicators. The Spearman correlation was used to analyze the collected data.

Major Points:

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

Summary: A survey was conducted to investigate the correlation between the performance of commercial printing companies and conducting the number of e-commerce activities. Attendees will gain information about bridging the gap between businesses and customers through the Web technology.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Graphics

Green Design: Lighting for 3D Scanning, Converting 3D Scan Data into Solid Models and 3D Printing with an Emphasis on Green Design

Author: Dr. Todd C. Waggoner, Bowling Green State University, Bowling Green, OH

Need: Lighting is becoming very important to the 3D scanning process as the technology is transferred into solid modeling programs for eventual 3D printing. The lighting, 3D scanning, solid modeling manipulation, and 3D printing really belong in the technology management focus that ATMAE has developed.

Overview: There is a need to focus on lighting for 3D scanning as the price of 3D scanners continues to drop and they become more available to both industry and education. 3D scanning, solid modeling, and 3D printing focus on a need for "Green Design," and that will be developed in this presentation.

Major Points:

- Solving lighting problems for 3D scanning including blobs which appear in scans.
- Point cloud, STL files, and other 3D scan representations.
- Converting 3D scan data into solid models and CAD.
- 3D scans create a 3D digital photographs.
- 3D scans of people can create enthusiasm for the new technology.
- Printing people in 3D.
- Printing 3D assemblies.
- The advent of combination 3D scanners and 3D Printers.
- The "Green Design" orientation of 3D scanning, 3D solid modeling, and 3D printing.

Summary: Attendees from Architecture, engineering, engineering technology, industrial technology, and graphics design will be encouraged to discuss what is new in their area of 3D image capture, processing, and printing. The contemporary nature of this topic usually brings out exciting and lively discussions in these presentations.

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Graphics

Does Digital Printing Impact Traditional Binding/Finishing Operations?

Authors: Dr. Thomas H. Spotts, Ball State University, Muncie, IN
Dr. Edward J. Lazaros, Ball State University, Muncie, IN

Need: With the growth of digital printing with in-line finishing capabilities, binding and finishing off press is sometimes overlooked or not needed. Digital printing, cross-media production, digital workflow, and digital communications are currently areas of industry emphasis that typically involve short runs with limited finishing or in the case of digital communications, no hard copy at all. Though traditional printing with off press binding/finishing is not disappearing, the digital revolution might seem to impact traditional finishing and bindery. Digital and on demand printing has, if nothing else, put the focus on greater automation in these areas (Tressler, 2009). This presentation explores the impact the digital revolution in printing has had on traditional finishing and binding.

Overview: Where as traditional binding and finishing has been characterized as the "tail that wags the dog" (source Bindery Success Strategies eNewsletter, 1/17/14), this may be changing due to the digital revolution in printing. Short run digital printing, on-demand printing, cross media, and various means of digital communications have made inroads and taken a share of the commercial printing market. Often this requires no or limited finishing off press, automation being the key. As a result, traditional bindery and finishing operations as we know them may be impacted. The presentation will share the results of individual contacts and discussions with finishing/binding professionals in the field and review feedback from a limited select population on whether the digital printing and communication has impacted traditional binding/finishing.

Major Points:

- Introduction to whether digital printing, on-demand printing, and digital communications may limit traditional off press bindery/finishing
- Traditional finishing and bindery offers added value to print
- Review of results of bindery/finishing inquiries Impact if any digital printing has on binding/finishing

Summary: Traditional binding and finishing techniques offer value to print products. The digital revolution in printing offers many advantages but may not take in to consideration the value added by off press binding and finishing. Several finishing and binding operations in Indiana were surveyed asking about digital printing's impact on their operations. This presentation examines the results of these inquiries. Attendees will learn the perceived impact, if any, on traditional binding/finishing operations.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Graphics

3D Mockups - The Responsible Way of Designing Flexible Packaging

Authors: Mrs. Hope Carroll, Appalachian State University, Boone, NC
Dr. John Craft, Appalachian State University, Boone, NC

Need: Teaching new technologies have always presented challenges for educators in higher education. There are few resources that address the teaching and learning of flexible packaging design. Specifically, designing 3D mockups for packaging for use in student portfolios. Flexible packaging has replaced the traditional pack types such as metal cans, glass and plastic bottles, and liquid cartons. A new study from Smithers Pira "The Future of Global Flexible Packaging to 2016" indicates how the growth of flexible packaging has been propelled by new products being developed by brand owners in a highly competitive marketplace. Growth in the industry has created a hiring demand for students with experience in packaging design, for both graphic and structural design. For the past several years, there has been a growing trend to implement packaging design curricula within graphic communications programs. This presentation offers a take-away lesson plan, offered in an introductory packaging course, that can be easily implemented within any graphic communications course.

Overview: With the growth of flexible packaging and the need to hire graduates who have hands-on experience in packaging design, this presentation offers best practices for designing for flexible packaging and includes a take-away, not only for educators interested in implementing packaging production and design within their curriculum, but for students interested in adding packaging design mock-ups to their portfolios. Specifically, this presentation covers packaging design guidelines and demonstrates the use of Adobe Creative Cloud tools for designing and producing a mock-up for student portfolios.

Major Points:

- Guidelines for packaging design
- Flexible packaging design requirements (FDA, USDA, barcodes)
- Using Adobe Creative Cloud tools for flexible packaging design and layout
- Creating effective packaging mock-ups
- Helping students add creative pieces to their portfolio

Summary: Attendees will gain an understanding of flexible packaging design as it pertains to graphic communications education at the undergraduate level. Recommendations for a course of study are to be presented with a sample lesson plan provided for each attendee. The lesson plan includes lesson goals, directions, supplies needed, project requirements, assessment criteria, and supplemental project files.

2015 Conference Proceedings

Thursday, November 12, 2015 - 4:45pm - 5:30pm

Graphics

Portable Virtual World: Using Unity 3D to Package Virtual Models and Spaces

Authors: Mr. Andrew Graham, Bemidji State University, Bemidji, MN
Mr. Lyle Meulebroeck, Bemidji State University, Bemidji, MN

Need: The world of 3D modeling is nothing new, nor is the need to share those models. In the past, sharing a 3D model meant spending hours rendering an image or short video. These renderings offered only a short limited look at the 3D model or space and could be very time consuming to generate. Imagine being able to let a client interact and explore all sides of a prototype or walk around a virtual model of their soon to be constructed home. Imagine that the client can do this from any computer, or that it can be done in real-time, or that this virtual experience can be self-contained and sent to them in an email. By combining current Videogame creation software (Unity 3D) with current 3D modeling software, designers can easily create and share fully functional virtual models and spaces, eliminating the need to render limited and simple representations of their creations.

Overview: The presentation will walk the audience through the process of creating 3D models and spaces that can be explored in real-time. The presentation will include a demonstration of how nearly any 3D modeling program can be used to generate a completely self-contained model or space. The file generated eliminates the need for hours of rendering and has the benefit of being easily shared with a client.

Major Points:

- Basic 3D Modeling
- Basic Materials
- Exporting Models for Unity -Exporting Materials for Unity
- Basics of Unity 3D
- Creating Unity Files
- Exporting Unity Files
- Benefits / Limitations

Summary: The audience will gain a basic understanding of what Unity 3D can do and how it can be incorporated into many different areas related to technology, construction, engineering and design.

2015 Conference Proceedings

Thursday, November 12, 2015 - 4:45pm - 5:30pm

Graphics

Service Learning: Designing a Mobility Device for Child with Disability

Authors: Dr. David L. Rouch, Ohio Northern University, Ada, OH
Mr. Christopher Waldron, Ohio Northern University, Ada, OH
Mr. Donald Thomas, Ohio Northern University, Ada, OH

Need: Product design courses many times are focused on the development of a product that is innovative and will either improve on previous designs, provide better functionality, improve manufacturability, or more attractive to the market. In most cases, these improved designs are conceptualized primarily considering financial reward. However, there are many situations that may not be as financially rewarding as they are personally rewarding. For instance, young children growing up with limited mobility abilities, still need to be active to live a healthy lifestyle. A motorized scooter is not the best solution for them, even though medical insurance may offer that option. Product Design courses need to focus on fostering attitudes that are not always about the money and earnings potential, but also how to help put a smile on one child's face.

Overview: The Product Design Course at Ohio Northern University (ONU) has a number of design related activities to accomplish during the semester. The most significant activity that pervades many aspects of the course is to work in a team project activity where students will identify a problem, design alternative solutions, and carry out the whole design and build process to completion of a prototype. This presentation will discuss working with a client, in this case another professor at ONU, who has a daughter who has experienced several brain tumors and has had surgeries and experienced strokes that has left her partially paralyzed on one side of her body. She and the family desires to be able to get around the neighborhood, while at the same time be active like other kids. With her many limitations, product design team members designed and developed a mobility device to meet her physical, emotional, and mobility needs.

Major Points:

- Product design for societal needs rather than financial gain
- Product design process for a real customer with real life needs
- Pointers for designing frame components
- How to fabricate and prepare weld joints with Chromalloy tubing
- Delivering the finished product
- Satisfaction of students

Summary: Attendees will hear about unique design opportunities that are waiting to reward those who take on the challenge to help others. This presentation discusses helping a child with partially paralyzed conditions due to brain tumors and strokes.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Graphics

Optimizing Part Design for Consumers using Open Source AM Technology

Author: Dr. John L. Irwin, Michigan Technological University, Houghton, MI

Need: Recent advances in additive manufacturing (AM) show that 3D printers can produce intricate and precisely designed parts to be used in everyday life. This technology has decentralized the engineering graphics environment over the past few years and 3D printing has become a "design factory for the home". However, AM versus traditional manufacturing methods decreases the physical limitations of the component in most instances. These replacement 3D printed parts may not perform in the same way as that of the original equipment manufacturer (OEM) components.

Overview: In this study, we attempt to provide guidelines for the consumer to make alteration in the graphic design of 3D printed parts. These alterations can make the 3D printed part structurally improved. The method used in the study begins with selection of a common everyday use component that may fail under a load and need replacement. First, an aluminum coat hook is purchased, recreated in CAD software, analyzed and tested. The bracket is manufactured using an open source RepRap Delta 3D printer with PLA as a material. This design is subjected to testing using finite element analysis (FEA) as well as physical testing using a loading apparatus. Both the AM part as well as the OEM aluminum coat hook are tested with identical loading and supporting conditions. The software packages used are NX9 for the CAD model, ANSYS for FEA and LabVIEW for instrumentation.

Major Points:

- Optimization design of parts produced using a RepRap 3D printer.
- Finite element analysis of 3D printed composite and OEM parts.
- Physical testing of the OEM and 3D printed part.
- Comparison of results and rectification of weakness in the design of 3D printed parts.
- Redesigning of 3D printed parts for improved strength.

Summary: Attendees will be introduced to the use of 3D printing for replacement of everyday household items. The use of design optimization guidelines for 3D printing of these items can radically change the graphic design environment. This study broadly underlines the implications of the open source 3D printing technologies and provides suggestions for 3D printing for the non-engineering oriented consumer.

Graphics

The Interaction of Students Online to Collaborate the Development, Design, and Completion of CAED Group Based Projects

Authors: Dr. David W. Melton, Eastern Illinois University, Charleston, IL
Mr. Sean T. Roberts, Eastern Illinois University, Charleston, IL

Need: CAED solid modeling is becoming the industrial standard for design and development in today's global market. Solid modeling pushes the classroom to the next level of CAED, as taught in the classroom. Will the next push for CAED courses involve the developing of curriculum that mimics the global interaction of individuals collaborating on group design projects via the web? Traditionally, in the classroom and on the web, individual assignments are not an issue, but what about the interaction of a group in developing a project, not in the classroom, but via the web. This project looks at the future of global interaction, design, development and completion of the CAED design through a project developed by individuals (students) in different places.

Overview: This presentation describes the creation of a CAED solid modeling course; its transformation to a web-based delivered course; then progression to a group based project that involves online interaction/ collaboration. The presentation focuses on the development of the CAED course for the classroom and then its evolution as a web based course. The initial course provided the students learning objectives required in meeting the needs of the course. Furthermore, it was found that the student's individual work could be submitted, reviewed, graded, and returned via the web tools support at the university. The real test of the project was the semester ending group project, which involved the used of both the solid modeling and internet tools, along with the skills necessary for involvement in global environments: communication, leadership, and collaboration.

Major Points:

- Overview of both the solid modeling and web tools
- The curriculum used in the classroom/laboratory
- The managing of the solid modeling and web tools
- Developing a meaningful online curriculum/course based on solid modeling
- Group interaction via the web in developing and designing a group project

Summary: This presentation will describe the preparation of the solid modeling course, from the classroom through the progression towards the web.

2015 Conference Proceedings

Friday, November 13, 2015 - 9:00am - 9:45am

Graphics

Design Refinement by Iterative Virtual Experimentation (DRIVE): A Methodology for Solving Engineering Problems

Authors: Mr. Charles M. "Matt" Watson, Link-Belt Construction Equipment Co., Lexington, KY
Dr. Nilesh Joshi, Morehead State University, Morehead, KY
Dr. Ni Wang, Morehead State University, Morehead, KY

Need: By combining experimental design methods with commonly used analysis and design tools such as CAD, FEA and CFD, engineering designers can develop powerful statistical models and utilize graphics visualization to analyze various design iterations. Prior to the usage of FEA & CFD, designers were limited in their exploration into design possibilities and produced limited numbers of physical models to be tested. This excludes many possibilities for consideration and severely limits the total system improvements that can be tested and implemented.

Overview: In this research, we propose the DRIVE (Design Refinement by Iterative Virtual Experimentation) methodology that combines commonly used design and analysis tools such as CAD, FEA, and CFD to optimize final designs of various components while maintaining absolute minimal requirements for prototype manufacturing or to negate the requirements altogether. By utilizing these tools, we can find that the total number of design possibilities to be explored will increase significantly and, thus, lead to an overall more robust and functional design. This integrated approach can help save countless hours of physical modeling, mock-ups and prototype manufacturing as well as eliminating waste and scrap that would be associated with testing of prototype components. The application of the methodology is demonstrated using a case study of steering column bracket design optimization used in heavy duty mobile equipment.

Major Points:

- Design Refinement by Iterative Virtual Experimentation (DRIVE) methodology
- Case study based on DRIVE methodology
- Selection of response variables & choice of levels, factors and range
- FEA Simulations on 3D CAD models
- Statistical Analysis
- Conclusion & Recommendations

Summary: The focus of this presentation is on demonstrating the use of DRIVE methodology to solve real-world engineering design problems. The presentation will be of interest to engineering design researchers and professionals.

2015 Conference Proceedings

Friday, November 13, 2015 - 9:00am - 9:45am

Graphics

Cars and People of Cuba; Challenges of Teaching Photography during a Study Abroad within a Communist Country

Author: Mr. Hans P. Kellogg, Ball State University, Muncie, IN

Need: With the potential increased in travel to Cuba, the island is becoming a popular alternative for study abroad programs. Photographic opportunities abound and the typical challenges that students encounter in the field are easily reinforced within this Cuban experience. The common perception is this unspoiled environment will quickly change with the influx of American culture. The financial and sociological influence of America will have a permanent and lasting effect on this remote communist country. Along with the photographic emphasis, there are cultural and social concerns in which a faculty leader must be aware. Understanding these challenges will help provide a positive and productive educational experience.

Overview: Using a visual photographic record, the program will address both the photographic and logistical aspects surrounding educational travel to Cuba. Based on actual experience, the desired result will be to provide faculty an understanding of what is required to organize and lead a study abroad program to this foreign island. Though only 90 miles south of the United States of America, the experience seems closer to the 1950 than the 2015.

Major Points:

- Uniquely stunning images used to supporting the photographic skills important to a study aboard program.
- Description of the process in which students and faculty both prepared and learn about their travel to Cuba.
- Important points to provide insight into the challenges of leading an educational group on such a venture. Safety and logistic concerns which relate to the successes and challenges with this educational project
- Rewards uncounted by both students and faculty throughout this travel experience.

Summary: This trip was designed to challenge the students to create a photo, video, and written content regarding their travels to Cuba. Returning to the states, the students were tasked to bring this content together to reflect their personal story regarding this travel experience. Attendees will “travel” along with the class, learning how faculty and students both learned and grew from this journalistic educational project.

Friday, November 13, 2015 - 10:15am - 11:00am

Graphics

Which Comes First: Print or Digital? The Role of Print in a Cross-Media World

Author: Dr. Sara B. Smith, University of Northern Iowa, Cedar Falls, IA

Need: The message "Print is dead" has been circulating since at least the 1980s, with some references to it in the '60s. Clearly, the last nail has not been hammered into the coffin. In fact, print is an industry that has embraced change and evolved to make the most of technological progressions. The question is, what is the next role for print as it continues to co-exist with and even compete against emerging technologies into the future? Will messages still be designed for print first, then converted/transferred to digital media, or vice versa? As printers evolve, will they change from PSPs (Print Service Providers) to MSPs (Marketing Service Providers) or even C-MMSPs (Cross-Media Marketing Service Providers)? Answering these questions will assist educators in preparing students to be successful contributors in the changing landscape of the Graphic Communications industry.

Overview: With Internet access and mobile devices now becoming extremely prolific, there has been an extreme upsurge in the use of digital delivery methods for communication. However, abandoning print in favor of newer technologies is not always the answer. There are factors to consider such as the novelty of the new technology wearing off, the actual costs of online and digital are not always less, and the result or ROI (Return On Investment) is not always better. There are many ways in which print can be more effective, either on its own or by being incorporated with newer technology. A few examples include: printed triggers to Augmented Reality (AR) with programs such as Aurasma; print-to-action products prompting recipients to go to a store for receiving a gift; printed direct mail pieces with PURLs (personalized Uniform Resource Locator or web sites); and even a web site where the user types in a message and the company will print and send it in an envelope with a wax seal, looking like a high-end handwritten note to the recipient. The technology options and uses will continue to change. What remains the same is that the content and message continues to be the most important aspect of the communications. New terminology also appears with new technology options. Cross-Media, also known as Cross-Channel, refers to distributing the same or similar messages across multiple methods of communication, such as email, direct mail, web pages, printed banners, social media, etc. This presentation will include both a literature review and a planned study from summer 2015 of printing companies and PSPs and how they use cross-media for their own self-promotion and for their customers.

Continued on the next page

2015 Conference Proceedings

Friday, November 13, 2015 - 10:15am - 11:00am

Graphics

Which Comes First: Print or Digital? The Role of Print in a Cross-Media World

Major Points:

- Traditional printers and even digital printers will experience challenges and opportunities as they cross the bridge into the world of Cross-Media communications. It's important to analyze the factors that will determine their success and consider the choices they will face.
- Content design, management, and distribution will continue to be important, since the messages that are delivered supersede the mediums used to deliver them. Traditional printers typically handled content that started as print and then was modified to go online. In some cases, this trend is now reversed. What impact will this have on who controls and manages the content?
- There will continue to be new technologies to incorporate with print, and educators need to discuss these with students in order to encourage interdisciplinary mindsets and solutions in students.
- There are real opportunities in media development, deployment, and management. Print workflow skills that printers have developed are an advantage in digital media to help them take advantage of these opportunities.

Summary: Participants in this seminar will be presented with many examples of how print is used effectively in Cross-Media communications. In addition, case studies from several companies will be discussed. Strategies will be offered for incorporating Cross-Media concepts in curricula, as well as how service providers are using these approaches in self-promotion. Resources and additional information will be provided.

2015 Conference Proceedings

Friday, November 13, 2015 - 10:15am - 11:00am

Graphics

Fostering a Problem Solving Approach in Graphic Communications Curriculum

Authors: Dr. Sara B. Smith, University of Northern Iowa, Cedar Falls, IA
Ms. Shaun L. Dudek, University of Wisconsin-Stout, Menomonie, WI

Need: As the Graphic Communications industry continues to evolve and technology changes, the positions that newly graduating students will enter are less defined by descriptions for specific jobs, and more defined by the Knowledge, Skills, and Abilities (KSAs) that are necessary for multiple jobs. In terms of the Graphic Communications industry, the whole structure of organizations is changing. When students enter the workforce, they will be in jobs that don't yet exist, or are unrecognizable from prior job descriptions. The necessary KSAs that industry leaders have identified include not only technical skills, but soft skills as well. These include is a problem solving ability and the proficiency to work in teams. Therefore, a need exists for educators to provide opportunities for students to develop a problem solving mindset and strategies, and the capability to function successfully in teams.

Overview: As traditional printers change from PSPs (Print Service Providers) to C-MMSPs (Cross-Media Marketing Service Providers) and other similar terms, they need employees who are able to think in terms of more comprehensive solutions to their customers' needs. While technology provides new opportunities, it does not have the capability to perform many problem-solving functions, or to see "the big picture", sometimes referred to as "Expert Thinking." Employees can contribute greatly to their organizations by being pro-active in changes that embrace the evolving technology. In addition, effective teamwork both internally and externally will be a deciding factor in the success of an organization. Studies have indicated that the relationships between the service provider and customer will continue to change greatly. These entities need to work together much earlier in the message creation and distribution cycle in order to take full advantage of new technologies.

Major Points:

- In an overview of changing job roles that will occur for the workforce of 2020, it can be noted that employees will need to have combined abilities such as problem solving and teamwork.
- Participants will see a curricular approach to present a framework for problem solving as students approach their assignments. For example, there are methods to include accountability such as requiring student evaluations to be filled out at the end of major projects.
- Examples of specific course projects for problem solving and teamwork, both with individual and group work, will be presented.

Summary: Participants of this presentation will hear an overview of the changes forecasted to take place within the Graphic Communications industry that necessitate future employees with a problem solving mindset and strategies and teamwork competencies. In addition, they will be presented with strategies for learning effective teamwork approaches to incorporate in curriculum. Finally, they will learn specific approaches and projects to include in the curriculum to foster and reinforce problem-solving abilities.

Friday, November 13, 2015 - 11:15am - 12:00pm

Graphics

How Could Knowledge of Forest Stewardship Council (FSC) Certification and Rainforest Alliance Certification Enhance Student Learning and the Marketability of Graphic Communication Students upon Graduation?

Author: Dr. Michelle L. Surerus, Ohio University, Athens, OH

Need: Students need every advantage possible to be competitive in today's job market. With knowledge of FSC Certification and Rain Forest Alliance Certification, students could contribute to an employer's ability to determine if becoming certified is a competitive advantage.

Overview: If students are to be successful they must be knowledgeable of trends and expectations associated with FSC Certification and Rain Forest Alliance Certification and how becoming certified can impact a printer's business. Students must understand the importance of sustainable practices, forest management, and how attaining or maintaining certification could effect how they do business when working in the print industry following graduation. Both certifications will be discussed and suggestions will be provided. Attendees will leave with ideas related to how to share this information with students and where students can apply this knowledge.

Major Points:

- Importance of sustainable and ethical forest management
- Understanding of certification process
- What it means to be certified
- How to enhance learning using sustainability practices as a means of being "green" and environmentally friendly and how this is linked to the certification process
- How can certification affect perceptions of the printing industry's carbon footprint?
- How can knowledge of certifications be an advantage to students upon graduation?

Summary: Attendees will gain an understanding of what FSC and Rain Forest Alliance Certifications are and why conveying this knowledge to graphic communications students could provide them with a competitive advantage upon graduation.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

Graphics

Is it Possible or Practical for a Graphic Communication or Printing Program to Earn Forest Stewardship Council (FSC) Certification or Become Rainforest Alliance Certified?

Author: Dr. Michelle L. Surerus, Ohio University, Athens, OH

Need: As graphic communication/print programs try to gain a competitive advantage and create niches for themselves, certification may be what a programs needs to differentiate themselves from everyone else. Forest Stewardship Council (FSC) Certification or Rainforest Alliance Certification may be an avenue to investigate.

Overview: This session will discuss what it takes to become Forest Stewardship Council (FSC) Certification or Rainforest Alliance Certified including cost, space, and other considerations necessary to determining if it is possible or practical for a printing/graphic communication program to become Forest Stewardship Council (FSC) Certification or Rainforest Alliance Certified.

Major Points:

- What does it mean to be Forest Stewardship Council (FSC) Certification or Rainforest Alliance Certified?
- What are the costs involved in certification
- What are considerations and commitments required to become and maintain Forest Stewardship Council (FSC) Certification or Rainforest Alliance Certification?
- Effects upon printing/graphic communication programs
  - Does it make sense to pursue certification?
  - Why/Why not?
- Chain of Custody and how it works

Summary: Understanding what it takes to become Forest Stewardship Council (FSC) or Rainforest Alliance Certified is crucial to determining whether or not it is possible or practical for print programs. Attendees will be able to determine whether Forest Stewardship Council (FSC) Certification or Rainforest Alliance Certification is an option or just an opportunity to share information with their students. Knowledge learned during this session about of Forest Stewardship Council (FSC) Certification or Rainforest Alliance Certifications can be shared with students to enhance student's knowledge and understanding to provide a more complete level of understanding about the field they will enter upon graduation.

2015 Conference Proceedings

Thursday, November 12, 2015 - 11:30am - 12:15pm

Management

Improving Universities and Colleges through the Adoption of the Malcolm Baldrige National Quality Award Criteria for Higher Education

Author: Dr. Merwan Burjor Mehta, East Carolina University, Greenville, NC

Need: Higher education is at a cross-roads. State governments are cutting funding for universities and there is increasing pressure from legislators to hold tuitions stable to help students reduce student debt. With enrollments stagnant, the only way for higher education to survive is by becoming more agile and efficient. However, the way most educators expect to become efficient and lean is by attempting to implement hit-and-miss ideas. One tool that can help educators become more versatile and organized by providing them with an overarching management umbrella to increase efficiency and quality of their institutions is the Malcolm Baldrige National Quality Award (MBNQA) criteria.

Overview: In this presentation, a brief introduction of how the Malcolm Baldrige National Quality Award Criteria was established in the late 1980's, and how it has helped companies and not-for-profits become more efficient and quality-oriented will be presented. Also, how the Baldrige Criteria is structured and evolves through the constant inclusion of latest best practices found in higher education will be discussed. How a university should go about implementing the Baldrige Criteria as a central framework for efficiency in all that they do in a quality manner will also be discussed.

Major Points:

- History of the Malcolm Baldrige National Quality Award
- The Baldrige Criteria for higher education
- Plan of action for implementing the Baldrige Criteria
- Expected results after pursuing the Baldrige Criteria in higher education

Summary: This session will briefly discuss the history of the Malcolm Baldrige National Quality Award and present salient points in the criteria for higher education. A plan of action for universities and colleges to pursue the criteria and the award will be presented, and results achieved by others who have embarked on the path will be discussed.

2015 Conference Proceedings

Thursday, November 12, 2015 - 11:30am - 12:15pm

Management

A Comparison of Organization Development Theories

Author: Mr. Perry J. Moler, Texas A&M University - Commerce, Commerce, TX

Need: Organizations need to adapt over time, in responses to developments in their work, society and market environments. This process can be difficult for companies to navigate correctly to improve their market position after a change. Organization Development (OD) is a process that allows companies to create a path to improve their organization. By understanding, these different styles and factors related to each, individuals would be better able to lead their organizations through developments.

Overview: This presentation will analyze three different Organization Development (OD) theories: Traditional Action Research, Appreciative Inquiry and SOAR. OD has been a concept since the 1940's. However, the definition of OD has adapted over time. From the authoritative top-down structure to the idea of open communication between individual looking into the future to see what the organization could become. There will be a discussion as to the different developments in society since the creation of OD and what role these changes have had on organization an OD theories. This includes generational changes in values and norms, the continued globalization/interconnectedness of organizations and the advancements of technology. Finally, there is a discussion about what some of the future impacts on OD could be including technological, continuous process improvement, sustainability and wholeness. The process of OD is ever changing as there are continual developments within society and how business is conducted.

Major Points:

- Understand various Organization Development theories
- What are some of the driving factors for this change
- Implications of these developments in the future

Summary: Attendees will understand three different organization development theories and some of the factors that have led to these different theories. Finally, there will be a discussion about what are some possible future developments within organizational development.

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Management

Effective Leadership of Contingent Technical Workers

Author: Mr. Joseph W. Lampinen, Kelly Services Inc, Chicago, IL

Need: Approximately 40% of workers in the USA are employed on a contingent basis (i.e. independent contractors, temporary employees, freelancers), including substantial numbers of engineers and other technical professionals. Technical managers who utilize contingent workers do not have formal, legal supervisor-employee hierarchical relationship with them. However, technical managers often assume a leadership role in making work assignments, directing activities, evaluating work product and obtaining best performance from the contingent workers. How can technical managers best provide effective leadership to contingent technical workers without incurring undesirable risk? What should technical managers consider in selecting optimal leadership approaches and tactics for the contingent engineering workforce?

Overview: The author discusses an extensive body of existing research in presentation of the literature review and new, primary research drawn from surveys of over 4,900 North American engineering professionals is introduced. Distinctions are drawn between effective leadership practices for regular employees and contingent workers.

Major Points:

1. There are some important differences in leading contingent technical workers vs regular employees
2. Technical managers benefit from an awareness of key motivators for contingent technical workers
3. Technical managers need to keep employment law considerations in mind (i.e. co-employment risk) when leading contingent workers
4. Specific tactics in leading contingent workers can lead to improved productivity and performance

Summary: Contingent technical workers are important resources that technical managers need to lead effectively in order to obtain best performance. Employing proper leadership tactics can help technical managers achieve optimal results.

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Management

Adoption of Food Safety Modernization Act: A Six Sigma Approach to Risk Based Preventive Controls for Small Food Facilities

Authors: Mr. Abhay K. Grover, Iowa State University, Ames, IA
Dr. Shweta Chopra, Iowa State University, Ames, IA
Dr. Gretchen A. Mosher, Iowa State University, Ames, IA

Need: With 17% of Americans at risk from the food borne illnesses and $75 billion worth recalls every year the Food Safety Modernization Act (FSMA) was signed into law in 2011, with focus on prevention of food safety problems rather than reacting to them. Furthermore, section 103 of Title I from FSMA (Public Law 111-353) requires eligible food facilities to comply with Hazard Analysis Risk Based Preventive Control (HARPC). Small food businesses are facing several challenges in meeting the new requirements. The goal of this study is to identify the root cause of these challenges and propose a framework to resolve them using Six Sigma DMAIC (define-measure-analyze-improve-control). This will help small food and grain businesses smoothly transition to FSMA requirements, leading to a more robust food safety system.

Overview: The much-needed FSMA has presented many challenges for small food businesses. These include: lack of employee training or preparedness, framework for inclusion of non-critical control points, and capacity building. A perspective analysis of food industry representatives, quality practitioners and FSMA experts is used to analyze the root cause of these challenges for small food facilities with basic quality management system in place. The use of Six Sigma tools has been demonstrated to propose a framework for effective adoption of FSMA. These tools will be applied to address the challenges identified by the perspective analysis.

Major Points:

- Compare FSMA with the existing food safety system, describe its need and importance
- Demonstrate the use of Six Sigma (DMAIC) methodology for adoption of FSMA
- Identify the major challenges for small food businesses in adopting FSMA
- Analyze the root cause of these challenges using the cause and effect analysis
- Propose a quality management framework to resolve these challenges

Summary: The audience will get an in-depth perspective of the challenges FSMA poses to small food facilities. The use of Six Sigma methodology to mitigate these challenges will be discussed. Implications of the work as applied to small food facilities will be shared.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Management

A Dynamic Simulation-Based Hybrid Model for Optimization of Billet Manufacturing Plant Layout

Authors: Ms. Fatemeh Davoudi Kakhki, Morehead State University, Morehead, KY
Dr. Nilesh Joshi, Morehead State University, Morehead, KY

Need: Iron and steel industry plays an essential role in industrial and developing economies such as Iran, where there are many small to large-size iron and billet manufacturing facilities. During our recent visits to some of the plants in Iran, we observed that these facilities are generally poorly-designed, resulting in excessive waste of raw materials, energy and overall production time. Thus, there is a need to prepare a facilities design template based on the best practices in billets manufacturing industry. Use of such a template will result in better facilities plan, reduced wastes, and improved production process yields.

Overview: Steel billets production is a continuous casting process, which requires induction furnaces, ladles, cranes, continuous casting machines, cutting machines, and secondary cooling arrangements. Optimizing these subsystems and their interrelationships is a difficult task, which can be best addressed by simulating the entire process using process simulation software. To study and optimize this complex process, we propose a dynamic simulation-based hybrid model which links both continuous and discreet process interfaces. The application of the model is demonstrated using a case study of a billet manufacturing plant located in industrial town of Mashhad in Iran. The plant's production processes were observed and data was collected over several months. Then, the current factory layout was modeled in a simulation program using the real data. Experiments were conducted on the model to identify areas for improvement. Next, changes were made to the existing layout in the simulation model in order to minimize various wastes and improve process yield by reducing cycle times. The results of the optimized model were validated using scenario analysis and were presented to the management for implementation.

Major Points:

- Production data collection from a billet manufacturing plant.
- Modeling the current plant layout using a dynamic simulation-based hybrid model.
- Model experimentation to investigate inefficiencies in billet production process.
- Redesigning the layout in the simulation model.
- Validation of the improved model using scenario analysis.
- Presentation of results prior to and post-optimization.

Summary: This presentation outlines a simulation-based method to address complexities in steel billet production process optimization. It will be of interest to industry professionals who seek ways to enhance operational efficiencies in iron and steel manufacturing industry.

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Management

Assessing Quality Climate and Understanding the Organizational Quality-Tendency

Authors: Dr. Nir Keren, Iowa State University, Ames, IA
Mr. Michael R. O'Donnell, Iowa State University, Ames, IA
Mr. Earl D. MacLeod, John Deere Des Moines Works, Ankeny, IA
Mr. Matthew E. Harvey, Iowa State University, Ames, IA

Need: Organizations devote significant resources toward (1) developing policies for quality management, (2) hiring employees with appropriate training and experience, and (3) investing in equipment for quality control and quality production. These three elements are facilitating the formal quality system. For decades it was believed that it is almost impossible to fail when an appropriate formal quality system is present. However, many organizations have faced a reality check with their quality production, although their formal systems were robust. The magnitude of influence of the informal quality system – the Quality Climate – on the organization's ability to maintain appropriate quality production became apparent in the late 90's. Therefore, understanding the construct of the informal quality system is critical to identifying the level of organizational quality-tendency (e.g., low quality-tendency, moderate quality-tendency, or high quality-tendency). Yet, little R&D efforts have been devoted to understanding these systems.

Overview: Organizations rely heavily on their ability to detect errors/deviations in order to stay competitive. In formal quality systems, policies, trained employees, and equipment facilitate the error detection system. In informal quality systems, employees' perception of quality as a prioritized operational goal has major impact on the organization's ability to detect deviations. When certain deviations are recurring and the organization becomes impervious to these deviations, the organization's 'field of view' is getting narrowed to 'not see' these deviations. This situation is known as 'collective blindness.' When collective blindness exists the level of accumulation of deviations can be disastrous for the organization. This presentation will discuss the factors of informal quality systems, assessing the performance of this informal system, and utilizing the results of the assessments to promote organizational growth in quality-tendency.

Major Points:

- Quality manufacturing is a fabric of formal and informal quality systems
- Appropriateness of an informal quality system is a determiner in identifying the level of organizational quality-tendency
- Failure to pursue a robust informal quality system will result in a collective blindness that if not aggressively addressed can lead to a business disaster

Summary: Informal quality systems are as much critical components for successful quality production as the formal quality systems. Yet, informal quality systems are understudied. This presentation will delve into the construct of the informal quality production systems and will introduce a procedure to assess (1) the robustness of an informal quality system, (2) the quality-tendency of the organization, and (3) how to utilize these assessments to improve the quality-tendency levels.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Management

Sustainability Metrics Maturity

Author: Mr. Scott Abney, Purdue University, West Lafayette, IN

Need: Trends in industry are moving to a focus on Sustainability. Throughout this focus, companies must examine their decision making and how it affects their social, environmental, and economic impact not only on themselves, but also outside stakeholders. The size of the company has an impact on which pillar of sustainability the company may focus more on.

Overview: This presentation will examine case studies of companies that range on the following scale: start-up, small business, corporation, multi-national corporation. Showing how the size of the company heavily impacts which focus of sustainability the company's decision making aligns to help promote success for the organization. For example, a company that is a start-up should focus more heavily on economic decisions in order to grow whereas a corporation will make decisions that not only effect economics, but also the community interactions (social) of its company within the community as well as within the environment its product serves. As companies grow the areas of sustainability focus for that company should mature to help the organization to become better-rounded and viable.

Major Points:

- Looks at Organizational Evolution (the growing business)
- Emphasize the importance of sustainability along with the three pillars (social, environmental, economic)
- Show how decision making changes overtime as the business grows
- Examine how if a company is to be long term viable, it must be well rounded in sustainability metrics

Summary: With the focus in Sustainability appearing to gain broader appeal within companies, it seems that case studies that show how decision making changes over time in regards to sustainability is lacking. This presentation is to assist in showing that while all 3 pillars of sustainability are important; the way companies interact with each pillar will vary depending on the company size. However, in order for a company to grow and become long term viable, the company must address each pillar of sustainability.

Thursday, November 12, 2015 - 4:45pm - 5:30pm

Management

National Cultures Impact on Quality Management: Building Bridges towards Globalization

Author: Ms. Lin Qian, Purdue University, West Lafayette, IN

Need: Quality management is embedded with cultural values and assumptions which are consistent with its culture of origin. Several studies have come to the conclusion that national cultures factor on quality performance. Globalized companies are seeking QM approaches to reach an equivalent level of product quality for worldwide locations. The purpose of this study is to assess how national cultural dimensions impact quality management effectiveness and examine the particular managerially relevant issue of QM.

Overview: This presentation is based upon research study on a quality management maturity model to develop an inductive theory-building approach in accordance with the exploratory nature of the study. The results of this study will propose a framework to facilitate a better QM adoption through the assessment of impact of national cultures.

Major Points:

- Introduction of QM in global companies
- Review of the QM maturity model
- Identify the factors for understanding national cultures barriers on QM adoption
- Propose a QM adoption framework under national culture

Summary: Attendees will understand the current situation of QM in global companies, QM maturity model, and its barriers. Furthermore, a framework of effective globalized QM adoption will be presented to attendees.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Management

Supply Chain Technologies in Northern Minnesota

Authors: Dr. Mahmoud A. Al-Odeh, Bemidji State University, Bemidji, MN

Need: The goal of this presentation is to share research results on the current and future use of information systems for Logistics and Supply Chain Management (LSCM) in Northern Minnesota. The result is developed based on surveying industrial experts from the area. The major information systems and technologies used for LSCM have been identified. The major challenges of using LSCM systems will be discussed. The needs for improving supply chain in Northern Minnesota will be shared with the audience. Figures, tables, charts, and discussion will be used to ensure audience involvement.

Overview: Enhancing LSCM will help organizations to generate more profit and reduce business expenses. The enterprises' policies and practices for managing supply chains in Northern Minnesota are explored. An online survey is used to collect information on three questions: What are the major challenges and developments with the use of information systems for LSCM in Northern Minnesota? What is the level of satisfaction of current enterprises' policies regarding LSCM? What is the actual need of enterprises for the effective use of information systems for LSCM? SPSS program is used to analyze the collected data. Descriptive analysis is used to present and explain the results. This research will help managers to determine the needs to improve their supply chains.

Major Points:

- Strategies, policies, and practices for Logistics and Supply Chain Management (LSCM) will be discussed.
- The needs and challenges in managing supply chains will be identified.
- Online survey is used to collect data from experts on using information systems (e.g. ERP, MRP …) to manage their supply chain.
- Current statistics will help managers improve their supply chains by reducing waste and improving value-add to customers.
- SPSS program is used to analyze the collected data.
- Hands-out of the presentation, survey, and major findings will be shared with the audience.

Summary: Attendees will gain a better understanding on the types of information systems used in LSCM. They will be aware of the challenges and needs for adopting technologies in LSCM. Attendees will be exposed to the best strategies for managing supply chains.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Management

Enhancing Quality and Management Decisions with Stochastic Risk Methods

Authors: Mr. Saxon J. Ryan, Iowa State University, Ames, IA
Dr. Gretchen A. Mosher, Iowa State University, Ames, IA
Dr. Charles V. Schwab, Iowa State University, Ames, IA

Need: Within complex systems, multiple options may emerge as potential solutions to a quality-oriented dilemma, but the value of the decision as compared with other options is often unknown. The ability to understand options relative to one another quantitatively will increase the ability of professionals to make the most optimal decision choice. Stochastic simulation provides a method for comparing decision options in the context of a problem and will greatly assist in making the most optimal decision for a given situation.

Overview: This presentation will discuss the use of stochastic risk assessment methodologies for quality decision-making. Important components of stochastic risk assessment will be presented in the context of quality management. Finally, approaches for identification of the most optimal decision choice will be shown, along with a strategy for optimizing the most cost effective decision.

Major Points:

- Data requirements and how data are used to calculate relative differences in risk
- Understanding the magnitude of change between options
- Implications for professionals in quality control and management

Summary: The audience will learn about how stochastic risk assessment methods can be applied to enhance quality-oriented decision-making. Use of the stochastic risk assessment methods will be discussed in terms of quality control. Implications of the potential uses in a variety of industries will be shared.

Management

Predicting Suppliers' Behavior on Changing of Quality Requirements in Supply Chain

Authors: Dr. Ekaterina A. Koromyslova, South Dakota State University, Brookings, SD
Mr. Jerry Visser, Daktronics, Brookings, SD

Need: Provision of high quality products for customers on time is vital in modern competitive market but this is impossible without effective supplier relationship management throughout supply chain. Although many companies acknowledge high influence of informal factors on customer-supplier relationship, this topic has not been widely explored in theory and practice of supply chain management and supplier relationship management. Opportunity to determine the likelihood of undesirable actions of suppliers will allow companies to make better decision on strategic relationships and resources investment decisions for suppliers development.

Overview: Companies-manufacturers have to deal with demand and supply uncertainties. They need to adjust to changing customer needs and to be able to pass new quality requirements through the supply chain. Even if suppliers' performance is satisfactory in stable environment, they can behave differently in dynamic situation. Some suppliers can fail to meet new quality requirements or even quit the supply chain. Underestimation of suppliers' motivation can lead to loss of sales, customers, and can face the situation of need of new supplier search. The goal of this presentation is to highlight an importance of consideration of informal factors in relationships with suppliers and to discuss a methodology of approach to predict high risk suppliers for changing quality requirements.

Major Points:

- Review of previous studies of suppliers behavior and motivation in supply chain;
- Application of motivation theory and models of behavior change to suppliers performance in supply chain;
- Role of traditional and informal factors in suppliers relationship management;
- Methodology of developing a predictive model of suppliers behavior on changing of quality requirements in supply chain;
- Supply risk assessment based on suppliers' motivation factor.

Summary: Attendees will learn an approach which utilizes analysis of informal factors including suppliers' motivation to predict suppliers' reaction on changing of quality requirements in supply chain. Understanding the influence of informal factors on suppliers' behavior helps avoid or mitigate supply risk.

2015 Conference Proceedings

Friday, November 13, 2015 - 9:00am - 9:45am

Management

A Model to Harmonize China-US Standards for Improved Trade

Authors: Ms. Jing Lu, Purdue University, West Lafayette, IN
Dr. Shweta Chopra, Iowa State University, Ames, IA
Dr. Chad M. Laux, Purdue University, West Lafayette, IN

Need: Increased trade via globalization has resulted in greater wealth spread among more individuals in modern times. Another aspect of freer trade has also resulted in products and services that are produced and consumed across a more complex supply chain. This has resulted in a number of problems, primarily consumption of food products. While China and the US employ the greatest amount of trade, these issues have persisted, despite food safety efforts. Approaching this issue from a policy, rather than organizational aspect is the purpose of this study.

Overview: For the purpose to better streamline international efforts, this presentation will demonstrate that a source of food safety problems arises from uneven rigor in prevention efforts among nations, in this case of infant formula, China and US law. To improve standardization, better harmonization of international efforts is needed.

Major Points:

- An introduction of food safety issues in infant formulization
- A review of US and Chinese policies
- Results of subject matter expertise interpretation
- Conclusions and recommendations

Summary: Attendees will learn about overall food safety and recent efforts to improve the food supply chain. Based upon infant formulization, this presentation will demonstrate that the varied regulations among trading partners results in breaches where standards and regulations are concerned. A method for improving interpretation by organizations involved in this supply chain will be presented.

Friday, November 13, 2015 - 10:15am - 11:00am

Management

Mapping Service Quality Problems to Their causes Using a Taxonomic Framework of Causal Candidates: A Diagnostic Tool for Facilitating Root Cause Analysis

Author: Dr. Darren C. Olson, Central Washington University, Ellensburg, WA

Need: Root cause analysis is a critical part of solving quality problems, but for various reasons the efforts to identify root causes often fall short. This can lead to outright failures to solve problems, to devising short-term solutions that permit an eventual recurrence of the problem, and to implementing solutions without proper regard to systematic causes and system-wide effects. When done within the context of a given industry, mapping common quality problems to their causes can help professionals in that field to understand the typical patterns of cause and effect for quality problems, enhancing their ability to effectively diagnose root causes.

Overview: This presentation will focus on a study in which the author used historical data from problem solving activities in the health care industry to map quality problems to their causes. Quality problems were sorted using the five SERVQUAL gaps as a classification scheme. Network analysis techniques were used to map these problems to their diagnosed causes, which were sorted using a taxonomic framework for causal candidates, based on a simple process inputs/outputs model. The resulting network analysis illustrated patterns between and among causes and effects.

Major Points:

1. Successful quality problem solving relies, in part, on effective root cause analysis.
2. Ineffective root cause analysis can lead poor solutions.
3. Using a systems perspective can help to understand the nature of problems, to point out the complex factors that contribute to problems, and to inform the devising of solutions that are effective and that do not produce undesired side effects.
4. Understanding the intricate relationship between problems and their causes can help professionals to become more skilled at diagnosing root causes within their fields.

Summary: Attendees will learn about a study that mapped quality problems experienced in the health care industry to the causes of those problems. The resulting relationship map helps to illustrate the linkages between and among causes and effects. This mapping process can be used in any profession to help practitioners become better diagnosticians when solving quality problems.

2015 Conference Proceedings

Friday, November 13, 2015 - 10:15am - 11:00am

Management

Lean Six Sigma Big Data: A Higher Education Institution Study

Authors: Mr. Arush Saxena, Purdue University, West Lafayette, IN
Dr. Chad M. Laux, Purdue University, West Lafayette, IN
Dr. John Springer, Purdue University, West Lafayette, IN

Need: Six Sigma is among the most important continuous improvement methodologies adopted by organizations. Big Data is a broad term to describe the use of very large datasets to explore and explain relationships. Both areas demonstrate varied strengths and weaknesses in application. Through an interdisciplinary effort, employed toward the exploration of the data generated in a higher education institution, the Six Sigma Big Data model will result in a synergy that results in a new, combined effort by organizations to improve in a data rich environment.

Overview: For the purpose to create a new metrics to better understand the value of the student college experience, this presentation is based upon a Lean Six Sigma project that employs the DMAIC methodology, in combination with Big Data to explore the definition of student success from a digital perspective.

Major Points:

- Lean Six Sigma: a review
- Higher Education Institution challenges
- The Big Data Concept
- A modified LSS – Big Data methodology
- Indicators of student success via social media

Summary: Attendees will learn about efforts to modify the LSS methodology with Big Data to understand the definition of student success as defined by the Purdue-Gallup Index. This project is based upon the concept that indicators of student success may be more accurately predicted from student generated data through social and other means.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

Management

To the Last Drop: Project Based Learning for Quality Assurance

Author: Dr. Yi-hsiang Chang, University of North Dakota, Grand Forks, ND

Need: To provide a holistic understanding of quality assurance in a single undergraduate course can be challenging: The mathematics behind SPC (statistical process control) could be overwhelming for some of the students. Discussing the principles of DoE (design of experiments) could be too theoretical and remote. The big picture view of TQM (total quality management) could be irrelevant if the students do not understand the basic of business operations. What can the course instructor do to provide a satisfying learning experience that links SPC, DoE, and TQM together?

Overview: This presentation will discuss the observed issues and challenges in an undergraduate quality assurance course, and the effectiveness of project-based learning in addressing these matters. Based on the three-pillar model developed by the instructor, a coffee brewing project was introduced to provide an experiential learning environment, where students can put different theories and principles into practice, and recognize the interaction in-between. The rationale behind individual activities of the project will be presented, and an analysis of the learning outcomes will be reported.

Major Points:

- Overview of the three-pillar model for quality assurance
- The need of the project-based learning approach
- The coffee brewing project: Pulling SPC, DoE, and TQM together
- Assessment of learning outcomes

Summary: Attendees will be informed about the design and implementation of using a coffee brewing project to help students practice the principles of SPC, DoE, and TQM.

2015 Conference Proceedings

Friday, November 13, 2015 - 2:00pm - 2:45pm

Management

Hospital Process Management - A Case Study

Author: Mrs. Tange D. Awbrey, Morehead State University, Morehead, KY

Need: Management philosophies and statistical process control methods, as part of quality assurance in manufacturing received world-wide support throughout the past century. In contrast, the application of these philosophies within the healthcare industry is a recent evolution. Despite proven concepts and innovations, change has progressed slowly. Current managerial concepts and practices fail to recognize the value of customers from both an organizational and community perspective. Fallon, Jr. et al (2013) emphasizes the change towards quality management practices is necessary since the healthcare system generates 2.5 trillion dollars per year in spending and accounts for 17.6 percent of the gross domestic product in the United States.

Overview: Many healthcare facilities receive demands from accreditation organizations, community-driven committees, and external customers in terms of what makes up quality healthcare. According to Sollecito et al. (2013). As learned from its industrial counterpart, the concept of customer specifications or 'personalization' is a recent movement within healthcare facilities. Continuous Quality Improvement, Six Sigma, and Lean Six Sigma are the primary modes of quality management within healthcare. These organizational-wide philosophies provide comprehensive tools and problem solving techniques used to re-engineer, monitor, and maintain the numerous, critical processes found throughout hospital wards. A comparative analysis utilizing statistical process control tools for St. Claire Medical Center in Morehead, KY and John D. Dingell Veterans Affairs Medical Center in Detroit, MI will be utilized to emphasize how the practices of specific quality management tools can provide additional value for internal and external customers.

Major Points:

1. Healthcare application of problem solving tools associated with Continuous Quality Improvement, Six Sigma, and Lean Six Sigma.
2. Identifying internal and external customers to improve the quality of services.
3. A comparative analysis between an urban and rural hospital utilizing statistical process control methods.

Summary: This presentation will emphasize the importance of quality management strategies in healthcare; techniques that can be learned from an industrial counterpart; exploring tools essential for the re-engineering, monitoring, and maintenance of the critical processes; a comparative analysis of two hospitals that utilize quality improvement measures.

2015 Conference Proceedings

Friday, November 13, 2015 - 2:00pm - 2:45pm

Management

Use of Kanban at an International Airport

Authors: Dr. Eli K. Aba, Indiana State University, Terre Haute, IN
Dr. M. Affan Badar, Indiana State University, Terre Haute, IN

Need: Kanban is a method of controlling excessive forward movement of materials through the production system. The presentation aims to critically discuss how Kanban can be used as a signaling device that gives authorization for the withdrawal of items in a pull system.

Overview: Kanban method helps in controlling production and is often accompanied by scheduling daily production for the final assembly area only. It is important that the process areas supplying final assembly react to the demands of the final assembly area, rather than work to a prearranged production schedule. This allows for production to be fine-tuned in reaction to the latest information and conditions. The presentation discusses how materials at an international airport are moved directly to the next station using Kanban.

Major Points:

- Importance of kanban to firms
- Benefits of kanban
- The six rules of kanban
- The use of Kanban as a load smoothing system

Summary: Attendees will understand how to use kanban as a card. The findings may help users of kanban to be in the position to know more about Kanban and adopt it.

Thursday, November 12, 2015 - 11:30am - 12:15pm

Manufacturing

Safe Production in Industry 4.0

Author: Dr. Clair J. Roudebush, Marshall University, Huntington, WV

Need: The concept of "Industry 4.0" originated in 2013 as a high-tech manufacturing initiative from Germany. This initiative purports that we are currently entering a very important 4th Industrial Revolution era. This era is followed in progression from Industry 1.0 utilizing steam engine power, Industry 2.0 utilizing assembly line/ mass production, and Industry 3.0 utilized automated production technologies such as numerical control and programmable logic controllers. In Industry 4.0, the manufacturing environment is transformed into a de-centralized smart manufacturing computer system. This shift to a de-centralized computer system has, however, been recently discovered to create small timing delays in dispatching messages between such linked computer systems. These timing delays can cause safeguarding equipment to malfunction and create hazardous situations for the personnel in these areas.

Overview: This presentation will: a) provide an synopsis of Industry 4.0, b) discuss how the fail-safe features of Industry 3.0 can malfunction in an Industry 4.0 environment, and c) outline potential educational curriculum needs for safe production in Industry 4.0.

Major Points:

1. Industry 4.0 is a major advancement in manufacturing technology.
2. The "hand speed constants" utilized in Industry 3.0 set-up protocols have potential safeguarding hazard implications when introduced into Industry 4.0.
3. A "call for action" regarding the need for a new type of Safety Control Circuit protocol is needed in Industry 4.0 to protect personnel working in this environment.

Summary: With the emergence of Industry 4.0 as the technological model of the future, educational programs in Manufacturing Technology will need to evolve to meet these new educational curriculum's needs.

2015 Conference Proceedings

Thursday, November 12, 2015 - 11:30am - 12:15pm

Manufacturing

Micro-Milling Machinability of Aluminum, Copper and Brass

Authors: Mr. Michael Harruff, Western Kentucky University, Bowling Green, KY
Dr. Muhammad P. Jahan, Western Kentucky University, Bowling Green, KY
Dr. Gregory K. Arbuckle, Western Kentucky University, Bowling Green, KY

Need: In recent years there is increasing needs for micro-parts, components and structures for applications in micro-electro-mechanical systems (MEMS) and electronic industries. In order to meet the increasing demands from these industries, micro-features are being produced using various mechanical and non-mechanical micromachining processes. Among the mechanical micromachining processes, micro-milling is found to be capable of fabricating almost any three-dimensional (3D) shapes using the computer numerical controlled machine tool. Aluminum, brass and copper are extensively used in production of micro scale parts and components for electronic and packaging industries because of the ease of machinability and excellent mechanical and electrical properties. Micro milling is the most popular machining process for fabricating micro parts and components with excellent surface finish and dimensional accuracy.

Overview: This study will compare the machinability of aluminum, brass and copper by the micro-milling process. The machinability will be evaluated based on the micro-structuring capability of three materials. Various complex shaped micro-features will be designed using computer-aided design (CAD) and attempt will be taken to fabricate those in aluminum, brass and copper. The optimum parameters setting for machining those complex shapes will be identified first based on the surface roughness, dimensional accuracy and burr formation. Finally, a comparison on the machining performance of the three materials will be done based on cutting tool life and surface finish of the micro-features.

Major Points:

- Optimizing machining parameters for micro milling of aluminum, brass and copper
- Designing various complex-shaped micro-features using the CAD software
- Machining of micro-features in aluminum, brass and copper
- Comparative study of the machinability of aluminum, brass and copper

Summary: This research will present a comparative study on the micro-structuring capability of three materials: aluminum, brass and copper using the micro-milling process.

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Manufacturing

Manufacturing and Non-Manufacturing Students' Perceptions on the Applicability of the Four Pillars

Authors: Dr. Muhammad P. Jahan, Western Kentucky University, Bowling Green, KY
Dr. Mark Doggett, Western Kentucky University, Bowling Green, KY

Need: In June 2011, a group of manufacturing educators in cooperation with the Society of Manufacturing Engineers (SME) developed Curriculum 2015, a four-year strategic plan to reverse negative trends in manufacturing education and improve manufacturing competitiveness. As a result, the Four Pillars of Manufacturing Engineering were formally introduced and supported by SME, ATMAE, and ABET. The Four Pillars consist of competencies relevant for entry-level Manufacturing Engineers. However, many of the competencies may also be applicable to non-manufacturing disciplines. For example, it is widely agreed that there is universal application of certain of leadership and management competencies across multiple contexts. Manufacturing programs typically emphasize a core set of technical competencies. This research sought to investigate the perceptions of students in both manufacturing and non-manufacturing programs on the applicability of Four Pillars competencies to their respective contexts.

Overview: This presentation discusses survey research on the perceptions of manufacturing, construction, architectural sciences, and master's level students regarding the Four Pillars technical competency areas. Manufacturing and non-manufacturing programs were surveyed regarding the applicability of the knowledge areas to their particular career goals. Specifically, the survey sought to answer the following research questions: • What technical skill areas of the Four Pillars could be applied in other contextual areas besides manufacturing? • What fundamental technical knowledge is required across all programs? • Is the knowledge specified by the Four Pillars model important for any entry-level technical manager?

Major Points:

- Background of the study
- Methodology of the research
- Findings
- Summary and interpretation

Summary: This presentation presents research on manufacturing and non-manufacturing students' perceptions regarding the technical knowledge specified by the Four Pillars model.

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Manufacturing

Model for Conducting Process Improvement Projects Using Concepts of Lean Six-sigma at the Green Belt and Black Belt Levels

Authors: Dr. Merwan Burjor Mehta, East Carolina University, Greenville, NC

Need: Companies have found it most beneficial to embark on process improvement initiatives through the pursuit of Lean principles, Six-sigma concepts and Theory of Constraint ideas. Many train their employees to be certified at the Green Belt and Black Belt levels of Lean Six-sigma (LSS), which requires conducting and presenting a successful project to show pre-determined savings or revenue growth. However, most companies do not realize the full extent of the potential that LSS promises for increasing their productivity and profitability because they do not utilized a standardized validated model for conducting training and pursuing projects.

Overview: In this presentation, a standardized validated model that the author has used to usher candidates into conducting projects at the LSS Green Belt (LSSGB) and LSS Black Belt (LSSBB) levels will be presented. A brief discussion on how the body of knowledge and training for LSSGB and LSSBB meshes with the project completion model will also be presented. This presentation is aimed at instructors and candidates who are interested in LSSGB and LSSBB certifications.

Major Points:

- Overview of body of knowledge for LSSGB and LSSBB certifications
- Discussion on model for conducting projects for LSSGB and LSSBB certification
- Results from application of the model and review of feedback from champions

Summary: This session will briefly discuss the body of knowledge for LSSGB and LSSBB certifications that the author has developed after working in LSS for over 10 years. A model for conducting projects required for LSSGB and LSSBB certification that has been standardized and validated will be presented, and results and comments from champions whose subordinates have utilized the model will be presented.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Manufacturing

Investigating the Surface Quality and its Effect on Biocompatibility during Micro-Electro-Discharge Machining of Titanium Alloys

Authors: Mr. Bradley C. Logsdon, Western Kentucky University, Bowling Green, KY
Ms. Pegah Kakavand, Western Kentucky University, Bowling Green, KY
Dr. Muhammad P. Jahan, Western Kentucky University, Bowling Green, KY

Need: In recent years titanium alloys have become an important choice of material for manufacturing biomedical implants for both orthopedic and orthodontic applications. Ti-6Al-4V (titanium alloy grade 5) and NiTi (shape memory alloy) are two widely used materials for biomedical applications because of their excellent mechanical properties and corrosion resistance. One of the important requirements of the biomedical implants is the surface quality. The surface characteristics parameters play an important role in determining the biocompatibility of the fabricated implants. While the implant material is placed inside the body, the surface of the implant comes in contact with human body. Therefore, it is important to investigate the surface generated in biomedical materials after machining.

Overview: Although titanium alloys posses excellent mechanical and corrosion properties, they are found to be difficult to machine using conventional machining processes because of their hardness and strong alloying tendency. In recent years, electrical discharge machining (EDM) is found to be a suitable option to machine hard and difficult-to-cut material, given that the material is electrically conductive. There have been numerous researches on the EDM of titanium alloys. However, very few studies have focused on the relationship between the surface characteristics generated during EDM and biocompatibility. The objective of this research is to investigate the surface characteristics and biocompatibility of titanium alloys after machined using micro scale electro-discharge machining (micro-EDM) process. The surface characteristics and their relationship with the biocompatibility will be investigated experimentally using different materials characterization techniques.

Major Points:

- Optimizing machining parameters for micro-EDM of Ti-6Al-4V and NiTi
- Investing the surface characteristics using SEM, EDX and XRD analysis
- Investigating surface roughness, recast layer, surface hardness, porosity, and the compounds formed on the surface after machining
- Effect of surface characteristics parameters on biocompatibility

Summary: This study will present a detailed experimental investigation on the surface characteristics of titanium alloys after machined by micro-EDM process. The study will also present the relationship between different surface characteristics and biocompatibility of titanium alloy machined by micro-EDM process.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Manufacturing

Current Nano Scale Manufacturing Processes and their Capabilities

Authors: Dr. Muhammad P. Jahan, Western Kentucky University, Bowling Green, KY

Need: With the growth of micro-electro-mechanical systems (MEMS) and nano-electro-mechanical systems (NEMS), the demand for nano-scale parts, components and devices are increasing. Some of the reported industrial applications of nano-scale parts and devices are DNA detection devices for biomedical industries, nano-wires for electronic industries, gyroscopes for aerospace industries, and pressure sensors for automotive industries. The types of nano-features that are being used for different applications are nano-holes, nano-pores, nano-vias, nano-channels, nano-wires, nano-tubes and so on.

Overview: This study aims to present the nano-manufacturing processes that have been reported in the literature. The study mainly focuses on the tool-based nano-manufacturing processes that resembles with the conventional and micro scale manufacturing processes. Other nano-technologies, such as chemical etching, photolithography or similar processes have not been considered, as they are better grouped into soft lithography techniques rather than nano-machining processes. Both contact and non-contact based processes have been included in the presentation. Many of these processes are already in use in the industry environment, whereas some are still in the development level at the laboratories. This presentation will explain the working principle of various nano-manufacturing processes along with application examples. A comparison of different nano-manufacturing processes based on their capability, advantages and disadvantages will also be presented.

Major Points:

- Importance and necessity of nano-manufacturing processes
- Working principle of various tool based nano-manufacturing processes
- Applications of various nano-manufacturing processes
- Comparative study of the nano-manufacturing processes

Summary: This presentation will present a review of the existing tool based nano-manufacturing processes along with their working principles, applications and capabilities.

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Manufacturing

Discrete-Event Modeling and Simulation for Continuous Improvement in Manufacturing Systems

Authors: Dr. Nilmani Pramanik, University of Northern Iowa, Cedar Falls, IA
Dr. Julie Zhang, University of Northern Iowa, Cedar Falls, IA

Need: Manufacturing Industry is going through rapid changes with more modern, complicated manufacturing processes and facing global challenges. To remain competitive, manufacturing industry needs continuous improvement (CI) of its existing processes as well as assesses newly introduced manufacturing entities on a continuous basis. This needs complete assessment of the discrete events that takes place in the manufacturing process. Unfortunately, oftentimes, these analyses are not feasible using closed form mathematical formulations and the best option to assess these processes is to use simulation and modeling techniques. There are several powerful simulation software packages available today. The manufacturing curriculums need to integrate simulation and modeling in their curriculum so that students prepare themselves to serve for the industry equipped with this important tool.

Overview: In this proposed presentation, the authors would discuss the CI process and the basic tenets on which these simulation techniques are based, and would provide a practical approach to integrate simulation software in the manufacturing technology curriculum with examples of process from the industry to show various aspects of the simulations techniques. Sometimes, it may not be feasible to offer a full course on simulation, and the idea would be to use a module for simulation and modeling in some relevant courses like Managing Manufacturing Systems or Production Planning and Control.

Major Points:

- Continuous improvement needs the PDCA (plan-do-check-act) cycle for evaluating parameters and taking actions on a continuous basis
- Manufacturing industry needs discrete event simulation for assessment of process parameters for existing process

Summary: The proposed presentation would enable the audience to understand the need as well as the procedure that are essential for effectively using simulation and modeling techniques for study and analysis of discrete events in manufacturing processes for continuous improvement. It is felt that this will be of interest and beneficial to both the manufacturing industry as well as academia, specifically those who are planning to incorporate modeling and simulation in manufacturing technology curriculum.

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Manufacturing

Zero Positional Tolerance at Maximum Material Condition: A Workforce Development Priority

Authors: Dr. Sharon M. Rouse, Mitchell Community College, Statesville, NC
Dr. Robert A. Chin, East Carolina University, Greenville, NC

Need: Zero Positional Tolerance at Maximum Material Condition is often misunderstood as being a tighter tolerance on position rather than a provision for providing greater flexibility in the production of parts. For many who do not understand this approach, it is just what it says—no tolerance at Maximum Material Condition. Findings from a recent study suggests that a lack of understanding on how Zero Positional Tolerance at Maximum Material Condition works to be the primary reason why this cost savings approach to assigning positional tolerances is not used to the extent it should. The findings from this study also suggest that there are ways in which the industry can improve understanding and overcome associated misunderstandings.

Overview: Geometric Dimensioning and Tolerancing (GD&T) is a system used by engineers and manufacturers to characterize part features and their allowable variation. It was developed in response to the problems associated with the production of parts manufactured for the war effort during World War II. Zero Positional Tolerance at Maximum Material Condition is one of the approaches used to characterize position tolerances. The literature suggests that the proper use of Zero Positional Tolerance at Maximum Material Condition will greatly increase the acceptance rate of useable parts, create less waste, provide more flexibility to the assignment of tolerances, and therefore reduce production cost. The intent of this study was to examine why manufacturers are or are not using this approach, despite the many purported benefits. A mixed method study using a survey and interviews was conducted to determine the predominant reasons for the use of Zero Positional Tolerance at Maximum Material Condition. The results suggest that the reason Zero Positional Tolerance at Maximum Material Condition is not more widely used is because of a lack of understanding.

Major Points:

• Introduction to the Study • Findings • Manufacturing Endeavors • Functional or Attribute Gages • Levels of Employment • Levels of Education • Training • Reasons for or for not using Zero Positional Tolerance at Maximum Material Condition • Implications for Workforce Development

Summary: If the goal of manufacturing endeavors is to increase profits, then it follows that manufacturing endeavors must reduce scrap and rework. This concept is embraced by industrial practitioners such as Goldratt (1989), Ohno (1988), and Taguchi (1988). If simply shifting tolerances from one characteristic to another results in a reduction in scrap and rework, all without sacrificing quality, fit, form and function, then more manufacturers should ensure that their workforce is educated and trained in the use of Zero Positional Tolerance at Maximum Material Condition.

Thursday, November 12, 2015 - 4:45pm - 5:30pm

Manufacturing

Teaching Innovation: Imagination, Conceptualization and Innovating, Utilizing 3D Printing Technology in a University Setting

Authors: Mr. Lyle Meulebroeck, Bemidji State University, Bemidji, MN
Mr. Andrew Graham, Bemidji State University, Bemidji, MN

Need: The world of Rapid Prototyping, also known as 3D Printing is a technology that is growing at an astronomical pace. An integral part of industry at many levels, it is being embraced as the technology we can't live without. According to Terry Wohlers (President, Wohlers Associates, Inc.), Industry wide growth in this area is projected to be $3.1 Billion by 2016 and $5.2 Billion by 2020. Because of this growth potential, there appears to be a significant need for topic related curriculum. This should provide students with knowledge of the equipment/materials and capability to manage that specific lab environment. They must also have the competences and expertise to interact with clients who request its services. This can be achieved by specific courses on multiple subjects directly related to this high growth technology.

Overview: The students who utilize this technology come from multiple majors and areas of interest. 3D printing is applicable to multiple majors. Applied Engineering, Model Making, Design Technology and Engineering Technology are some examples. Many of our students are versed in multiple 2D and 3D software programs, with 3D being the course of choice for 3D printing. Various courses require students to incorporate rapid prototyping which allows freedom for Creativity and Innovation. Utilizing the multiple 3D Printing machines available to them, it requires construction of a 3D model; this allows students to visualize the output of their idea and creation. These outputs create design challenges and require them to test, analyze, redesign and subsequently seek final design approvals. They also will be exposed to a "real world" situation by coupling them with a business professional or mentor on a project. The student will be required to meet on a weekly basis (email, skype, etc.) to review the assigned project. Students must also be familiar with the management aspect of the RP industry. This may include soft skills, such as; client interaction, purchasing, knowledge of production, etc. Course requirements include Project Management, Quality Assurance, Engineering Economics, etc.

Major Points:

- Knowledge of 3D Printing Equipment/Materials
- Capability and knowledge of 3D software
- Work with Clients on "Real World" project

Summary: Students will gain knowledge and understanding of the 3D printing industry and the many styles of equipment and the various types of materials needed to support them. These capabilities will give them employment opportunities in a vast number of industrial and product development settings.

Friday, November 13, 2015 - 8:00am - 8:45am

Manufacturing

A New Way of Looking At Shear Angle from the Standpoint of Tool/Chip Engagement Time

Author: Dr. John E. Wyatt, Mississippi State University, Mississippi State, MS
Dr. Oliver J. Myers, Clemson University, Clemson, SC

Need: In all machining calculations the angle of the primary shear zone is used to make many calculations regarding the machining condition. However, this shear angle is impossible to predict and many FEA simulations do attempt to predict it but do not take into account other machining parameters. From this the main premise is that the shear angle rises when the cutting speed increases. A simpler way to determine shear angle needs to be developed which takes into account the cutting conditions such as feed per tooth, axial depth of cut and the time the tool insert/workpiece material engagement which is a function of the rotational speed and the radial depth of cut in milling. From a determination such as this simple empirical models can be developed.

Overview: While undertaking his PhD the author noticed that while machining with two different machining approaches, low speed-high torque, and high speed - low torque, the shear angle of the same cutting speed in the same material were vastly different. The only explanation for this difference was the amount of time that the cutting insert was actively engaged in the cutting of the workpiece material. This presentation will show new preliminary experimental results where the tool/chip contact time is the factor that has been fixed but the cutting speed has to be altered to maintain the fixed contact time.

Major Points:

- The importance of the shear angle in machining calculations
- Experimental work that initiated this work
- A new experimental procedure that controls the tool/chip contact time, which can also be employed as a student experiment
- Presentation of the experimental results

Summary: Attendees will see that there is a possibility of creating simple empirical models through the use of tool/chip contact time. They will also be able to employ such an experiment in their classrooms as a teaching aid in the theory of machining, especially in the explanation of the shear angle.

Friday, November 13, 2015 - 8:00am - 8:45am

Manufacturing

Optimization of Machining Parameters Using Simulated Annealing in Sustainable Wet Machining

Authors: Dr. Rukmini Srikant Revuru, University of Northern Iowa, Cedar Falls, IA
Dr. Nageswara Rao Posinasetti, University of Northern Iowa, Cedar Falls, IA

Need: Manufacturing being a very resource consuming activity, there is a constant drive to optimize the parameters associated with machining. The review of existing literature found many types of models for optimization, most of them are used for dry cutting only. No significant literature was found that incorporates the cost of cutting fluids with their associated environmental impacts into account while optimizing the process parameters. Hence, there is a need of a model that optimizes the machining cost by choosing optimum machining parameters in wet machining for sustainable manufacturing.

Overview: Literature is reviewed to understand the state-of-art of empirical modeling and optimization in machining. Several mathematical models were formulated in literature to optimize machining parameters and achieve an objective function like minimizing tool wear, surface roughness or cost of machining. However, the effect of cutting fluids or the costs associated with them were not incorporated in the models. The conventional optimization techniques are sometimes not able to achieve optimality within a short time. In such situations it is found that evolution techniques such as genetic algorithms, and simulated annealing have been found to provide a quick response time. The present work aims to develop an optimization model to minimize the total cost of machining including cutting fluid procurement, maintenance and disposal costs and then solve it using simulated annealing.

Major Points:

- Data required for modeling generated through experimentation
- Development of a mathematical model in wet machining
- Optimization of developed model using Simulated Annealing Technique
- Analysis of results
- Implication on how the study results can guide industrial applications

Summary: Economy is an important factor in deciding the sustenance of a manufacturing facility. Though cutting fluids are conventionally used in machining to improve the performance of the process, they are often looked at as an additional expenditure. This paper presents an empirical model to minimize the total cost of machining, when cutting fluids are applied. The model was formulated using the data generated through experimentation. The model was optimized using Simulated Annealing technique to choose the optimal machining conditions.

Friday, November 13, 2015 - 9:00am - 9:45am

Manufacturing

Comparing Particle Swarm Optimization and Simulated Annealing for Optimization of Machining Parameters in Wet Machining of AISI 1040 Steel

Authors: Dr. Rukmini Srikant Revuru, University of Northern Iowa, Cedar Falls, IA
Dr. Nageswara Rao Posinasetti, University of Northern Iowa, Cedar Falls, IA

Need: Production of quality products at low cost is one of the major goals in manufacturing. The common way of achieving this goal is through the optimization of machining parameters. Though several studies related to optimization of machining parameters can be found in literature, all of them deal with dry cutting only. Not many works can be found in literature that deal with optimization in wet machining. Even the available works do not consider different levels machining parameters and their effect on the cost. Hence, there is a need for a model that optimizes the machining cost by choosing optimum machining parameters in wet machining.

Overview: Available literature is reviewed to comprehend the different optimization models proposed in literature. Various models that aim at minimizing tool wear, machining cost or surface roughness can be found in literature. While some models deal with constant cutting conditions namely cutting speed, feed and depth of cut, other models try to optimize the values of these parameters. However, the models deal with only dry machining and the effect of cutting fluids is generally neglected. Since cutting fluids are widely used in the industry, the existing models do not successfully represent the real-time scenario. The present work aims to bridge the gap by developing an optimization model to minimize the total cost of machining including cutting fluid costs and then solve it using simulated annealing (SA)/particle swarm optimization (PSO) techniques. Two techniques are used to investigate the applicability of the techniques in online monitoring.

Major Points:

- Generation of data through experimentation at different levels of machining parameters
- Development of a mathematical regression model in wet machining
- Optimization of developed model using SA/PSO Techniques
- Analysis of results
- Comparison of the optimization techniques
- Analysing the scope of possible application of the methodology for Industrial applications

Summary: Economy is a deciding factor for the growth and sustenance of a manufacturing facility. Though cutting fluids are popularly used as coolants and lubricants in machining, they are often viewed as additional expenditure. However, the cutting fluids play a crucial role in improving the machining performance and quality of the product. Though different models that try to suggest optimal machining parameters are proposed in literature, the models often neglect the cutting fluids and their associated costs. This paper proposes an empirical model to minimize the total cost of machining in wet machining. The model was framed using the data generated through experimentation. The developed model was optimized using SA and PSO techniques to choose the optimal machining conditions. The results from the two techniques are compared to decide estimate the efficacy of the techniques in the scenario.

Manufacturing

The Effects of Performance and Longevity of AISI 4141 Steel in the Firearms Industry

Authors: Mr. Daniel T. Stock, Eastern Illinois University, Charleston, IL
Dr. David W. Melton, Eastern Illinois University, Charleston, IL
Dr. Isaac S. Slaven, Eastern Illinois University, Charleston, IL

Need: Today's firearms industry has a business model based off performance and longevity of products however the industry has failed to provide support of their claims. This study looks at the common steel coatings used in the firearms industry to protect against corrosion, impact, and many other things. These coatings include manganese Parkerizing, Dura Coat, and bluing. This was done by putting specimens of 4140 steel, an industry standard, with these coatings through a variety of treatments, such as freezing temperatures, high temperatures, sand, mud, gravel, and a highly corrosive environment.

Overview: To measure the effect the coatings have on the metal, two tests were used: Rockwell Hardness and Charpy impact. The Rockwell hardness test was used multiple times throughout the research to track the progress of the steel. The Charpy impact test was the final test that the specimens went through to see how the steel was affected during the treatments. This study will included over 85 individual specimens. Those specimens will consider all conditions as stated in previous sections of this proposal. It is estimated that there is a potential of over a 1000s readings will be take between both the Charpy and Hardness testing.

Major Points:

The Major Points include:

1. What is the effect of the different coatings on metals?
2. What is the effect of the different environmental changes on the metal?
3. What are the degrees of impact and hardness after both #1 and #2 has been applied
4. What can be concluded from the results

Summary: Attendees will gain information to help them understand the complexity of how common steel coatings used in the firearms industry can be effected when different environmental conditions occur during the usage of firearms.

Friday, November 13, 2015 - 10:15am - 11:00am

Manufacturing

Improve Global Competitiveness: A Software Development for Fast and Accurate Cost Estimation of Machined Parts

Authors: Dr. Haoyu Wang, Central Connecticut State University, New Britain, CT
Dr. Paul J. Resetarits, Central Connecticut State University, New Britain, CT

Need: Accurate and fast cost estimation of a product is very critical for a successful business in global manufacturing. A company normally loses a contract due to too high or slow estimate or lose money due to too low estimate after getting the contract. For manufacturing companies, the biggest cost comes from machining where cutting time, materials, and machine tools are major factors. CCSU initiated a faculty in residency program with many local manufacturing companies to help solving their imminent technical issues. Faculty members propose solutions and collaborate CCSU students and company engineers in implementing them. One of the projects is to help a company to automate the machining cost estimating process to achieve quick and accurate cost estimating.

Overview: The company is using an industrial main stream CAD (Computer Aided Design) software named SolidWorks. SolidWorks API (Application Programming Interface) was used through .NET programming technology to develop add-in software in SolidWorks. So when the company salesperson gets the inquiry of a part from a customer, the part model or information will be passed to a company designer to generate SolidWorks model. The add-in cost estimating software will automatically detect the manufacture features on the model and output the cost in terms of machining time of all manufacturing features based on the part material, cutting tool and machine tool used. The cutting time for each manufacturing features is obtained through time study of the feature in the form of a formula or through time study of computer aided manufacturing software.

Major Points: The framework of the software has been designed and the core manufacturing feature module has been developed. The software can detect standard library features and nonstandard features. This dramatically reduced the time which was conducted by human being. It also provides much higher efficiency, repeatability, reliability than the results from human. In addition, it can detect material of the part, the location and orientation of features, which are critical for accurate machining time estimation. Once the time study of all features (standard or non-standard) are finished, the software can map the detected features to its respective machining time hence calculate the cost the whole part.

Summary: An automatic cost estimating software to quickly and accurately estimate cost of a machined part was designed and partially implemented. The finished core module of the software can automatically detect all manufacturing standard and non-standard features and other important information such as part material and feature location and orientation. The soon completion of the project will provide a method for manufacturing companies to get solution of cost estimate of machined part in a relatively low cost.

2015 Conference Proceedings

Friday, November 13, 2015 - 10:15am - 11:00am

Manufacturing

Eventorbot: An Open Source 3D Printer Manufacturing and Improving

Authors: Mr. Haizhou Li, Eastern Illinois University, Charleston, IL
Dr. Jerry Cloward, Eastern Illinois University, Charleston, IL
Mr. Brendan Clary, Eastern Illinois University, Charleston, IL

Need: 3D printers will be more popular in the future. However, there are several factors that slow down the popularity of 3D printers. First, the cost of a 3D printer is much higher than a normal printer. The cheapest printer on the market cost at least five hundred dollars. Second, it is too complex to make a 3D printer and it is hard to find an open source 3D printer design. Third, people do not realize how useful 3D printers are and how to correctly use a 3D printer. The main purpose of my presentation will be to show how to control the costs of making a 3D printer and how to easily manufacture a 3D printer within a school production lab. Imagine if you could make a 3D printer on Campus or even at home! It sounds crazy, but exciting right? If a group of students could work part time on a project to make a 3D printer and if the school were to help with the purchase materials, then the school would not only save a lot of money, but would also allow more students have chance to use 3D printers.

Overview: I will be telling the audience about the manufacturing process of a 3D printer, as well as how to assemble and how to use a 3D printer. The manufacturing process will cover the following: the kinds of materials one should choose, the kind of processing technology that is involved, the accuracy requirements and how to control the costs. When showing the audience the assembly procedure, first I will introduce the different kinds of parts necessary to building the printer, then I will show the audience what the final product should look like. At the end of my presentation I will show the audience how to use an already existing 3D printer to print the parts needed to create a new 3D printer. The goal of my presentation is to leave the audience with new opinions about 3D printers and to be encouraged to make their own 3D printers.

Major Points:

- The outlook of 3D printers
- The benefits to making your own 3D printer
- An open resource 3D printer manufacturing
- How to use an already owned 3D printer to print assembling parts
- How to assemble your own 3D printer
- Correctly using your own 3D printer

Summary: Manufacturing your own open source 3D printer will be a good way for schools to educate students and attract students' interests. In the future many of our everyday tools will be designed via computers and manufactured using 3D printers. If people can easily use already owned 3D printers to print more 3D printers then it will not only decrease the cost of a 3D printer, but also allow more people to use 3D printers. Allowing students and institutions to create their own 3D printers will increase peoples' knowledge and interest in this area.

Friday, November 13, 2015 - 11:15am - 12:00pm

Manufacturing

Opportunities in Manufacturing of Renewable Energy Components in Central Kentucky

Author: Mr. Scott Abney, Purdue University, West Lafayette, IN

Need: With fossil fuels being a limited resource, a heavier focus has been placed on incorporating alternative energy sources into the energy grid. Due to this focus, an opportunity exists for manufacturing industries to develop components that can be used in the renewable energy market. Many companies may not realize that such opportunity exists between their products and those used in renewable energy components. This presentation showcases case studies that have used frameworks to identify opportunities as well as the development of a framework for the Central Kentucky area.

Overview: This presentation will examine research of the presenter in examining the manufacturing infrastructure of the Central Kentucky (Bluegrass Region) in relation to the possibility of making renewable energy component parts. Included is the framework developed by the presenter that incorporated standards from the U.S. Renewable Energy Policy Project along with local manufacturing guides. The focus of the study is to present opportunities that may exist for manufacturing industries in the area that may be able to capitalize on a growing opportunity.

Major Points:

- Examine energy policies of the state of Kentucky
- Statistics of the areas identified in the Central Kentucky area
- Showcase existing frameworks and case studies used to identify opportunities for manufacturing renewable energy components
- Develop a framework that more closely aligns for the Central Kentucky area
- Conclude with showing the potential of increasing the market and employment opportunities for the area

Summary: The state of Kentucky is primarily known for its coal production. However, with the increase of incorporating renewable energy to replace fossil fuels an opportunity exists for manufacturing industries to enter the renewable energy component market. This study will show that by the development of a framework for the area based on REPP standards, there are a number of existing manufacturing industries that may be able to enter the market with the potential to attract renewable energy companies with impacts that would increase the social and economic of the local communities. The potential long term effects could help the state replace job losses in the coal community with those in the renewable energy market.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

Manufacturing

Simulated Manufacturing Company Class Case Study—The Good, the Bad, and the Useful

Author: Mr. Paul Nutter, Ohio Northern University, Ada, OH

Need: It can be difficult for students to truly understand the complications and process of establishing a manufacturing company and taking a product through the full product lifecycle. Finding ways for them to see the consequences of poor decisions are often not fully realized in traditional lectures and textbooks studies. It is very good if they share their insights with others in a real type application understanding the multiple aspects associated with company creation, finance, management, product design, marketing, sales, manufacturing and distribution.

Overview: Our program offers students majoring in Manufacturing Technology a two course sequence, beginning with the creation a simulated manufacturing company and going through the entire process of creation, management, and dissolution of a company to produce and sell a tangible product. A second course provides lectures, textbook studies, and video examples of these aspects for creating a company for manufacturing, with the students able to associate the theory with their experiences and difficulties in the previous course. This presentation documents the good, the bad, and the useful information, and the learning effectiveness realized by the students during this process.

Major Points:

- Description of this class and the processes to create a simulated manufacturing company within a classroom environment.
- Descriptions of the products and projects created and sold over the past several years.
- Description of the successes and the failures students have experienced, and comments on how failures sometimes teach more than successes.
- Feedback from students as to the adequacy of this course to prepare them for their careers.
- Explanation and evaluation of the follow-up course in manufacturing management, and the effectiveness for students to better grasp the consequences of decisions.

Summary: This presentation explains a class where students create a simulated manufacturing company which designs, markets and manufactures a real product for sale on campus. The students learn and apply management principles, production technologies, engineering design and teamwork during this process. Recommendations are also provided for appropriate curriculum revisions to enhance the job-readiness of students to better serve these 'customers' of our academic services.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

Manufacturing

Implementing 3D Modeling in Packaging Industry

Author: Dr. Farzin Heidari, Texas A&M University-Kingsville, Kingsville, TX

Need: 3D modeling is defined as the process of developing a mathematical representation of any kind of three dimensional surfaces. The 3D modeling helps in designing various forms of digital designs that are printable in a physical form. The 3D modeling software is the answer to withstanding global competition in the current packaging industry. There is a need to cut down the time in the process of releasing a successful product into the market. 3D modeling and printing is the leading technology in product innovation and design to minimize the manufacturing process time. The presentation proposes a methodology to the packaging industry on how to digitally design a model and use it as a base to produce packaging material through thermo-forming.

Overview: The purpose of this presentation is to apply 3D modeling to improve the design and functionality of the packaging materials. The packaging industry strives for an efficient design and this can be achieved in a simpler way by using 3D modeling. The pattern for thermoforming process can be designed and generated using 3D printing. Thermo-forming is a manufacturing process where a plastic sheet is given heat to an extent where it becomes pliable. The plastic sheet then is pulled into a mold using vacuum force. This approach provides the flexibility to analyze the physical characteristics of the model and make modifications if necessary. Any decision about making necessary changes that might increase its efficiency or its functionality can be made before actually sending it for commercial level production.

Major Points:

- Introducing the new technique of producing packaging material using 3D modeling.
- Using a 3D modeling software to design a digital model.
- Printing the digital model physically using a 3D printer.
- Applying the thermo-forming process.

Summary: The global packaging industry generates over $485 billion in sales annually. Packaging has been integrated into various industries such as healthcare, food, drinks, cosmetics and various other consumer goods. There are numerous advantages associated with the process of 3D modeling and 3D printing in relationship to packaging. It minimizes the cost associated with the manufacturing of any kind of packaging. The procedure helps achieve a relatively short lead time to production of packaging material and provides the possibility to produce different shapes and sizes quickly.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

Manufacturing

Evaluation of Stereoscopic Vision for Manufacturing Applications

Author: Dr. Wutthigrai Boonsuk, Eastern Illinois University, Charleston, IL

Need: Stereoscopic vision technology has been introduced for decades. While recently there are tremendous growths in the area of stereo vision in consumer products such as 3D televisions, movies, and games, very few integrations of stereo vision have been practically utilized in manufacturing applications. Major applications include robotic vision, defect detection, and object measurement. This study investigates parameters that may hinder this technology from being widespread in the industry.

Overview: In manufacturing applications, stereoscopic vision offers benefit in depth information retrieval from a scene using a pair of images. The accuracy of the results usually depends on the camera system and the algorithm to estimate pixel's distance (disparity). Both system and algorithm can be considered as internal parameters that operators can control and adjust according to their needs. On the other hand, there are external parameters such as lighting condition, surface roughness, and material property that can also impact the accuracy of depth estimation. This study will present the effects of these external parameters on the depth calculation (depth map) in stereo vision. Furthermore, the results from the study will help develop the standard settings that allow the stereo vision to be fruitful for industrial applications.

Major Points:

- Usefulness of stereoscopic vision for industry
- Depth estimation method for stereoscopic vision
- Effects of external parameters on the accuracy of depth estimation
- Standard settings of external parameters for industrial applications

Summary: Attendees will learn the usefulness of stereoscopic vision for industrial applications. The effects of external parameters (e.g. lighting condition, surface roughness, material property) on depth estimation will be analyzed and presented. Proper setting of these external parameters will also be discussed.

Friday, November 13, 2015 - 2:00pm - 2:45pm

Manufacturing

Aligning the ATMAE Accredited Manufacturing Engineering Technology Curriculum Content with the Society of Manufacturing Engineering (SME) Four Pillars of Manufacturing Knowledge

Authors: Ms. Fatemeh Davoudi Kakhki, Morehead State University, Morehead, KY
Dr. Ahmad Zargari, Morehead State University, Morehead, KY
Dr. Yuqiu You, Morehead State University, Morehead, KY

Need: As globalization and rapid technological changes are the norm in the world today, manufacturing is of high significance in industrial economy growth and creating jobs. Thus, it is critical to meet the skills requirements of advanced manufacturing industries to remain on the cutting edge of the profession. This emphasizes the need for educating and training a highly- strong generation of manufacturing technologists who are skilled in a wide range of manufacturing techniques.

Overview: To keep up with innovations needed in manufacturing, a constant modification of manufacturing technology curriculum is necessary. In this research, we study the existing Manufacturing related programs, and identify the content that is required to align the ATMAE programs curricula with the SME Four Pillars of Manufacturing Knowledge so that the ATMAE accredited program graduates are capable of meeting the expectations contemporary and future workforce. We plan to collect data by sending survey questionnaires with focus on the SME Four Pillars to the program coordinators, heads, or chairs of the ATMAE Accredited Manufacturing relate programs to identify the content which should be included in their programs Prior to mailing, the survey will be pilot-tested for validity, relevance, and appropriateness by a group of 5 manufacturing Technology advisory board members. The results would be used to revise the manufacturing technology curricula.

Major Points:

- Designing and validating the survey questionnaire
- Applying the collected data to prioritize the current curriculum
- Utilize the findings to align the program curricula with SME Four Pillars of Knowledge. the improved curriculum to management for implementation

Summary: The Manufacturing Engineering Technology programs are designed to prepare Engineering Technology students to enter advanced industries workforce where they will be expected to practice new and relevant skills necessary to keep updated with innovation and high-tech development in manufacturing sector.

2015 Conference Proceedings

Friday, November 13, 2015 - 2:00pm - 2:45pm

Manufacturing

Redirect Focus of Industry and Academic Relationships

Authors: Dr. Alton L. Kornegay, NC Agricultural and Technical State University, Greensboro, NC
Dr. Bankole K. Fasanya, NC Agricultural and Technical State University, Greensboro, NC

Need: Industry - academia collaboration has become a subject of great interest to industry, academics and policy makers. Industry - academia collaboration is now acknowledged by noted industry advisors to be valuable for innovation. In today's global economy, disruptive innovation and disruptive technology may well be the catalysts that determine whether a manufacturing or service organization exists. Industry and academia partnerships could well be the vehicle that propels an industrial organization to the front of its field, or, the lack of such a partnership may doom the organization to oblivion. The primary goal of this paper is to explore the dichotomy between the strong motivations of both industry and academia to conduct research that promotes new product development, more efficient processes, scholarly productivity, and, of equal importance, to make the collaborative effort effective.

Overview: Strengthening industry and academia partnerships means industry personnel in the classroom and academic students in the industrial workplace. To develop cutting-edge products and services at the pace that advanced manufacturing innovation gains demand, academia and industry must change the way each thinks about education and industrial relationships. A joint industry-academic comprehensive approach to this very complex problem of educating the workforce will most likely yield the best results.

Major Points:

- Loss of government funding for public education
- Need improved industry-academia relationships for collaborative innovative manufacturing.
- Show how collaborations aid in "industry ready" graduates.
- Show innovative solutions that promote faster workforce development and American jobs creation.

Summary: Today's competitive global manufacturing environments demand ever increasing workforce education to promote new product introduction, to maximize innovation and to increase manufacturing process efficiencies. Industry, academia and governments must work together to educate graduates who can "hit the ground running" using effective research and development to add more value to themselves and to the hiring organizations. Attendees will see that industry - academia partnerships are one sure way to increase American manufacturing workforce readiness, innovation and productivity.

2015 Conference Proceedings

Friday, November 13, 2015 - 2:00pm - 2:45pm

Manufacturing

Workers' Perception of Night-Shift Schedule

Author: Dr. Bankole K. Fasanya, North Carolina A & T State University, Greensboro, NC
Dr. Alton L. Kornegay, North Carolina A & T State University, Greensboro, NC
Dr. Musibau Shofoluwe, North Carolina A & T State University, Greensboro, NC
Mr. Emmanuel Dada, North Carolina A & T State University, Greensboro, NC

Need: This presentation is put together to showcase the importance of technology in STEM and why high consideration should be given to workers' scheduling. Technology advancement is important in our environment today as technologists are ready and willing to take the challenges so that workers safety; psychologically, physically, morally and emotionally can be taken into consideration.

Overview: Circadian rhythms disruption as a result of nightshift work has been extensively described in different medical articles. Meanwhile, it is a statement of fact that practice makes perfect. Therefore, everyday night-shift work should have adjusted the human system to a balanced state. Because of the technological advancement all over the world today, about one in five workers in western countries have their employees work night shift for at least 10 hours per week. This study was conducted to investigate how night shift has affected workers' well-being. Questionnaires were distributed and forty manufacturing night shift workers voluntarily participated in the study. Participants ages were grouped into four categories (18-34), (35-54), (55-74) and 75 or older.

Major Points:

- Human circadian rhythm was measured from night shift workers' perspective.
- Yes/No questions were used to capture workers' perceptions.
- Manufacturing company workers were the only people sampled.
- Ages were categorized into four groups.

Summary: This presentation is put together to showcase the importance of technology in STEM and why high consideration should be given to workers' scheduling. Technology advancement is important in our environment today as technologists are ready and willing to take the challenges so that workers safety; psychologically, physically, morally and emotionally can be taken into consideration.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Micro/Nanotechnology

International Skill Standards for Micro-Nano Workforce Education

Author: Mr. Robert K. Ehrmann, Pennsylvania State University, University Park, PA

Need: Micro and nano workforce education programs are in place and/or are being developed at post-secondary institutions all across the U.S . It is important that the student products of these programs effectively meet the collective needs of companies that are working at this scale.

Overview: Micro and nano workforce education programs are in place and/or are being developed at post-secondary institutions all across the U.S . It is important that the student products of these programs effectively meet the collective needs of companies that are working at this scale. The National Science Foundation sponsored Nanotechnology Applications and Career Knowledge Network headquartered at Penn State in partnership with leading nano workforce education programs across the country as well as ASTM International is now in the process of developing standards to define a consistent educational content for these existing and budding programs. This session will enable the attendee to learn the process that is being followed to develop these standards and how these standards can be accessed by programs across the country.

Major Points:

- Definition of the need for nano workforce education standards
- Review of the Standards that are in the process of being created
- Review of the consensus process that is being followed via ASTM International
- Review of progress to date
- Review of how these standard will be utilized by educational institutions as well as industry
- Review of next steps

Summary: Micro and nano workforce education programs are in place and/or are being developed at post-secondary institutions all across the U.S . It is important that the student products of these programs effectively meet the collective needs of companies that are working at this scale. The National Science Foundation sponsored Nanotechnology Applications and Career Knowledge Network headquartered at Penn State in partnership with leading nano workforce education programs across the country as well as ASTM International is now in the process of developing standards to define a consistent educational content for these existing and budding programs. This session will enable the attendee to learn the process that is being followed to develop these standards and how these standards can be accessed by programs across the country.

2015 Conference Proceedings

Thursday, November 12, 2015 - 4:45pm - 5:30pm

Micro/Nanotechnology

Classroom Ready Micro–Nanotechnology Multidisciplinary Resources

Authors: Dr. Matthias W. Pleil, University of New Mexico, Albuquerque, NM
Mr. Robert K. Ehrmann, Pennsylvania State University, University Park, PA

Need: Classic tech programs are under constant pressure to continually evolve and engage students in current and relevant high technology disciplines. The MEMS (Microsystems) Industry continues to grow at 10 to 15% compounded annual growth rate (CAGR), while the Nano-based materials and device sectors are growing at 20% and 16% CAGR, respectively. This high growth rate is fueling a demand for additional technicians and engineers that have a core understanding of these two industries.

Overview: The Southwest Center for Microsystems Education (SCME) and the Nanotechnology Applications and Career Knowledge (NACK) Network are National Science Foundation funded Advanced Technological Education (ATE) Centers. These Centers provided vetted online educational material resources, professional development opportunities, mentoring, support, and hands-on classroom kits. This joint presentation will provide a tour of the wide range of educational materials available from these two centers that can be immediately plugged into your STEM courses and bring these exciting new technologies to your students. You will learn how to access these materials and be provided with samples of the educational resources to take away with you.

Major Points: These two centers have not only the "classic" written and presentation materials available online, but also:

- • YouTube lectures and animations,
- • Micro and Nano-based films,
- • Hands-on classroom activities and kits,
- • Online distance learning shells you can use,
- • Remotely Accessible Instruments for Nanotechnology (RAIN)
- • Clean-room Pressure Sensor fabrication Workshops
- • Online Webinars
- • Industry and workforce relevant information o listings, o maps of companies in your region o skill standards • Multimedia files
- • Course and modules
- • Professional development and mentoring opportunities

Summary: Attendees will learn how to access and acquire the knowledge and skills needed to bring micro-nano educational opportunities to their students. From integrating one or two short hands-on experiences within a STEM course, to creating a Micro-Nano course all the way to offering a two-year program, participants will have plenty of resources to access. Consider attending this session If you are interested in learning about SCME, NACK as well as other NSF ATE resources and how to access them.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

Micro/Nanotechnology

Leveraging Your Equipment and Facilities for Program Development utilizing Remote Access and Control

Author: Mr. Robert K. Ehrmann, Pennsylvania State University, University Park, PA

Need: Nanoscale characterization equipment can be quite costly. Due to this high cost, getting students hands-on training on state of the art nanoscale equipment is not always practical. An inexpensive and effective way to address the strong need for hands-on meaningful training is through the utilization of remote access technology.

Overview: Teaching students through distance technology is nothing new. Utilizing distance technology to effectively perform hands on training and to also perform outreach and recruitment to current students as well as prospective students is now at the cutting edge of education. Through this session participants will learn how several members of the NACK Network are utilizing RAIN (Remotely Accessible Instruments for Nanotechnology) to more fully utilize their equipment investment to access classrooms across the nation without leaving their home base. Remote equipment access and control of expensive nano characterization are being used for outreach to classrooms, workshops, conferences as well as a multitude of student learning enhancement activities.

Major Points:

Participant Understanding of:

- What we mean by remote access and control of equipment
- The cost and benefits of providing remote access and control opportunities
- The national growth of RAIN through the NACK Network
- Feedback to date from educators and students

Summary: Utilizing distance technology to effectively perform hands on training and to also perform outreach and recruitment to current students as well as prospective students is now at the cutting edge of education.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

Micro/Nanotechnology

Design and Manufacturing on a Head of a Pin - Enhancing Engineering Education with a Project-based Microsystems Design Course and Competition

Author: Dr. Matthias W. Pleil, University of New Mexico, Albuquerque, NM

Need: Tech programs often include computer aided design (CAD) components. These programs are under constant pressure to continually evolve to engage students in cutting edge technology. The MEMS (Microsystems) Industry continues to grow at a rapid rate, 10-15% CAGR, fueling a demand for additional technicians and engineers having some CAD background. MEMS are found in most electronics-based consumer products and are fueling the Internet of Things (IoT). Being able to use CAD based design systems in one of the key skills sought after by high tech manufacturing enterprises and allows students to create and visualize mechanical systems. This presentation will bring the classical mechanical CAD design down to the micron scale and a path to getting these designs manufactured at reasonable cost. Students are engaged and intrigued with design, and unique fabrication processes, which enable the construction of tiny components that can fit on the head of a pin.

Overview: This presentation will review a CAD based course, which uses L-Edit and MEMSPro8 software whereby students design complex mechanical systems on the micron scale. Students learn how tiny hinges, hubs, motors, actuators and sensors are designed and fabricated into systems. By leveraging the University Alliance MEMS Design competition, Central New Mexico Community College (CNM) has enabled undergraduate Advanced Systems Technology students to compete with graduate and undergraduate engineering students from across the nation and Mexico. Access to the curriculum will be offered (online course), and student products will be presented along with information on MEMS Design Competition.

Major Points:
The key components of this presentation include:

- MEMS Design concepts and terminology
- Designing on the space of a computer chip
- Surface micro machining fabrication and design
- Designing to a process – MEMSCAP PolyMUMPS

Summary: Attendees will be presented with resources and opportunities to engage students in MEMS micro-scaled design and a pathway for them to demonstrate their abilities by participating in a MEMS Design Competition.

Friday, November 13, 2015 - 8:00am - 8:45am

Safety

Development of the Nano/Advanced Materials Safety Certification

Authors: Dr. Dominick E. Fazarro, University of Texas at Tyler, Tyler, TX
Mr. Don Ewert, RJ Lee Group, Monroeville, PA
Dr. Mark R. Miller, University of Texas at Tyler, Tyler, TX
Dr. Walt Trybula, Texas State University, San Marcos, TX

Need: Nanotechnology is a rapidly emerging field in the 21st century and represents one of the most robust topics in advanced materials sciences worldwide. Nanotechnology is generally defined as the engineering of materials at the nanometer scale with particles having size range of 1-100 nanometers (1 billionth of a meter). Nanomaterials are a core component within aerospace, the auto industry, agriculture, and as an enabling material in most consumer products. Industries who are manufacturing nanomaterials, must consider worker safety. Presently, there are Materials Safety Data Sheets (MSDS) on some nanomaterials, such as, single/double-walled carbon nanotubes and nano titanium oxide. These nanomaterials are produced in large quantities for product development. Workers must be competent in knowing the basic hazards and health effects of nanomaterials and what types of Personal Protective Equipment (PPE) to use to minimize hazards in the work environment.

Overview: The Development of the 4-hour Nano/Advanced Materials Safety Certification is the first short course of its kind in the world. This presentation will discuss the development of the certification.

Major Points:

- Target Audience
- Benefits of the Certification
- Exam Content
- Delivery of study guide and exam
- Pilot Study
- Going Forward

Summary: Due to the increasing number of Engineering Nanomaterials, the implementation of a Nano/Advanced Materials Safety Certification is vital to worker protection as well as the future of nanotechnology. Technicians, scientists, and managers who work with the development of nanomaterials must have the necessary expertise to ensure a safe and productive work environment.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Safety

Evaluating Employees' Perceptions of Trust and Safety Climate in the University Research Laboratory Environment over Two-Levels of Management

Authors: Mr. Stephen A. Simpson, Iowa State University, Ames, IA
Dr. Steven A. Freeman, Iowa State University, Ames, IA
Dr. Gretchen A. Mosher, Iowa State University, Ames, IA

Need: Research excellence and worker health and safety should be primary goals in the university research laboratory environment. However, sometimes safety is sacrificed or forgotten in the pursuit of research excellence. High profile university laboratory incidents and pursuant investigations in the United States demonstrate the need to improve safety in the research laboratory environment. In many industries, research has determined that employee perceptions' of trust in their leadership is a key factor in promoting a positive safety climate. Little research has been completed in understanding safety climate and trust perceptions and their impact on the two levels of management associated with university research laboratories. Evaluating these factors will play an important role in developing innovative safety process improvements to minimize incident rates in the university research laboratory environment.

Overview: Colleges and universities laboratory/shop incidents have resulted in injuries and deaths, prompting significant, landmark investigations by federal and state agencies as well as leading campuses to critically evaluate safety practices. Although many campuses evaluate safety processes with the intent of finding gaps and implementing process improvements, worker perceptions and attitudes are not always evaluated. The relationship between trust and safety climate has been documented in industry but not in academic research laboratories. A better understanding of the relationship between worker perceptions of trust in their leadership and safety climate in university research laboratories has the potential to improve safety outcomes in these environments.

Major Points:

- Impact of significant incidents on the academic research laboratories
- Overview of the literature related to employees' perceptions of trust and safety climate
- Importance of perceptions on worker trust and safety climate at two levels of management in the university research laboratory environment
- Results of the study into employee perceptions of trust and safety climate at two levels of management in a university research laboratory environment
- Application of the research findings in academic teaching and research laboratory environments

Summary: Attendees will understand the role perceptions of trust have on the safety climate in university research laboratories at two levels of management – principal investigator and laboratory supervisor. Understanding the safety climate can help in developing innovative process improvements to help ensure a safer workplace while pursuing research excellence.

2015 Conference Proceedings

Friday, November 13, 2015 - 9:00am - 9:45am

Safety

Identifying and Evaluating Leading Indicators to Measure Safety and Manage Industrial Risks

Authors: Mr. Sai K. Ramaswamy, Iowa State University, Ames, IA
Dr. Gretchen A. Mosher, Iowa State University, Ames, IA

Need: Continuous evaluation and improvement of safety performance is essential to successfully manage risks in an industrial environment. Past research has successfully documented the importance of using leading safety indicators to measure the effectiveness of organizational safety performance. While there is consensus about the use of leading indicators, the research literature reflects a range of design approaches, terminology, and types of indicators, measurement objects and recipients. Thus far little research has investigated how leading indicators of safety can be used in continuous safety improvement across various industry domains and the benefits and limitations of such contextualization.

Overview: The use of leading safety indicators such as safety climate to measure and manage safety risks is well documented. However, literature regarding these leading indicators suggests a varied compilation of methodologies, opinions, case studies and empirical information from diverse sources such as industry, academia, public enterprise and government. This presentation will discuss the challenges in designing and developing leading safety indicators and the concerns in their use and ability to predict future safety performance. The understanding, practical applications and organizational practices to track, analyze and apply information provided by leading indicators will be explored. The presentation will conclude with implications for continuous safety improvement.

Major Points:

- Overview of safety indicators
- Recent research related to leading indicators
- Design and development of leading indicators
- Factors and challenges in the use of leading indicators for continuous improvement
- Scope for future work

Summary: Attendees will understand and appreciate the role of leading safety indicators in the management of safety risks and also gain insight on the desirable characteristics and practical application of these indicators.

Friday, November 13, 2015 - 9:00am - 9:45am

Safety

A Mixed-Methods Investigation of Safety Leadership

Author: Mr. Jon L. P. Judge, Iowa State University, Ames, IA
Dr. Gretchen A. Mosher, Iowa State University, Ames, IA

Need: Safety leadership is thought to be an important component of safety management programs, yet little research exists on the characteristics of safety leadership. This is especially true in process-based environments, such as agriculture. A second gap in the knowledge of safety leadership is the perspective of safety leadership held by employees at different levels within a work environment. A better understanding of how management, supervisors, and employees define and characterize positive safety leadership has the potential to guide safety intervention for both safety researchers and safety professionals.

Overview: The purpose of this research study is to examine Safety Leadership as it is defined by employees at three levels in the field of Agriculture. The presentation will describe the use of qualitative and quantitative methods to construct a working definition of safety leadership. Specifically, the identification of characteristics and traits that define Safety Leadership for workers, supervisors, and management will be discussed. Implications for safety intervention and future work will conclude the presentation.

Major Points:

- Importance of safety leadership in process-based industries such as agriculture
- Use of mixed methods to construct a working definition of safety leadership
- Safety Leadership as defined by supervisors, managers and workers
- Implications for future work and safety workplace interventions

Summary: Attendees to this presentation will gain information regarding how employees at three levels define Safety Leadership. Attendees will also learn how information on safety leadership can potentially be used in further avenues of research to focus efforts of the safety and health profession in the field of agriculture.

2015 Conference Proceedings

Friday, November 13, 2015 - 10:15am - 11:00am

Safety

Monitoring UV Exposure in Synthetic Life-Safety Equipment

Authors: Ms. Stephany Fonseca, Eastern Illinois University, Charleston, IL
Dr. Isaac S. Slaven, Eastern Illinois University, Charleston, IL

Need: Working on ropes, specifically the category of ropes called "life safety ropes," is unavoidable for military, rescue, and various construction applications. The structural integrity of life safety rope is affected by exposure to ultra-violet (UV) light. Currently the test for degradation due to UV exposure is the "thumbnail test," where a thumbnail scraping of the powering material is the go/no-go indicator. Currently, no accurate and commercially available UV dosimeter is on the market. This project develops a proof-of-concept to create one for the application of synthetics in life safety.

Overview: This research project consisted of defining degradation with ultra-violet (UV) light exposure. Using substances that are known to fade in UV, accumulated exposure was determined with a UV chamber. Additionally, yarns from 371-Nylon were tested for structural degradation. In aligning these fading and degradation curves, a proof-of-concept for developing an easy-to-use UV dosimeter that could be installed on life-safety harnesses, synthetic ropes, and rigging equipment.

Major Points:

- Synthetic life-safety equipment structurally degrades with UV exposure
- Controlled UV exposures are used to develop fading and structural degradation curves
- Known color degradation indicators are applied to safety tags to indicate UV accumulation

Summary: Synthetics used in life-safety and rigging equipment degrade with ultra-violet (UV) light exposure. This presentation outlines a technique used in developing a proof-of-concept for a UV dosimeter to monitor the accumulated UV radiation.

2015 Conference Proceedings

Friday, November 13, 2015 - 10:15am - 11:00am

Safety

Probabilistic Design Analysis (PDA): Prospects and Pitfalls

Authors: Mr. Sai K. Ramaswamy, Iowa State University, Ames, IA
Mr. Stephen A. Simpson, Iowa State University, Ames, IA
Mr. Matthew E. Harvey, Iowa State University, Ames, IA
Dr. Nir Keren, Iowa State University, Ames, IA

Need: The dynamic world we presently live in is an ever-increasing complex environment. This increased complexity introduces various challenges. One of these challenges is the lost expertise due to the wider knowledge base that is required for completing ordinary tasks. Thus, the opportunity for failures increases as well. Statistically this can be presented in wider probability distribution functions of errors. Therefore, it is conceivable that the traditional approach taken for safe design that relies on safety factor for safety margin is turning dated. The development of mathematical, statistical and software tools over the last few decades have led to the development of highly quantitative techniques such as Probabilistic Design Analysis (PDA) that take into account the loss of expertise described above. Although more popular in areas such as structural analysis and space exploration, PDA techniques have thus far found limited traction among safety practitioners and professionals. Simplification of this highly mathematical technique will introduce opportunities that can positively impact the safety arena and its professionals.

Overview: "When in doubt build it stout", is still the prevalent school of thought among design engineers and safety professionals. Despite using recommended safety factor principles, design failures resulting in industrial accidents have not been mitigated. Traditional approaches to achieve safety in engineering design have failed to completely address the complexity of multiple factors and the occurrence of extreme risk events. This presentation will discuss the details of the Probabilistic Design approach and contrast it with the traditional approach. The proposed comparison, with presentation of simplified solved examples, will demonstrate the challenges, advantages, and limitations of each one of the approaches.

Major Points:

- "Safety factors" as an approach for safe design may be becoming a dated approach
- Simplified Probabilistic Design Analysis may be an alternative to the current approach
- Limitations, advantageous, and opportunities for each approach will be reviewed
- Future efforts

Summary: Knowledge is being regarded as one of the most important resources besides labor and capital. To solve complex problems of the 21st century safety professionals and practitioners need to adopt newer ideas and review potential approaches for safe design. The potential hidden in probabilistic design analysis and its opportunities for meeting the demand of an ever increasing complex world will be reviewed in this presentation, including the challenges and limitations.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

Safety

Employing Hazard Recognition and Control: Effective Techniques to Reduce Accident and Injuries

Authors: Mr. Charles R. Hunt, Norfolk State University, Norfolk, VA
Dr. Jeenson Sheen, Norfolk State University, Norfolk, VA
Mr. Munir Sulaiman, Norfolk State University, Norfolk, VA

Need: In high-hazard manufacturing industries, workplace hazards are prevalent and pose potential harm and danger to employees. Although large industrial sectors have the means to make a significant impact in reducing accidents and injuries, medium-sized and small firms, unfortunately, lack appropriate means for effectively mitigating hazards, accidents, and injuries. However, workplace accidents and injuries can be prevented in the work environment by recognizing hazards in workplace operations; establishing proper job procedures; ensuring that employees are properly trained; and applying appropriate control measures. Ideally, after hazards are recognized/identified, procedural steps must be taken to reduce or eliminate the hazards to an acceptable risk level.

Overview: Hazard recognition and control together with risk assessment are integral components of proactive safety efforts designed to positively impact safety improvement. This presentation will highlight hazard recognition and control approaches appropriate to mid-sized and small manufacturing industries. Relevant issues, hazard analysis, control techniques, and examples will be addressed in the presentation.

Major Points:

- Rationale for hazard recognition and control
- Benefits to employees and employers
- Hazards and descriptions
- Sources to help recognize hazardous conditions and unsafe behaviors
- Process and phases of hazard analysis and control
- Applying root cause techniques to hazards
- Hazard risk assessment

Summary: In high-hazard manufacturing industries the safety or personnel and other assets are vital for ensuring and injury-free work environment. This presentation will provide attendees insight regarding the application of hazard analysis and control techniques for mid-sized and small manufacturing industries.

Thursday, November 12, 2015 - 11:30am - 12:15pm

School Administration

What is "Technology, Management, and Applied Engineering"?

Author: Dr. Robert A. Chin, East Carolina University, Greenville, NC

Need: In ATMAE's 2011 Outcomes Assessment Accreditation Handbook, paragraph PA.2, Program Definition specifically, it says that "in situations where an option is not appropriate for ATMAE accreditation based upon the approved definition of technology, management, and applied engineering, the request for accreditation…". And in standard 7.1, it says, "The program/option title, definition and mission shall be compatible with the ATMAE definition of Technology, Management, and Applied Engineering". So what is "Technology, Management, and Applied Engineering"? Are ATMAE and Technology, Management, and Applied Engineering one in the same?

Overview: A study was conducted, which examined ATMAE's accredited undergraduate programs in an attempt to shed additional light on what is "Technology, Management, and Applied Engineering". On ATMAE's About ATMAE page, ATMAE suggests, with the aid of a Venn diagram, that ATMAE is all those elements that technology, management, and applied engineering have in common. On its About ATMAE page as well, ATMAE refers visitors to its Wikipedia page. On its Wiki page, ATMAE provides additional details, and along with its Venn diagram, offers definitions for the following: Industrial Technology, Technology Management, Operations Management, Engineering Management, Applied Engineering (field), and Engineering Technology. For its definitions of Industrial Technology, Operations Management, Engineering Management, and Engineering Technology, it appears ATMAE prepared its definitions by paraphrasing Classification of Instructional Programs Code definitions.

Major Points:

- Overview of the Study
- Classification of Instructional Programs
- 2000 vs 2010 Industrial Technology 15.0612
- Technology Management
- Operations Management 52.0205
- Engineering Management 15.1501
- Applied Engineering (field) Engineering Technology 15.0000
- ATMAE's Accredited Undergraduate Programs
- Definition of Technology, Management, and Applied Engineering
- Conclusions

Summary: The data tend to suggest that at the baccalaureate level, ATMAE's Board of Accreditation defines Technology, Management, and Applied Engineering somewhat more broadly than does ATMAE.

School Administration

A National Study on the Current and Evolving Characteristics of Today's Applied Engineering College-Level Educator

Authors: Dr. Troy Eugene Ollison, University of Central Missouri, Warrensburg, MO
Dr. Doug Koch, University of Central Missouri, Warrrensburg, MO
Dr. Jeffrey M. Ulmer, University of Central Missouri, Warrrensburg, MO

Need: Higher education is constantly changing and evolving. Many contend that the recent changes have not always been positive and that current changes have greatly affected applied engineering programs. The purpose of this presentation is to disseminate information regarding current issues and the current state of educators in post secondary, applied engineering/technology programs.

Overview: Most industries and businesses are in a constant state of change. As economies change, technologies evolve, and labor forces fluctuate, industries have to adapt and changes as well. Higher education is no different. Some might argue that education, particularly post-secondary education, is somewhat slow and reluctant to change but it does change none the less. Two hundred and twelve faculty members within the United States responded to a national survey to help fellow faculty determine the current and evolving characteristics of today's applied engineering college-level educator. Previous literature and data identifies changes related to financial challenges, salaries, technological advancement, professional experience, course load and class size, globalization, and lack of advancement opportunities. This study was three-fold for applied engineering college-level educators: 1) conduct a broad literature review on employment conditions affecting faculty, 2) administer a career-status-update survey to faculty in the United States, and 3) to report summarized survey results on the current and evolving characteristics in order to identify future, more in-depth research needs. The survey sought to determine the current status of the field in those areas.

Major Points:
Current Challenges Facing Educators:

- Financial Challenges
- Technological Advancement
- Professional Experience
- Course Loads and Class Sizes
- Globalization
- Lack of Advancement Opportunities
- Methodology
- Results of the Study
- Conclusions
- Future Research

Summary: This presentation will provide insight into the challenges of today's applied engineering college-level educator and what the future may hold. The results which will be shared are a first step toward future research which will take a deeper look at some of these perplexing issues.

School Administration

Increasing Student Awareness, Enrollment, and Retention at Underrepresented Minority Institutions in Nuclear Related Subject Areas or Programs: A Case Study at Alcorn State University

Authors: Dr. Steve K. Adzanu, Alcorn State University, Alcorn State, MS
Mr. Jermiah Billa, Alcorn State University, Alcorn State University, MS
Ms. Shimi Didla, Alcorn State University, Alcorn State, MS

Need: In July of 1985, Grand Gulf Nuclear Station in Port Gibson, Miss., made history by becoming the first and only nuclear power plant to produce electricity in Mississippi. Grand Gulf marked another milestone by completing a power upgrade June 16, 2012, that makes it the largest single-unit nuclear power plant in the country and fifth largest in the world. Grand Gulf is owned and operated by System Energy Resources, Inc. (90 percent) and South Mississippi Electric Power Association (10 percent). Today, Grand Gulf is the most affordable source of electricity in Mississippi. Recruitment and retention of nuclear related subject areas are major challenges confronting colleges and universities across the United States. These problems are pronounced among the underrepresented minority institutions.

Overview: Health Physics is one of the Science, Technology, Engineering, and Mathematics (STEM) curricula commenced in the fall of 2007 at Alcorn State University (ASU). The program was initiated with seed money from the Nuclear Regulatory Commission (NRC) and Entergy. ASU is the oldest member of 1890s land grant Historically Black Colleges and Universities (HBCU) institutions with at least 90% of student body consisting of minorities. Research collaborations extended to various Universities within and outside of Mississippi and more importantly to the Los Alamos National Laboratory. In fall of 2012, ASU initiated graduate program in Health Physics, the only nuclear related graduate program in the state of Mississippi. The primary purpose of this presentation or paper is to examine how summer programs, career awareness, workshops, outreach and mentoring programs to K-12 students originating from, at least, the following counties: Claiborne, Warren, Jefferson, Wilkinson, Adams, and Hinds, which can help to increase enrollments, retention and career paths in nuclear related subject areas & fields of students into underrepresented minority institutions. Also, the presentation will address how is attract elementary, middle, and high school students originating from the surrounding counties o into nuclear related programs at Alcorn State University.

Major Points: • Role of Outreach & Mentoring Programs in Nuclear/Health Physics and related Areas; • Socio-economic conditions of Underrepresented Minority Students; and • Highlight some of the Recruitment, Retention, Career Path and Success Stories

Summary: The presenter will primarily focus on, share their experiences, and strategic plans about hosting nuclear related outreach programs to K-12 students originating from the counties around Alcorn State University (ASU). The presentation will also focus on how these programs help to increase enrollment and retention at minority colleges and universities such as ASU. Finally, students will be exposed to nuclear and related fields that are in need of workforce at the local and nationwide levels.

2015 Conference Proceedings

Thursday, November 12, 2015 - 11:30am - 12:15pm

School Administration

Utilizing Rubrics, Certification Exams, and Surveys Keep Program Assessment Plans Simple and Effective

Authors: Dr. Randell W. Peters, Indiana State University, Terre Haute, IN
Dr. Michael A. Hayden, Indiana State University, Terre Haute, IN

Need:

1. Many faculty struggle with program assessment
2. Outcomes Assessment for programs is not an assessment of each course
3. Assessment has often been done separately and inconsistently throughout the various college units and often has been dependent on specific program accreditation

Overview: Rubrics designed to assess competence in a program help create consistency. Surveys help to validate program outcomes and provide supporting data. Nationally recognized exams help to prove desired competencies. This presentation will concentrate on the incorporation of certification exams, surveys and rubrics in assessment plans. The presenters will provide rubrics and surveys used in engineering technology programs at their university.

Major Points:

- The role of ATMAE Certification exams as effective assessment instruments
- Rubrics useful for measuring competencies not measured in exams
- Examples of surveys of graduates
- The role of ABET and ATMAE accreditation practices

Summary: An effective assessment plan can be incorporated that minimizes the faculty assessment burden and melds the assessment requirements of educational institutions with regional and program accreditations. Program accreditation practices can provide the framework for various assessment requirements and other faculty and administrative concerns.

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

School Administration

Adjunct Faculty: Bridges to Success

Authors: Dr. James W. Jones, Ball State University, Muncie, IN
Mr. Brent C. Baumer, Ball State University, Muncie, IN

Need: The use of part-time and adjunct faculty is on the rise nationwide, and technology programs are not immune to this phenomenon. Administrators considering or already utilizing adjunct members on their faculties are faced with both opportunities and challenges when integrating them onto their teams. When utilized effectively, the use of adjunct faculty members in the delivery of a technology curriculum can be a beneficial experience for students, faculty, and administrators. When adjunct faculty members are poorly recruited, integrated, equipped, and supported, student learning can suffer.

Overview: There are many factors influencing a technology administrator's decision to employ adjunct faculty, ranging from course content to time to budgetary constraints. Without thoughtful consideration, this can result in suboptimal results for all parties involved, particularly students' learning. One program has approached the use of adjunct faculty simply as specialist members of the faculty team, attempting to integrate them as much as possible. Through examining both the perspectives of the program director (who is also a former adjunct faculty member) and an adjunct faculty member, keys for successful outcomes for all are explored. Other technology administrators can incorporate lessons learned and suggestions for improvement into their own programs for future success.

Major Points:

- Factors influencing adjunct use
- Keys for success
- Opportunities
- Challenges
- Lessons learned
- Conclusions and recommendations

Summary: Attendees of this presentation will understand successful strategies for utilizing adjunct faculty members in technology programs. Perspectives of both administrators and adjuncts are provided in the discussion of keys for successful utilization of these team members.

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

School Administration

Mentoring New Faculty Members in Technology Programs

Authors: Dr. James W. Jones, Ball State University, Muncie, IN
Dr. Tarek Mahfouz, Ball State University, Muncie, IN
Dr. Sherif Attallah, Ball State University, Muncie, IN

Need: The technology faculty search can really only be deemed "successful" when the new member is welcomed into the faculty team and is making adequate progress in their discipline. Mentoring, both formal and informal, can be a critical component of both integrating the new professor and charting their course as a successful scholar.

Overview: As with any team, new technology faculty must be properly integrated for both the existing and new members to function at their fullest potential. While this can occur by happenstance, a dedicated mentoring effort can make the transition and integration easier for all parties. This mentoring effort begins at the point when the employment offer is accepted and continues throughout the development of the faculty member as a productive scholar and integral team member. This presentation examines the mentoring approaches, including formal and informal strategies, utilized by one program through the perspectives of program director, mentor, and mentee. Technology administrators at other institutions can implement and adapt these methods for suture success in their own programs.

Major Points:

- Transitioning from employment offer to mentored team member
- Mentor assignment and preparation
- Mentoring objectives and tasks
- Mentee perspectives
- University resources
- Conclusions and recommendations

Summary: Attendees of this presentation will understand successful approaches for mentoring new faculty members in technology programs as well as how to continue this process throughout their development. Perspectives of administrators, mentors, and mentees are provided.

School Administration

Degree Completion Programs: Enhancing Community Colleges, Universities, and Economic Development

Author: Dr. David L. Batts, East Carolina University, Greenville, NC

Need: Associate in Applied Science (AAS) degrees were once considered terminal degrees. Thus students in these programs would need to start over at a four year institution to work towards a Bachelor's degree. There is a large population of students that go to the two year institutions in AAS degree programs and no viable educational pathway to a four year degree. University departments in the technology and industrial fields need to provide a pathway for these students. Collaboration and cooperation with the two year institutions will be beneficial for both institutions and the surrounding industries. Southern Association of Colleges and Schools (2011) stated "The national priority to sharply increase the percentage of Americans holding undergraduate degrees has resulted in a number of creative educational pathways to facilitate accomplishment of that goal" (para. 1). One of the examples Southern Association of Colleges and Schools mentioned was degree completion programs.

Overview: This presentation will focus on the Bachelor of Science in Industrial Technology (BSIT) at East Carolina University (ECU). The BSIT program is a degree completion program with curriculum designed for students who have been awarded a qualified Associate in Applied Science (AAS) degree in an industrial or technical related field. The BSIT had 170 students in 2005 and currently have over 500 students, which accounts for nearly half the total amount of undergraduate students in the Department of Technology Systems at ECU. The BSIT program has eight concentrations, five of which mirror four year degree programs in the Department. This alignment enhances the other traditional four year degree programs in the Department. Six of the eight concentrations can be completed online, thus giving working professionals the educational pathway to complete their degree while continuing to work. The BSIT faculty members worked with ECU administrators and admissions to qualify 52 AAS degrees admittance into ECU and the BSIT program with minimal obstacles. This work revolved around ECU's accreditation standards set by the Southern Association of Colleges and Schools. The BSIT is a true success story turning the once considered terminal degree into a highly sought after degree that can lead to a four year degree

Major Points:

- Degree completion programs; structure, alignment, and organization
- Accreditation and admission criteria

Summary: Attendees will learn about a successful degree completion program including structure, alignment and organization of the program. They will also learn about the work done to remove organization hurdles in regards of admission that meet national accreditation standards.

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

School Administration

Developing a One Year Organizational Leadership Capstone Experience

Authors: Mr. Daniel L. Lybrook, Purdue University, West Lafayette, IN
Dr. Andrew C. Hurt, Purdue University, West Lafayette, IN

Need: We are transforming the experience for technology students here in the College of Technology at Purdue University. From the first semester of the freshman experience to graduation, our program is being redesigned to create a more applications oriented, integration based plan of study for our students. This plan of study change was initiated three years ago, with a complete program redesign. Our program, which had historically focused on general leadership, initiated this transformation to better prepare graduates for leadership positions in technology rich organizations. We found that leaders must possess a broad base of technological knowledge; its processes, products, and implications, as well as the leadership skills necessary to be able to influence change and motivate others. One of the missing features of this transformed plan of study was a summative experience that could serve to tie key concepts from across a broad array of courses. Thus, we developed a one year integrated leadership capstone experience.

Overview: This session will discuss the development of the one year capstone for the Organizational Leadership program in the Technology Leadership and Innovation Department. This model offers flexibility and choice to students, while also maintaining a degree of control for faulty. This experience will serve as the formative evaluation of the OL degree. In it students will explore leadership through one of four areas: a) Cross-Disciplinary Leadership Projects, b) Leadership in Teaching Projects, c) Leadership Research Projects, or d) Industry Leadership Projects. This will enable students to learn by doing, and use the capstone experience over the year to expand their autonomy and maturity by fostering critical thinking and logic.

Major Points:

- A capstone plan that can be scaled to fit program or department
- Integration of research into the program design
- Leadership curriculum for the program as well as details about the various integrations
- One year capstone experience for students offering flexibility

Summary: Attendees will learn about the development of a one year Leadership Capstone Experience, from idea to fruition. Details of the capstone, of the design down to the individual courses, will be presented.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

School Administration

Accommodating Accessibility Issues for Faculty

Authors: Dr. James W. Jones, Ball State University, Muncie, IN
Mr. Gary R. Birk, Ball State university, Muncie, IN
Mrs. Valerie Birk, Ball State University, Muncie, IN

Need: While literature and services focus on accessibility issues for students, administrators in technology programs should also be cognizant of accessibility issues for faculty and how to best approach accommodation as a means to enhance both the faculty member's teaching and students' learning.

Overview: Technology programs are known for their distinctive approach to learning, with students engaging in a variety of real and simulated classroom and laboratory activities with high instructor involvement. While conversations regarding accessibility issues for students are becoming more commonplace, administrators who listen to faculty needs can make reasonable and prudent accommodations for faculty with physical disabilities as well. This presentation examines the approaches used through the perspectives of both administration and faculty, with examples of issues raised during a building renovation that disrupted normal classroom use, scheduling, etc. Other technology administrators can use these lessons learned in their own programs for future success.

Major Points:

- Accessibility issues on campuses
- Opening the conversation
- Space issues
- Scheduling considerations
- Challenges, solutions, and lessons learned
- Conclusions and recommendations

Summary: Attendees of this presentation will understand successful approaches for addressing accessibility issues for faculty members, from starting the conversation through making accommodations. Perspectives of administrators and faculty members are provided, along with examples and case studies.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

School Administration

Academic Rigor in Higher Education Institutions: Pros and Cons to Faculty, Students, and Administrators

Authors: Dr. Tarek Mahfouz, Ball State University, Muncie, IN
Dr. James W. Jones, Ball State University, Muncie, IN

Need: Growing public concern about the rigor in higher education has been noticed over the last decade. Whether pre or post tenure, it is becoming one of the most important criteria for faculty performance evaluation. As a result, a number of researchers have published in this regards. The objectives of these endeavors ranged between defining academic rigor, identifying evaluation parameters related to teaching, research and services, as well as deriving policies in an attempt to insure it in higher education. Furthermore, relations between student educational outcomes in classrooms and faculty incompetence have become two of the common phrases when addressing higher education academic rigor. Consequently, multiple universities have been implementing post-tenure review and unsatisfactory performance policies. Similarly, under the criticism of the academic community and university administrators other institutions are looking for best practices to address this issue. However, in a lot of times, effects of these policies on faculty performance and future have become blurred. In an attempt to address this need, this presentation highlights efforts exerted by one institution to tackle this problem.

Overview: Researchers have attempted to undertake the concern of academic rigor in higher education. Between efforts to define academic rigor in relation to student engagement to tenured faculty incompetence, multiple research have made outstanding. These accomplishments fail to acknowledge effects on faculty performance and their points of view associated with new policies in higher education institution. Consequently, the current undertaking deals with new efforts and policies implemented by one university to tackle this concern with special focus on technology faculty perceptions.

Major Points: What is academic rigor?; Academic rigor and student performance measures; Academic rigor and faculty performance measures (Pre and Post tenure); New policy implementation at Ball State University; and Faculty concerns and points of view in this regards.

Summary: Attendees will gain knowledge about efforts to take in hand academic rigor concerns in higher education institutions including recent changes implemented by one institution. Furthermore, they will be engaged in a lively discussion about faculty perceptions in this regards

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

School Administration

Developing Sustainable Minds in 21st Century Students

Author: Dr. Patricia Polastri, Texas A&M University , Kingsville, Kingsville, TX

Need: Sustainability topics are frequently not fundamental part of the curriculum in engineering and management courses

Overview: This presentation is intended to offer educators at higher educational institutions some ideas about how to incorporate sustainably topics into their curriculum. Oftentimes students enrolled in engineering and management courses question the need or usefulness of addressing sustainability issues. Their lack of concern comes mostly from a Simmonist misconception that technological advances will indeed solve any sustainability problems. Therefore, including sustainability topics into their regular curriculum will help them understand the significance of preserving and using more efficiently the natural resources we have today.

Major Points:

- Reasons to introduce sustainability issues in the curriculum
- Some relevant topics that usually spark interest in sustainability
- Gaia theory and its effects on humanity
- Introducing sustainability in Engineering and Management related courses
- Develop critical thinking and decision making
- Introduce global thinking and corporate responsibility
- Explore renewable sources of energy

Summary: Attendees will be presented with viable ways of introducing sustainability related topics into their curriculum by giving sustainability the importance it deserves. The presentation seeks to encourage educators to introduce topics that discuss sustainability without altering their current curriculum content. Natural resources preservation can become really interesting for students if their impact on their lives is addressed. Therefore, students that are confronted with environmental and sustainability issues can gain invaluable knowledge that will enhanced their critical thinking, decision making, ethics and problem solving skills while learning how to preserve our natural resources.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

School Administration

ATMAE Faculty Demographics and Salaries: Trends and Characteristics of the ATMAE Faculty in 2015

Authors: Dr. Ahmad Zargari, Morehead State University, Morehead, KY
Dr. John Sutton, Oakland University, Oakland, IN
Dr. Jeffrey M. Ulmer, University of Central Missouri, Warrensburg, MO

Need: The primary purpose of this presentation is to present the 2015 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. As an administrative mandate, the Demographic data has been collected annually and used since 1997 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.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

School Administration

ATMAE Certification and Training: What Does Training Bring to the Table?

Authors: Dr. Mark R. Miller, The University of Texas at Tyler, Tyler, TX
Dr. Heshium R. Lawrence, The University of Texas at Tyler, Tyler, TX

Need: As the ATMAE Certification programs geared up for ANSI accreditation, fundamental changes were made to these programs to allow for this distinction. However, improving the certification programs has done nothing to increase the number of certifications nor has it attracted more organizations to use the programs.

Overview: This presentation will focus on the key factors that are involved with offering training programs to prepare individuals for ATMAE certification programs. More specifically, this presentation will focus on the historical perspective of existing ATMAE certification programs and the future ramifications for providing training.

Major Points:

- Brief overview of the purpose for the ATMAE certification programs
- Description of how ATMAE exams are currently being used and who are the main customers
- Discuss the premise for training and its important link to certification
- Review the timeline for developing training programs for ATMAE certifications
- Assess the implications of ATMAE training programs and their impact with industry

Summary: As ATMAE certification programs continue to improve and provide academia, individuals, and industry with important assessment data, there still seems to be a disconnect that prevents them from gaining a wider appeal. This presentation focuses on the ATMAE Certification Board's new venture in offering online training programs for each of its certification programs as well as the broader implications for ATMAE and its constituents.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

School Administration

Enhancing Student Learning Using a Problem Based Learning (PBL) Approach in Engineering and Technology

Authors: Dr. Olusegun Odesina, Central Connecticut State University, New Britain, CT
Dr. Nicholas O. Akinkuoye, Imperial Valley College, Imperial, CA

Need: Problem Based Learning (PBL) is an innovative approach that uses an educational method that allows students to enhance their learning through solving real life problems. Even though it has long been adopted in fields including business and law, PBL is only beginning to emerge in the STEM field. It is an exciting and challenging alternative to traditional lecture-based instruction that provides students with learning experiences that engage them directly in the types of problems and situations they will encounter in the 21st century workplace.

Overview: Businesses and Industries are seeking employees who are capable of solving problems and thinking through a situation through the analysis of problems to find solutions. It is important that students are not only capable of thinking critically but they must also be able to think carefully through finding solution to business and industrial /manufacturing problems. PBL allows students to work in teams, using the resources available to them, and the scientific or engineering approach that will allow them to find solutions to posted problems. The ability of students to work independently and in teams cannot be overemphasized in today's global economy. This teaching process can be applied at three levels. The structured level is for novice problem solvers; the guided level focuses on beginning problem solvers; and open level can be used by advanced problem solvers.

Major Points:

- What Problem Based Learning is
- Problem Solving Analysis
- The three levels of PBL challenges
- Example of result of a problem based learning project applied
- Implication for Technology and Applied Engineering Programs

Summary: Problem Based Learning will provoke independent thinking, team work and also enhance learning through analysis. It allows students to engage in research to find solutions to real life problems.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

School Administration

A Comparative Analysis of Faculty Salaries between Management, Engineering and ATMAE Related Disciplines: The Need for Establishing a Benchmark and Enhancing Visibility in a Market Driven Economy

Authors: Dr. Ahmad Zargari, Morehead State University, Morehead, KY
Dr. Charles Coddington, East Carolina University, Greenville, NC

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 ATAME'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:

- Discussing Internal and external challenges with market value and faculty salaries.
- Introducing the integration of research grants and contracts as a contemporary model for funding departmental operations.
- Presenting the strategic directions for ATMAE and the role of new ATMAE leadership.
- Exploring the socio-economic roles, positions and responsibilities of ATMAE alumni.
- Explaining the focus of ATMAE programs in the future.

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.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

School Administration

A Credible Model for Strategic and Operational Planning in a University Department of Technology

Authors: Dr. Jeenson Sheen, Norfolk State University, Norfolk, VA
Mr. Charles R. Hunt, Norfolk State University, Norfolk, VA

Need: Departments of Technology across the country are being asked to respond increasing student and industry demands in an environment of severe fiscal constraint. This set of circumstances requires attention to issues of strategic and operational planning for prioritizing scarce budget resources. Clear, well understood and consistent strategies for deploying strategic and/or operational planning are crucial for the sustainability and viability of effective departmental programs. The combined lack of understanding of strategic and operational planning concepts and the absence of performance measurement data poses daunting challenges for prioritizing academic functions in some departments. However, many of these challenges can be resolved by effectively deploying strategic and/or operational planning as an integral parts of a department's operations.

Overview: Strategic or operational planning is recognized as means for translating organization vision, mission, goals, and objectives into achievable targets for aligning available unit resources with institutional priorities to assure student career success. This presentation will focus on strategic and/or operational administrative planning linked to unit and institutional missions and visions for setting program priorities. Relevant issues, strategic and/or operational planning development techniques and examples will be shared in the presentation.

Major Points:

- Benefits of a strategic and/or operational planning
- Components of a plan
- Link between strategic plans and operational plans
- Driving strategic thinking up the organization
- Developing gap analysis

Summary: As financial resources continue to dwindle in institutions of higher education, administrative departmental personnel in departments of technology must ensure that scare budgeted resources are prioritized and aligned with institutional priorities. This presentation will provide attendees insight regarding the development of a credible model for strategic and/or operational planning for linking the departmental mission and vision to the institution's mission and vision.

2015 Conference Proceedings

Thursday, November 12, 2015 - 4:45pm - 5:30pm

School Administration

The ATMAE Lean Six Sigma Exam: First Year Status Report

Authors: Dr. Heshium R. Lawrence, The University of Texas at Tyler, Tyler, TX
Dr. Mark R. Miller, The University of Texas at Tyler, Tyler, TX

Need: The ATMAE Lean Six Sigma Exam has been available for almost a year now and since the exam was developed as a low cost alternative to similar exams, a thorough analysis of its merits needs to be conducted to determine if it met its intended purpose.

Overview: This presentation will focus on the content of the Lean Six Sigma certification exam based upon an item analysis of past examinees performance and their subsequent earned belt status (yellow, green, and black). In addition, other statistical analyses of the exam will be reviewed and presented.

Major Points:

- Overview of exam results
- Review of the format, delivery method, and data analysis provided with this exam
- Outline of the content addressed by this exam
- Discuss possible training programs for the LSS exam
- Review strengths and weaknesses of the exam

Summary: As the ATMAE Certification Board continues to improve its quality of certifications, the Lean Six Sigma Certification Exam was the first one to be developed under the new ANSI accreditation standards. The focus of this presentation will be to review the first year results of the Lean Six Sigma Exam as well as give the audience an update on future training programs associated with the exam.

2015 Conference Proceedings

Thursday, November 12, 2015 - 4:45pm - 5:30pm

School Administration

Applying a Business-Level Strategy Perspective to Technology Department Administration

Author: Dr. Austin C. Cheney, Eastern Illinois University, Charleston, IL

Need: The landscape in higher education is changing rapidly in many regions of the country, and with it is coming increased competition for students and other resources. The tradition mode of operation for higher education departments is insufficient to make sound technology department/school/college long-term strategic decisions that improve competitiveness.

Overview: This presentation will provide attendees with an overview of some of the primary business-level strategies, walk through the areas that need to be addressed in order to implement a strategic approach to planning, and provide some brief examples of what the approach might look like as applied directly to an academic setting.

Major Points:

- Overview of some key business-level strategic options
- Analysis steps required to develop a business-level strategy (one perspective)
  - ◊ Environmental
  - ◊ Industry
  - ◊ Internal
  - ◊ SWOT
  - ◊ Idea Development
  - ◊ Strategic Option Development/Review/Selection
- Examples

Summary: My experience working at four different types of institutions (2-year technical college, 2/4 year technical college, master's comprehensive, and doctoral institution) has shown that colleges and universities typically do not approach academic department/school/college/university management from a business perspective. The changing environment in higher education necessitates that we approach planning differently if our institutions wish to remain competitive.

2015 Conference Proceedings

Thursday, November 12, 2015 - 4:45pm - 5:30pm

School Administration

ATMAE Alumni: A Trends Analysis and Demographics of 2009 ATMAE Accredited Programs Alumni

Authors: Dr. Yuqiu You, Morehead State University, Morehead, KY
Dr. Ahmad Zargari, Morehead State University, Morehead, KY

Need: The ATMAE accredited programs alumni survey results were among the indicators that created the need for changing the name of NAIT to ATMAE. A trends analysis of ATMAE graduates will help to determine the market value of our graduates, and to help promote ATMAE programs. This presentation presents the data obtained from selected ATMAE accredited institutions alumni of 2010 regarding their positions and responsibilities, salaries, job satisfaction, professional achievements, qualifications, and promotions. The data presented will contribute to the revision and development of the discipline.

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

Major Points:

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

Summary: Although ATMAE has recognized the importance of programs graduates feedback by asking ATMAE accredited programs to conduct an alumni survey and disseminate the results, a review of literature indicates that very limited research data is available on alumni perceptions of their programs. This presentation will provide a trend analysis of ATMAE alumni of 2010 at the national level.

Thursday, November 12, 2015 - 4:45pm - 5:30pm

School Administration

Closing the Gap—Building the Bridge for Female Success in STEM programs

Author: Ms. Pam A. McGee, Minnesota State University-Moorhead, Moorhead, MN

Need: The United States ranks 23rd in the world in women's right and equality (Forbes, 2013). Only 4% of all Fortune 500 Company CEO's are female (Fortune, 2012). Only one in seven students are female in STEM fields (Forbes, 2012). Watch the Oscars, a popular US TV show, there is growing unrest with female equity. Watch the United States political debates, political figure, Hillary Clinton, has committed to improve women's inequality, along with past president Jimmy Carter, who stated: "My last legacy is Women's Equality." (CNN, 2015). Although gender inequality may seem outdated to some, it appears that is not the case. The timing may be perfect to make the necessary changes in STEM programs , to increase female enrollment (and thus overall enrollment), participate in the women's equality initiative as educators, and bridge the gap between women and males in STEM related fields.

Overview: "There is a quality that sets people apart. It is hard to define, but easy to recognize. With it, you take on the world; without it, you live stuck on the starting block of your potential" (Kay & Shipman, 2014). This quality is confidence. Research indicates that over 70% of all women admitted they lack confidence in the workplace (Blackstone, 2011). Could that be part of the reason why females are almost non-existent in senior leadership roles in Fortune 500? Could it be why females are under-represented in STEM fields? To help solve the issue of women's inequality in STEM and general gender unrest in the workplace, FWFM chamber surveyed over 150 women to gain a better understanding of why women engage or don't engage in male dominated STEM environments. This presentation focuses on the survey results and a balanced, practical approach to how both genders can work together to bridge the gap for female equality and engagement, not only in STEM programs, but in businesses, government, and education.

Major Points:

- Overview of the Current US Women's Equality Movement
- Overview of Research Methodology and Survey Results
- Female Barriers to Entry
- Myths of Equality
- Confidence Gap
- Recommended Solutions
- Next Steps, Need for Future Research , and Conclusions

Summary: Attendees will have a balanced understanding of the women's equality issue in STEM, understand myth's that blind, gain future research ideas and gather actions items to bridge the gap for females in their STEM program. Attend whether you are male or female, to bridge the gap in female representation in STEM, it needs both genders seated at the table, with their eyes wide open.

School Administration

Hosting a Regional Technology Fair: Opportunities for STEM, Student Recruitment, & University Service

Authors: Dr. Jess Godbey, Jacksonville State University, Jacksonville, AL
Mr. Terry Marbut, Jacksonville State University, Jacksonville, AL
Mrs. Teje Sult, Jacksonville State University, Jacksonville, AL

Need: There are many tasks required of an academic department: student recruitment, university service, community service, among many others. In addition, long term success of a Technology & Engineering Department depends on young people's exposure to STEM activities. This presentation looks at one method for addressing these needs.

Overview: This presentation provides participants with information on one University's experiences hosting an annual Regional Technology Fair. Winners in this Regional Fair progressed to the State competition. This Technology Fair has approximately 700 participants coming from several counties in the State and ranging from 3rd grade to seniors in high school. There are a wide range of Technology Fair categories including robotics, programming, multimedia, and video production. The Department of Technology & Engineering organizes the Fair, which is no small feat for a 6-person academic department. The Department administers and develops the written exam component, recruits and organizes judges from across the University and the community at-large, provides lunch, and conducts an exciting awards ceremony. The benefits of hosting the Technology Fair are numerous. It provides an excellent opportunity for young people to explore activities in science, technology, engineering, & mathematics (STEM) in a fun and exciting environment. It provides an opportunity for the University and in particular the Department of Technology & Engineering to recruit potential students and allows the Department to fulfill its obligation of University & Community Service.

Major Points:

- Activities required for hosting a Regional Technology Fair
- Increasing exposure of STEM activities
- University student recruitment
- University Service

Summary: Participants will leave this presentation with information on what is involved in hosting a Regional Technology Fair for area elementary and secondary school students and, more importantly, the benefits of hosting a Fair.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

School Administration

Current Enrollment Trend Data for 4-Year Technology Programs in ATMAE Accredited Universities

Authors: Dr. Richard F. Miller, Ohio Northern University, Ada, OH
Dr. Trevor Robinson, Ohio Northern University, Ada, OH
Dr. Feng Jao, Ohio Northern University, Ada, OH

Need: As the need for technology driven graduates continue to escalate, the identification of enrollment data can assist in identifying shortfalls that are not meeting the needs in industry. Understanding the enrollment data vs. industry opportunity also allows practitioners to realize current trends associated with curriculum growth within their own programs.

Overview: As the need for various disciplines emerges in different technological realms, the ability to supply graduates to industry becomes an issue. The development of a database that reveals current enrollment trend data in different areas can guide programs and universities in determining direction and possibly new areas of study. Current enrollment data in ATMAE accredited programs combined with current and emerging job data rates will show those areas that universities can take advantage of to promote program growth.

Major Points:

- Enrollment data in different technology driven areas such as Manufacturing and Construction.
- Elevate awareness of opportunities for program growth in technology disciplines.
- Creation of a repeatable database for future research opportunities.

Summary: Attendees will have the opportunity to see the development of a database system that can be used to garner information concerning enrollment data for ATMAE programs and opportunities for programs to distinguish future enrollment areas to meet industry demands.

2015 Conference Proceedings

Friday, November 13, 2015 - 9:00am - 9:45am

School Administration

Plagiarism: Graduate Student Awareness, Perceptions, and Cultural Attitudes

Authors: Dr. Mark Doggett, Western Kentucky University, Bowling Green, KY
Ms. Marietta Byerline, University of Central Missouri, Warrensburg, MO

Need: The most commonly perceived causes for student plagiarism include purposeful intent to deceive, seeking an easier way of completing assigned work, ignorance or confusion on proper citation methods, grappling with unfamiliar content, or any combination of these factors. Inconsistencies in the application of and attitudes toward plagiarism policies by faculty may obscure the student knowledge needed to understand and comply with institutional ethics policies. Students may also rationalize plagiarism based on their cultural background. Training and education in plagiarism and proper use of citations may reduce the number of offenses.

Overview: This presentation discusses research on graduate student knowledge of plagiarism and their perceptions of its impact. The study also sought to classify perceptions based on student cultural background. Specifically, the following research questions were of interest:

- What depth of knowledge do students have regarding plagiarism?
- What are the perceptions of these students regarding the impact and ethics of plagiarism?
- Is there relationship between cultural background and plagiarism knowledge or perception?

Major Points:

- Background of the study
- Methodology of the research
- Findings
- Summary and interpretation

Summary: This presentation presents survey research on the knowledge, perceptions, and attitudes of graduate students enrolled in technology management programs. The information will show how different cultures perceive plagiarism and its impact on the ethics of graduate programs.

2015 Conference Proceedings

Friday, November 13, 2015 - 9:00am - 9:45am

School Administration

A Systematic Methodology to Improving Literature Review Results

Author: Mr. John R. Haughery, Iowa State University, Ames, IA

Need: For novel research to produce the highest impact, it should be solidly grounded in germane literature. As graduate students, research staff, and faculty strive to produce exceptional research in engineering and technology fields, inequalities in the rigor between primary research and literature reviews can exist. By using a systematic and transparent methodology, researchers can increase the strength of evidence informing their research.

Overview: This presentation will present a process for constructing a sound, data-driven foundation on which to frame research questions. To accomplish this, we present a systematic methodology that includes a clearly defined review strategy, enabling a researcher to make robust screening, mapping, quality appraisal, and synthesis decisions on each source of literature within a literature review. This methodology will bolster the credibility and clarity of a study's conclusions as well as the fidelity of the literature review.

Major Points:

- Why literature reviews should be systematic
- Methodology for systematizing literature reviews
- Systematic reviews as primary research

Summary: This presentation makes a case for a systematic and transparent literature review process, which increases the rigor and strength of primary research. Methods for collecting, screening, mapping, appraising, and synthesizing literature are presented. Application examples are included to solidify presentation concepts.

2015 Conference Proceedings

Friday, November 13, 2015 - 10:15am - 11:00am

School Administration

Increasing Student Engagement through Seminar Series and Plant Tours

Author: Dr. Shweta Chopra, Iowa State University, Ames, IA
Dr. Gretchen A. Mosher, Iowa State University, Ames, IA
Dr. Michelle Soupir, Iowa State University, Ames, IA

Need: In spite of continued efforts taken by the government, universities, companies, and other organizations to increase the involvement of women and underrepresented minorities in Science, Technology, Engineering, and Mathematics (STEM) disciplines; the number in STEM fields remains low. One explanation for this is the lack of students in the pipeline. One reason for the lack of students in the pipeline is the "uninviting, unaccommodating, and unappealing" climate of many STEM workplaces. Other research suggests factors of social isolation, uninviting environments, chilly climates, bias, hostility, and the subtle differences that accumulate and make it more difficult for women and underrepresented minorities to succeed in demanding STEM fields.

Overview: The common feelings of isolation can be addressed in part by role models and mentors from the STEM field to reinforce belongingness among peers. Mentors and role models provide evidence to females and underrepresented groups that successful careers in STEM fields are possible. Even if students have a mentor to talk with, it can be difficult to find an environment that allows for discussion of workplace questions and concerns . This presentation will discuss how we used a series of seminar/workshops to connect undergraduate technology students with potential mentors.

Major Points:

- Issues faced by women and minorities in STEM discipline
- Ways to designing curriculum for actively involving Women and minorities.
- Role of mentoring on retention of women and minorities
- Benefits and challenges of providing role model and mentoring services to women and minorities

Summary: The audience will learn about a mentoring program used in retaining female and other underrepresented minorities in the field of technology. Implications for academic and industrial workplaces will be shared.

School Administration

Projects as Learning Bridges: Interlinking Projects for Building Connections Across the Technology Curriculum

Authors: Dr. Vigs J. Chandra, CSTM, Eastern Kentucky University, Richmond, KY
Dr. Ray E. Richardson, CSTM, Eastern Kentucky University, Richmond, KY
Mr. Jeffrey B. Kilgore, Eastern Kentucky University, Richmond, KY

Need: Coursework in lower-division technology and applied engineering management programs while traditionally covered using a combination of lecture and laboratory activities, offers limited opportunities for working on projects until the end of the semester. The technological workforce on the other hand is largely project driven and team based. There is thus a need for introducing group projects early on in technology courses and across the curriculum, allowing students to develop project planning and implementation skills. Even in upper-division classes where projects are frequently used, taking on a single large end-of-semester large project can seem overwhelming in its complexity and somewhat paralyzing. By sectioning the project into multiple parts--whenever it is feasible to do so--students can begin their research, design and development work early in the semester. Testing and troubleshooting of individual projects sections, along with its integration with downstream sections strengthens understanding of theory with practice throughout the semester. Visualization of the links between various sections of the project can be used to organize and prioritize the work needed. Projects can thus serve as learning bridges leading to mastery of high-specialized technical content both within a course and span multiple courses within a thematic cluster.

Overview: Student technology projects are very helpful in providing the larger context within which learning can occur. Using multiple interlinked projects as compared to a single large project can provide students the opportunity to see how the different sections fit together, along with developing both global and localized views of the system itself. They can also understand the need for abstractions on one hand and details on the other. Students can see the impact of their design choices on the overall project through simulations and prototyping. Customization of these prototypes for improving efficiency, safety or ease of access also makes students think about these important real-world considerations.

Major Points: - Building key competencies related to project planning and implementation should start early in the technology curriculum, and develop in complexity as students advance through the major. - Challenges faced by technology students while transitioning

Summary: Attendees of the presentation will learn about strategies for interlinking multiple projects within the fabric of a course and across the technology curriculum. Doing so can allow students the opportunity to learn about problem solving, communication, teaming, and work attitudes. These complex ideas that are best learned through immersion rather than from the sidelines. Samples of multiple mini projects completed within a course and across a cluster of courses will be shared with the audience, along with rubrics for evaluating the projects. Interlinking and customizing smaller projects culminating in an overall semester project provides a meaningful way for integrating the core concepts of the discipline into tangible products. Considerations for equipment needs and time constraints which need to be balanced while trying to complete these projects will be shared with the audience.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

School Administration

Analysis of Critical Thinking Skills of Upper Division Technology Students

Authors: Mr. Matthew E. Harvey, Iowa State University, Ames, IA
Dr. Steve Freeman, Iowa State University, Ames, IA
Dr. Gretchen A. Mosher, Iowa State University, Ames, IA
Dr. Charles Schwab, Iowa State University, Ames, IA

Need: It is valuable to have a direct measure of critical thinking skills, because they are necessary for the future success of undergraduate technology students. By using an empirical assessment of these skills (Critical Thinking Assessment Test), faculty can assess what critical thinking skills are present or are lacking in undergraduate students and make curricular improvements to better develop these skills. This test also provides feedback that can assist the faculty in determining some measure of the effectiveness of coursework, curricula, and departmental learning activities. In addition, the analysis of other student data to include demographic information, grades in requisite coursework, grades in technology specific courses, and scores on college entrance exams is made along with the assessment test results. We will present the results of the administration of this critical thinking assessment over the past six semesters, the analysis of test results and student data, and the implications for current and future curriculum design.

Overview: This project makes use of the Critical Thinking Assessment Test (CAT), developed by Tennessee Technological University under the sponsorship of the National Science Foundation. It is an assessment tool that is designed to measure important components of critical thinking. The test was administered to six groups of undergraduate students during their final year of study. Results from the assessment and student data were analyzed, correlations were identified, and recommendations for curriculum improvement are made. Specific emphasis was given to examining correlations between student performance in technology specific courses and their results from the CAT. A model to support department continuous improvement activities and accreditation preparation with the use of the CAT was developed. Further opportunities for research are identified.

Major Points: · The Critical Thinking Assessment Test (CAT) is reviewed and test results analyzed · Technology course performance and test results are correlated · Methods for using CAT results for continuous improvement will be discussed · Recommendations for the use of the CAT in program accreditation are made

Summary: Attendees will gain an understanding of critical thinking skills, the use of the CAT, and correlations between the CAT results and other student data. Attendees will also gain insight into the way the tool has been used for assessment and continuous improvement in an ATMAE accredited program. Participants will leave with both a model for implementing the use of the CAT in program evaluation and the results of correlation analysis from an undergraduate technology program over three years.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

School Administration

What Midlife Crisis? Encouraging and Retaining the Nontraditional Student

Author: Dr. Kimberley A. Gordon, University of Arkansas - Fort Smith, Fort Smith, AR

Need: As the rolls of nontraditional students expands nationwide, so expands the need for educators to connect with these students if they are to impart knowledge and skills for an encore career.

Overview: The presentation is designed for those involved in the education of nontraditional students with applicable information from key theoretical foundations in lifespan development. To be successful, educators should possess basic understanding of the cognitive, biological and socio-emotional processes. Once an educator possesses such understanding, the ability to articulate the process should aid in connecting with the nontraditional student and bolster student success.

Major Points:

- Androgogy: the theory of adult learning
- Characteristics of adult learners
- Development processes (cognitive, biological, socioemotional)
- Life-span development research Erikson's Theory of Psychosocial Development
- Levinson's Theory of Life Stages and Human Development
- Vygotsky's Sociocultural Theory
- Incorporating theory in practical approach

Summary: Participants in this session will learn and immediately apply their knowledge of three lifespan development theories the presenter believes are foundational to instruction of nontraditional students. By learning and applying the information to their own lives, participants synthesize the theoretical crux and are more likely to utilize the information upon return to the classroom.

2015 Conference Proceedings

Friday, November 13, 2015 - 2:00pm - 2:45pm

School Administration

Partnering with Industry: Discussion of the Partnership Leading to, and the Applied Research of an Analysis of Reaction Times in NHRA E.T. Bracket Racing Classes

Authors: Dr. Randell W. Peters, Indiana State University, Terre Haute, IN
Dr. Michael A. Hayden, Indiana State University, Terre Haute, IN

Need: Partnering with industry can be daunting and time consuming. This particular partnership developed slowly over time. The discussion of developing the partnership, the need for the study, and the results of study, will inform the audience of the process that may be repeated. In this session we will discuss our partnership with the National Hot Rod Association (NHRA). The NHRA is continually looking for innovate ways to grow participation in drag racing by many different stakeholders. Data collection and analysis can serve as a foundation for a marketing platform to reach this goal.

Overview: In NHRA ET bracket racing, it has long been accepted that sportsman racers have slower, less consistent reaction times than the other classes. The Pro class is generally accepted as being more competitive with regard to quicker, more consistent reaction times than the sportsman class. The Super-Pro class has long been understood to be the most competitive with respect to reaction times as this class is allowed the most starting line enhancements. However, no comprehensive data-based study has been conducted—until now. Bracket racing is considered the backbone and the grassroots of drag racing. This style of racing allows for racers with very different machines to compete on a level playing field. Essentially, the three classes represent three levels of monetary investment. Each class has different starting line rules regarding the use of technology. This presentation will be derived from an analysis of more than 50,000 passes on selected NHRA drag strips.

Major Points:

- Developing industry partnerships
- Understanding reaction times
- Discussing the electronics for starting line enhancement across the three classes
- Data analysis:
  - * Statistics and data conditioning
  - * Is there a statistically significant difference in reaction times between three classes of three NHRA ET Bracket Classes: Super Pro, Pro, Sportsman
- More than 50,000 competition runs/passes were analyzed from the 2013 season

Summary: This presentation contains industry partnership development and applied research that should be of interest to many faculty and students. Reaction times are very important to winning in drag racing. This study includes many variables in addition to bracket, dial in, and time, e.g., temp, wind speed, and other track and weather variables. The results may both reinforce and negate conventional wisdom concerning the technological starting line advantage, reaction time, and bracket.

Thursday, November 12, 2015 - 11:30am - 12:15pm

Teaching Innovations (TI)

Identification and Validation of Competencies Expected of the Graduate Programs in Renewable Energy

Authors: Mr. John R. Haughery, Iowa State University, Ames, IA
Dr. Hans Chapman, Morehead State University, Morehead, KY
Dr. Ahmad Zargari, Morehead State University, Morehead, KY
Dr. Nilesh Joshi, Morehead State University, Morehead, KY

Need: Universities and colleges across the United States are striving to keep pace with renewable energy technology and policy. This has fostered an emerging conglomerate of renewable energy degree offerings. There exists, though, a disconnect between renewable energy industry workforce needs and academic program competencies. This is evidenced by an absence of clearly defined curriculum content in many of these renewable energy graduate programs. This can be overcome by new or updated degree programs that have clearly defined program competencies that relate to specific renewable energy knowledge, skills and attributes needed for successful careers in this field.

Overview: The purpose of this presentation is to identify appropriate curriculum competency content for graduate degrees in renewable energy. This proposed content flows from a review of literature from government initiatives, professional society's body of knowledge, and related research studies. Leaders and experts in the field of renewable energy and sustainability were then surveyed to rank each items priority on a 5-point Likert scale.

Major Points:

- List of curriculum competencies identified for renewable energy graduate programs
- Competency items statistically ranked based on expert input from industry
- Analysis of results of statistical rankings

Summary: At the conclusion of this study, a clear list of 42 content items was identified and statistically ranked. It was found that seven competency items ranked as very important, 30 as important, and five as somewhat important. These results are presented and discussed as a framework in developing or improving existing renewable energy graduate programs.

2015 Conference Proceedings

Thursday, November 12, 2015 - 11:30am - 12:15pm

Teaching Innovations (TI)

Development, Implementation and Reflection of Sustainable Manufacturing Modules for Manufacturing Program at UNI

Authors: Dr. Julie Zhang, University of Northern Iowa, Cedar Falls, IA
Dr. Nageswara Rao Posinasetti, University of Northern Iowa, Cedar Falls, IA
Dr. Nilmani Pramanik, University of Northern Iowa, Cedar Falls, IA

Need: The manufacturing sector is an important contributor to economy, as it leads to well-paid jobs, better living standard, and society prosperity. Recent decades, a series of problems worldwide such as climate change, diminish of natural resources, environmental deterioration, public health due to the unbalanced manufacturing activities have made great attentions in the international community to seek for sustainable development. The industries already responded to this trend by pursuing sustainable manufacturing strategies at different levels, because they must meet the national and international regulations concerning environmental issues in order to remain competitive. This emerging trend raises a need for educators to consider how to prepare future generation of technologists who understand and can apply sustainable manufacturing strategies.

Overview: Although sustainable manufacturing has different definitions according to varied literature, the three dimensions in sustainable manufacturing model, economy, society and environment, as well as education's key role for sustainable manufacturing are agreed upon. Converting sustainable manufacturing from a slogan to a real practice confronts pressing challenges. This paper will present the sustainable manufacturing teaching modules that were developed at UNI through faculty research synchronization and how the teaching modules were embedded in existing manufacturing classes to motivate students learning.

Major Points:

- Sustainable manufacturing evolution
- Sustainable manufacturing at three levels- product, process and system
- Aspects considered for decision making based upon green manufacturing, from product design & evaluation, material selection, machine tool selection, manufacturing process planning and implementation, actual production process and waste management
- Faculty engagement and professional development at UNI— Sustainable Education Leadership Program
- How students are motivated by the research related learning

Summary: Technology, innovation and education are essential to social and economic growth and environmental protection with the ultimate goal of sustainable development. Going a long way in ushering sustainable manufacturing, infusing green thinking to future workforce should start from the early stage. As major players, industrial and academic institutions should synchronize their strengths to promote sustainable manufacturing. Illustrative examples included will provide some insights of how research and teaching can be tied with green thinking towards sustainability. This presentation also will reflect how faculty is benefited in the development of the sustainable manufacturing teaching modules for self-professional enhancement.

2015 Conference Proceedings

Thursday, November 12, 2015 - 11:30am - 12:15pm

Teaching Innovations (TI)

Mobile Technologies for Engineering Technology Education – Impact and Case Study

Author: Dr. Jin Zhu, University of Northern Iowa, Cedar Falls, IA

Need: Mobile devices and social media are becoming increasingly common in our daily life. Widely available mobile technologies makes its use both an opportunity and a challenge to higher education. Many people consider that mobile devices, such as mobile phones and smart watches, could be a major distract source inside the classroom. In another hand, some educators are starting to integrate the mobile technologies and social media into the teaching pedagogy. Can it really improve the teaching effectiveness and student engagement? If so, what practice is recommended? Many questions needs to be answered.

Overview: Our society is entering to the mobile era, with over 80% population with wireless access, mobile technologies have become one indispensable part of our daily life. To engineering technology students, it is important to experience that the mobile technology can not only be used for fun, such as hanging on social media, but also it can be used to improve the productivity. It would be helpful and interesting to learn their perception on mobile technologies. In this case study, mobile tools are utilized to help an engineering technology course contents delivery and self-assessment. Both pre-survey and post-survey are used to compare and learn how and if the way the students think about mobile technologies changes. The impact of the mobile technologies on student engagement will also be discussed.

Major Points:

- Mobile technologies and social media usage in higher education
- Faculty attitude and perception on the Use of Mobile technologies and social media in teaching
- Challenges and pitfalls utilizing Mobile technologies inside and outside classroom for teaching and learning.
- Case study on how to integrate Mobile technologies and social media in one engineering technology course and assessment results.

Summary: The challenges and opportunities of integrating mobile technologies and social media into teaching and learning are discussed. One case study on utilizing mobile tools into one engineering technology course and its outcomes are presented.

Teaching Innovations (TI)

Implementation of Rapid Prototyping Technologies in Multidisciplinary Coursework and Research Applications

Authors: Dr. Faruk Yildiz, Sam Houston State University, Huntsville, TX
Dr. Ulan Dakeev, University of Michigan-Flint, Flint, MI
Dr. Mehmet Goksu, Millersville University, Millersville, PA

Need: Rapid Prototyping (RP) technologies has made significant inroads in a number of design and manufacturing sectors in the near past because of ease of customization and quick improvement of concepts to prototypes. 3D printing or additive manufacturing is a process of making a three-dimensional solid object of virtually any shape from a digital model. The 3D printing technology is used for both prototyping and distributed manufacturing with applications in architecture, construction, industrial design, automotive, aerospace, military, engineering, medical industries, education, geographic information systems, and many other fields. Various institutions now have or in the process of implementing RP machines for research and teaching. Current literature reports that involving RP in design and manufacturing courses can significantly enhance active learning by providing quick and direct feedback on their designs via prototypes. In some cases, functional mechanical components can be made directly, which is especially useful for capstone design projects.

Overview: While 3D printing technology has been around since the 1980s, it was not until the early 2010s that the printers became widely available commercially. The first working 3D printer was created in 1984 by Chuck Hull of 3D Systems Corp. Since the start of the 21st century there has been a large growth in the sales of these machines, and their price has dropped substantially. Taking all the recent RP developments into a consideration, an increasing number of institutions are utilizing 3D printers and scanners in engineering and technology classrooms to enhance the teaching and research of the design process. There are variety of benefits of 3D prototyping and scanning include evaluation for form, fit, style, and ergonomics. One of the most important benefits of 3D printing and scanning is enhanced communication between product designers and builders during the initial design phase and product refinement. Today, a large number of equipment are available in the marketplace. They are used for a much wider range of applications and are even used to manufacture production fully functional parts in relatively small numbers. Depends on program and research requirements there maybe more than one RP equipment are available in the market for consideration.

Major Points: - Existing RP technologies - Ability of 3D printers/scanners and supported file formatting Comparison of 3D prototyping technologies (cost, ability, material type, ease of use etc.) - Multidisciplinary curricular activities - Where to start implementing a RP technology into an existing course or project

Summary: In this study, the use RP equipment, existing programs and courses that use RP technology, how to prepare students and instructors to manage RP technology properly, past experiences from other studies, how to create a more enjoyable and effective learning environment for RP technology will be shared with academia.

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Teaching Innovations (TI)

Engineering Problem Solving, Engaging the Imagination, Paper Airplanes, College Students, and 5th Graders

Authors: Dr. Timothy M. Brockman, Bemidji State University, Bemidji, MN
Mr. David R. Towley, Bemidji State University, Bemidji, MN

Need: According to the 2010 U.S. Census, approximately 36.3 percent of the population currently belongs to a racial or ethnic minority group. Universities are seeing increased efforts to engage regional communities in an attempt to plant the early seeds of recruitment for underrepresented populations in nearby communities. One of the tools used by many universities is the campus tour that coordinates multiple short, creative project-based activities of various disciplines with middle school students. These campus tours are directed to all students in a middle school class, and in so doing involve ethnically and racially diverse populations in a less conspicuous manner. Using a diverse group of college students to engage 5th graders will provide wide-ranging perspectives, and build confidence in the engineering student presenters while possibly recruiting for racial and ethnic minorities.

Overview: When challenged to provide a thirty minute activity for multiple groups of thirty 5th graders in a 45-minute time rotation on a limited budget the following project-based activity was designed. The Paper Airplane Aerodynamic Applied Engineering Challenge was created with the intention of engineering students running the complete activity. College students would be presenting the information, assisting 5th graders with designing and assembling their airplanes, and then launching, modifying, re-launching and reviewing the lessons learned. The success of the project came as the engineering student worked with multiple groups of 5th graders, and the presenters' confidence built with the repetition of the activity. As faculty supervisors encouraging the flow of the processes, it was rewarding to see the engineering students meet the challenges and questions of the 5th graders; as both came to the conclusion of, "Let's see how it flies!" followed with the question, "Why do you think it did that?" As terms like inertia, pneumatic launchers, thrust, drag/air resistance, gravity and lift were explored.

Major Points:

- Outreach to regional middle schools
- Engages regional racial or ethnic minorities
- Engages females in under-represented roles
- Engineering students working with middle school students
- Low budget and fun project-based learning activity
- Students gain presentation and teaching experience
- Potential early encouragement for recruitment

Summary: Attendees will experience an idea for a low-budget, project based activity that can be paired with engineering students and 5th graders. When female, racial or ethnic minority populations are represented in both stakeholder groups potential is created to plant the seeds of early engineering recruiting possibilities.

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Teaching Innovations (TI)

Developing and Sustaining High Quality Academic Advising with Technology Undergraduates

Author: Dr. Gretchen A. Mosher, Iowa State University, Ames, IA

Need: The basis of high quality academic advising is a strong relationship between the student and the adviser. These types of relationships can be difficult to cultivate with high numbers of advisees. Activities which encourage student engagement with the adviser can also boost retention and success rates of students, yet little research has investigated characteristics of high quality advising in STEM fields, especially in areas experiencing high enrollment levels.

Overview: The role of high quality academic advising is often overlooked when measuring student undergraduate experiences. This presentation will discuss the challenges of developing policies and practices to ensure high quality academic advising for students in technology disciplines. Factors considered in measuring advising effectiveness and the development of departmental advising policies will be shared. The implementation of these policies in large enrollment environments will be discussed. Implications for adviser performance evaluation and continuous improvement will conclude the presentation.

Major Points:

- Characteristics of high-quality academic advising
- Development of policies and practices to enhance student engagement with faculty
- Factors considered in the evaluation of advising effectiveness
- Implications for supervision of employees and continuous improvement

Summary: The audience will learn about the components of an effective academic advising program created for a technology and engineering department. Factors and strategies for measuring effectiveness and encouraging a culture of continuous improvement will be discussed.

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Teaching Innovations (TI)

Teaching Communication in a Technical Field: Focusing on the Soft Skills

Authors: Miss Jennifer A. Warrner, MA, Ball State University, Muncie, IN
Dr. James W. Jones, Ball State University, Muncie, IN

Need: According to annual research conducted by the National Association of Colleges and Employers, communication skills are the number one skill that employers look for in new employees. Students learn about general communication skills in college, but they often do not learn communication skills that are specific to their specific technical industry.

Overview: This presentation discusses a new course, Technical Presentation, that was incorporated into one program's curriculum beginning in Fall 2014. This course, examined as a case study for other technical programs, focuses on specific written and verbal communication skills that are essential for professionals in the construction industry. Based on feedback from students, alumni, employers, and our construction management advisory board, the Technical Presentation course was developed so that students would be equipped with the communication skills needed to be successful in the construction industry. In this activities based course, students learn about topics including presentation skills, business writing, email etiquette, and phone skills. Professionalism topics, such as creating job search documents and interviewing skills, are also included in the course to help prepare students for their internship and job searches.

Major Points:

- Reasoning for including a new communications course into the construction management curriculum
- Development of Technical Presentation course curriculum
- Innovative teaching strategies to teach construction specific communication skills
- Strategies to incorporate students' work experiences into course activities
- Plans for modifications to the course based on student and employer feedback

Summary: Attendees will understand the value of including an industry-specific communication skills course into their curricula. Attendees will learn about innovative teaching strategies and course content that could be incorporated into curricula at other institutions. Attendees will learn how to incorporate students' work experiences in an industry with significant technical and managerial aspects into the curriculum of a communication skills course.

2015 Conference Proceedings

Thursday, November 12, 2015 - 1:30pm - 2:15pm

Teaching Innovations (TI)

To be More than a Student: Case Study of Undergraduate Research on Addressing Food Security

Authors: Ms. Ria N Gasaway, Iowa State university, Ames, IA
Mr. Brian Nakayama, Iowa State University, Ames, IA
Dr. Shweta Chopra, Iowa State University, Ames, IA

Need: Very often undergraduate students restrict their education to classroom. However outside classroom research project helps student to gain expertise in their field of education and become ready for the future workforce. Communities around universities are often benefited by such research. In this research faculty and industrial technology undergraduate students are working with food rescue organization in Johnson County, Iowa to improve food collection and distribution. This project provided undergraduate students opportunity to learn more about community and apply their classroom learning in real world, to clarify their interests and goals for their future, to sow the seeds of a career, to develop mentoring relationships with faculty and to participate in the scholarly dissemination of research.

Overview: Under the guidance of university faculty, an undergraduate student develops skills required for being a researcher. Gaining this guidance in the early stages of higher education benefits students immensely. Furthermore, these research opportunities provide students leadership skills in problem solving, networking and most importantly goals setting for future education and career path. Undergraduate research is positively correlated with entering graduate school as was observed by Universities undergraduate research assistantships. In this presentation we will discuss the experience of undergraduate students involved in undergraduate research at Iowa State by examining their work in community project addressing food security.

Major Points:

- Discuss ways for students to get involved in undergraduate research assistantships
- Highlight the relationship between undergraduate research and graduate school
- Describe the ways in which professor can involve their undergraduate students in research.
- Explain the challenges and outcomes of students involved in undergraduate research
- Explicate on the benefits of students' projects on local community and industry

Summary: Undergraduate research can help student be ready for future workforce or graduate school. Such research can also help students be motivated towards their career. Faculty and undergraduate students can help local community with the help community led project.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Teaching Innovations (TI)

Creating and Sustaining High-Quality Senior Capstone Experiences

Author: Dr. Gretchen A. Mosher, Iowa State University, Ames, IA

Need: Senior capstone courses focus on the integration and application of technical knowledge and skills in previous coursework along with a consideration of multiple realistic constraints. Because students are often new at project management, they often struggle with capstone projects. Capstone courses are also challenging for faculty, particularly in sourcing appropriate projects, managing expectations, and evaluating students.

Overview: A high quality capstone experience has many positive outcomes for the student, faculty, and department. This presentation will outline the challenges and best practices learned in the development and implementation of a senior-level capstone course with technology undergraduates. Specifically, strategies for sourcing student projects, student team formation and management, and options for ensuring accountability among student teams will be discussed. Ideas on fair and consistent assessment methods for group and individual work will also be emphasized.

Major Points:

- Challenges of industry-based capstone projects
- Sourcing and assigning project teams
- Management of projects
- Holding individuals and groups accountable for progress

Summary: The audience will learn about successful approaches to senior capstone courses for technology students. Factors and strategies that have characterized successful project sourcing, team management and student assessment will be discussed.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Teaching Innovations (TI)

The Need for Incorporating Geometrical Dimensioning and Tolerance in Engineering Technology Undergraduate Curriculum

Author: Dr. Zaki Kuruppalil, Ohio University, Athens, OH

Need: Drawing is Engineers language and the person who drafts has a message for the person who reads it. As any other graphical representation methods, engineering drawings, if not properly dimensioned could be misinterpreted or lacks clarity. Simple dimensioning with + or - minus tolerances may not be able to efficiently express complex functional requirements such as a feature to feature tolerance refinement or orientation between features. Geometrical Dimensioning and Tolerance (GD&T) was developed based on American Society of Mechanical Engineers (ASME) standard Y14.5 1994 to address functionality aspect of dimensioning. Since GD& T is increasingly being used in design, manufacturing and quality, it is important that engineering and technology graduates have the knowledge and skill regarding practical interpretation and application of the subject.

Overview: This presentation is intended in showing how proper interpretation and application of GD&T language is taught in a Production Tooling class room. The focus of the presentation will be from a tooling manufacture perspective. In addition the relevance of GD&T in attaining high level of manufacturability and functional requirement of a product will be discussed.

Major Points:

- What is GD&T?
- Industry standards and symbols used
- Why is it important for students to have an understanding of GD&T
- Application of GD&T in a class room setting
- Practical examples of student projects
- Conclusion

Summary: At the end of this presentation the attendees will have an understanding on the benefits of incorporating GD&T in engineering drawings and the need for incorporating it in undergraduate curriculum.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Teaching Innovations (TI)

Bridging Engineering Technology with General Education: Faculty Lessons Learned from the Survey of Motorsports

Author: Dr. Randell W. Peters, Indiana State University, Terre Haute, IN

Need: (1) Many universities stress the need for and mandate general education courses. (2) Students in STEM programs often dismiss general education courses as something with little or no value. (3) The US market demand for additional graduates of STEM programs is increasing (4) There is a corresponding increase in recruiting efforts to attract STEM students. (5) Engineering technology programs may benefit from increased SCH production by offering technology courses suitable for all majors (6) 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 efforts of teaching a general education course focused on motorsports technology that blends the student outcomes of general education and technology. The course includes experiential learning and distance delivery. Over a thousand student have taken the course. The lessons learned by the professor will be discussed relating to delivery mode, number of students, timing of classes and other information.

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.

2015 Conference Proceedings

Thursday, November 12, 2015 - 2:30pm - 3:15pm

Teaching Innovations (TI)

The Electric Guitar: Design, Production and Testing

Author: Dr. Gary S. Mahoney, Berea College, Berea, KY

Need: The increased demands of a global manufacturing world require today's learners to be fluent in the design/manufacturing cycle. They need experiences that allow them to develop knowledge and skills in being able to go from a concept, to a design, to a prototype, through testing, redesign, and then to production engineering. Using 3D modeling tools, rapid prototyping equipment, computer aided manufacturing software and computer numerical control equipment allows students to apply these concepts in a timely manner. The electric guitar has proven to generate a lot of interest and enthusiasm. It provides enough complexity to be challenging and meaningful, and can still be realized in a semester long class.

Overview: In order to develop understandings related to design and production, key concepts, content, and interaction must be incorporated throughout the curriculum. Varied levels of interactions strategically placed can assist in moving the learner from a level of awareness to one of conducting research/design for specific applications. Challenges include keeping up to date with the changes in technology, developing meaningful learning opportunities, and providing relevant context. This presentation will discuss how electric guitar design and production coupled with current automation technology can be used to provide a holistic learning opportunity.

Major Points:

- Developing understandings of product design and production
- Developing technical skills in predictive design using 3D modeling software
- Developing technical skills in prototyping and testing
- Developing technical skills in production engineering
- Course changes, conclusions, and recommendations

Summary: Attendees will understand the use of the electric guitar as a medium for teaching design, testing and production concepts. A basic understanding of guitar design will be discussed and examples of how CAD, CAM and CNC tools have been used to complete both unique one off designs and larger scale productions.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Teaching Innovations (TI)

Building International Bridges with Courses Abroad to Europe and Asia

Authors: Dr. Paul J. Resetarits, Central Connecticut State University, New Britain, CT
Dr. Haoyu Wang, Central Connecticut State University, New Britain, CT

Need: Manufacturing today is an international business. Students need experience traveling, communicating effectively, including using a foreign language, and interacting with people from other cultures. Additionally they gain personal experience with coping with unfamiliar and challenging settings while traveling through foreign countries. Our Industrial Advisory Board members have helped us to better meet their needs of having students/employees who are prepared to travel internationally and work with their suppliers throughout the world.

Overview: Annually we offer two, three credit courses abroad for students in the majors of Engineering, Technology and Business. Typically one course travels to Asia (China, Japan, Korea) and the other to Europe (Austria, Czech Republic, Germany, Poland). Over the years we have developed relationship many different universities and multinational companies. In the past we have visited BMW, Mercedes Benz, Porsche, Hyundai, Mitsubishi, Toyota, Pratt & Whitney, Carrier, Libherr, Voest Steel and Doppelmayer. Students are required to evaluate and analyze the production systems of the various companies that we visit. They also must keep a journal of their experiences and make a presentation based on the new knowledge they have gained through this experience. They note that this is a life altering experience.

Major Points:

- Exposure to manufacturing/production systems in other countries
- Visits to Universities and discussions with their peers/fellow students
- Exposure to international travel and transportation systems
- Requirements for getting necessary travel documents i.e. passport or visa
- Understanding of diversity of values, beliefs, ideas, and world views

Summary: Students gain a competitive edge in their job search by having international experience thorough these courses abroad. Given that most students cannot do a semester studying abroad, the short term course abroad offers a great alternative.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Teaching Innovations (TI)

Impression Management through Interdisciplinary Collaboration

Authors: Dr. James W. Jones, Ball State University, Muncie, IN
Mr. Gary R. Birk, Ball State University, Muncie, IN
Mrs. Valerie Birk, Ball State University, Muncie, IN

Need: While most technical programs properly focus their curricula on the scientific preparation of their students, the so-called "soft skills" are notoriously more difficult to teach but are in high demand from industry. Impression management, including appropriate dress and image, can vary by discipline but can be addressed outside the classroom through an unlikely student peer collaboration from different disciplines.

Overview: The old image of the technology professional might stereotypically have included a pocket protector and taped eyeglasses, but modern graduates need to be aware of the importance of impression management throughout their careers. Impression management, including appropriate dress and other image-related issues, is not typically part of most technology curricula, potentially leaving students unaware of these issues. Fortunately, most programs have ready access to experts in these fields, whether across campus or within their own departments. This presentation details the innovative approaches used by one technology program to collaborate with consumer sciences to promote impression management awareness and reflection. Other faculty members can utilize these methods to assist their own students with their professional impression management as well as provide real-world research and activities for students in allied disciplines.

Major Points:

- Impression management issues for students
- Collaborative activities for technology and supporting disciplines
- Reflective practices
- Challenges and lessons learned
- Conclusions and recommendations

Summary: Presentation attendees will understand successful collaborative practices to introduce and reinforce impression management topics to technology students. Perspectives of administrators, technology faculty, and supporting discipline faculty are provided.

Teaching Innovations (TI)

Student Training and Professional Development: How Community Emergency Response Teams (C-CERT) in Technology Programs Develop New Emergency Management Practitioners

Authors: Dr. Jessica L. Murphy, Jackson State University, Jackson, MS
Dr. Pao-Chiang Yuan, Jackson State University, Jackson, MS
Mrs. Casey Fitch-Randolph, Jackson Sate University, Jackson, MS

Need: The Community Emergency Response Team (CERT) program is started in 1985 at City of Los Angele's fire department (LAFD); a pilot program training leaders in a neighborhood watch organization. The Emergency Management Institute has made an "all hazards" program available with the consideration that responders may not be able to timely assist when disaster strikes. In this instance, local community residents may assist until responders arrive. In 2011, Jackson State University (Jackson, MS) established an Emergency Management Technology degree program in the Department of Industrial Systems and Technology. Students in this program, along with graduate students in the existing Hazardous Materials Management program began to participate in Campus CERT or C-CERT trainings; thus, developing skills in light rescues, first aid, incident command system, forecasting technologies and more. By participating in C-CERT; students develop competencies through hands-on training, cultivate an understanding of the Emergency Management profession, and promote campus and community safety. This is an essential element in producing new Emergency Management practitioners with modern technology proficiency.

Overview: Following a major disaster, first responders who provide fire and medical services may be inundated with responsibilities to save lives. Factors such as number of victims, communication failures and road blockages will prevent people from accessing emergency services they have come to expect at a moment's notice. People will have to rely on each other for help in order to meet their immediate lifesaving and life sustaining needs. C-CERT training on the college campus aids in campus and local community disaster preparedness. In addition, students who participate in C-CERT engage in academic programs where they can develop disaster management skills and obtain degrees in this high demand discipline. Training for future emergency management practitioners will develop and enhance skills that promote proficiency in mitigation, preparedness, response, and recovery.

Major Points: · Establishment, purpose, and types of training for CERT and C-CERT · C-CERT Emergency Management students skills and professional development · C-CERT promotions of disaster preparedness and civic responsibility · C-CERT development of new Emergency Management Practitioners with modern technology proficiency.

Summary: In fulfilling the need for training by incorporating more technology and hands-on experience, JSU Emergency Management students who participate in C-CERT learn from drills and practice. They also have collaboration with local Emergency Management practitioners to learn more about the field, the demand for new Emergency Management practitioners, and how to properly to prepare for the careers in this arena.

2015 Conference Proceedings

Thursday, November 12, 2015 - 3:45pm - 4:30pm

Teaching Innovations (TI)

Development of a Master's Project Option Focused on the Entrepreneurial Development of Technical Innovations

Author: Dr. Darren C. Olson, Central Washington University, Ellensburg, WA

Need: The importance of this presentation is that an overview of this development can demonstrate a means whereby educators can formally recognize the mastership of subject matter via the completion of creative and entrepreneurial activities.

Overview: The purpose of this presentation is to illustrate how a framework was developed for a master's project option in a Master of Science in Engineering Technology (MSET) program that is centered on the development of technical innovations by students, within the context of product design and development, and operations management, over the life cycle of a product. Working via interdisciplinary collaboration with faculty members from their home department and from other departments across campus, students can conduct a master's project in which completion involves the successful development of an innovation. One fundamental aspect of earning a master's degree is developing the ability to evaluate what is learned and synthesize knowledge from a variety of sources. Students who do this are demonstrating that they have achieved a high level of understanding. Many master's degree programs contain a research component requirement, commonly manifested in the form of thesis papers or research projects. This presentation will provide an overview of a research component option that was developed to allow students the opportunity to demonstrate mastership via an avenue focused on innovation. The project can take the form of successfully developing and launching a product, obtaining a design patent or a utility patent, or completing a consultative project focused on innovative problem solving. Variations of these options can be approved by the student's master's committee.

Major Points:

- The importance of innovation and entrepreneurship to the field of Engineering Technology
- Overview of the program for which this option was developed
- Overview of the development process
- Overview of the project requirements

Summary: Attendees will gain insights about the importance of innovation and entrepreneurship to the field of Engineering Technology, how these principles guided the development of a a master's project option, and how this project option is configured.

2015 Conference Proceedings

Thursday, November 12, 2015 - 4:45pm - 5:30pm

Teaching Innovations (TI)

Green Campus Experience: Developing a USGBC LEED® Lab™ Course

Authors: Dr. James W. Jones, Ball State University, Muncie, IN
Mrs. Janet Fick, Ball State University, Muncie, IN
Mr. Kevin Kenyon, Ball State University, Muncie, IN

Need: While sustainability has become an increasingly significant topic in many technology programs, the majority of curricula focus on classroom learning without providing actual, applied experience for the students. The LEED® Lab™ initiative provides students with the opportunity to not only learn about sustainability, but to apply this learning in the actual certification of an existing campus building.

Overview: The United States Green Building Council (USGBC) has been at the vanguard of sustainability in the built environment since its inception in 1993. Its Leadership in Energy and Environmental Design (LEED) certification program is recognized and used worldwide. While LEED certification was originally developed for new construction, it has expanded into other areas, including existing buildings. LEED for Existing Buildings: Operations and Maintenance (LEED-EBOM) is a certification process for buildings not undergoing construction or renovation and is based on actual (as opposed to theoretical or projected) building performance. The USGBC is promoting university action in sustainability through their new LEED Lab program, in which students take part in certifying an existing campus building. This presentation examines the approach used by one program through the perspectives of both faculty and facility representatives. Other technology instructors can consider whether the LEED Lab program might be a good fit for their campuses.

Major Points:

- USGBC LEED Lab overview
- Different approaches to LEED Lab implementation
- Curriculum development
- University as client
- USGBC support
- Challenges and lessons learned
- Conclusions and recommendations

Summary: Attendees of this presentation will understand how the LEED Lab program was successfully developed and implemented in a technology program. Perspectives of faculty and the university as client will be provided.

2015 Conference Proceedings

Thursday, November 12, 2015 - 4:45pm - 5:30pm

Teaching Innovations (TI)

An Undergraduate Energy Systems Track for Engineering Technology

Author: Dr. Hans Chapman, Morehead State University, Morehead, KY
Dr. Nilesh Joshi, Morehead State University, Morehead, KY
Dr. Ahmad Zargari, Morehead State University, Morehead, KY

Need: The Energy Systems Track as a program option for undergraduate students in Engineering Technology students will prepare graduates of the track to enter the energy and sustainability workforce where they will be expected to introduce new and relevant skills necessary to integrate environmentally-friendly technologies while maintaining or retrofitting aging infrastructure. In recent times, renewable energy technologies such as solar, wind, biomass, geothermal, and hydroelectricity have gained importance in the global effort toward energy efficiency and conservation. In addition, design of intelligent systems, such as smart grids; have enhanced the functionality of energy distribution systems. A career in energy systems will be rewarding for prospective graduates of an Energy Systems Track in Engineering Technology.

Overview: The Energy Systems track will provide students with the knowledge and skills for designing and managing emerging technologies. The development of the required competencies is essential to the preparation of skilled technical professionals who can undertake tasks requiring greater depth and understanding of such advanced technology. The main objectives of the track are: 1) to develop students with enhanced technological skills in energy systems; and 2) to place these students in business, industry and government as effective problem-solvers.

Major Points:

- Energy Systems Trends
- Energy Systems and Smart Grids
- Program Requirements and Competencies
- Prospects in Energy Systems

Summary: The Energy Systems Track is designed to prepare Engineering Technology students to enter the energy and sustainability workforce where they will be expected to introduce new and relevant skills necessary to integrate environmentally-friendly technologies while maintaining or retrofitting aging infrastructure.

2015 Conference Proceedings

Thursday, November 12, 2015 - 4:45pm - 5:30pm

Teaching Innovations (TI)

Student Mentoring Through Group Leadership

Authors: Mr. Daniel O. Lybrook, Purdue University, West Lafayette, IN
Dr. Andrew C. Hurt, Purdue University, West Lafayette, IN

Need: We are transforming the experience for technology students here in the College of Technology at Purdue University. Employers have ranked "be able to work in /lead work groups and teams" as one the five most desired skills for graduates. As a part of our transformation, group development/ team leadership has been scaffolded into the plan of study in a series of courses – starting with simply working in a group and culminating in being the assigned leader of a project work group. Not only do the students learn the knowledge surrounding group development and leadership, but they actively apply and experience this – a much more powerful form of learning. The students will graduate from our program with the assessed ability to develop and lead teams, as well a project manager certification.

Overview: Group development and leadership are important topics in our introduction to the program course. The scaffolding of these topics continues in our third semester offering of Project Management, where project management methodology is introduced. In this course, third semester students are divided into groups of six to tackle a global challenge type of problem, using and learning project management methodology. This scaffolding of these topics continues throughout the plan of study. Whenever an instructor uses groups, this is processed consistently throughout and the same follows for team leadership and project management. Finally, in our capstone offering, seniors are assigned to be team leaders in the Project Management course, assuming responsibility for the task and process over an entire semester. As the instructor works through the course materials, the mentors/team leaders also become instructors for their groups, further enhancing learning. This presentation will address this design of this "no one learns more than the teacher" model of student mentoring and address why this is successful. Scaffolding will be addressed and all places in our plan of study where this occurs will be identified.

Major Points:

- A scaffolding plan for group development, team leadership, and project management
- Integration of research into the program design
- A mentoring model integrating senior students coaching and leading first and second year students
- Ability to build this into almost any plan of study

Summary: Attendees will learn about the development of a scaffolded approach to teaching group development, team leadership, and project management. Details of the scaffolding, of the design down to the individual courses, will be presented.

2015 Conference Proceedings

Thursday, November 12, 2015 - 4:45pm - 5:30pm

Teaching Innovations (TI)

My Dear Watson: Imparting Clinical Reasoning Skills to the First-year Medical Students

Authors: Ms. Phondie Simelane, University of North Dakota, Grand Forks, ND
Dr. Yi-hsiang Chang, University of North Dakota, Grand Forks, ND

Need: High fidelity simulation is used to help medical students acquire primary care skills. Students are placed in a mock hospital environment and required to collaboratively evaluate medical complications presented by human patient simulators. The first-year medical students, while appearing to have the background knowledge, possess weak clinical reasoning skills. Such a competence is essential for taking both focused history and focused physical assessments that lead to a proper differential diagnosis. Due to the nature of clinical reasoning being a complicated problem solving cycle, what can be done to better prepare the first-year students prior to their attending high fidelity simulation sessions?

Overview: We will present an ongoing collaborative project with the University of North Dakota's medical simulation center. This research aims to develop instructional material that can help first-year medical students obtain critical clinical reasoning skills. The material developed, with suitable instructional design technology, will model the problem-based learning activity as a path-finding process. The instruction will front load the clinical reasoning cycle to students so that they are mentally prepared for the cases used in simulation. Thus, students will be able to acquire and assimilate the information necessary for diagnosis propagation during the simulation and arrive at accurate judgments with confidence.

Major Points:

- Overview of the high fidelity medical simulation
- The clinical reasoning process for differential diagnosis
- Using the pathfinding strategy to guide the problem solving process
- Assessment of learning outcomes

Summary: Attendees will be informed about the conceptualization and development of instructional material for enhancing the clinical reasoning skill of the first-year medical students.

Teaching Innovations (TI)

Student Engagement in Data Networking Labs

Author: Dr. David M. Hua, Ball State University, Muncie, IN

Need: Networking is the cornerstone that supports almost all other forms of information technology. It is important for information technology students to receive a strong foundation in data networking. As instructors, we provide students with the conceptual and theoretical framework that governs data communications. The problem is providing students with opportunities to go from theory to practice.

Overview: Applied learning experiences in data networking have been provided through physical labs, remote labs, and simulation labs. Physical labs are those in which students work directly on actual hardware devices in the lab environment. With remote labs, students work indirectly with the hardware devices through remote connections over an existing network. Simulation labs utilize applications that mimic the interface and configurability of hardware devices. There are strengths and weaknesses associated with each of these alternatives. This presentation will explore the each of these options.

Major Points:

- Discuss the need for applied learning in data networking courses.
- Identify the strengths and weaknesses of different data networking lab options.
- Present the implications of a survey of student preferences among the three options.

Summary: As more people and devices engage in electronic communications on a global level, the demand for students skilled in data network will continue to grow. The challenge is providing these students with the opportunity to learn the applied skills that will be required by employers. This presentation will explore the different options for engaging students in applied data networking skills development and their relative strengths and weaknesses.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Teaching Innovations (TI)

Impact of Learning Style on Success in Team Problem Solving

Authors: Dr. Sophia K. Scott, Professor, Southeast Missouri State University, Cape Girardeau, MO
Ms. Belinda McMurry, Southeast Missouri State University, Cape Girardeau, MO
Ms. Geethanjali Gaddam, Southeast Missouri State University, Cape Girardeau, MO

Need: Team problem solving is a vital component of most careers, especially those in technical fields. Learning style or preference is defined as the manner in which an individual prefers to learn. Learning Style is considered to be separate from ability and has been widely researched in the education setting. These styles are self-reported accounts of individual's preferences for and perceptions of how they process information. In other words, learning styles predict the way in which learners want to learn and solve problems. As educators, if we understand the learning preferences of students, we can better equip them with the skills to solve problems and to work with and learn from others with different learning preferences.

Overview: This presentation will focus on learning styles of students in solving problems. The proposed subjects of the research are students enrolled in a technical management program at a Midwestern university. Participants will be asked to complete an instrument to assess their learning style. In addition, the students will be placed in teams and have a problem to solve. The presentation will provide the results of this study.

Major Points:

- Identifying learning styles of technology students
- Results of the study will be presented
- Tips and techniques for using learning style to help team solve problems

Summary: Attendees will understand how learning styles can impact team problem solving. This presentation provides results of a study using learning styles to assess team problem solving. Additionally, lessons learned will be presented.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Teaching Innovations (TI)

Team Learning in Technology: Replicating Industry's Problem-Solving Approach

Authors: Mr. Michael M. Mezo, Ball State University, Muncie, IN
Dr. James W. Jones, Ball State University, Muncie, IN
Ms. Jennifer A. Warrner, Ball State University, Muncie, IN

Need: As both challenges become increasingly complex, solutions in technical industries demand interdisciplinary, innovative, team-based approaches. While many technology curricula focus on and assess individual skills, problem solving as a member of a team is often left underdeveloped. Through structured team-learning assignments, and even entire courses, students can develop and advance their teamwork skills to be ready for the demands of industry upon graduation.

Overview: Problems in industry are often tackled by teams who are able to approach solutions creatively and innovatively. However, problem-solving as a member of a team is a skill that must be developed in and cannot be simply expected to come naturally to graduates without practice. At the same time, many students have some negative perceptions of team assignments and may not want their grade to be based on others' work, creating potential issues for faculty members. This presentation examines how faculty (of one program) have integrated a variety of team assignments into different level courses, and how the capstone courses uses team learning exclusively. Different team-based learning strategies' advantages and disadvantages are provided, based on experience and industry input. Other technology instructors can consider whether team learning assignments and potentially even entire team-based courses would be appropriate for their programs.

Major Points:

- Developing team assignments
- Team-based courses
- Team member selection processes
- Grading and assessment approaches
- Deterrence of social loafing
- Lessons learned
- Conclusions and recommendations

Summary: Attendees of this presentation will understand how team-based learning can be integrating into their curricula, from single assignments to entire courses. Team learning can be integrated into a variety of technology programs to provide innovative learning opportunities that prepare students to solve problems in the same way they will in industry upon graduation.

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Teaching Innovations (TI)

Fluid Power Laboratory Modes versus Resource Utilization Effectiveness

Author: Dr. Phillip Cochrane, Indiana State University, Terre Haute, IN
Dr. Randall W. Peters, Indiana State University, Terre Haute, IN

Need: The challenge of resource conservation in ongoing, which in turn means considering new delivery methods and modes for traditional laboratory courses. Technology Laboratory models are usually synchronously delivered with lecture content. Why not consider asynchronous and distance delivery models which lead to better resource utilization?

Overview: Background: The mechanical engineering technology fluid power course is the crossroads for many disciplines within the College of Technology. For most students the course is a 300 level elective, which allows them to maintain a technical footprint having some continuity with their major, as opposed to traveling across campus to explore the nether regions of some humanities course. There are no prerequisites for the course, which means that students taking the course include a multidimensional spectrum of ethnicities, experience, majors, and interests. Historically, the fluid power laboratory exercises begin in the last quarter of 16 week course. This amounts to 6 weeks of intense interaction with 10 hydraulic and pneumatic trainers. Associated with each trainer are approximately 40 exercises which must be completed by a team of four students. Each exercise requires the team to set-up a particular system/configuration of components, activate the system, record, and analyze the results. Recent events have caused several questions to surface regarding the delivery mode for the laboratory portion of the fluid power technology course. The first event being a severe shortage of faculty resources, exacerbated by a sharp increase in demand for fluid power sections. This resource challenge generated questions about resource utilization, having a single faculty member dedicated to as many as four sections of fluid power. The models sunder consideration and the subject of this research is can the lecture be separated from laboratory portion and the course credit be reapportioned. Potentially, having a graduate assistance service the laboratory requirement. Clearly, this would require retooling the course: a one model would involve an asynchronous laboratory experience, b.) a complementary model would be based upon a closely coordinated/synchronous experience, and c.) what is possibility of operating both models at once? As consequence of informally considering the various models, distance learning was also folded into the realm of possibilities. However, in keeping with the university policy, a distance learning environment must truly be distance. It defeats the purpose of a distance environment if taking the course mandates that certain sections be done on campus. This thinking has informally generated some distance learning models that involve using Auto-Sim or similar software as a substitute for a physical laboratory experience. The concerns are, while this mode might be effective for students who have had prior experience with mechanical systems, it remains studied if such a delivery mode would meet the needs of students will limit exposure to mechanical system. There is a special concern for international students who seem to benefit most from the laboratory experience. Current plan are develop some preliminary models and develop, test and collect data during the fall semester 2015.

Continued on next page

2015 Conference Proceedings

Friday, November 13, 2015 - 8:00am - 8:45am

Teaching Innovations (TI)

Fluid Power Laboratory Modes versus Resource Utilization Effectiveness

Major Points:

- Traditionally the laboratory size is a limiting factor in determining the number of students
- Small laboratory sizes can be major consumers of faculty time
- Teaching 4 sections for the same course make not be a sound utilization of resources
- Several models being developed involve separating lab form lecture
  - o Asynchronously
  - o Synchronously The is also a consideration for a total distance delivery
  - o Using auto-sim or similar software to build the lab experience
  - o There are concerns for student integrity
  - o Would this model be generalizable to the entire student population?
- These researchers envision a modeling and data collection effort to support whatever models seem plausible

Summary: Many attendees are facing the same resource and delivery pressures as outlined in the presentation/ proposal/paper. They profit from the lessons learned and the data collected. Conversely, these research who like to engage colleagues in an open forum, to refine these model even further.

2015 Conference Proceedings

Friday, November 13, 2015 - 9:00am - 9:45am

Teaching Innovations (TI)

Impact of Thinking Style on Team Decision Making

Authors: Dr. Sophia K. Scott, Southeast Missouri State University, Cape Girardeau, MO
Ms. Belinda McMurry, Southeast Missouri State University, Cape Girardeau, MO
Ms. Rohini Chitlam, Southeast Missouri State University, Cape Girardeau, MO

Need: Educators are in constant contact with industry personnel. Today more than ever, technical organizations need employees who can make quality decisions. With changes in organizational structures, innovation and increased workforce diversity, universities are tasked with preparing students to meet the global challenges in the complex work environment. Team decision making is critical to success for organizations. Thinking styles impact teams in solving problems. Many current models of team decision making do not address thinking styles that make up the diversity of team members.

Overview: This presentation will focus on thinking styles of students in making quality decisions. The proposed subjects of the research are students enrolled in a technical communication course at a Midwestern university. Participants will be asked to complete an instrument to assess his or her thinking style. In addition, the students will be placed in teams and have a problem to solve. The presentation will provide the results of this study.

Major Points:

- Identifying thinking styles of technology students. Results of the study will be presented
- Tips and techniques for using thinking style to help students in decision making

Summary: Attendees will understand how thinking styles and how this understanding can help them in quality decisions. This presentation provides results of a study on thinking approach and team decision making. Additionally, tips and techniques for using thinking styles to help students in decision making for success in the future workforce.

2015 Conference Proceedings

Friday, November 13, 2015 - 9:00am - 9:45am

Teaching Innovations (TI)

Perceptions of Technical Communication among Students, Faculty Members and Industry Personnel

Authors: Dr. Sophia K. Scott, Southeast Missouri State University, Cape Girardeau, MO
Ms. Belinda McMurry, Southeast Missouri State University, Cape Girardeau, MO
Mr. Sahith Sanike, Southeast Missouri State University, Cape Girardeau, MO

Need: Engineering and technology graduates must possess technical aptitude as well as the ability to communicate technical information. Engineers and technologist are expected to bridge the communication gap between the subject matter expert and the end user. Yet, many students do not see the relevance of taking technical writing and communication courses. Although many technology programs require courses like technical writing, report writing, and scientific and technical communication, the courses are taught typically by English faculty who may focus on grammar rather than technical content. Increasing, technical writing in engineering courses prepares students for the type of writing expected in the profession. Despite the many advantages, many engineering faculty find that increasing the technical writing and communication in their courses is time consuming. The purpose of this presentation is to assess perceptions of the importance of technical communication for engineering and technology programs.

Overview: The future workforce requires employees who can communicate technical communication, but the perceptions of industry personnel, faculty and students may differ. These differences may impact the future direction of curriculum in engineering and technology programs.

Major Points:

- Present ATMAE accreditation requirements for technical communication and how they are implemented in technology programs
- Present results of survey of industry personnel, faculty members and students
- Make recommendations for engineering and technology programs on how to incorporate technical communication in programs

Summary: This presentation will provide an overview of the importance of technical communication for engineering and technology students. The results of a survey among industry personnel, faculty members and students will be discussed. Recommendations for engineering and technology programs will also be presented.

2015 Conference Proceedings

Friday, November 13, 2015 - 9:00am - 9:45am

Teaching Innovations (TI)

Motivation and Learning Strategies of Students in Turkey

Author: Dr. Ulan Dakeev, University of Michigan-Flint, Flint, MI
Dr. Faruk Yildiz, Sam Houston University, Houston, TX
Miss Linsay Bartle, University of Michigan-Flint, Flint, MI

Need: Students are pressured to retain most or even all of the information relayed to them throughout years of teaching. While most students are relying purely on memorization of material, they are not completely understanding what is being taught to them in the classroom. Motivational Learning Strategy Questionnaires have been used to interpret how students study to better understand their strengths and weaknesses as a learner. Students from various classroom settings are examined for this type of test to give a more varied background and more clear result.

Overview: The purpose of the study is to compare the level of motivation and strategies for learning on two different groups of engineering students in Turkey. The respondents will be taken from both public and private universities and then compared based on gender, university type, and class standing. This allows us to determine the best teaching methods for professors to use when relaying information to their students, allowing them to further their learnings and boosting their overall test scores.

Major Points:

- Conduct random sampling in various public and private universities using a motivational strategies for learning questionnaire
- Chart all received data and organize into categories of gender, university type, and class standing
- Analyze the responses based on an independent T-test
- Compare the three categories to determine the most effective method of learning

Summary: All of the results gathered will be analyzed and shared within the academic community to assist engineering professors in their teaching methods; therefore, refining the learnings of their students to improve overall test scores.

Friday, November 13, 2015 - 10:15am - 11:00am

Teaching Innovations (TI)

Providing Real World Experiences for Students through a Long-Term Collaboration with Habitat for Humanity

Authors: Mrs. Janet Fick, Ball State University, Muncie, IN
Miss Jennifer A. Warrner, Ball State University, Muncie, IN
Mr. Doug Wilson, Ball State University, Muncie, IN

Need: Students are provided with hypothetical projects, but are not provided the opportunity to apply their knowledge to real world projects. Meanwhile, our local chapter of Habitat for Humanity needed assistance in determining what was required to rehabilitate existing vacant houses they had acquired. A collaboration was then born. The students are assigned a house, and working with representatives from Habitat, analyze the house, identify potential problems, recommend solutions and complete the construction documents for its future rehabilitation.

Overview: This presentation discusses an immense learning course which, beginning with the Fall 2012 semester and still continuing, has given students from construction management, architecture, interior design and other programs the opportunity to collaborate while helping their local community. Since rehabilitation projects require individualized evaluations and redesigns, Habitat found that the shift from new construction to rehabilitation of existing houses required more time commitment than their current staff could handle. In 2012 Habitat asked our construction management program if they could coordinate an interdisciplinary group of students to assist them in analyzing existing homes for rehabilitation. The students are assigned a house, and working with representatives from Habitat, evaluate its potential, redesign as necessary and complete the construction documents for its future rehabilitation. This partnership allows students to affect actual change in our local community and allows Habitat to future their mission of affordable housing for low income families.

Major Points:

- Innovative teaching approach that could be used at other institutions
- Challenges unique to real world projects
- Habitat and its partner families as clients
- Programming needs of Habitat for Humanity
- Required final construction documents
- Execution of the course and refinements in subsequent semesters

Summary: Attendees will familiarize themselves with this innovative teaching approach that could be used at their own institutions. Attendees will learn the value of combining an interdisciplinary team of students with a non-profit organization to complete real world projects. Attendees will comprehend the challenges and opportunities of coordinating the skills of the students with the needs of our partner organization. Attendees will also understand the execution of the course and refinements in the subsequent semesters.

2015 Conference Proceedings

Friday, November 13, 2015 - 10:15am - 11:00am

Teaching Innovations (TI)

Conceptual Art as an Agent in Furthering Technological Progress

Authors: Mr. Daniel Feinberg, Berea College, Berea, Kentucky
Dr. Alan Mills, Berea College, Berea, Kentucky

Need: The visual arts, while often utilizing technological tools and processes, have not historically been viewed as a disciplinary driver that furthers the field of technology. Often, technology and art are seen as two distinct fields, with people in the arts concerned with how things look (form) and people in technology concerned with how things work (function). However, recent trends in manufacturing and education demonstrate that both fields can benefit through mutual collaboration.

Overview: This presentation will serve to demonstrate how the relationship between the visual arts and technology can push innovation and progress to new heights in both fields. Given that the most challenging problems to solve are initially unknown or unpredictable in our process, the visual arts provide a venue where solutions for these speculative and unique problems can be addressed through ways that can inform the standard practices of today's technology. The most important facet of this dialogue is the realization that this is not a one-way street, where only art benefits from the manufacturing developments that occur in technological fields. Technology, too, can benefit from art's attempts to utilize current technology in creative and atypical ways that push beyond standard limits of thinking and doing.

Major Points:

1. The Visual Arts can lead to creative technological progress
2. Technology can help push Visual Arts to new limits
3. Arts challenge people in technology to engage in solving problems that may go beyond the standard scope of technological applications
4. Collaboration brings art and technology students together as creative problem solvers
5. Several major manufacturers are currently taking advantage of the Art/Technology bridge by creating "Artist in Residence Programs" that allow production workers and management to rub shoulders with working artisans

Summary: Attendees will gain exposure to a series of art projects that have provided technology students with some of the most challenging problems they have faced throughout their education. In addition, the project will highlight the creative interactions between art students and technology students, as well as professionals in both fields. The presentation will also provide concrete examples of collaborations between visual artists and manufacturing industries that have resulted in positive gains for both parties. For this project, one-of-a-kind parts were designed and prototyped by students using CAD software and 3D printing in Dr. Alan Mills' Design and Documentation course. This is only one example of the many art/technology collaborations that took place throughout this process.

2015 Conference Proceedings

Friday, November 13, 2015 - 10:15am - 11:00am

Teaching Innovations (TI)

Impact of Instructional Strategies in the Classroom

Authors: Dr. Eli K. Aba, Indiana State University, Terre Haute, IN
Dr. M. Affan Badar, Indiana State University, Terra Haute, IN

Need: Instructional strategies are needed in helping students understand concepts, tools, and principles. The presentation aims to critically discuss the instructional strategies used by the author in his classes and how they impact his students.

Overview: Students must understand and be able to practice concepts, tools, and techniques they are taught. The presentation discusses instructional techniques that he uses in his classes to impact his students.

Major Points:

- Importance of instructional techniques to students' understanding
- Benefits of instructional techniques
- Definition and types of instructional techniques
- Impact of instructional techniques

Summary: Attendees will understand how instructional techniques impact students. The findings may help users of instructional techniques appreciate and see the relevance of instructional techniques in helping students understand their teachings better.

2015 Conference Proceedings

Friday, November 13, 2015 - 10:15am - 11:00am

Teaching Innovations (TI)

Teaching Engine Diagnostics and Monitoring via Customized Microcontroller Board

Authors: Dr. Yuetong Lin, Indiana State University, Terra Haute, IN
Mr. Scott Livengood, Indiana State University, Terre Haute, IN
Dr. Phillip Cochrane, Indiana State University, Terre Haute, IN
Dr. M. Affan Badar, Indiana State University, Terre Haute, IN

Need: Electrical components and computers are ubiquitous in automobiles. As consumers become more and more concerned about fuel efficiency, safety and convenience, it is expected that the advances in electrical, electronics, computing, communications, controls and software technologies are the central enablers to drive the vision for ideal automobiles in a sustainable future. College graduates with fundamental knowledge and experience in vehicle electronics and computer systems will have a noticeable advantage in the very competitive job market.

Overview: Engine systems and controls is a core course in automotive engineering (AET) program that teaches students the theory and application of on-board diagnostics and monitoring system. We report preliminary results on a National Science Foundation supported project to develop customized microcontroller (MCU) boards accompanied with a suite of lab modules to engage students through MCU-based, engine-targeted measurements, communications and controls. We are using open-source hardware and software that can be easily adapted to different engine types and course needs. Meanwhile, by allowing students from AET, computer engineering technology, and mechanical engineering technology to work on the project, we show how a multi-disciplinary team can help enhance students' learning experience in engineering design.

Major Points:

- Multi-disciplinary team design
- Open source hardware and software for microcontroller applications
- Modular approach for lab material development
- Fundamental method for engine testing and diagnosis
- Hands on experience with real vehicular electrical and computer system

Summary: Attendees of this presentation will learn how to implement basic engine testing and diagnosis methods using open source microcontroller hardware and software. They will also gain understanding of how forming a multi-disciplinary team can enhance students learning experience in complex engineering design.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

Teaching Innovations (TI

Does Work Experience Influence the Decision Making Ability of College Students?

Authors: Mr. Saxon J. Ryan, Iowa State University, Ames, IA
Mr. Sai K. Ramawamy, Iowa State University, Ames, IA
Dr. Gretchen A. Mosher, Iowa State University, Ames, IA

Need: The workplace is an increasingly competitive arena for college students. Internship experience is considered an important differentiator when searching for career opportunities. However, little is known about the effects of internship work experience on the decision-making ability of college students. Understanding the impact of internship experience in the related field of study may be helpful in developing appropriate pedagogical interventions and approaches. The goal of this research is to understand the effect of an internship experience on decision making specifically pertaining to quality control methodologies.

Overview: This presentation will discuss the use of a decision analysis methodology to identify differences in decision-making patterns between students who have had an internship experience and those students who have not. Key concepts of survey development will be shared. Results from the survey describing the relationship between students having an internship and those that have not had an internship will be discussed. Finally, implications for further use of the data and the survey will be shared.

Major Points:

- Importance of internship experience
- Defining internship experience in this research
- Influence of internship experience on decision-making patterns
- Implications for future use of internship and decision-making knowledge

Summary: The audience will learn about how internship experience can influence student decision-making patterns. Measurement of internship experience and decision-making patterns will be discussed. Implications of use for educators and industry will also be shared.

2015 Conference Proceedings

Friday, November 13, 2015 - 11:15am - 12:00pm

Teaching Innovations (TI)

From Student to Practicing Engineer: Preparing Future Engineers for Industry Via a Capstone Course Project

Author: Dr. Harvey F. Hoffman, Fairfield University, Fairfield, CT

Need: Above and beyond the ability to design and analyze products, services, processes and systems, entry-level engineers must be able to communicate with the management level in their organization. A failure to satisfactorily address topics such as need, schedule, budget, cost, risk, return-on-investment, and resources required when presenting a proposal for a new venture may likely doom their efforts. A young engineer's project management skills may be the key to early career advancement.

Overview: Successful engineering professionals in industry rely on a combination of technical depth, business fundamentals, communication competencies, an appreciation for societal issues and interpersonal skills. A pedagogical approach to teaching a capstone course has been implemented which simulates an engineering project as conducted in industry. This course involves students completing the following "learning by doing" steps: Identifying a need for a product, service, process or system Creating a team and working effectively together towards common goals Generating a project proposal Preparing a design Developing the product, service, process or system Testing the product, service, process or system Examining a project's business viability Monitoring the project's key performance factors Preparing and delivering status reports and presentations.

Major Points:

- As will be shown from a survey of engineering and technology faculty, many faculty members do not have business and industry engineering management experience. They require guidance on the best practices associated with preparing a capstone course that will cover business as well as engineering topics. This paper will present a solution to this issue.
- Explain the challenges for gaining approval of a project in industry.

Summary: This presentation addresses a restructuring of the capstone course to meet industry and academic needs that will prepare students to solve "real-world" problems using project management techniques. Educators will learn how to guide and mentor students in areas beyond design. They will learn to identify, quantify and monitor key management performance factors as well as the significant project technical items.

2015 Conference Proceedings

Friday, November 13, 2015 - 2:00pm - 2:45pm

Teaching Innovations (TI)

Effect of Industry Engagement on Students Learning in the Undergraduate Program

Author: Mr. Caleb Burns, Iowa State University, Ames, IA
Dr. Shweta Chopra, Iowa State University, Ames, IA

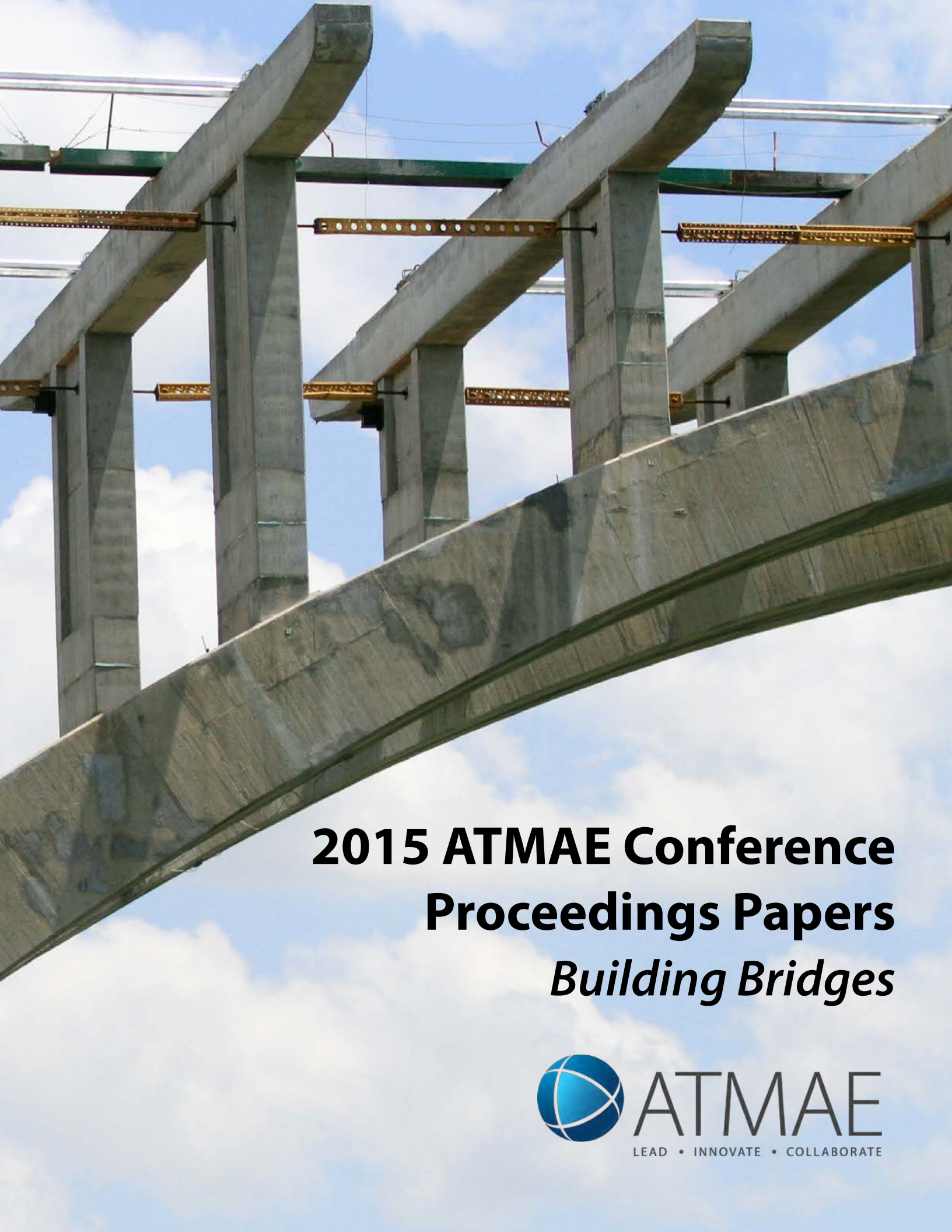
Need: There is existing research that suggests that student learning is improved through industry engagement. However, there is death of research which measures the effect of industry engagement on student learning outcomes. This research systematically looks into various activity conducted by the instructor to create industry engagement in the classroom or outside the classroom environment. Based on research findings faculty will be able to make an informed decision about restricting classroom schedule to include the most effective industry engagement activities.

Overview: Engineering and Technology students are exposed to industry engagement in multiple classes through guest speakers, facility tours, virtual plant tours, and industry-focused final projects. The purpose of this research is to systematically evaluate the impact of these varying student-industry engagement activities. Furthermore this research will help understand important activities which enhance the students' ability to learn and apply the classroom learning in the real world. This project will address the gap between industry engagement and student learning by methodically measuring the effect of various activities conducted as student-industry collaborations. When students are provided opportunities to engage directly with commercial industry, the end result is often a well-rounded graduate who has a clearer understanding of how industry operates and of the working-world expectations. This, combined with their academic knowledge puts them in a better position to succeed in their career. Engagement opportunities provide students with life-changing experiences that: (i) enhance the students' networking connections with professionals who can potentially provide employment references and future job positions; (ii) give students a chance to gain practical experience by observing and applying the methods and theories learned in classes, as well as understand the difference between theory and reality; (iii) gain experience in their prospective career path; (iv) improve their professional communication skills; and (v) build confidence in their abilities and job prospects.

Major Points:

- Define a systematic way of measuring benefit, learning outcomes, and pitfalls of industry engagement activities.
- Compare different types of industry engagement activities and identify the most effective student industry engagement activity.
- ·rovide faculty with systematic, result-based approach when evaluating their current and future industry partnerships for effectiveness.

Summary: The audience will obtain a better understanding of the impact of student-industry engagement on learning and which specific industry engagement activities will enhance student learning. Findings from this study will be shared with faculty to help build their course to include industry engagement activities.



2015 ATMAE Conference Proceedings Papers

Building Bridges

ATMAE

LEAD • INNOVATE • COLLABORATE

Presentation Papers - Table of Contents

Construction

Implementing Solar: Research for a "Greener" Campus 212

Distance Learning

Analysis of Asynchronous Supplemental Course Modules in Statistical Process Control 219

The Hybrid Program: The Key to Unlocking the "Glass Ceiling" 230

EECT

Bridges to the Cloud: Technologies for Integrating Security in the Development of Online Systems 236

Developing a BYOD Deployment Strategy in an Enterprise Environment 244

Teaching Challenges in Embedded Systems Design 241

Graphics

Bridging the Gap between Businesses and Customers through the Web Technology..... 260

Design Refinement by Iterative Virtual Experimentation (DRIVE) for Analysis of Steering Column Mounting Bracket Design of an On-Highway Construction Vehicle *Best 2015 ATMAE Conference Paper* 269

Management

Adoption of Food Safety Modernization Act: A Six Sigma Approach to Risk Based Preventive Controls for Small Food Facilities 283

Zero Positional Tolerance at Maximum Material Condition: A Workforce Development Priority..... 296

Manufacturing

Manufacturing and Non-Manufacturing Students' Perceptions on the Applicability of the Four Pillars..... 305

School Administration

Partnering with Industry: Discussion of the Partnership Leading to, and the Applied Research of an Analysis of Reaction Times in NHRA E.T. Bracket Racing Classes 317

Teaching Innovations

Creating and Sustaining High-Quality Senior Capstone Experiences 334

Teaching Engine Diagnostics and Monitoring via Customized Microcontroller Board 326

Presentation Papers - Author Index

Dr. M. Affan Badar 326
Dr. Vigs J. Chandra 236
Dr. Robert A. Chin 296
Dr. Shweta Chopra 283
Dr. Phillip Cochrane 326
Dr. Mark Doggett 305
Mr. David Freet 236
Mr. Abhay K. Grover 283
Mr. Matthew E. Harvey 219
Dr. Michael A. Hayden 317
Mr. John R. Haughery 219
Dr. Muhammad Jahan 305
Dr. Nilesh Joshi 269
Mr. Jeff B. Kilgore 236
Dr. Jack Li 241
Dr. Yuetong Lin 326
Mr. Scott Livengood 326
Dr. Devang P. Mehta 260
Dr. Richard F. Miller 212
Dr. Gretchen A. Mosher 283, 334
Dr. Randell W. Peters 317
Mr. Sai K. Ramaswamy 219
Dr. Sharon M. Rouse 296
Mr. Bryant Seaton 244
Mr. Charles M. "Matt" Watson 269
Dr. John E. Wyatt 230
Dr. Baijian Yang 244

Construction

Implementing Solar: Research for a "Greener" Campus

Dr. Richard F. Miller, Ohio Northern University, Ada, Ohio

Abstract

As the construction industry continues to move toward sustainability in the construction and operation of new projects, it is imperative that undergraduate Construction Management (CM) students become aware of different sustainability concepts. Alternative energy sources such as hydro power and wind energy have been used in the energy industry as potential opportunities to generate or reduce Kilowatt hours (kWh) for societal needs. Examples of this can be seen at the Hoover Dam or the massive wind farms in the foothills of Oahu. Sustainable concepts help to reduce or minimize the impact of energy. A couple of examples can be seen with the building materials utilized or building components employed in a project. Students get the opportunity to see things in presentations or even set up miniature applications on campus but many do not realize that this is just one component of sustainability as it pertains to society. As stated in the Brundtland Report (1987), it is our responsibility to realize a sustainable society that will exist for generations to come.

As part of a university initiative on the campus of Ohio Northern University (ONU), Construction Management (CM) students have become involved in a sustainability research project within one of their CM courses. The course meets 3 times a week and students use one of the meeting days to conduct the research and conduct their own meetings. The research is directed at all aspects of sustainability and expands to the entire Operations and Maintenance (O & M) of the university. The framework for the research project is embedded in identifying potential savings for the university over a specified period of time.

In the past 10 years, sustainable concepts have become a major component of all construction projects in the United States. Recent initiatives by the U.S. government have resulted in a positive direction for the industry. The United States Green Building Council (USGBC) developed a program recognized as Leadership in Energy and Environmental Design (LEED) which set a threshold for the industry for recognition of projects that contain certain levels of sustainability (USGBC, 1993). Education programs have been set by the USGBC to educate and accredit individuals in sustainable concepts. While many projects do not try for the certification of LEED, many use the sustainable concepts that are embedded in the program. Other programs have been developed to assist the industry in recognizing and implementing sustainable concepts as well. Energy Star, a voluntary EPA program, has had success in turning the industry into a more efficient energy consumer by recognizing certification levels for appliance and also envelope applications (EPA, 1992). Much of the success of all programs has been a concentrated effort by the industry to educate workers within their companies.

Based on the need to educate future CM leaders on sustainable concepts, this research project served as an opportunity to assist in making ONU a "greener" more sustainable campus. The focus of the research was twofold: (1) to find different sustainable concepts that could be used on campus that would realize a payback to the

university over a specified time, (2) identify potential energy savings with alternative energy sources such as solar energy. Each group was responsible for doing a comparison of current and alternative components and identifying potential savings or payback opportunities.

Background

The campus consists of 10 instructional buildings, a sports center, two performing arts centers, a student activity center, an inn, 17 student dorms, and other miscellaneous buildings. The campus is divided into three energy consumers. Therefore, the main component of the research was limited to one area or the instructional buildings. Sustainable concepts already employed on the campus are three wind turbines and 230 geothermal wells. For the purposes of the research project, these concepts have already been considered.

The original direction of the research was to develop a decision matrix for the installation and operation of a solar field that was capable of reducing the carbon footprint and energy consumed on campus. While this concept becomes a staple for the university, other sustainable or retrofit concepts were introduced to expand the possibilities over time. Some of the concepts identified were:

1. Solar implementation and resources
2. LED lighting
3. Biofuel
4. Motion or sensor lighting
5. Energy Star retrofits (applicable areas)

Using the five identified areas, the students were broken down into groups based on their interest level. The students worked on each area and were responsible for weekly updates into Microsoft Office SharePoint program. This program allows users to post, collaborate, organize and share information. At the end of the semester, each group presented their initial findings to faculty of the Department of Technological Studies. While each group was responsible for the above research objectives, the initial research report will be presented to the Office of Sustainability on the campus.

Initial energy audits were conducted on the 10 instructional buildings to develop a baseline. From the audit, all students were involved in developing the overall research objectives for the project. Each group developed supplemental objectives within the overall research objectives listed below:

1. To identify plausible concepts that can enhance the sustainability of the campus.
2. To identify potential payback for viability of each sustainable concept.

Based on the five areas above, each group was responsible for:

- Develop a 7 week project schedule for completion
- Determine components of their area for possible use
- Develop a payback analysis for their area of research
- Prepare a report for their area
- Present their findings as part of a whole class presentation to the appropriate officials

Discussion

Based on the five areas mentioned earlier, each group of students were required to develop a set of supplemental objectives for investigation. Students where then charged to develop different procedures or analysis to satisfy the supplemental and main research objectives. The students were given a small budget to buy necessary testing equipment and materials to obtain their objectives. The groups were broken down with 4 students in the solar area, 3 students in the biofuels or alternative fuel area, 3 students in the Energy Star area, and 5 students combined the last two areas (LED and lighting components/reduction). All students combined were involved in the energy audit at the beginning of the course to determine the baseline.

In the solar group, background research found that much of solar in today's sustainable industry is not to replace the whole energy grid but to reduce the peak rate and kWh used from the grid over time. This information guided the groups objectives listed below:

- Total solar field vs. Building Retrofit
- Determine peak rate
- Direct vs. Battery fields
- Payback period vs. Cost

The largest group, LED and lighting, were directed to look at different combinations concerning the sustainability or reduction in costs associated with the lighting of the instructional buildings. In this area, there is a plethora of different components, materials, or processes that can be utilized and the group found that drilling down to objectives were very difficult. Therefore, the group limited the scope of the area to LED lighting in the classrooms, hallways, and restrooms, limit the motion control to the classrooms and restrooms, and security lighting to the hallways only. The group came up with the following objectives for this portion:

- LED lighting retrofit vs. fluorescent lighting
- Determine costs for classrooms, hallways, restrooms
- Motion control in the classrooms and restrooms
- Alternative lighting plan for hallway security lighting
- Payback vs. Cost

The alternative fuel group was charged to look at the possibility of incorporating a biofuel or other alternative fuel source for the maintenance vehicles and work carts on the university. This group worked with the university physical plant staff. Due to the limited time frame, this group focused the majority of their work on the work carts on the university instead of the maintenance vehicle fleet. The following objectives were identified:

- Propane vs. Biofuel
- Determine costs for switch overs
- Fuel sources for biofuels
- Payback vs. Cost

The last group investigated the mechanical applications on the university that could be upgraded to use EnergyStar certified equipment. In order to reduce the ambiguity within the area, only appliances and equipment that were five years or older was to be considered for replacement. Additionally, alternatives were considered if there was a cost savings available. For example, the reduction of printing equipment, removal of individual refrigerators or microwaves and others. The group's focus was:

- EnergyStar applications
- Identification and reduction of "energy hogs"
- Cost Benefit/Payback analysis

The course set up was developed to make students go to outside sources and resources to obtain details. This allowed students to network with areas that they were interested in and also allowed for the autonomy of research by them and not directed from the instructor. As mentioned earlier, the course met one hour, three times a week for a full semester. At the beginning of the course, the students were exposed to a number of different sustainable concepts concerning the industry. Guest lecturers, field visits and classroom instruction set the stage for the students in the first 5 weeks of the semester. In the sixth week, an energy audit was conducted to set the baseline for the research. There was one day set aside for student research and meetings. An interesting note here is that students were required on that day to set an agenda and run a regular meeting. As future professionals, it allowed them the opportunity to hone their skills in setting an agenda, running a meeting, and identifying action items to be completed.

Results and Recommendations

The results were compiled and presented to the individuals that were involved in the project. The students prepared and delivered a "Sustainability Analysis" report and presentation during the last week of the semester. The report was then passed along to the appropriate officials for consideration in the master plan for the university. Before the results are shown, some of the supplemental learning outcomes that resulted from the project are:

- Students had an opportunity to manage their own respective area and collaborate with other groups.
- Students developed project schedules using software to monitor their progress during the semester.
- Students fostered a sense of collaboration with other groups and industry professionals.
- Students analyzed data to make an educated decision concerning a project.
- Students strengthened communication skills.
- Students developed strong organizational skills for managing a project or an area of a project.

While other competencies were developed over the course of the project, the results were to be used for consideration in the master plan for the university. Due to limited space, the following are abbreviated results and recommendations for the project. The energy audit information is contained in the following table:

Table 1 Energy Audit

Building #	Lighting (2 x 4)	Outlets	Switches	Emer. Lighting	Outdoor Lighting	Computers	Appliance
#1	124	264	27	10	4	35	11
#2	148	210	30	8	6	32	7
#3	108	182	24	8	6	50	10
#4	160	216	32	12	6	22	21
#5	184	277	31	10	4	38	5
#6	122	202	21	12	6	16	9
#7	117	180	29	9	6	41	8
#8	94	132	17	10	4	18	6
#9	165	126	28	10	6	29	12
#10	147	118	23	12	6	34	10

The energy audit was used to assist students in determining a ballpark figure for kWh usage for the building. In order to be consistent, the energy usage for the mechanical systems was averaged as the same for each building based on similarity of building usage per day. The U.S. National Grid (2013) states that the national average for electrical consumption for an educational building is $1.34 per square foot and $0.18 per square for natural gas or heating and cooling. Based on solar integration, a conservative value to use as a solar panel's generating capacity is 10 watts/sq. ft. This represents a panel conversion efficiency of about 12%, which is typical. This means that for every kW you generate, you need about 100 sq. ft. of solar panels (Devlin, 2012).

Solar:

Students enlisted the help of a regional energy company to assist them in the development of their research. The overarching question that was answered was the implementation of a solar field in lieu of a retrofit to each building, but in a unique application. The solar field would be installed in the parking lot area elevated above the regular parking lot. The solar panels would be installed using the directional method and returned to a 32 degree angle each night to allow wind and rain or elements to pass harmlessly. Additionally, the formation of a coop with the town and university or donors could benefit all parties. Members of the coop will realize tax credits through the purchase of solar power to reduce the peak rate at the university. While there are many things that need to be worked out concerning the design, location, and development of the solar field, the group feels that it is feasible.

The payback analysis associated with the solar aspect of the research project is based on some assumptions and costs based on national and regional data. Also, since the university grid system is only broken into three areas, an assumption was made based on the average kWh usage and costs for one building and then assumed for the remaining instructional areas.

The recommendation of the group is to first develop the co-op between interested parties and the university. The selection of a solar focused company that can lead the project from start to finish. Next, revisit the cost benefit to find the Return on Investment (ROI) and potential areas where the solar implementation can be an efficient model.

LED and Lighting

The average 2' x 4' light uses approximately 100 watts of energy in a normal business day. As shown in the energy audit table, lighting makes up a large portion on the building's energy use. LED lighting uses approximately 10 to 15 watts per business day but the costs associated with the light and emplacement make it cost prohibitive (EarthEasy, 2012). Based on this initial find, the group concentrated on two facets of lighting, (1) ability to turn on and off lighting (2) security lighting during the off peak hours of the building.

First, the group's recommendation is the emplacement of time or motion switches in classrooms, restrooms, and other rooms that are not used consistently during the day. The payback for these types of switches is based on two years. The normal operation time for the buildings is 16 hours a day. Using a simple formula of 100 w/16 h, it can be shown that a potential savings of 6.25 watts per hour/per light could be realized.

Secondly, the reduction of security lighting in the hallways of each building was addressed. The group looked at the illumination of 2 x 4 lights and the possibility of reducing the footprint if applicable. The recommendation here is the reduction or lighting during the hours of 11:00 pm to 7:00 am by alternating the lighting with a timer or by motion activation during that time. The group also looked at the possibility of reducing wattage use during down or non-business durations.

Biofuels

As mentioned earlier, this group directed much of the research at the work carts being utilized on the campus for either propane or biofuel use. Initial research found that propane is a viable option but due to the length of usage, it could become troublesome for replacement because of locality of the work cart during the day and also the storage necessary to house tanks. Therefore, the group turned their attention toward the possibility of biofuels. Interestingly, an alumnus of the Department of Technological Studies had emplaced a biofuel operation at their place of business to reduce costs for dump and hauling trucks which resulted in a $0.04 cent savings per gallon. The information was used to develop a possible scenario for implementation of a biofuel site for the work carts. There are 14 carts that are used on the campus during a regular 10 hour day.

The cost of a filtration system (one 500 gallon tank for storage, two trash pumps and filtering tanks) and the ability to retrieve or buy used oils from local or regional sources make this a favorable condition. But, in order to accomplish this, a cost upfront of replacing gaskets and rubber housings will need to be completed which could elongate the payback over time. The group found that the campus dining and 3 local establishments would donate used oil but there will have to be a schedule of pick up set and this, while not vast, would drive up a labor cost to process the oil and pick it up. The group felt that there is a payback for this sustainable concept but further refinement is needed to identify potential choke points or adverse results.

EnergyStar and Appliances

While this is not a large research area, it has very real results. When the energy audit was conducted, this research group focused appliances as: stoves, microwaves, refrigerators, and water heating units. One of the interesting findings for the group was the number of small refrigerators and microwaves found in offices within the buildings. It was noted that the mere elimination of these appliances could reduce the energy usage per building and reduce peak demand. Of the 89 appliances, there were 46 refrigerator types in the buildings. Building #4 from the energy audit table shows that it houses 13 refrigerator types and are EnergyStar or energy efficient. Only 18 of the other refrigerator types are energy efficient as well, making the group's recommendation to either remove or update to EnergyStar refrigerator types for the remaining. The group also made the observation that microwaves need to be monitored and limited within each building. The overall group's recommendation was to eliminate as many non-university purchased appliances to help reduce peak rates and also to promote energy savings. Projected cost savings can range from $18.00 to $32.00 a month per appliance based on age and efficiency and higher with EnergyStar models (EnergyStar, 2015).

Conclusion

This research project has allowed students to become acquainted with a wide range of sustainable opportunities that can be utilized in planning or the retrofit of a structure or project. While this research was completely introductory and the information obtained will be utilized to further develop a "greener" environment for the university, it is a starting point that garnered initial figures that will be used this coming year. In closing, the application of the research project infused the student's into a real world, high-impacting learning experience that has tangible results.

References

Devlin, L. (2012). How Much Does It Cost to Install Solar. Chicago: Solar Power Authority.

EarthEasy. (2012, December 10). Solutions for Sustainable Living. Seattle , Washington, United States of America.

EnergyStar. (2015, August 16). Appliance Energy Savings and Retirement. Washington D.C., District of Columbia, United States.

EPA. (1992). Clean Air Act Section 103(g). Washington D.C.: Environmental Protection Agency.

Grid, U. N. (2013, June 20). Managing Energy Costs in Office Buildings. Washington D.C., Washington D.C., United States of America.

USGBC. (1993). Leadership in Energy and Environmental Design. Washington D.C.: United States Green Building Council.

WCED. (1987). Our Common Future aka. The Brundtland Report. Stockholm, Sweden: World Commission on Environment and Development.

Distance Learning

Analysis of Asynchronous Supplemental Course Modules in Statistical Process Control

Mr. Matthew E. Harvey, Iowa State University, Ames, IA
Mr. John R. Haughery, Iowa State University, Ames, IA
Mr. Sai K. Ramaswamy, Iowa State University, Ames, IA

Introduction

Many engineering and technology departments at the collegiate level have developed extensive online and hybrid (face-to-face and online) course offerings (Bourne, Harris, & Mayadas, 2005). These courses may meet several goals such as increasing access, reducing university costs, providing schedule flexibility, and increasing curriculum offerings. An additional opportunity for computer-based learning is to increase student success by offering asynchronous learning modules to extend content beyond traditional lectures.

The authors analyzed the helpfulness of asynchronous online video modules specifically focused on Statistical Process Control (SPC) chart content. This topic has been historically difficult for technology students enrolled in a large Total Quality Improvement course, offered at a mid-west university. The intent was to better understand how helpful do students perceive these online modules in learning to construct and interpret SPC charts. The authors proposed the following research questions:

1. How helpful do students, who view at least one unique module, perceive video modules in learning to construct Statistical Process Control (SPC) charts?
2. Does the number of unique modules viewed positively affect the level of perceived helpfulness to students who view at least one unique module?
3. Does the proportional viewing duration to overall module length positively affect the level of perceived helpfulness to students who view at least one unique module?

Background

The use of the Internet as an educational tool has significantly increased in the last decade. Students appreciate the use of supplemental course modules provided over the Internet (Freeman & Field, 2004). Many courses and classes are being offered that contain online or hybrid units of instruction that combine classroom and online components. One qualitative study of students participating in hybrid and online courses reports that students identified benefits of each type of content (El Mansour & Mupinga, 2007).

DeNeui & Dodge (2006) report student satisfaction with online instructional materials that included interactive demonstrations and video lectures. Their study found "…a significant positive partial correlation between overall usage and their exam scores" (DeNeui & Dodge, 2006, p. 256). Another study concluded that most students preferred a hybrid course to a traditional course (Mosca et al., 2010, p.10).

Hybrid Learning

There are several studies that help guide the development of successful hybrid course materials (Babb, Stewart, & Johnson, 2010; Hensley, 2005; Potosky, 2014). Hensley (2005) makes some specific points with regard to such course content and design:

- You should clearly convey objectives/learning outcomes in the syllabus and in each module.
- Make sure content is available to students in manageable segments (modules).
- Prepare to present the content in a logical, sequential manner.

As part of a comprehensive discussion of faculty and the development of hybrid courses, one group of authors noted a good activity for creating a hybrid course is, "Develop new learning activities that capitalize on the strengths of the online and face to face learning environments" (Kaleta, Skibba, & Joosten, 2007, p. 138). In general, faculty members may not be using online learning management systems to their full potential (Woods, Baker, & Hopper, 2004).

Statistical Process Control Charts

There are many topics covered within a Total Quality Improvement course. One common component, SPC chart creation and analysis, is "a powerful problem-solving technique used for monitoring, controlling, analyzing, managing and improving a process using statistical methods" (Antony, Balbontin, & Taner, 2000. p.242). Additionally, "a control chart is a powerful tool for identifying out-of-control situations in the presence of assignable or special causes of variation" (Antony, Balbontin, & Taner, 2000, p.246).

Many people often relate SPC applications primarily to manufacturing. However, there are other opportunities for students to apply these valuable tools and techniques. Individuals and institutions are using SPC charting techniques to monitor healthcare clinical practice (Smith, Rivers, & Brighouse, 2014), and changes in other health care delivery services (Benneyan, Lloyd, & Plsek, 2003). Understanding the popularity of SPC techniques in fields as disparate as health care and manufacturing will allow students to better appreciate the value of this topic (Woodall, 2006). There are many charting techniques that are available for a variety of situations. Providing students with real-world examples outside of the classroom better equips them to apply this technical problem-solving tool in future endeavors.

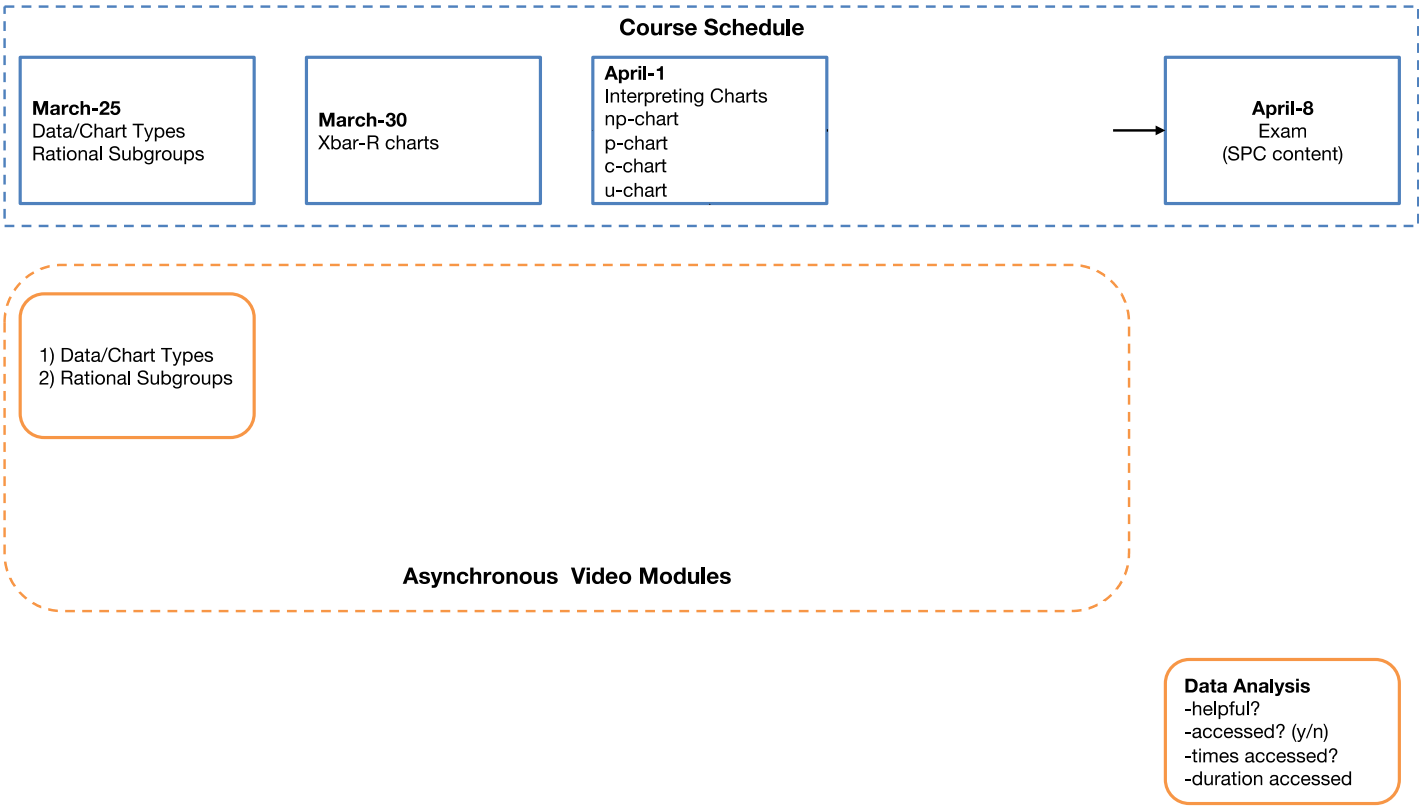
Observational Sample

The authors chose an observational sample of 145 students from a department required junior-level technology course.

Methods

The focus of this IRB designated exempt study was to determine how helpful do students perceive supplemental video modules towards learning to construct and interpret SPC charts. To that end, nine video modules were generated and made available to students to view in preparation for an exam that covered this content. To

understand how these students perceived the helpfulness of these asynchronous modules, data were collected from two sources. The first was a Likert scale survey that measured student's perceived helpfulness of each supplemental video module after viewing and the second was online access data for each module, as tracked by Panopto (Panopto, Inc.) video capture software and database. After these sources of data were collected, the results were analyzed to understand the connection between perceived helpfulness verses number of unique modules viewed and proportional overall viewing duration for students. A sequential flow of research activities, including module administration, data collection, data analysis, interpretation, and dissemination is illustrated in Figure 1. Additionally, this figure depicts the parallel activity structure used to align with the course's schedule and content. The following sections detail each of these research activities in detail.



Supplemental Modules

Nine supplemental video modules formed the educational foundation of this research. These videos were generated specifically for this project to reinforce the lecture content and made available to students on an asynchronous schedule. Each video was released directly after its corresponding content was discussed in lecture, with the last being released two days before the exam. The staggered release, as depicted by Figure 1, was intended to allow the modules to parallel the course content. These videos were made available to all class members, but not required as part of a graded course assignment. The module content pertained to solving SPC charts similar to those covered in the lecture. Additionally, the videos were framed in a way to cover material from diverse real-world scenarios. Students were encouraged to use the videos to reinforce class lecture content and as preparation resources for the exam. In this way, students were incentivized to engage with the asynchronous modules.

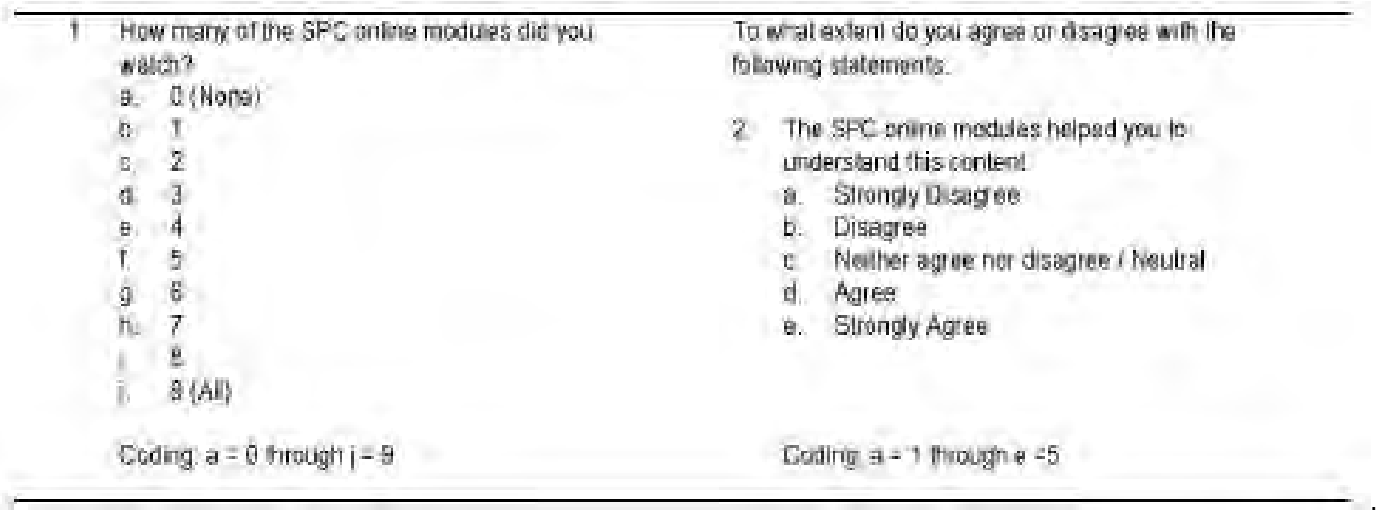
An expert review committee that included the current course instructor validated the content of the video modules and five quality professionals from industry with an estimated combined level of experience of over five decades in quality and statistical process control. Their employers ranged from small manufacturing companies to a Fortune 500 corporation. Two were the Quality Managers of their organizations, one was a Corporate Quality Systems Lead, and two were Lean Consultants within their respective organizations. All agreed that the modules were suitable for the undergraduate students in the course and one expressed specifically the potential benefit if their employees had the opportunity to view the modules. After industry review and module updates, the faculty member responsible for the course for the past three years provided a final review and approved the modules for release to the students. A two-week window was allotted for this validation process, which allowed for adequate review time for the expert committee.

Data collection

A paper survey instrument was administered to students at the beginning of the exam to collect responses on how may modules they watched and how helpful they were. Responses were recorded with standardized bubble sheets. The timing of the survey administration was intended to allow for a maximum response rate from class participants. Students were asked to rate (on a 5-point Likert scale: 1 strongly disagree to 5 strongly agree) how the modules helped them to understand the SPC content, as illustrated in Figure 2. This survey was used to answer research question 1.

In tandem with the paper survey, data was also collected with Panopto's viewer statistics tool and specifically included the number of unique modules viewed by each student and the total viewing duration for each module by each student. This data was combined with the survey results to answer research questions 2 and 3.

Figure 2. Survey instrument administered to students



1 How many of the SPC online modules did you watch?
a. 0 (None)
b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h. 7
i. 8
j. 9 (All)

Coding: a = 0 through j = 9

To what extent do you agree or disagree with the following statements:

2 The SPC online modules helped you to understand this content
a. Strongly Disagree
b. Disagree
c. Neither agree nor disagree / Neutral
d. Agree
e. Strongly Agree

Coding: a = 1 through e =5

Data Analysis

Data from both the paper survey and the online viewing statistics were analyzed to answer the research questions. This statistical analysis included descriptive statistics, Chi squared tests (), Pearson correlation coefficients (*r*), and fitting of individual simple linear regression models for the relationships between the response variable of student perceived *helpfulness* and the explanatory variables of the number of *unique modules viewed* and *proportional viewing duration*. The response of perceived *helpfulness* was coded 1 (not helpful) through 5 (helpful) in question two of the survey (see Figure 2). Furthermore, the self-reported explanatory variable of *unique modules viewed* was coded 0 (a) through 9 (j) in question one of the survey (see Figure 2). These responses were further validated using Panopto's viewer statistics to guard against false responses. The explanatory variable of *proportional viewing duration* was calculated as the duration of all modules viewed divided by the total duration of all nine modules (58.22 minutes) and was tracked by Panopto. Table 1 indicates each variable, its source, the sample sized used, and which research question it was used to answer. Finally, the data points for respondents who viewed and/or reported zero *unique modules viewed* were removed from all data analyses, as they were philosophically inappropriate to answering the research questions of this study.

Table 1. Variables used to answer each research question.

Research Question	*Response Variable*	*Explanatory Variable*	*Source*	*Sample Size (N)*
1	Helpfulness	–	Self-reported Paper Survey	71
2	Helpfulness	Unique modules viewed	Self-reported Paper Survey & Panopto Viewer Statistics	71
3	Helpfulness	Proportional viewing duration	Self-reported Paper Survey & Panopto Viewer Statistics	59

Limitations

The observational nature of this study requires that conclusions may only apply directly to the course and students involved. Any association to a broader population of students or courses is cautioned. This does not in anyway diminish the conclusions of this study, but only tempers them. Other institutions and faculty can draw benefits from these results in as much as they relate to their specific situations. In contrast, the ancillary purpose of improving the teaching within the course discussed is not adversely affected by the observational design of this study. Inferences about this course and its student population can be robustly made from the conclusions of this study by way of supporting continuous improvement efforts internal to this course.

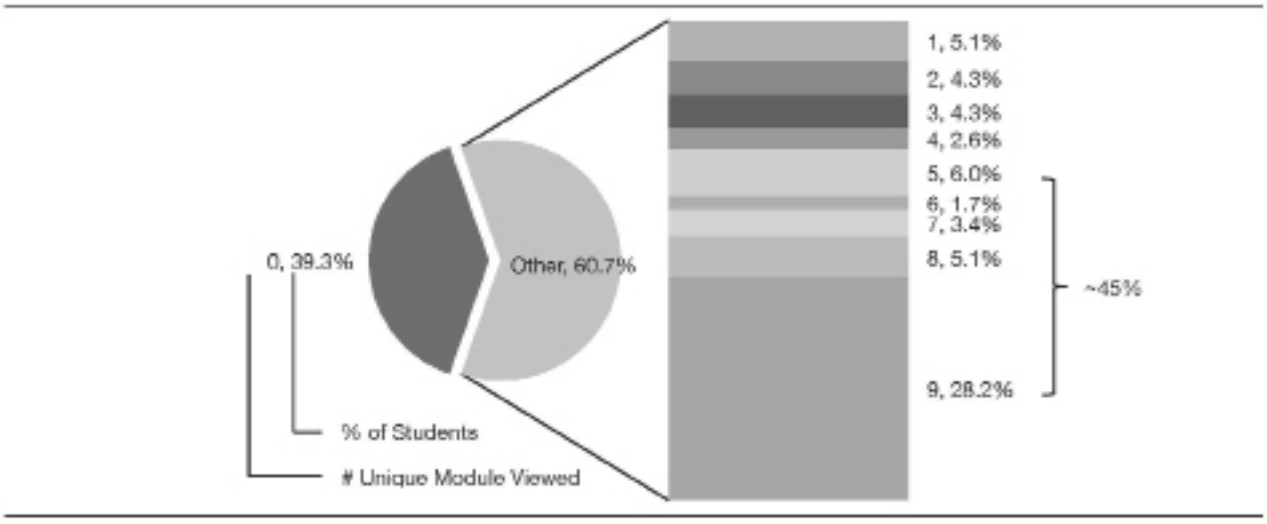
Results

Descriptive Statistics

The survey instrument was administered to 138 of the 145 students enrolled in the course. Of these responses 117 were considered for purposes of data analysis, with the other 21 being dropped due to missing and/or inconsistent responses. Out of the 117 responses considered for data analysis, only 71 students watched one or more of the modules. Hence the number of responses valid for answering the first two research questions was N= 71. Even so, a very high 49% response rate from the entire class was achieved.

Thirty-nine percent of the participants stated they did not watch any of the modules, while 28% of students stated they watched all nine modules. Close to 45% responded they watched five or more modules. The complete distribution of modules watched is shown in Figure 3.

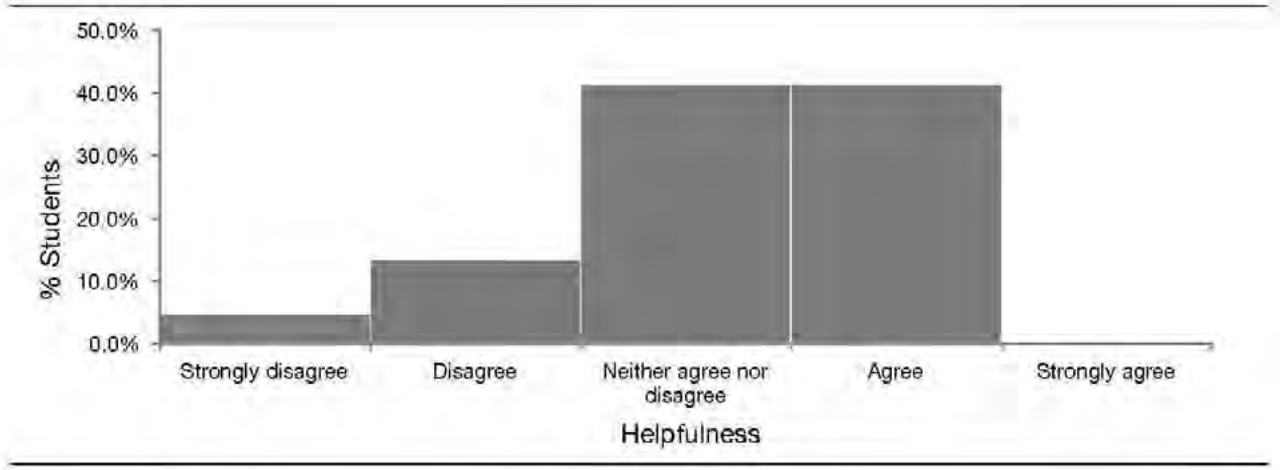
Figure 3. Number of unique modules viewed by student population



Research Question One

The first research question investigated student's perception of the helpfulness of asynchronous video modules in learning to construct SPC charts. To answer the research question, the authors analyzed student's self-reported responses to the survey question: "The SPC modules helped you to understand this content" (see Figure 2). Students responded by selecting one option from a 5-point Likert's scale ranging from 1 (strongly disagree) to 5 (strongly agree). Out of the 117 participants, only 71 students stated that they watched at least one module. The distribution of these responses is shown in Figure 4 and illustrates that 18% of the students who watched at least one module either strongly disagreed or disagreed with the statement that the online modules helped them understand the concepts related to SPC. Approximately, 41% of the students neither agreed nor disagreed and 41% of the students agreed that online supplemental videos helped them understand more about SPC. Furthermore, it should be noted that none of the students stated that they strongly agreed that online supplemental videos helped them understand more about SPC.

Figure 4. Distribution of students' self-reported perception of helpfulness of SPC video modules (N = 71)



Overall, the proportion of students who found the online modules helpful was higher than the proportion of students who did not. A Chi-squared test was used to validate the hypothesis and results showed that the proportion of students who agreed was significantly different (p-value < 0.05) from the proportion of students who strongly disagreed or disagreed. The results of this test are shown in Table 2.

Table 2. Chi-square test to validate research question 1

Chi-squared test statistic value	6.4
Degrees of freedom	1
p-value	0.01

α = 0.05; N = 71

The result indicates there was a significant difference in the proportion of students who perceived the helpfulness of asynchronous video modules in learning to construct SPC charts. The proportion of students who perceived the video modules as helpful was significantly higher than the proportion of students who perceived the video modules as not helpful.

Research Question Two

The second research question explored if there is a significant relationship between number of unique modules viewed and the level of perceived helpfulness of students who watched at least one module. Correlation and regression analysis were used to validate the hypotheses. Correlation coefficients between the number of unique modules viewed by student and their perceived helpfulness are depicted in Table 3.

Table 3. Correlation between self-reported unique modules viewed and perceived helpfulness

	Unique modules viewed	Perceived helpfulness
Unique modules viewed	-	0.27*
Perceived helpfulness	0.27*	–

*P < 0.05; N = 71

The moderate correlation between the number unique modules viewed and students perceived helpfulness indicates a positive relationship between the two variables. Simple linear regression was used to further validate the relationship between unique modules viewed and students perceived helpfulness. In the regression analysis, the number unique modules viewed was the explanatory variable, while students rating of helpfulness was the response variable, as shown in Table 4.

Table 4. Regression self-reported unique modules viewed and perceived helpfulness

Regression Statistics	
Multiple R	0.27
R Square	0.07
Adjusted R Square	0.05
Standard Error	1.00
Observations	71

	df	SS	MS	F	P-value
Regression	1	5.40	5.40	5.30	0.02
Residual	69	70.37	1.02		
Total	70	75.77			

	Coefficients	Standard Error	t Stat	P-value
Intercept	2.44	0.3	8.2	<0.05
Unique modules viewed	0.09	0.04	2.30	0.02

α = 0.05; N = 71

Data analysis indicates there was a significant linear relationship between the number of unique modules viewed and perceived helpfulness for students who watched at least one module. The value of the regression coefficient for number of unique modules viewed indicates a positive relationship between number of unique modules viewed and the student perception of helpfulness.

Research Question Three

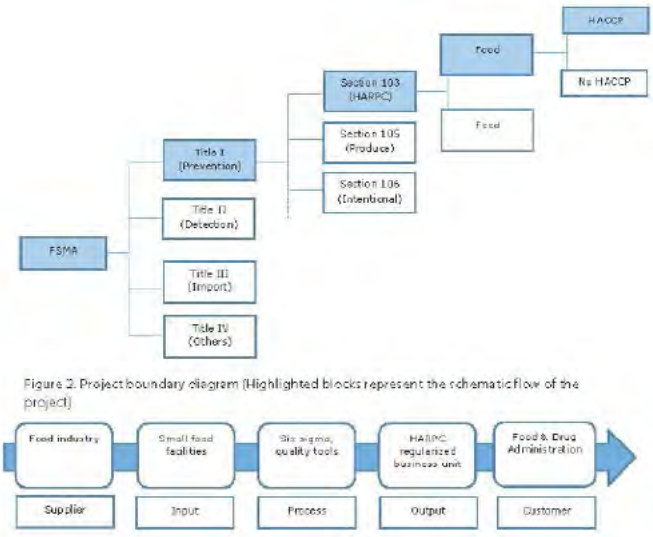
The final research question explored if there is a significant relationship between the proportion viewing duration and the level of perceived helpfulness of students who watched at least one module. Again, correlation and regression analysis were used to validate the hypotheses. Table 5 contains the correlation values between proportion viewing duration and perceived helpfulness.

	Proportion viewing duration	Perceived helpfulness
Proportion viewing duration	–	0.1700*
Perceived helpfulness	0.1700*	–

*P <0.05; N = 59

The correlation value between the proportion viewing duration and student's perceived helpfulness indicates a weak positive relationship between the two variables. Simple linear regression was used to further validate the relationship between the proportion viewing duration and perceived helpfulness. In the regression analysis, the proportion of time viewed was the explanatory variable, while student's rating of helpfulness was the response variable, as shown in Table 6.

Table 6. Regression model of proportion viewing duration and students perceived helpfulness



Regression analysis indicates there is a significant linear relationship *between the proportion of time viewed* by the students and their perceived helpfulness of the video modules in learning to construct SPC charts. The value of the regression coefficient for number of modules watched indicates a strong positive relationship between proportion of time viewed and the student perception of *helpfulness*.

Conclusions

The following conclusions, organized by research question, were drawn from this study:

- Research Question One: This question looked at student's perception of helpfulness of asynchronous SPC video modules. From the analysis it was found that students who reported watching at least one module (N = 71), 41% perceived online video modules to be helpful. Furthermore, 41% perceived the modules as neither helpful

nor unhelpful, with 18% responding that they were not helpful. A Chi-square test ($\chi^2 = 6.4$; p-value = 0.01) for this case showed that the proportion of students who found the video modules helpful was significantly different ($\alpha = 0.05$) from the proportion of students who did not find them helpful. Therefore, answering research question one, it was found that a large amount (41%, N = 71) of students who watched the video modules perceived them to be helpful.

- Research Question Two: This question looked at the relationship between helpfulness and number of unique modules viewed. A moderate positive correlation of 0.27 (p-value < 0.05) with significant linear relationship (p-value < 0.05, N = 71) was observed. This indicates that when more modules were viewed students' perception of how helpful they were increased. From the regression analysis in Table 4, the average student response at one unique modules viewed was 2.44, while at nine it was 3.16. This resulted in a range of 0.72 in perceived helpfulness. Thus, answering research question two, it is clear that the number of *unique modules viewed* positively affects the *helpfulness* as perceived by students.

- Research Question Three: This question examined the extent to which the proportional viewing duration effected student's perception of helpfulness. To answer this question, only students who watched more than 50% of the total viewing duration were analyzed. Looking at this sub-population (N = 59), a weak positive correlation of 0.1700 (p-value < 0.05) with significant linear relationship (p-value < 0.05) was observed. This also indicates that as viewing duration increased so did perceived helpfulness. Therefore, answering research question three, it was found that the proportional viewing duration positively affected student's perception of helpfulness.

- From these results, it can be concluded that students who watched video modules perceived them to be helpful in learning to construct SPC charts. Furthermore, the number of unique modules viewed and proportional viewing duration were both positively associated with the level of perceived helpfulness. These results support the use of asynchronous video modules to help students construct SPC charts and aligns well with the notion that online supplemental content can extend student learning beyond the classroom.

References

Antony, J., Balbontin, A., & Taner, T. (2000). Key ingredients for the effective implementation of statistical process control. Work study, 49(6), 242-247.

Babb, S., Stewart, C., & Johnson, R. (2010). Constructing communication in blended learning environments: Students' perceptions of good practice in hybrid courses. *Learning*, 6(4), 735-753.

Benneyan, J. C., Lloyd, R. C., & Plsek, P. E. (2003). Statistical process control as a tool for research and healthcare improvement. *Quality and Safety in Health Care*, 12(6), 458-464.

Bourne, J., Harris, D., & Mayadas, F. (2005). Online engineering education: Learning anywhere, anytime. *Journal of Engineering Education*, 94(1), 131-146.

DeNeui, D. L., & Dodge, T. L. (2006). Asynchronous learning networks and student outcomes: The utility of online learning components in hybrid courses. *Journal of Instructional Psychology*, 33(4), 256.

De Vries, A., & Reneau, J. K. (2010). Application of statistical process control charts to monitor changes in animal production systems. *Journal of Animal Science*, 88(13 electronic suppl), E11-E24.

El Mansour, B., & Mupinga, D. M. (2007). Students' Positive and Negative Experiences in Hybrid and Online Classes. College student journal, 41(1), 242-248.

Freeman, S. A., & Field, D. W. (2004). Student Perceptions of Web-Based Supplemental Information. *Journal of Technology Studies*, 30(4), 25.

Hensley, G. (2005). Creating a hybrid college course: Instructional design notes and recommendations for beginners. *Journal of Online Learning and Teaching*, 1(2), 66-78.

Iowa State University. (2015). Show Course: TSM 310. Retrieved April 8, 2015, from Catalog: http://catalog.iastate.edu/showcourse/?code=TSM-310&edition=2014-15

Kaleta, R., Skibba, K., & Joosten, T. (2007). Discovering, designing, and delivering hybrid courses. *Blended learning: Research perspectives*, 111-143.

Mosca, J. B., Ball, D. R., Buzza, J. S., & Paul III, D. P. (2010). A comprehensive student-based analysis of hybrid courses: student preferences and design criteria for success. *Journal of Business & Economics Research (JBER)*, 8(5).

Mostafaeipour, A., Sedaghat, A., Hazrati, A., & Vahdatzad, M. A. (2012). The use of Statistical Process Control Technique in the Ceramic Tile Manufacturing: a Case Study. *International Journal of Applied Information Systems (IJAIS)*,2(5), 14-19.

Potosky, D. (2014). Developing and teaching an online/in-class hybrid: a demonstration. *Developments in Business Simulation and Experiential Learning*, 31.

Smith, I., Rivers, J., & Brighouse, R. (2014). PT393 Use of statistical process control charting techniques for prospective monitoring of outcomes of changes in clinical practice. *Global Heart*, 9(1), e248.

Smith, J. A. (2005). Evaluating the direction of research in online education: are we going anywhere? *Developments in Business Simulation and Experiential Learning*, 32.

Wardell, D. G., Moskowitz, H., & Plante, R. D. (1992). Control charts in the presence of data correlation. *Management Science*, 38(8), 1084-1105.

Woodall, W. H. (2006). The use of control charts in health-care and public-health surveillance. *Journal of Quality Technology*, 38(2), 89-104.

Woods, R., Baker, J. D., & Hopper, D. (2004). Hybrid structures: Faculty use and perception of web-based courseware as a supplement to face-to-face instruction. *The Internet and Higher Education,* 7(4), 281-297.

Distance Learning

The Hybrid Program: The Key to Unlocking the "Glass Ceiling"

Dr. John E. Wyatt, Mississippi State University

Background

The term the "glass ceiling" has been around for many years. The term has been used mainly to describe the failure of companies to promote staff, especially into leadership positions, based on gender, (Leeds & Leeds, 2015), (Russo & Hassink, 2012), (Weinberger, 2011), (Hoobler, Wayne, & Lemmon, 2009), or race or culture, (Wilson, 2014). However, there has been previously published work that stated males also had a glass ceiling concerning their inability to adapt to changing situations, (Titkow, 2010).

This paper looks at a different type of glass ceiling, which is not illegal, but which affects a great many people in industry. This particular glass ceiling has to deal with an employee's educational level. There are employees all over the country, working in the manufacturing sector, who have two-year associate degrees from their local community college. These employees would make excellent middle managers/team leaders, or even higher in the company structure. However, due to company policy and their not having a four-year technical degree their career progress is prematurely halted due to this company enforced glass ceiling. During the authors research for this paper there was no previous literature found regarding an educational glass ceiling.

Nationwide there is a severe shortage in people with technical backgrounds to support manufacturing industry. This does not just include two-year degree staff but four-year as well. More and more high tech companies have begun to situate themselves in the southeast of the United States. This is especially true of the automotive industry. The move of these companies to the southeast has created a strain on the workforce for people with the necessary technical skills and educational level to allow them to operate.

Many of their current employees have two-year degrees but are unable to advance any further up the corporate ladder. Their only solution at this moment is to take an interdisciplinary studies degree to just give them a four-year degree. These purely online four-year degree programs do help the student as they enable college work to be done in the employee's free time. However, these interdisciplinary type of degrees do not give the student a thorough background in the technical aspects of manufacturing.

Several years ago, the industrial technology program at Mississippi State University began looking at ways of offering their courses to such students in several different formats. The first was having the lectures and quizzes for laboratory classes offered online and the student take the laboratory portion of the class at their local community college. This idea was abandoned due to the logistical and cost-sharing implications of having a university student use a community college laboratory.

The second format that MSU investigated was that of a completely online program. This would require the use of simulation software to provide the labs to the students. This idea was discarded due to two factors; 1. The high

cost of the associated software for the simulations, 2. The steep learning curve that distance student would have to overcome to enable them to use the simulation software.

Finally, after consultation with our industrial advisory board, it was felt that offering the industrial technology degree to people already in industry was a worthwhile pursuit. To this end a final option is currently being explored. This option is similar to the first one with all of the lectures quizzes etc. being delivered online. However, the student would come to campus several times during the semester to undertake the labs for that particular course. This is what the industrial technology program terms as a hybrid/blended class.

The Hybrid Course/Program

There are many definitions of the hybrid/blended program or class from those being a mixture of online and face-to-face classes, (Amrein-Beardsley, 2007), (Kilgore, 2004), to those with students who attend face-to-face for several days before online classes start, (Kung & Logan, 2014), and some where the classes are a combination of online and workplace activities, (Totterdell, Hathaway, & la Velle, 2011). Our definition of the term hybrid is a class where the lecture quizzes and discussions are delivered online, while the lab sessions are given on campus in a face-to-face setting.

The reason for using this hybrid definition is that the target audience for this program are those who are currently working in industry, where time, due to work and family commitments is very limited. The problem is that the program at MSU contains many technical courses that have labs associated with them. Therefore, we wanted to give the student some flexibility with the online learning part of the class but combine that with the benefits that an on-campus student receives through going to class,(Amrein-Beardsley, 2007),(Nollenberger, 2015), (Garcia, Abrego, & Calvillo, 2014). This is vitally important as the labs help to reinforce the material that was delivered online, (Killian et al., 2014). Also, according to Zacharis, this hybrid delivery system will allow for the accommodation of students with different learning styles, (Zacharis, 2011). There have been several claims in the literature that state that students prefer the hybrid type of course delivery with their liking the flexibility and freedom the online portion allows them, combined with the increased depth of learning that the combination of the online and face-to-face gives them, (Foulger, Amrein-Beardsley, & Toth, 2011). Students also like the large amount of interaction the hybrid format gives when compared to the purely online program, (Ferrer-Cascales, Walker, Reig-Ferrer, Fernández-Pascual, & Albaladejo-Blázquez, 2011).

According to Gallagher and LaBrie (2012), hybrid offerings of both courses and programs have not received much attention in higher education. The implementation of this new program would be the first at Mississippi State University. However, to undertake this we must look at the program as a whole and not just focus on the design and delivery of individual courses,(Husmann & Miller, 2001).

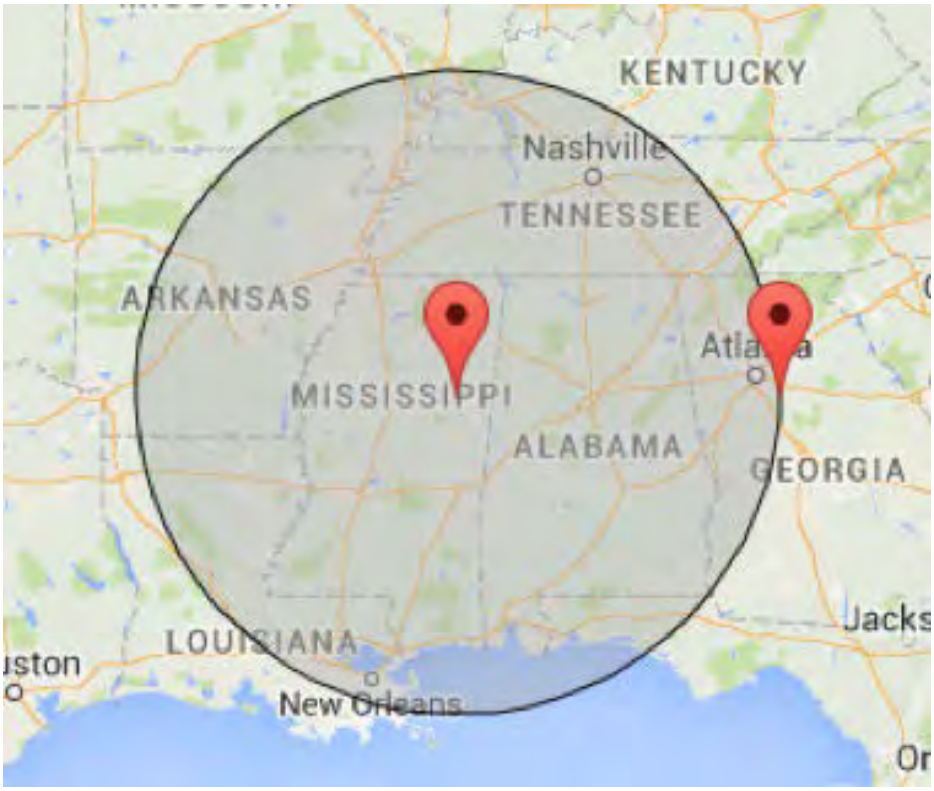
With the lab sessions being delivered in a face-to-face format at the main Starkville campus on Saturdays, the target area that the students will come from has to be defined in terms of ease of getting to the campus, e.g. travel time. It is felt that many of these potential students, would receive backing from their companies to pursue a four-year technical degree. Therefore, we felt that the maximum driving time would be approximately five hours. This would mean that students would arrive in town late Friday night to begin lab sessions on Saturday morning and then leave that afternoon. This would give a catchment area of approximately 59,000 square miles, with a radius of approximately 275 miles as can be seen in figure 1. This gives a catchment area which covers nine states with the

major cities of Atlanta, Nashville, and New Orleans being at the periphery of the area. From a population finder the approximate population within that area is 21,220,000. Sustainability should not be a problem once the program gets started and word gets out about it. However, targeted advertising must done to both start of the program and to keep it going.

Currently, we are in the initial planning phases of this program and are working on the things we are required to do, not just for the University protocols, but to make this program successful. The first major step is how to redesign the courses so that they cover the same material with the same rigor as the face-to-face class but in the new hybrid format. Osguthorpe and Graham (2003) pointed out that hybrid courses have to be designed for specific purposes which pertain to that particular course. They recommend designing a hybrid course with six goals in mind, (Osguthorpe & Graham, 2003), these being:

1. Pedagogical Richness - methods supported by theory
2. Access to Knowledge - taking advantage of media rich materials
3. Social Interaction - student to student communication
4. Personal Agency - student control of the learning process
5. Cost Effectiveness - wise investment in professor time
6. Ease of Revision - a vital concern for rapidly changing technical content

Figure 1. A catchment area with a 275 mile radius centered on MSU



One of the first things we have to think about upon the redesign of the courses for hybrid delivery, is the ability of the student who may have not been in an education setting for many years, to adapt to online learning. We cannot just add technology to instruction as this can complicate it, (Yang, Cornelious, Association for Educational, & Technology, 2004). According to Kilgore (2004) we have to provide these nontraditional students with accessibility to online materials but without scaring them off. Mississippi State University has many online videos which explain how to do things in Blackboard, such as submitting an assignment or taking a quiz. Students will have access to these resources to familiarize themselves with the system. In the literature some of the drawbacks were that there was too much work to do and, issues with the instructor and the technology, (Foulger et al., 2011). This will require the faculty to work with both instructional designers and instructional technical support personnel to design a simplified, easy to use, template within the Blackboard learning system. This will require the support of not only the departmental head but senior administration as well, (Toth, Foulger, & Amrein-Beardsley, 2008). One way to simplify the process is to take the course and modularize it. This will make it easier to not just plan the course in both its face-to-face and online components but to also deliver it to the student in manageable chunks, (Tabor, 2007). Also, time will be given at the beginning of every lab session for the students to ask questions they have about the online content. This will help to strengthen the communication between the instructor and the students but will also allow for demonstrations of how the online content can be applied.

Another thing that has to be considered is the cost of the program, not only to the student but the university. New faculty would have to be hired and trained in the delivery of this hybrid program. Also, students who travel from the outer edges of the 275 mile radius would need to have lodging for the Friday night before class. The lab classes would run from 9:00 a.m. till 4:00 p.m. on three to four Saturdays a semester. Students within 3 hours could easily come in that morning but those from five hours away would be expected to pay for their own lodging which would be a small fee for them, especially if their company is paying the tuition. Another small problem is that of which Saturdays to have classes on. During the spring semester that is not a problem and classes can be scheduled as needed. However, the fall semester in an SEC school has many challenges with football. Therefore, once a football schedule is released lab sessions can be factored into the class timetable to avoid clashing with home football games. This will also allow students who need hotel rooms for the Friday night to be able to reserve them.

As stated previously, MSU is in the initial planning stages of the creation of a hybrid program. There are many things that still need to be done. This paper has just presented some of the basic information that we had to use to develop a starting point for the creation of the new program. Currently, we are undertaking a needs assessment to see if a hybrid program would be worth creating to meet the needs of industry, the results of which will be presented with this paper.

References

Amrein-Beardsley, A. T. S. T. M. (2007). Examining the Development of a Hybrid Degree Program: Using Student and Instructor Data to Inform Decision-Making. *Journal of Research on Technology in Education (International Society for Technology in Education), 39*(4), 331-357.

Ferrer-Cascales, R., Walker, S. L., Reig-Ferrer, A., Fernández-Pascual, M. D., & Albaladejo-Blázquez, N. (2011). Evaluation of hybrid and distance education learning environments in Spain. *Australasian Journal of Educational Technology, 27*(7), 1100-1110.

Foulger, T. S., Amrein-Beardsley, A., & Toth, M. J. (2011). Students' Roles in Exposing Growing Pains: Using the "Dean's Concerns" to Refine Hybrid Instruction. *International Journal of Teaching and Learning in Higher Education, 23*(2), 150-165.

Gallagher, S., & LaBrie, J. (2012). Online Learning 2.0: Strategies for a Mature Market. *Continuing Higher Education Review, 76*, 65-73.

Garcia, A., Abrego, J., & Calvillo, M. (2014). A Study of the of Hybrid Instructional Delivery for Graduate Students in an Educational Leadership Course. *Journal of Distance Education, 29*(1), 1.

Hoobler, J. M., Wayne, S. J., & Lemmon, G. (2009). Bosses' Perceptions Of Family-Work Conflict And Women's Promotability: Glass Ceiling Effects. *Academy of Management Journal, 52*(5), 939-957. doi: 10.5465/AMJ.2009.44633700

Husmann, D. E., & Miller, M. T. (2001). Improving distance education: Perceptions of program administrators. *Online Journal of Distance Learning Administration, 4*(1).

Kilgore, D. (2004). The Medium Is the Message: Online Technology and Knowledge Construction in Adult Graduate Education. *Adult Learning, 15*(3-4), 12-15.

Killian, S. A., Beck, D. E., O'Bryan, C. A., Jarvis, N., Clausen, E. C., & Crandall, P. G. (2014). Student-Centered and Dynamic Interfaces that Enrich Technical Learning for Online Science Learners: A Review of the Literature. *Journal of Food Science Education, 13*(3), 47-56. doi: 10.1111/1541-4329.12034

Kung, M., & Logan, T. J. (2014). An Overview of Online and Hybrid Doctoral Degree Programs in Educational Technology. *Tech Trends -Washington DC-, 58*(4), 16-18.

Leeds, E. M., & Leeds, M. A. (2015). Cracking The Glass Ceiling (pp. 1): Richard Ivey School of Business Foundation.

Nollenberger, K. (2015). Comparing Alternative Teaching Modes in a Masters Program: Student Preferences and Perceptions. *Journal of Public Affairs Education, 21*(1), 101-114.

Osguthorpe, R. T., & Graham, C. R. (2003). Blended Learning Environments: Definitions and Directions. *Quarterly Review of Distance Education, 4*(3), 227-233.

Russo, G., & Hassink, W. (2012). Multiple Glass Ceilings. *Industrial Relations, 51*(4), 892-915. doi: 10.1111/j.1468-232X.2012.00705.x

Tabor, S. W. (2007). Narrowing the Distance: Implementing a Hybrid Learning Model for Information Security Education. *Quarterly Review of Distance Education, 8*(1), 47-57.

Titkow, A. (2010). Do Men Have Their Own Glass Ceiling? *Polish Sociological Review*(172), 391-409.

Toth, M., Foulger, T. S., & Amrein-Beardsley, A. (2008). Post-Implementation Insights about a Hybrid Degree Program. *TechTrends: Linking Research & Practice to Improve Learning, 52*(3), 76-80. doi: 10.1007/s11528-008-0159-4

Totterdell, M., Hathaway, T., & la Velle, L. (2011). Mastering Teaching and Learning through Pedagogic Partnership: A Vision and Framework for Developing "Collaborative Resonance" in England. *Professional Development in Education, 37*(3), 411-437.

Weinberger, C. J. (2011). In Search Of The Glass Ceiling: Gender And Earnings Growth Among U.S. College Graduates In The 1990's. *Industrial & Labor Relations Review, 64*(5), 949-980.

Wilson, E. (2014). Diversity, Culture And The Glass Ceiling. *Journal of Cultural Diversity, 21*(3), 83-89.

Yang, Y., Cornelious, L., Association for Educational, C., & Technology, W. D. C. (2004). Ensuring Quality in Online Education Instruction: What Instructors Should Know? Association for Educational Communications and Technology.

Zacharis, N. Z. (2011). The Effect of Learning Style on Preference for Web-Based Courses and Learning Outcomes. *British Journal of Educational Technology, 42*(5), 790-800.

2015 Conference Proceedings

EECT

Bridges to the Cloud: Technologies for Integrating Security in the Development of Online Systems

Mr. David Freet, Eastern Kentucky University, Richmond, KY
Dr. Vigs J. Chandra, Eastern Kentucky University, Richmond, KY
Mr. Jeff B. Kilgore, Eastern Kentucky University, Richmond, KY

Introduction

Cloud computing is emerging as a commercial infrastructure that eliminates much of the overhead of maintaining traditional computing hardware and assets. In recent years, cloud computing has revolutionized how information is processed by providing a scalable, cost-effective and efficient technology platform. From a technology management standpoint, cloud computing offers additional computing power and more storage at a low cost. A study by Market Research Media states that the global cloud computing market is expected to grow at a 30% Compound Annual Growth Rate (CAGR) reaching $270 billion in 2020 (Market Research Media, 2012). However, the characteristics that make cloud computing so powerful also make cloud-based crimes and attacks on clouds and their users more difficult to prevent and investigate (Zawoad & Hasan, 2013). While cloud technology provides a distinct competitive advantage to many organizations, a recent report found that 52 percent of large companies and one-third of small and medium businesses are not moving to the cloud because of security concerns (Talbot, 2014).

Security is one of the most complex and critical facets of modern computing and the management of IT systems in the current business environment. Even the term "security" is so encompassing that it is difficult to know what is meant by its use. Security can refer to the physical security of servers and workstations and protecting them from harm. Or it can refer to the security of data and protecting it from viruses and hackers. It may also refer to the security of knowing that data is backed up and protected from loss. When referring to "security" in the context of information systems, the term encompasses the products, processes and people in an organization. Although information security has typically been viewed as a technology issue, it has clearly become more of a management issue as the threat level has increased and IT systems have evolved into a more highly critical component of the business model.

Traditional Firewalls

One of the most important tools for network protection is the firewall. As shown in Figure 1, a firewall is a combination of hardware and software that is placed between the organization's private internal networks and distrusted external networks such as the Internet, and controls the flow of incoming and outgoing network traffic.

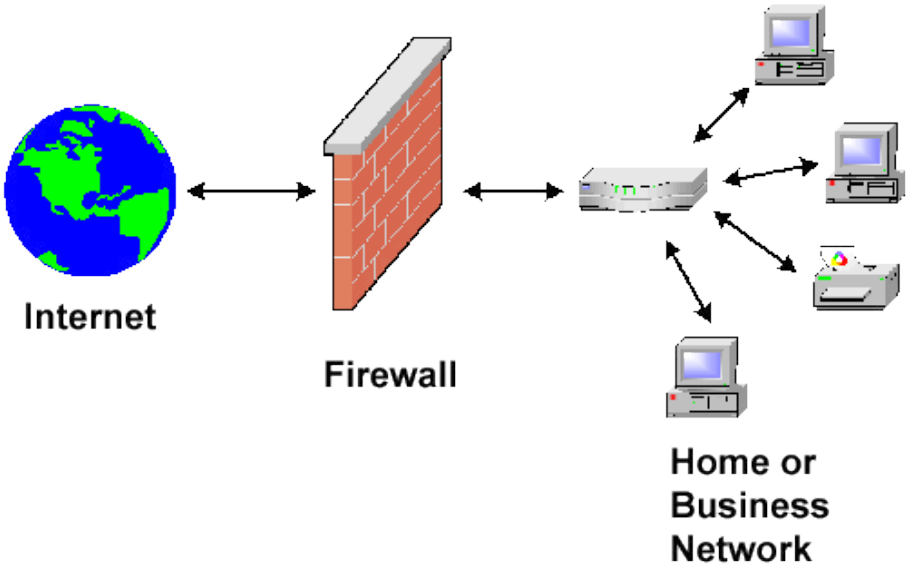


Figure 1. Network architecture with firewall for preventing unauthorized access

In general firewalls can be divided into four major categories based on processing-mode: First Generation, which looks at the source and destination addresses, ports and services requested; Second Generation, which looks at the state and context of packets; Third Generation, which acts as a middleman between communicating systems by breaking the session and re-establishing a new session to each system; and Fourth Generation, which looks deep into packets and makes granular access control decisions based on packet header and payload (Abdel-Aziz, 2009). There are many firewall screening technologies including packet filtering, stateful inspection, application proxy filtering, deep packet inspection (DPI), and intrusion detection systems. Whereas the traditional firewall architecture focused on blocking ports and IP addresses, the growth of Internet usage and increased accessibility to account information, names, passwords and proprietary data has necessitated a firewall architecture that can not only perform deep packet inspection but can also evaluate the data coming into the network at the application layer of the OSI model (Thomason, 2012).

Next Generation Firewall

A next-generation firewall (NGFW) is a new generation of firewalls that integrate intrusion prevention, malware filtering, and other security functions to allow more advanced control over the data flow. The defining characteristic of a next-generation firewall is the ability to identify and control traffic at the application layer. These new firewalls look deep into the packet's payload before making a decision on whether to allow or deny the traffic flow (Abdel-Aziz, 2009). While traditional firewalls have tended to focus on network ports and protocols, NGFWs focus more heavily on the applications and data. Application Intelligence, or awareness, is a foundational component of a NGFW that enables the identification of individual applications within network traffic, ideally irrespective or port, protocol or evasive tactic (SonicWALL, 2011).

Threat evolution has made a significant shift from attacks directed onto the operating systems or network protocols to attacks of vulnerabilities in the application layer. Currently, over 70% of all attacks are targeted toward the application layer (Koch, 2011). As attack vectors have begun to focus more heavily on applications versus the network, it is necessary to implement a deeper level of protection in this area. Traditionally, each type of application – web pages, email and FTP transfers went through a specific TCP port. If an organization wanted to stop a certain type of communication from happening within the network, it could simply block the corresponding port. As more applications have been written to function over HTTP (port 80), it has become increasingly infeasible to block HTTP communications through the firewall. There are too many legitimate uses for HTTP to universally restrict access (Powers, 2011). The growth of service-oriented architectures and Web communication has led to more data going through fewer ports with fewer protocols, meaning port/protocol-based policy has become less effective. While deep packet inspection intrusion prevention systems inspect for known attack methods against operating systems and software, they cannot effectively identify and block the misuse of specific features within applications. Gartner has long supported the concept of NGFWs as the next stage of evolution in dealing with these issues (Pescatore, & Young, 2009).

Significant changes have occurred recently to both the application and threat landscapes. As personal applications have become more pervasive they have become more difficult to distinguish from legitimate business applications. This implies that much of the traffic looks the same and so it is more important to identify the applications being used and which users are using them and for what purpose (Weller, & Lowe, 2011). Applications such as instant messaging, personal communication, file sharing, web mail and a host of social networking applications have become a primary target for access into the enterprise network. Even "pure" business applications have been designed to use the same evasive techniques such as use of non-standard ports, tunneling within commonly used services, and hiding within SSL encryption so that they can be accessible and functional for legitimate business use in every network, for every user, regardless of the security infrastructure in place (Palo Alto Networks, 2010).

The ability to generate revenue by circumventing or cracking existing security measures by building threats that operate on, and through applications, is on the increase. Applications give attackers access to many options to avoid detection such as tunneling, encryption, compression and port evasion. This method of attack passes through many enterprise defenses because they are designed mostly for protection at the network layer and not the application layer. Today's hackers are focusing more heavily on the growing popularity of user-centric applications such as those seen in social networking which provide a good platform for worms and trojans. Worms and botnets also target P2P file sharing networks; not only as a means to spread but also as a platform for command and control communication (Palo Alto Networks, 2010).

In addition to applications, threats have evolved to avoid detection by traditional IPS solutions by using encryption and compression. Although security researchers have warned that encryption would be used by various threats, encrypted attacks still need a conduit which is available through user-centric applications. Through phishing and other attacks, users are easily tricked into clicking on encrypted links which can then send encrypted threats through the enterprise network. In order to detect these type of threats it is necessary to decrypt SSL and unzip content to look more deeply into the possibility of threats. This functionality is generally far beyond the capabilities of the traditional IDS. The "find it and kill it" model of the traditional IDS doesn't work well with the types of control necessary to deal with the new generation of threats that move across the enterprise network through applications (Palo Alto Networks, 2010).

In addition to identifying the actual threats it is necessary to look for the hidden transmission vectors that traditional IDS is not able to detect. Within the business environment there is always the tension between security and functionality. The most secure device is one that's unplugged. While applications can be threats or enable threats, it may not be practical to completely block the application if it has legitimate business value. For example a Web application such as Facebook can be seen as both bad and good to a company – as a productivity threat, a security threat, and a valuable marketing tool. A NGFW has the granularity of control to enable the marketing department in a company to have prioritized bandwidth to use Facebook, but at the same time to prevent other departments from using it during working hours and ALL users from accessing Farmville or Mafia Wars (Palo Alto Networks, 2010). This can allow for legitimate use of applications for business functions while providing a satisfactory level of protection for the enterprise network as well. NGFWs provide classification of traffic based not only on signatures, but an ongoing process of application analysis, decryption and decoding in order to analyze the layers of a traffic stream to determine its true identity.

With new technologies being integrated into existing enterprise-level computer systems continued vigilance on the part of network professionals is needed for maintaining security while ensuring ease of access and 24/7 availability. Organizational leaders should take note that the security of their computer systems are continuously being probed for vulnerabilities and every effort should be made by networking personnel to increase confidentiality, integrity, and availability of the information. While the growth of network-aware devices and appliances at the office and home provide us with a tremendous opportunity for automation and mobile access, it also opens up the system for unauthorized access over the network. This highlights the need for development of comprehensive software systems that can offers secure high-availability access without compromising confidentiality or integrity of the information regardless of the modality through which the data is transmitted or received.

Always-on, mobile, and more recently wearable technologies that interface with database driven applications for fitness or banking are making demands that many systems were not originally designed for. Network administrators can increase the resiliency of online systems to unauthorized access by embedding NGFW based security into the design of computer systems and applications, particularly in online systems.

Conclusion

Next-generation firewalls are the next step of improvement over the traditional firewall and intrusion detection system. Traditional firewalls generally perform packet forwarding and blocking and often incorporate packet inspection techniques. The IDS adds the ability to detect and dismantle attacks but these functions typically fail to be tightly integrated with network access and WAN connectivity capabilities of enterprise-class firewalls. To protect networks in the presence of social media and other Web-based applications, a NGFW infrastructure intelligently combines network security, content security, application control and network access to detect application-specific attacks, enforce application-aware access policies, and perform traffic routing and prioritization for application-aware traffic across the WAN. Although NGFWs are available through many different companies with pros and cons for each system, the concept of integrating the functionality of a traditional firewall with IDS and the ability to manage traffic at the application layer will characterize the future standard for enterprise network protection.

Bibliography

Abdel-Aziz, Ahmed. (2009, February 29). *Intrusion Detection & Response : Leveraging Next Generation Firewall Technology*: SANS Institute. Retrieved from: http://www.giac.org/paper/gcia/3874/intrusion-detection-response-leveraging-generation-firewall-technology/109243

Koch, Robert. (2011). *Towards Next-Generation Intrusion Detection*: CCD COE Publications. Retrieved from: http://www.ccdcoe.org/publications/2011proceedings/TowardsNextGenerationIntrusionDetection-Koch.pdf

Market Research Media, 2012. Global cloud computing market forecast 2015-2020. Retrieved from: http://www.marketresearchmedia.com/2012/01/08/global-cloud-computing-market/

Palo Alto Networks. *Research White Paper – The Future of Intrusion Detection – Why Your Next IPS is a Next-Generation Firewall*, 2010.

Pescatore, John, Young, Greg. *Defining the Next Generation Firewall*, Gartner RAS Core Research Note G00171540, 12 October 2009, R3210-04102010.

Powers, Adam. (2011). *Your Network is Changing – Are You Ready For It?*: Computer Fraud & Security, Volume 2011, Issue 3. Retrieved from: http://dx.doi.org/10.1016/S1361-3723(11)70030-6

SonicWALL. (2011). *Next-Generation Firewall Market Analysis – White Paper*. Retrieved from: http://africa.westcon.com/documents?documentId=40460&filename=Generation_Firewall_Market_Analysis_The_SonicWALL_Difference7_march_11.pdf

Talbot, Chris (May 1, 2014). Talkin' Cloud. *Bitglass Report: Security Concerns Limit Cloud Adoption*. Retrieved from: http://talkincloud.com/cloud-computing-research/050114/bitglass-report-security-concerns-limit-cloud-adoption

Thomason, Steven. (2012). *Improving Network Security: Next Generation Firewalls and Advanced Packet Inspection Devices*: Global Journal of Computer Science and Technology. Retrieved from: https://globaljournals.org/GJCST_Volume12/6-Improving-Network-Security-Next-Generation.pdf

Weller, Todd., Lowe, Ben. (2011, April). *A White Paper on Next Generation Firewalls*: Stifel Nicolaus. Retrieved from: http://www.genesyspr.com/gtech/uploads/publisher/41_A_White_Paper_on_Next_Generation_Firewalls_April_2011.pdf

Zawoad, Shams., & Hasan, Ragib. (2013, February 26). Cloud Forensics: A Meta-Study of Challenges, Approaches, and Open Problems. Retrieved from: http://arxiv.org/abs/1302.6312

EECT

Teaching Challenges in Embedded Systems Design

Dr. Jack Li, Southwestern Oklahoma State University, Weatherford, OK

Introduction

In electronics and computer technology fields, embedded system designs include circuit designs with a microcontroller and a software design, while software designs include Board Support Package (BSP) and application software design [1]. New hardware and internet applications make the Embedded System Design course more challenging. Finding methods to make the basic education adapt to rapidly changing technology and market pushes educators to seek a new way to help students face the market as soon as possible. This paper gives us a possible way to solve this problem in an undergraduate education.

Challenges in Embedded System Design Class

Undergraduate education always faces challenges from the market, especially in electronic and computer technology fields. A very good example is the Embedded System Design course. The educators teaching these courses are consistently faced with problems.

As in the other fields, basic education and new technologies always raises questions by students, such as: "Why do we have to learn about outdated markets?" For example, there is a big change in microprocessor field. Recently, 8-bit CPUs are being replaced by the advanced 32-bit CPUs, such as ARM CPUs, at the same price. The 8-bit CPUs are normally used in microprocessor classes while markets ask to use new 32-bit CPUs with advanced Human Machine Interface (HMI), such as LCDs with touchscreens, which are hardly implemented while using an 8-bit CPU. Most basic parts have already integrated into new CPUs (which are called microcontrollers or MPUs), such as memory, which changes circuit design.

Most old CPU systems just run a control program, and no operation system is needed. However, because there are so many functions added to the new CPUs, program designing becomes so complex that it is hard to design software from low level to application level. Using operating systems, such as Linux or Android, in an embedded system is a common way to solve these problems. Operating system designs are very complex, especially for 8-bit systems. Even an embedded operating system is used, there are still more hardware and software designs, such as a driver or a BSP design.

Outdated market systems increase expense of education. When an 8-bit CPU system is built, more components are required, which increase the hardware expense. In comparison, when most basic components are integrated on the new MPUs, the cost of a system is reduced to 20~30% of the old system, significantly lowering the price of the development kits, making the kits more affordable and accessible to students. Therefore giving students more opportunities to practice what they learned in classes.

Confliction between booming technology and limited education time becomes worse. There was originally one class to introduce microprocessor technology 30 years ago. Since then, more and more hardware are being introducing and being changing, such as internet application, and displays from LED indicator to color picture LCD with a touchscreen. All these design methods are hardly ever covered in one class. It is so important to introduce these new changes to students in order to help them face new markets.

Finally gaps between basic educations, the market, high costs, and less time for in depth studies are hardly motivations for students continue in their private studies.

Therefore a new setup for the Embedded System Design course is needed to find and to solve the problems described above, especially for some undergraduate program which offers only one or two classes in this field.

A New Setup for Embedded System Design

Although there are a lot of changes in hardware and software designs, the basic operation of CPUs make it possible to use a new setup to help students get a general idea about different topics related to the Embedded Systems Design course. Students have to be more active in their studying in order to make all those topics fit into one class. The new setup aims to let students touch the general design processes. They can, according to their interests, do further studying by themselves.

The following material will/should be included in the new setup [2]:

1. Learn basic operation and structure of systems with CPUs
2. Setup development system
3. Read and design basic interface circuits
4. Design bootloader, driver/BSP according to the hardware
5. Integrate operating system
6. Design application software

The students should get the whole idea about different topics in the Embedded Systems Design class by this introduction. They can pick up special topics in further studies according to their interests. The hardware is setup according to market products, which should motivate students into studying.

Implementation of New Setup

The big difference between this new setup and the traditional class is that the new setup does not focus on a specific CPU; several ARM evaluation boards are selected. They include: a S3C6410 ARM11 development board with touch screen, a STM32 development board, and a PSoC 5 development kit. Although there are many kinds of CPUs, circuit designs with different CPUs are comparably the same. One of the listed boards will be introduced in class and students will use the similar method to dive into deeper understandings of the other boards, which can

train students to design systems with different MPUs. The new setup focuses on teaching common digital circuit design. After studying different design work according to schematics, students will be able to summarize general interfaces to MPUs, such as GPIO, memory and communication protocol interface by with the help of faculty.

Programs running on a board directly will be tested when a circuit design is introduced. Also introduced will be learning to write programs according to communication protocol. Board programs can also help students gain a deeper understanding how a CPU works. All these skills will help students write bootloader and driver programs. C language will be the main program language.

There are several operation systems used in embedded systems with similar development steps. The differences among the operation systems are the interfaces between operation systems and hardware, and the interfaces between operation systems and application software. The MPUs are ARM based processors and their embedded operation system is Linux, which makes the development systems as cheap as possible because of the free operation system and free open source complier. Students can use their PCs to practice at home at a significantly less cost. Driver designs and test application programs will be introduced in Linux too.

Most homework assignments ask students to use the internet to search related material according to different setups, so students learn how to use internet to find helpful information.

A basic embedded Linux system with a touch screen will be designed at the end of the class. Students should get the general idea about the embedded system design process, and they can, according to their interests, do any further studying, such as circuit design, driver design, and et cetera.

Conclusions

New technology makes the new setup beneficial to students facing markets, as well as being a motivation to their future studies because they will create a Linux computer with touch screen.

It should be emphasized that much appreciation will be directed towards the SWOSU Organized Research Funding for providing hardware.

References

1. http://www.focusembedded.com
2. http://free-electrons.com/training/embedded-linux/

EECT

Developing a BYOD Deployment Strategy in an Enterprise Environment

Dr. Baijian Yang, Purdue University, West Lafayette, IN
Mr. Bryant Seaton, Purdue University, West Lafayette, IN

Introduction

Managing the modern enterprise mobility environment can be expensive and complex (Brown, Bradley, & Luk, 2014). The movement towards BYOD has become increasingly inevitable with the rapid advancements in technology. Employees desire to use devices that they are comfortable with and that are technologically current.

"More Enterprises are Embracing BYOD: The percentage of enterprises formally supporting BYOD increased from 72 to 76 percent. More significantly, those companies that indicated they had no plans to support BYOD dropped from 9 to 5 percent year-over-year, suggesting that BYOD is becoming more inevitable for the enterprise." (Good Technology, 2013, p. 3)

Companies have documented gains in cost savings, employee satisfaction, and productivity after implementing a BYOD strategy (Anderson, 2012). Despite this trend towards mobility and flexibility, there can be significant requirements and cost for implementing a BYOD policy. Organizations need to evaluate the risks incurred by implementing BYOD and the implications of new policy and security requirements. Companies must also take into account employees' attitudes toward the security of their own devices and the resources they use in the cloud (Lennon, 2012).

The organization studied in this article needs to support 3,000 lines of devices. The total cost (devices, plan, usages cost and service charges) were more than $8M in 2014. That is approximately $3,000 per line of service per year. In contrast, the Wall Street Journal calculates average personal plans (unlimited data, calls, and text) at $2400 a year (Ketineni, Antonson, & Austin, 2013). These costs, compared with the average, call into question the value derived from the current contract and strategy. Cost control has become an outsized challenge for any organizations in today's global competing environment. In addition, with the steady loss of market share of Blackberry's parent company RIM (Silcoff, Jacquie, & Ladurantaye, 2013), the organization faces potential outage of push e-mail service.

Within the current environment of continued cost reductions, it is essential to evaluate all possible cost savings. With an annual cost of mobile platform in the millions of dollars, it is prudent to determine if these costs are critical to the business and invest effort in finding more cost effective alternatives. The rapid evolution of mobile technology and the cost of maintaining corporate devices creates an opportunity for the evaluation of cost reductions that BYOD may provide (Fiorenza, Tepe, Riberia, & Vanessa, 2012).

The aim of this study is to determine whether BYOD is a cost effective mobile device strategy for the organization. It discovered the current cost and compared them against the industry cost found in organizations that have adopted a BYOD strategy. The result of this analysis was a cost comparison including an analysis of the mitigation strategies and recommendations for security issues with BYOD.

The study focus only on iOS and Android platforms because their combined global market share is 96% (Rivera & van der Meulen, 2014). All the legal implications of a BYOD strategy are not being evaluated (e.g. personal phones used in legal discovery) because it is outside the scope of this project.

Literature Review

BYOD is a corporate policy of sanctioning and encouraging employees to bring personally owned mobile devices (laptops, tablets, and smartphones) to the workplace and allowing those devices to access private company information and applications.

The term BYOD was referenced in a paper by Ballagas at UBICOMP 2005 (Ballagas & Rohs, 2004). It was later adopted by firms such as Intel, Unisys, VMware and Citrix Systems as they found more of their employees bringing their devices to work and connecting them to the corporate network. Consumerization is a term used in conjunction with BYOD. It refers to the increasing trend in IT moving away from the top-down implementation of technology and towards a bottom-up focus. Consumerization is the movement of consumers towards purchasing consumer level technology as it has grown in capability. A study by Forrester Research, Inc. found that 50% of young and 40% of older adult workers believe that consumer technology is better than corporate technologies (Disterer & Kleiner, 2013). Booz & Company states that overwhelming pressure from Consumerization will eventually leave organizations with one of two choices in the future. Organizations can either "bring in" employees allowing them to use corporate devices for personal use or "reach out", allowing them to use their own devices (Bernnat & Acker, 2010).

> "The increased daily use and technological advances of personal devices, such as tablets and smartphones, has led to the trend of many companies allowing employees to use them within the enterprise. The primary motivation for this trend is the perception of cost savings and productivity gains."

This idea is supported by a survey conducted by Good Technologies. They found that 95% of respondent companies either support BYOD or are considering it (Good Technology, 2013)." A study by Logicalis Group showed 75% of employees in high growth markets and 44% in developed markets, are already using their personal technology at work (Absalom & Drury, 2012).

Research conducted by Cisco found that 56% of government agencies (local, state, and federal) believed that BYOD served AS An effective retention and recruitment tool (Fiorenza et al., 2012). Good Technology also found in half the instances of a BYOD policy employees will pay the full service fee for their personal choice. They concluded that 50% of companies supporting BYOD strategies required that all costs be covered by employees and the employees overwhelmingly cover that cost. The remaining 50% of employers provide a mix of options to their employees, such as a stipend or "expense back" options to help subsidize the cost of their mobile device or service plan. This expense back and stipend model offers remarkable cost-savings for organizations that move from a company-owned device model, which can cost on average $60-100 per device, per month (Good Technology, 2013).

BYOD also may contribute to dealing with the difficulties of recruiting and retaining top talent. A study by Forrester Research states that 82% of employees think that smartphones play a critical role in business (Evangelista, 2013). The study also purports benefits of BYOD include increased productivity, employee satisfaction, and cost savings for the company. The increased productivity correlates from users being more comfortable with the navigation and interface of their personal device.

Ref.	Metric	Calculation	Initial (Pilot)	Year 1	Year 2	Year 3
F1	Devices enrolled in the BYOD program		100	9,000	11,000	12,500
F2	Percent of devices used regularly for work-related activities		98%	95%	92%	90%
F3	Additional minutes worked per week per employee enrolled in BYOD		60	55	50	45
F4	Number of weeks		24	48	48	48
F5	Employee hourly rate	Initial: A3 Years 1-3: A5	$135	$58	$58	$58
Ft	Increased employee productivity	F1*F2*(F3/60)*F4*F5	$317,520	$21,819,600	$23,478,400	$23,490,000

Figure 1: Employee Increased Productivity - Forrester Research

In a study by the Journal of Hospital Librarianship they found that users are more apt to upgrade their devices on a regular basis whereas company technology refreshes happen less frequently (Moyer, 2013). BYOD policies also have the potential to reduce capital expenditure as employees use their own personal devices to do work (Bernnat & Acker, 2010).

BYOD policies should be a part of an organization's Enterprise Mobility Management (EMM) strategy. The strategy comprises the Mobile Device Management (MDM), Mobile Application Management (MAM) and mobile security. Mobile workforce strategy can be classified in three major Enterprise Mobility Management layers of capability (Brown et al., 2014):

- "Basic Mobility Management: Device restrictions require passcode, VPN, remote wipe, remote lock
- Enterprise Mobility Management: Basic + Advanced MDM and mobile application and content management, geofencing (GfE), versioning, rollback, containerization
- Regulated-level EMM: EMM + compliance, control and advanced security (e.g. up to 100% lock-down) for government, defense agencies, financial services, healthcare, and other high security and regulated industries."

(Brown et al., 2014, p. 3)

The policies are priced either on a per-user or per-device basis. The implementation of the strategies can be either On-Premise or Cloud based.

EMM services are offered by vendors that provide Platform as a service (PaaS) and Software as a service (SaaS) to large organizations. These offerings come on either perpetual (i,e. quantity-based) or subscription based (i.e. time-based). Perpetual service fees are derived from the incremental devices added each year and tend to reduce the TCO over time. Subscription based fees apply the number of active devices managed by the vendor.

There are three leading industry vendors for a regulated-level of EMM: RIM Blackberry Enterprise Server version 10 (BES10), Good Technology, and MobileIron. (Brown et al., 2014). All the vendors offer the ability to secure corporate data and applications on BYOD personal devices. Currently RIM (BES10) and Good only have an On-Premise solution due to their focus on regulated environments while MobileIron has both On-Premise and Cloud offerings. Both RIM and Good will be launching cloud-based services in 2015. Strategic Analytics (SA) found that RIM was the best solution for the On-Premise regulated-level of EMM followed by Good and MobileIron respectively (Brown et al., 2014).

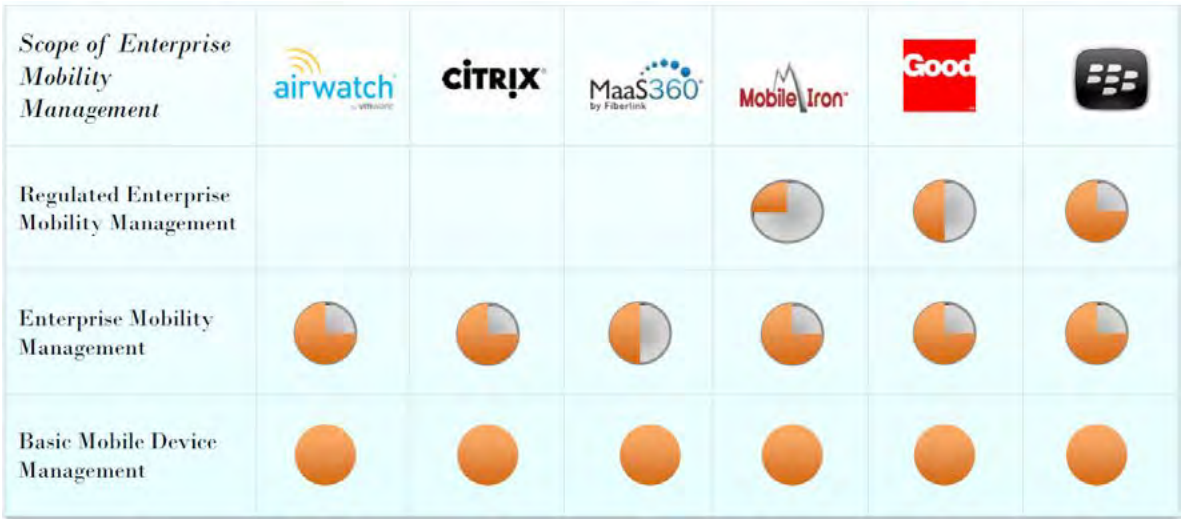


Figure 2: Scope of Enterprise Mobility Management by Vendor

The main cost factors for all MDM approaches are the maintenance fees, initial capital cost, and long-term software license cost. Another factor to consider is the security of the Network Operations Center (NOC) for regulated environments. Only RIM and Good have secure NOCs as part of their base infrastructure (Brown et al., 2014). The results of Strategy Analytics study show that for a regulated-level EMM, RIM (BES10) is the most secure and cost effective solution followed by Good Technology.

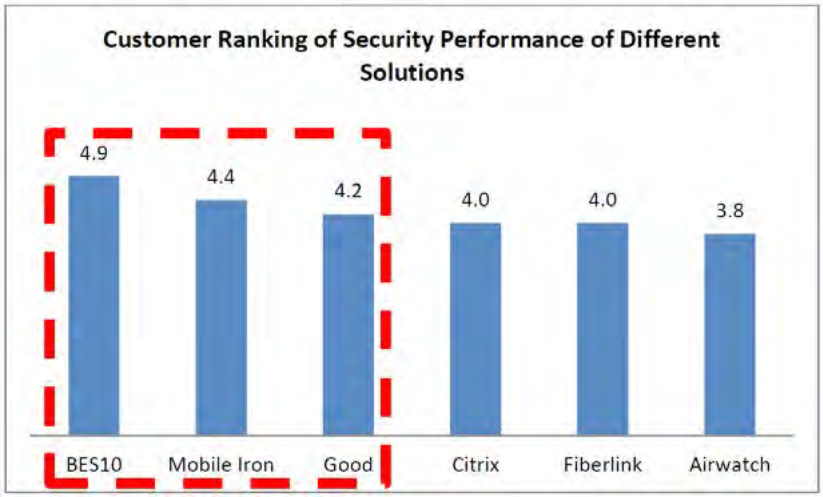


Figure 3 Customer Rankings of BYOD Solutions

One of the main detractors for BYOD as a policy is device and enterprise data security. A study by Decisive Analytics, LLS, showed that the main the issue with a BYOD policy are the security concerns,

> "Nearly half of enterprises that allow employee-owned devices to connect to a company's network have experienced a data breach" (Harris, 2012, p. 4)

Many security concerns such as a loss of the device, employee resigning/firing, must be addressed and mitigated prior to adopting BYOD as a strategy. The risk to BYOD are divided into four categories: Operational, Technology & Data Protection, Legal and Regulatory and Infrastructure & Device (Norton, 2012).

Operational risk applies to existing IT and security departments that do not have the skill, technical ability, processes, and infrastructure to manage a BYOD policy. Organizational leaders must invest resources in the development of new skills in their IT organization or invest in an external vendor who can manage the new technology. Process improvement and new process creation focused on BYOD and risk mitigation must be made a priority in the organization.

Improper technology and data protection creates a risk to a possible loss of intellectual property and, in the worst, case a compliance violation in a regulated industry. These risks take the form of users misusing or leaking corporate information, installing applications containing Malware, or identity and access attacks. Methods of mitigating this risk start with a layered security strategy (Morrow, 2012). Specific to the organization in the study, this policy must take into account an EMM that includes features for regulated environments. The policy must include aspects such as centralized device administration, configuration, encryption and lockdown policies, enforced password complexity, remotely lock and wipe devices, and allow end-user self-service. Policies should support the management of application inventory and provide protection from rogue applications.

Legal and regulatory risks apply to the possible breach of employment labor laws, HIPAA requirements, privacy requirements, and e-discovery requirements. A BYOD policy raises ethical and legal questions about monitoring and device wiping upon employee termination. There also needs to be knowledge of the complexities of implementing policies that address the regulatory requirements for e-discovery, monitoring, and data archiving. Laws that apply to the data ownership and legal liability for employee-owned devices used for business purposes are not clearly defined.

Infrastructure and device risk pertain to the risk created by introducing diverse devices, mobile operating systems, applications and platforms into the enterprise. Similar to technology and data protection, policies must be developed to create an EMM strategy for a regulated environment with the same abilities.

Two additional issues with BYOD are enterprise scalability and capability. Many organizations today lack the proper network infrastructure to handle the large amount of network traffic that gets generated when employees start using different devices at the same time. These challenges can by met through services that support multiple devices and a dynamic growth plan (Brown et al., 2014).

Cost Analyses on potential BYOD Strategies

As previously stated, BYOD strategies must work within an organization's EMM strategy. Within the EMM, BYOD strategies are segmented into three layers. Per a study by Strategy Analytics on mobile workforce strategy, there are three primary Enterprise Mobility Management layers of capability (Brown et al., 2014):

- Basic mobility management, typically for small businesses using, for example, ActiveSync for email
- Enterprise mobility management – often used by commercial organizations for managing corporate and personal device use
- Regulated-level enterprise mobility management – preferred or required by corporate and government organizations with the highest expectations of security and control

Each of these layers can either be implemented On-Premise or in the Cloud. With an On-Premise implementation, most of the capital investment in infrastructure, support, and maintenance cost are taken on by the organization. If there is an outage, the organization has full access to determine the cause of the issues as well as evaluate the impact to the enterprise. Estimated downtime can be calculated and reported back to users. Conversely, with a cloud implementation, the organization pays for most of those components as service. When there is an outage, the organization is reliant on the vendor to resolve issues. The regulatory and compliance burdens of the organization necessitate the use of the regulated-level of EMM because this layer requires more granular IT policies defining hardware and software control. Also, these policies must also be controlled centrally, which is necessary for highly regulated environments.

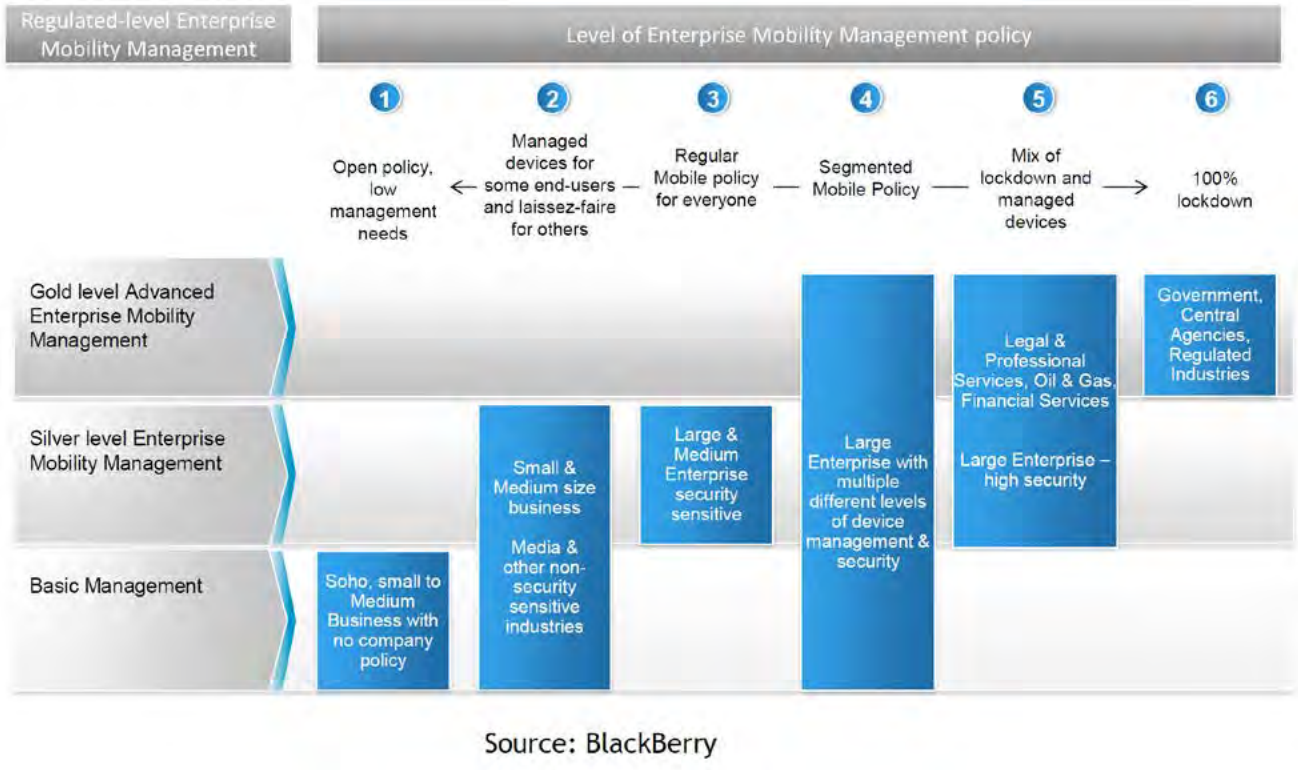


Figure 4 Level of Enterprise Mobility Management Policy

As stated before EMM services are offered by vendors that provide Platform as a service (PaaS) in addition to Software as a service (SaaS). The licensing can either be per user or device. These services can be contracted on either a perpetual or subscription bases. Perpetual service fees are derived from the incremental devices added each year and tend to reduce the TCO over time. Subscription based fees apply the number of active devices managed by the vendor.

The organization in this study needs a Regulated-level MDM. This research is therefore focused on On-Premise solutions for BYOD. All of these platforms support both iPhone and Android devices. The architectures for these environments are illustrated in Figure 5: Walled Garden & BlackBerry Architecture Source: Strategy Analytics.

All three environments offer hardware controls that enable the organization to completely manage and isolate device elements such as disabling ports on a device to prevent data removal and access that goes beyond encryption. They also offer software controls allowing the ability to not only manage and disable wireless controls, but also the ability to manage all communication. For example, Good Technology can manage email logging as instructed by NYSE & NASD SEC 17-A, "Joint Guidance" require brokerage firms to capture broker/dealer communications with customers. BlackBerry offer all-inclusive and multiple logging options that extend to Voice (Phone log Wireless Synchronization), Video Chat (Video chat log wireless synchronization), SMS and MMS logging and CCL (Context Collection Library) for data collection across all apps.

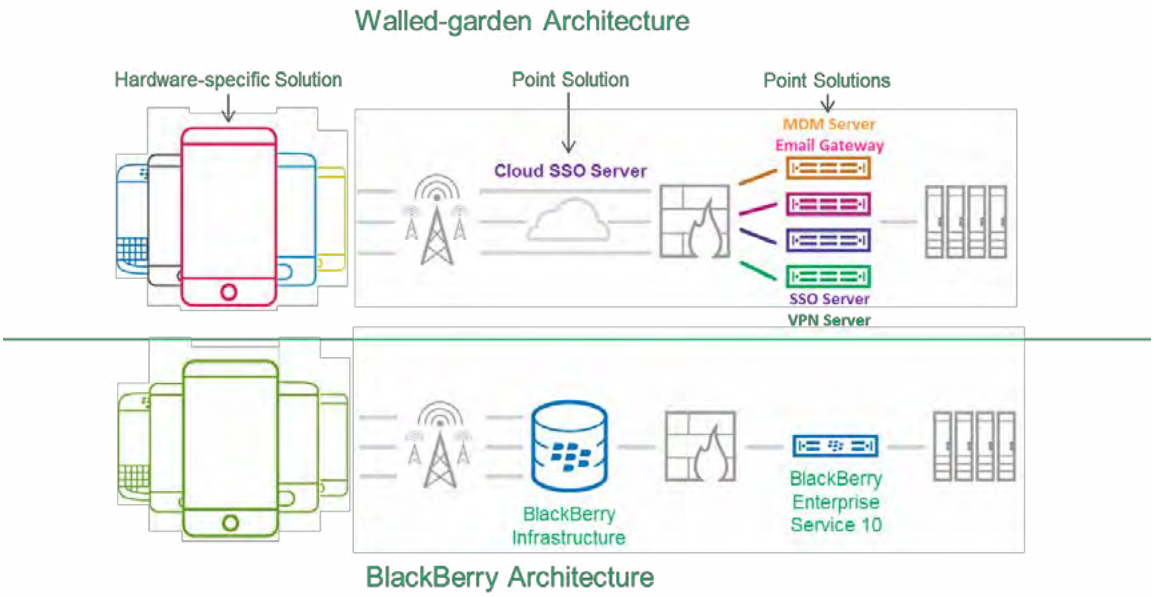


Figure 5: Walled Garden & BlackBerry Architecture
Source: Strategy Analytics

Research done by SA calculated the TCO for migrating from a Blackberry Enterprise Server version 5 (BES5) On-Premise environment to either a BES10, Good Technology or MobileIron On-Premise solution. The methodology used by SA to derive TCO calculates the total costs over five years, 3000 devices, and includes the following factors:

- Capital costs, such as servers, routers, and gateways
- Hosting costs for cloud services
- Software Licensing costs
- Installation and set-up costs
- Training costs
- Support and update costs
- Maintenance fees

The capital costs are established from estimates on routers and gateways and determined according to the capacity of each server component. The cost for training and support costs can be annual flat fees, and are scaled according to the number of devices supported, which is the method SA adopted in this analysis. SA examined several scenarios of developing its EMM solution over a five years period. These scenarios anticipated business expansion, support for a growing number of devices, operating systems, and different ownership models. Unfortunately, voice and data plans were not a part of their calculations.

All scenarios assume that BES5 is the current platform and that the migration to a new platform is immediate (not gradual) in order to see the effect over five years. The pricing represents a 2014 price point, but the pricing trends applied to SA's modeling are similar across all vendors. For example, the cost per device of basic MDM functionality is expected to fall rapidly at a rate of 15% per year, being a relatively commoditized service offering. Whereas, the pricing of mobile application management declines only at 5% per year (Brown et al., 2014). However, they expect maintenance and support fees to increase slowly year on year. These assumptions have been applied consistently to all vendors.

Table 2: Key Assumptions and Parameters for Base Scenarios

Parameter	Assumption
User base growth	From 1000 users in 2014 to 1500 users in 2018
Number of devices per user	2.0 (constant) (3000 devices)
Feature options desired	MDM, Email, Application Management, Container solution, Content Management
Support options desired	Training, support and maintenance
Choice of implementation	On Premise
Preferred payment method	Subscription
BES5 migration	Migration to any new platform choice over 2 years

The calculation for TCO is as follows (where y is years and N = 5):

∑_(Itemized Maintenance fees+Support and update cost+Installation setup cost
+((Software licensing costs) * Total managed devices) +Training costs
+ Hosting costs for cloud services +Capital costs)

(Note: voice and data plans were not a part of this analysis)

Figure 6, 7, and 8 graph the TCO for the migrations of BES5 to BES10, BES5 to Good, and BES5 to MobileIron respectively:

Figure 6: Regulated EMM Cost Structure for BES5 to BES10 Migration

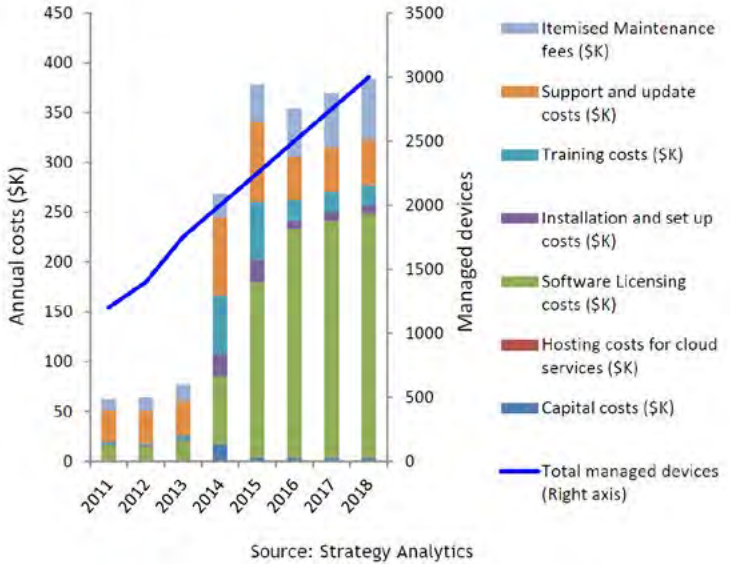


Figure 7: Regulated EMM Cost Structure for BES5 to Good Technology Migration

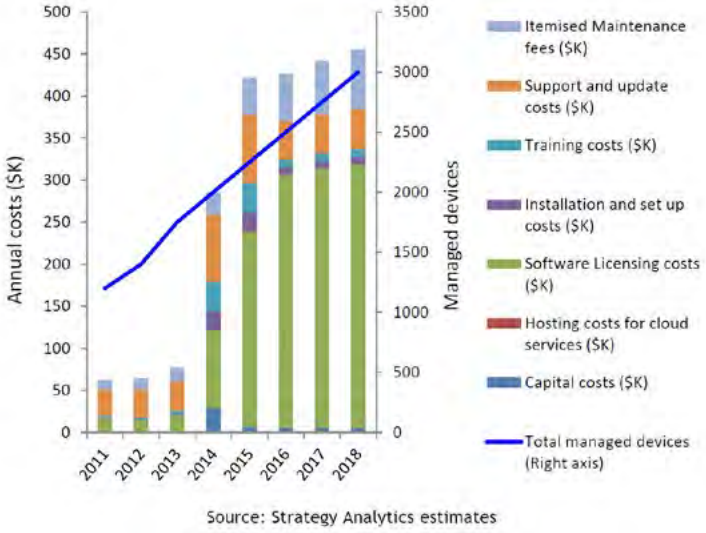


Figure 8: Regulated EMM Cost Structure for BES5 to MobileIron Migration

Strategy Analytics TCO study results:

Regulated EMM (Subscription, On Premise)	TCO (5 Years)
BES5 to BES 10 *The cost is significantly lower due to the following factors*: o *BES10 server software is free in an upgrade* o *Transfer of current licenses* o *Fewer devices needing to be added in the first year*	$908K
BES5 to Good	$1.8M
BES5 to MobileIron	$2M

As part of their study, Strategy Analytics only provided aggregate numbers and failed to provide a table of figures. They also did not calculate the wireless voice and data plan cost. To make the TCO comparisons more equivalent the researcher calculated a mobile service plan of $100, each month (12), with device growth, for five years. The mobile plan fee (shown in) resulted in approximately $14M over five years (without a subsidy):

Table 3 Wireless Plan Cost

Ref	Metric	Calculation	Year 1	Year 2	Year 3	Year 4	Year 5	Total
A	Number of devices enrolled in BYOD prog ram		1,000	2,000	3,000	3,000	3,000	
B	Monthly data and voice charges per enrolled device		$100	$100	$100	$100	$100	
C	Nu mber of months		12	12	12	12	12	
	Wireless service costs	A*B*C	$1,200,000	$2,400,000	$3,600,000	$3,600,000	$3,600,000	$14,400,000

TCO including wireless plan cost:

Table 4: SA TCO Adjustment

Implementation Type	TCO
BES5 to BES 10 (5 years)	$14.9M
BES5 to Good (5 years)	$15.8M
BES5 to MobileIron (5 Years)	$16M

As mentioned previously the primary cost factors in both approaches are the maintenance fees, initial capital cost, and long-term software license cost. Another factor to consider is the security of the Network Operations Center (NOC) for regulated environments. Only RIM and Good have secure NOCs as part of their base infrastructure (Brown et al., 2014). The results of Strategy Analytics study show that for a regulated-level EMM, RIM (BES10) is the most secure and cost effective solution followed by Good Technology.

Forrester Research conducted a case study on the organizations where they (Forrester Research) implemented BYOD for TCO and employee satisfaction. The interviewed customers experienced the following costs associated with their BYOD implementations with Forrester Research:

- Internal implementation costs
- BYOD licensing and service fees
- Wireless service costs
- Program planning and management costs

The calculation for TCO is as follows (where y is years and N = 6):

∑_(Internal implementation costs +BYOD licensing and service fees
+Wireless service costs
+ Program planning and management costs)

Table 5 Forrester Research TCO

Costs	Initial (Pilot)	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Internal implementation	$ 261,000	$ 38,560	$ -	$ -	$ -	$ -	$ 299,560
BYOD license and service fees	$ 12,600	$ 252,000	$ 504,000	$ 756,000	$ 756,000	$ 756,000	$ 3,036,600
Wireless service costs	$ 54,000	$ 1,020,000	$ 2,040,000	$ 3,060,000	$ 3,060,000	$ 3,060,000	$ 12,294,000
Program planning and Management costs	$ 48,720	$ 58,464	$ 58,464	$ 58,464	$ -	$ -	$ 224,112
Total Costs	$ 376,320	$ 1,369,024	$ 2,602,464	$ 3,874,464	$ 3,874,464	$ 3,874,464	$ 15,854,272

Costs appeared in year one and two and were confirmed based on the customer's experience. The cost in Year 1 and all successive years were internal projections based on planning conducted by the customer for its BYOD program. All costs have been rounded to the nearest US dollar. The TCO for their BYOD solution was approximately $16M after five years (Evangelista, 2013). In the study, the model detailed 9,000 devices in the first year, 11,000 devices in the second year and 12,500 devices in the third year. The researcher extrapolated a TCO more appropriate for this paper by using the cost model defined in the Forrester Research study and adjusting for fewer devices in each year. The researcher used the same cost model to simulate the costs for years four and five.

Both studies found that employee satisfaction increased as personal devices were allowed within the organization. Employees in the Forrester Research study indicated that, on average, they spend one additional hour per week on business related activities after joining the BYOD program (Evangelista, 2013). Employees cited increased access to company email and the ability to work during none core hours or dead time (traveling on the train, flying, on the couch) as reasons for the increase in overall productivity. The new capabilities were especially important to employees who did not have access to a corporate device under the previous mobility program.

Case study

The data used to do the TCO analysis are from the 2013 and 2014 reports from the organization. This project only focused on the previous two years due to the availability of those reports.

The service charges for approximately 3000 devices at the organization increased by 5%, $7.6M to $8.1M from 2014 to 2015 respectively. The projected services cost for all of 2016 was estimated at $8.3M. A conservative estimate can be made that if the current model is continued and the increase in fees is at a rate of 3% greater each year, then the cumulative cost of services for five years from 2013 - 2018 would be well over $40M.

The calculation for TCO is as follows (where y is years and N = 5):

∑(Total Monthly Access Charges + Total Feature Charges + Airtime Charges

+ Additional KB Usage Charges + Messaging Charges + Equipment Charges
+ Long Distance Charges + Roaming Charges + Other Fees)*1.03

These service cost can be contrasted directly with the TCO of the researched alternatives shown in Table 6: TCO Analysis6 (Brown
et al., 2014):

Table 6: TCO Analysis

Implementation Type	TCO (5 Years)
The Organization's Current Policy	$40M
Interviewed Company (initial cost + 5 years of support)	$13M
BES5 to BES 10	$14.9M
BES5 to Good	$15.8M
BES5 to MobileIron	$16M
Forrester Research EMM service	$16M

As it can seen from Table 6, the current model is two and a half times more expensive than Forrester Research's implementations, and it is three times more costly than the actual figures for the BYOD implementation from the company interviewed.

Conclusions

When deploying BYOD, a company needs to first determine if regulated-level security is needed. The next key decision point was whether to implement the solution On-Premise or as a Cloud based solution. On-Premise solution will be preferred for organizations that are concerned with vendor support, security and network latencies.

It is clear from the TCO analysis in this study that the organization's mobile strategy cost are unsustainable and are considerably higher than the BYOD implementations researched. The evidence from literature indicated that BYOD is a starting to be a widely accepted strategy; 95% of companies either support BYOD or are considering it as a policy (Good Technology, 2013). That BYOD can reduce the cost for corporate-owned mobile devices as well as a reduction in the amount paid on service plans (Evangelista, 2013). There are also gains in productivity due to improved access to company resources and the ability to work during none core hours.

The key focus of this project was to explore the benefits of BYOD, determine the best BYOD deployment strategy for the organization and define the primary concerns. The critical benefits of BYOD discovered in the study include cost savings (service plans, support, and maintenance), increased productivity and employee satisfaction (due to increased device flexibility). The research literature similarly suggested that BYOD can assist in the recruiting and

retention of exceptional talent.

A strategy for subsidizing personal wireless devices and plans as part of providing a benefit to the employee. Many employees carry two devices. The authors suggest employing a model similar to the Company interviewed. Employee subsidies should be based on their need to access corporate data and role. If access is deemed necessary, employees should receive a subsidy. Research literature suggests a subsidy of 40% of employee's mobile plan cost not to exceed $50. All others employees may access company resources through the BYOD policy but are not eligible for the subsidy. The additional benefit of the recent Good Technology strategy is a reduction in a portion of the EMM service cost due to the removal of device and service plan support. The 40% reduction in the wireless service cost cold further reduces the total cost from $14M to approximately $8.4M.

References

Absalom, R., & Drury, A. (2012). BYOD: an emerging market trend in more ways than one Logicalis. Available at: [Accessed 23 March 2013], 1-12. Retrieved from http://scholar.google.com scholar hl=en&btnG=Search&q=intitle:BYOD+:+an+emerging+market+trend+in+more+ways+than+one#0

Accelerating, C. I., Gens, F., Levitas, D., & Sega, R. (2011). 2011 Consumerization of IT Study : Closing the " Consumerization Gap ." IDC I V I E W C O N T E N T, 1156, 1 – 21. Retrieved from http://www.achab.it/Download/kaseya/Doc/IDC_Consumerization.pdf

Anderson, N. (2012). Cisco Bring Your Own Device: Device Freedom Without Compromising the IT Network.

Ballagas, R., & Rohs, M. (2004). Byod: Bring your own device. Proceedings of the …. Retrieved from http://www.vs.inf.ethz.ch/publ/papers/rohs-byod-2004.pdf

Bernnat, R., & Acker, O. (2010). Friendly Takeover The Consumerization of Corporate IT. … Home/what-We …. Retrieved from http://strategyand-dev01.atlasworks.com/media/file/Friendly_Takeover.pdf

Brown, A., Bradley, M., & Luk, G. (2014). Enterprise Mobility Management : A review of Total Cost of Ownership Mobile Workforce Strategies Service, (May).

Disterer, G., & Kleiner, C. (2013). BYOD Bring Your Own Device. Procedia Technology, 9, 43–53. doi:10.1016/j.protcy.2013.12.005

Evangelista, M. (2013). The Total Economic Impact of IBM Managed Mobility for BYOD.

Finneran, M. (2011). BYOD Requires Mobile Device Management. Information Week. Retrieved from http://www.informationweek.com/news/mobility/business/229402912

Fiorenza, P., Tepe, L., Riberia, J., & Vanessa, V. (2012). EXPLORING BRING YOUR OWN DEVICE IN THE PUBLIC SECTOR. Retrieved from http://api.ning.com/

Good Technology. (2013). Good Technology 's 2 Annual State of BYOD Report. Retrieved from http://media.www1.good.com/documents/Good-BYOD-Report-2013.pdf Harris, C. P. D. (2012). IT

Executive and CEO Survey.

Ketineni, L., Antonson, P., & Austin, S. (2013). WSJ's Wireless Savings Calculator. Retrieved from http://graphics.wsj.com/PhonePlan/

Lennon, R. (2012). Changing user attitudes to security in bring your own device (BYOD) & the cloud. … 2 Federation Grid, Cloud & High Performance …. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6528243

Marston, P. (2014). IDC MarketScape IDC MarketScape : Worldwide Mobile Application Development, Testing , Management , and Infrastructure Services 2014 Vendor Assessment, (March).

Mell, P., & Grance, T. (2011). The NIST Definition of Cloud Computing. NIST Special Publication, 3.

Mell, P., Kent, K., & Nusbaum, J. (2005). Guide to malware incident prevention and handling: Recommendations http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Guide+to+Malware+Incident+Prevention+and+Handling+Recommendations+of+the+National+Institute+of+Standards+and+Technology#0

Morrow, B. (2012). BYOD security challenges: Control and protect your most sensitive data. Network Security, 2012(12), 5–8. doi:10.1016/S1353-4858(12)70111-3

Moyer, J. E. (2013). Managing Mobile Devices in Hospitals: A Literature Review of BYOD Policies and Usage. Journal of Hospital Librarianship, 13(3), 197–208. doi:10.1080/15323269.2013.798768

Norton, K. (2012). Developing a Mobile Security Strategy Webinar for the institutions in the University of Texas System, (April).

Rivera, J., & van der Meulen, R. (2014). Gartner Says Sales of Smartphones Grew 20 Percent in Third Quarter of 2014. Retrieved December 16, 2014, from http://www.gartner.com/newsroom/id/2944819

Silcoff, S., Jacquie, M., & Ladurantaye, S. (2013). Inside the fall of BlackBerry: How the smartphone inventor failed to adapt. Retrieved December 13, 2014, from http://www.theglobeandmail.com/report-on-business/the-inside-story-of-why-blackberry-is-failing/article14563602/

Souppaya, M., & Scarfone, K. (2013). Guidelines for managing the security of mobile devices in the enterprise. NIST Special Publication. Retrieved from https://llamasinmynetwork.com/llamafiles/NIST/SP800/SP800-124-1306-Rev1 - Guidelines for Managing the Security of Mobile Devices in the Enterprise.pdf

Wyatt, C. (2014). Has Britain's defence budget been cut too much? Retrieved from http://www.bbc.com/news/uk-

26271018

Appendix: Interview Questions

1. How was the appropriate BYOD strategy determined for your company?
    a. What were the steps to determine that strategy
    b. What were the costs involved?
2. What were the major security implications?
    a. How where they mitigated?
    b. What were the costs involved?
3. What if any services were utilized to implement your BYOD strategy?
4. How has BYOD changed workplace flexibility and productivity?
5. How has access to business assets changed (improved, suffered, etc.) with business applications on BYOD devices?
6. Was there a measurable reduction in the cost of acquiring, provisioning and replacing corporate-liable devices
7. Was there a measurable decrease in overhead and administrative coast for an on-site device?
8. Was there a measurable reduction in complexity and cost from internally maintaining the mobility infra-structure?
9. Was there a measurable decrease in help desk support cost with a reduction in the number of inbound calls for corporate-liable devices?

Graphics

Bridging the Gap between Businesses and Customers through the Web Technology

Dr. Devang P. Mehta, North Carolina A&T State University, Greensboro, NC

Introduction

The Web is one of the fastest growing technologies. The access to Web was limited to networked desktop or laptop computers in the past. Nowadays with the advent of smart devices the access to Web is on users' fingertips. The International Data Corporation (IDC) believes the world-wide smartphone market, having reached 1.0 billion units shipped in 2013, will increase 19.3%, and reach a total of 1.2 billion units shipped in 2014. From there, total smartphone shipments will extend to 1.7 billion units in 2018 (Bouchard et. al., 2014). The Web technology is a multi-functional tool that has numbers of advantages. Companies can use Web technology as a business tool to publish the information about their products and services; to market and sell their products and services; and to communicate with their customers, vendors, and employees. Additionally, through Web technology companies can offer technical support and receive payments (Creati, 2006). Findings gathered from the review of literature showed that there were contradictions on the effect of Web technology on the performance of companies. Some professionals believed that their companies were performing better because of Web technology. Some professionals did not notice any change in the company's performance. On the other hand, some professionals perceived that Web technology negatively affected their performance.

Based on the review of literature, an empirical research study was conducted to investigate the association between the performance of commercial printing companies and conducting the number of e-commerce activities. The performance was divided into three categories: financial, non-financial, and overall. The financial performance (FP) was measured using four financial indicators: sales, profits, costs, and return-on-investment (ROI). The indicators used for measuring the non-financial performance (NFP) were number of customers, merchandise return rate, and sales and marketing productivity. The overall performance (OP) was measured by combining both financial and non-financial indicators. The positive correlation would suggest the Web technology improves the business relationship between commercial printing companies and their customers, hence enhances the performance of companies.

Purpose

The purpose for conducting this research was to bridge the gap between businesses and customers through the Web technology. The association between the performance of commercial printing companies and conducting the number of e-commerce operations was investigated.

Problem

The problem of this study was not many commercial printing firms were performing better by conducting e-commerce operations based on the review of literature. However, it was found from the Auger's study there was a direct relationship between the number of e-commerce operations performed by a company and its performance.

Hypotheses

Based on the review of literature the following hypotheses were formulated.

H_1: The number of e-commerce activities is positively related to the financial performance of a commercial printing firm.
H_2: The number of e-commerce activities is positively related to the non-financial performance of a commercial printing firm.
H_3: The number of e-commerce activities is positively related to the overall performance of a commercial printing firm.

Review of Literature

This paper is mainly based on Rogers' theory of diffusion of innovations (2003), Auger's empirical study (1997), and Roth's findings (1998). Rogers (2003) defined diffusion as the process by which an innovation is communicated through specific channels over time among the members of a social system. The innovation can be an idea, practice, or object that is perceived as new by an individual or other unit of adoption (Rogers, 2003). This study examines the Web as an innovation or technology and its diffusion in society in terms of how it brings changes to the organizational performance of companies. Rogers (2003) stated that the consequences are the changes that occur to an individual or to a social system as a result of the adoption or rejection of an innovation.

There are adequate findings on desirable, direct, or anticipated consequences of Web technology based on the Rogers' theory. McLean (2000) said that Web sites could be powerful tools for printers, if they were well constructed. He added that Tonya Starr, president of Premierprinter.com, cited the research study finding that a company that has a Web site achieves a 35% higher level of credibility than a company that does not. Behrens (1997) indicated that the usefulness of e-mail and Web sites as present-day marketing vectors can trigger sales promotion, and thus can be widely used by many printing companies. Williamson (1997) stated that using the appropriate software, Internet-based retailers can communicate customized messages and promotions to individuals with the desired interests and shopping patterns. Because of interactive technology, manufacturers can build a one-to-one relationship with their customers, tailoring the marketing mix to individual preferences (Pine, Peppers, & Rogers, 1995). Hirshowitz (1997) stated that the World Wide Web provides several benefits to quick printers. For instance, Kinko's uses its site to display products and services, while Herndon, a Virginia-based Insty-Print, generates $5,000 to $15,000 monthly sales on the Internet (Hirshowitz, 1997). Hirshowitz (1997) cited that AlphaGraphics in Scottsdale, Arizona, developed a Web site that allows customers to transact business with its 300 franchised print shops worldwide. Frank Romano, chair of the School of Printing, Rochester Institute of Technology, mentioned that e-commerce would allow printers to deal more efficiently with the everyday rapid changes ("E-commerce options," 2000). Cummings and LeMaire (2006) found from their empirical study that printers, customers, and end users all benefited from e-commerce services in the printing industry.

Based on Rogers' theory, there are undesirable, indirect, or unanticipated consequences associated with Web technology, also. It was stated in the "The Ultimate E-commerce Study" (2002) that the Indian industry has clearly understood that e-commerce is not a solution for all business problems and marketing strategies. It is important to note that a blind choice of Web technology has further added to many firms' problems, those who have been unable to comprehend the effect of the Web on their businesses. Durfee and Chen (2002) indicated that one of

the important lessons learned in the last year is that e-commerce is not for everyone, because investments are significant, and mistakes are expensive and highly visible. Webb (2008) suggested e-commerce is not a threat, it's a tool, but only for those who choose to use it. It's not easy, and it requires investment and planning. Roth (1998) cited the findings of research conducted by the Graphic Arts Marketing Information Service of Printing Industries of America (GAMIS/PIA) that not many printing companies are making profits by conducting business-to-customer (B2C) activities on the World Wide Web. Roth indicated that only 11% made money on Web sites, while 43% thought they broke even and 38% lost money. Burke (1997) discovered that existing retailers have also been reluctant to support electronic shopping for the following reasons:

1. Building and maintaining a Web site requires a significant investment of time and money with an uncertain return on investment.
2. If retailers post their prices on the Internet, customers and competitors have easy access to this information, increasing market efficiency and reducing margins.
3. Electronic-sales incur shipping and handling costs.
4. Electronic-sales have higher return rates of goods because sometimes customers do not obtain the goods that meet their expectations.

In another study, Jarvenpaa and Todd (1997) indicated that the main drawbacks of Internet shopping were not technical issues like network security and bandwidth. Instead, consumers complained that the Web was hard to navigate, specific items were difficult to find, and offerings of individual sites were too limited and not competitive in price. Auger (1997) conducted similar research to investigate the relationship between a Web strategy and the financial and non-financial measures of performance of a company. He concluded that there was a positive association between multi-objective sites and overall performance. Additionally, he found a positive relationship between advertising of the Web site and overall performance. Auger investigated that there was a similar relationship between the number of visitors and overall performance as well as between the frequency of site updates and overall performance. Surprisingly, he found a negative association of Web site design features and services with overall performance. Further, Auger found that the more complicated the Web site, the less the number of visitors. Hence, the overall performance could be negatively affected.

Nath, Akmanligil, Hjelm, Sakaguchi, and Schultz (1998) conducted research on e-commerce. They interviewed executives of ten organizations. They found that the executives believed that the Internet was an inexpensive advertising tool that can reach a huge audience, the barriers to conducting business were minimal, and an Internet presence improved the image of the business. However, they also found that executives were worried about security, costs, site maintenance and support, lack of knowledge, lack of skilled personnel, and legal issues.

Inc. magazine asked a panel of CEOs and entrepreneurs to evaluate a number of leading online printing Web sites (A Guide, 2000). They published the findings of their survey as shown in Table 1. It represents how CEOs and entrepreneurs graded each company on different criteria.

Table 1

CEOs and Entrepreneurs' Evaluations of Online Printing Companies on a Grade of A to D

	Ease of navigation	Selection	Ease of use and ordering	Reliability	Value	Versus traditional printers	Final grade
ImageX.com	B+	B+	B-	B+	B	C+	B
inaQuest.com	B+	B	B	B	B	B-	B
iPrint.com	A-	B	C	B-	C-	C+	C+
Kinkos.com	A	C	C+	B-	D+	C-	C+
Mimeo.com	B	C+	B	B-	B+	B-	B-
NowDocs.com	B	B	B-	B	B-	C	B
Printomat.com	B+	A-	B+	A-	B	C+	B
Staples.com	B-	C+	A	B	B	C+	B-
VistaPrint.com	B	D-	B+	C+	C-	D	C

Based on the literature, Web technology brings about both positive and negative consequences that affect organizational performance. Positive consequences of Web technology, such as reaching a large number of customers, online marketing and sales, online transactions, and customization of messages, usually improve the performance of a company. On the other hand, there are negative consequences as well, such as the costs of building and maintaining a Web site, shipping and handling costs for tangible goods, higher return rate of items sold on the Web, and increasing competitiveness. There was no study found on the correlation between the performance of a commercial printing firm and the number of e-commerce activities.

Methodology

A survey instrument, a questionnaire, was pre-tested for its validity and reliability. A pilot test was conducted to check the validity of the questionnaire, eliminate any ambiguity, and make appropriate corrections according to respondents' suggestions. A targeted sampling technique was applied to select the final subjects. Commercial printing firms of the Midwest region of the United States that had Web sites were selected for the pilot test and the final study. The Printing Industries of America (PIA) and its affiliations provided the list of commercial printing companies which had Web sites and were located in the Midwest region. Questionnaires were sent to appropriate graphic communications professionals such as presidents or owners, vice-presidents, directors, and marketing managers of those firms. A seven-point Likert scale was used to measure the organizational performance. The seven-point Likert scale was designed as: (1) strongly disagree, (2) disagree, (3) somewhat disagree, (4) no difference, (5) somewhat agree, (6) agree, and (7) strongly agree. Four financial indicators, including sales, profits, costs, and ROI were used to measure the financial performance. The three non-financial indicators include number of customers, merchandise return rate, and productivity related to marketing and sales functions. All the seven indicators were combined to measure overall performance. The Spearman correlation was used to determine the correlation between the number of e-commerce activities performed on the Web and three levels of performance (financial, non-financial, and overall) of a commercial printing company.

Findings

A total of 38 questionnaires out of 103 subjects were received. The response rate was 36.89%. Table 2 exhibits the frequency of responses to the question on the number of e-commerce operations conducted by a commercial printing firm. Twenty-four e-commerce activities were identified in the survey (see Table 3). It was found from the Frequency Table (Table 2) that about 39% of samples performed five or less than five e-commerce activities and about 61% performed more than five e-commerce activities. The maximum number of e-commerce operations conduced were eleven which was less than 50% of the total number of e-commerce activities the company can performed. The results demonstrate that some companies are more active in doing business on the Web than other, but none of them are taking full advantage of the Web.

Table 2
Frequency of Number of E-Commerce Activities Performed

Number	Frequency		Percent	
2	2		5.26	
3	1		2.63	
4	6		15.79	
5	6		15.79	
6	8		21.05	
7	8		21.05	
8	4		10.53	
9	2		5.26	
11	1		2.63	
Total	38		100.00	

Table 3 shows break down of e-commerce activities. All respondents (100%) mentioned they used web sites to provide information about their products and services, but very few companies listed prices or applied promotional tactics, such as, coupons, discounts, and rebates. About 92% respondents communicated through email. None used their web sites for chatting, discussions/blogs, or videoconferencing. More participants (about 76%) exchanged print job related files as compared to electronic job related files. About 63% of samples agreed that they exchanged quotations over the Internet. Only 10% accepted payments through their web sites. None of the commercial printing firms published their information in languages other than English. Refer to Table 3 for further details.

Table 3

Responses on E-Commerce Activities

#	Activities	Responses out of 38	Percent
	General Information About Company		
1	General Information	36	94.73
	Communication Tool		
2	Email	35	92.10
3	Chat Group	0	0.00
4	Discussion Group	0	0.00
5	Videoconferencing	0	0.00
6	Other	4	10.52
	Graphic File Exchange		
7	Print Job Related File Exchange	29	76.31
8	Electronic Job Related File Exchange	15	39.47
	E-Form Exchange		
9	Quotation	24	63.15
10	Purchase Order	7	18.42
11	Payment	4	10.52
12	Receipt	2	5.26
13	Other	5	13.16
	Marketing Activity		
14	Information About Products & Services	38	100.00
15	Listing of Prices	1	2.63
16	Distribution of Discount Coupons	0	0.00
17	Special Discount Prices	2	5.26
18	Sweepstake	1	2.63
19	Rebate	0	0.00
20	Related Links	15	39.47
21	Other Promotional Activity	1	2.63
22	Publishing Information in Different Languages	0	0.00
23	Other Marketing Activity	2	5.26
	Other Activity		
24	Other e-Commerce Activity	5	13.16

To find out the relationship between the number of e-commerce activities (A) and the three levels of performance (FP, NFP, OP), the Spearman correlation method was performed. To test the research hypotheses, H_1, H_2, and H_3, the data were collected from the questionnaire. The number of e-commerce activities conducted on the Web had a positive relationship with the three levels of performance. There was a positive relationship between the variables A and FP ($p = 0.014$) that is significant at $a = 0.05$. A significant positive relationship was found between A and NFP ($p = 0.0009$) and between A and OP ($p = 0.0023$) at $a = 0.01$. These findings supported the directional hypotheses H_1, H_2, and H_3. The higher the number of e-commerce activities performed, the better will be the performance. See Table 4 for additional information.

Table 4
Association Between Performance Indicators and Total Number of E-Commerce Activities

Performance Indicator	Spearman Correlation Analysis	
	Coefficient	p-value
Financial Performance	0.4061	0.0140*
Sales	0.5326	0.0006**
Profits	0.4577	0.0039*
Costs	0.2779	0.0912
Return on Investment	0.2889	0.0874
Non-Financial Performance	0.5183	0.0009**
Number of Customers	0.4025	0.0122*
Merchandise Return Rate	0.1944	0.2422
Sales & Marketing Productivity	0.3890	0.0158*
Overall Performance	0.4926	0.0023**

Note. * significance level $a = 0.05$. ** significance level $a = 0.01$.

Conclusions

The findings matched Auger's study. There was a positive correlation between the number of e-commerce activities and three levels of performance. The results matched with the GAMIS/PIA study that not many printing firms were making profits by conducting e-commerce activities on the Web. Based on the study here are the following suggestions in order to bring customers close to a company and make more profits using e-commerce:

1. The commercial printing companies should take full advantage of the Web in order to get the most out of their online investment. They should not keep their Web sites limited to publish the information about their products and services but they need to make their Web sites more interactive so that they can exchange job related files and business forms. This can expedite the process and reduce the costs on travel and shipping.
2. The companies should have responsive Web design in order to view Web pages on a variety of screen sizes.
3. The companies should offer more promotions, such as, coupons, discounts, and rebates on their Web sites to attract more customers.

4. Along with their Web sites the companies should show the presence on social networking Web sites and should add bookmarks of social media on their Web sites. The companies need to incorporate Web 2.0 components into their Web sites. Sonnier et al. (2011) found the significant impact of online communications across a variety of social media on sales. They found the effect sizes for positive and negative comments were larger than that of neutral comments and that the effect size for positive comments was larger than that of negative.
5. The companies should make use of instant messaging (IM)/chatting on their Web sites to answer customers' questions effectively.
6. They need to have multilingual Web sites in order to reach a larger audience. They should be able to print products in multilingual.
7. The companies need to educate and train customers to do business online. They need to provide more online information interested to their customers.
8. The companies need to expand their business by offering more services, such as, creating and maintaining Web sites for their customers.

Future research studies should be conducted over a larger population to determine which other factors are responsible for bridging the gap between businesses and customers and hence, improving the financial, non-financial, and overall performances of commercial printing firms to conduct e-commerce.

References

A Guide to Online Printing Companies (2000, September 5). Inc. [On-line]. Retrieved December 15, 2014, from the World Wide Web: http://www.inc.com/articles/2000/09/20221.html.

Auger, P. (1997). *Marketing on the World Wide Web: An empirical investigation of the relationship between strategy and the performance of corporate Web sites.* Unpublished doctoral dissertation, Syracuse University, New York.

Behrens, J. C. (1997, July). Check out the Web. *American Printer, 219*(4), 46.

Bouchard, J. P., Hoffman, B., Jackson, J., Llamas, R. T., Stofega, W. (2014, March). Worldwide smartphone 2014–2018 forecast and analysis. *IDC* [Online]. Retrieved September 11, 2015, from the World Wide Web: http://www.idc.com/getdoc.jsp?containerId=247140.

Burke, R. R. (1997, Fall). Do you see what I see? The future of virtual shopping. *Journal of the Academy of Marketing Science, 25*(4), 325-360.

Creati, M. (2006, December 14). 10 website advantages. *PromotionWorld* [Online]. Retrieved September 11, 2015, from the World Wide Web: http://www.promotionworld.com/internet/articles/06121410Website.html.

Cummings, T., & LeMaire, B. (2006, February). *Utilization of e-commerce by commercial printing companies* (Research Monograph No. PICRM-2005-04). Rochester, New York: Rochester Institute of Technology, Printing Industry Center.

Durfee, T., & Chen, G. (2002, January). E-Commerce. *Journal of Business Strategy, 23*(1), 14.

E-commerce options. (2000, September). *American Printer, 225*(6), 11.

Hirshowitz, M. (1997, April). Web wise: Quick printers use the Internet to promote their image and generate incremental income from far-flung clients. *American Printer, 219*(1), 44-46.

Jarvenpaa, S. L., & Todd, P. A. (1997). Is there a future for retailing on the Internet? In Robert A. Peterson (Ed.), *Electronic marketing and the consumer* (pp. 139-154). Thousand Oaks, CA: Sage.

McLean, A. K. (2000, September). Getting more from your Website. *American Printer, 225*(6), 64.

Nath, R., Akmanligil, M., Hjelm, K., Sakaguchi, T., & Schultz, M. (1998, April). Electronic commerce and the Internet: Issues, problems, and perspectives. *International Journal of Information Management, 18*(2), 91-101.

Pine, B. J., Peppers, D., & Rogers, M. (1995). Do you want to keep your customers forever? *Harvard Business Review, 73*(2), 692-703.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: The Free Press.

Roth, J. (1998, October). Printers and the Internet. *American Printer, 222*(1), 40-46.

Sonnier, G. P., McAlister, L., & Rutz, O. J. (2011, July-August). A dynamic model of the effect of online communications on firm sales. *Marketing Science, 30*(4), 702-716.

The ultimate e-commerce study (2002, March). *Computers Today,* 18-40.

Webb, J. W. (2008). *Renewing the printing industry: Strategies and action items for success*. Harrisville, RI: Strategies for Management, Inc.

Williamson, D. A. (1997, May 19). Wanted: Info on you and your interests. *Advertising Age*, 60, 64.

Graphics

Design Refinement by Iterative Virtual Experimentation (DRIVE) for Analysis of Steering Column Mounting Bracket Design of an On-Highway Construction Vehicle

Mr. Charles M. "Matt" Watson, CSTM, Morehead State University, Morehead, KY
Dr. Nilesh Joshi, Morehead State University, Morehead, KY

Selected after Peer Review as the "Best ATMAE 2015 Conference Proceedings Paper"

Introduction

In designing componentry for industrial equipment, it is often necessary to theorize and design many versions of a system and/or components. While there exist applications where Finite Element Analysis (FEA) is utilized along with Computer-Aided Design (CAD) to produce design optimizations, there are very few applications where CAD and FEA are combined with experimental designs or design of experiments (DOE). By combining experimental design methods with commonly used analysis and design tools such as CAD and FEA, designers can develop powerful statistical models and utilize graphics 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 the cumulative time and cost spent on designing the system. This paper proposes the DRIVE (Design Refinement by Iterative Virtual Experimentation) methodology that integrates DOE with traditional CAD and FEA tools in a concurrent manner. With the utilization of the DRIVE methodology, the total number of design possibilities that can be initially explored will increase significantly and, thus, lead to an overall more robust and functional final design. Another benefit of the DRIVE methodology is that this 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.

DRIVE Methodology Components

To better understand the working of the DRIVE methodology, let us first explore its three basic components: CAD, FEA, and DOE.

The Fundamentals of Design (CAD)

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 et al., 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, computing, and graphics fields can be combined to formulate a plan that yields a product with desirable characteristics. Nowadays, CAD modeling is extensively used by engineering designers to assist in the overall design process.

Finite Element Analysis (FEA)

Finite element analysis (FEA) is a procedure utilized in engineering as an approximation to the solutions of boundary value problems. In a typical boundary value problem, one or more variables satisfy a differential equation within known boundaries. Depending on the problem that is being solved, these variables can include displacement, temperature or many other parameters (Hutton, 2004). While basic methods of mechanics can be used to analyze simple geometrically shaped components, analyzing more complex components is challenging. Methods of approximation that are less representative than their simple counterparts are used in such cases. By dividing the structure of any complex component into small, finite elements, we are able to closely approximate the true geometry of the component. As the number of elements increases and their corresponding size decreases, we get better approximation of the geometry of the actual component. Use of powerful FEA software with efficient and accurate solver routines brings a general ease to the preprocessing stage of the analysis that includes the building of the model and creating the mesh. The FEA software also aids in the post-processing stage of reviewing the calculated solution results (Budynas et al., 2008).

Experimental Designs (DOE)

The last part of the engineering analysis assemblage in this research involves experimental designs or design of experiments (DOE). Experiments are performed in nearly every field to discover some sort of information about a particular system or process. In its formal definition, an experiment is simply a test, or series of tests, in which deliberate changes are made to the inputs of a process or system for the express purpose of observing and analyzing the effects that those changes make on the output of the system being studied. 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 in these activities is usually to develop a component or system that is robust and receives minimal influences from outside sources of variability (Montgomery, 2012). Some of the more useful aspects of experimental designs in the engineering design process are:

- Validation of important product features that affect product performance.
- Comparison and evaluation of multiple design configurations.
- Determination of product features that yield robustness.
- Evaluation of alternative materials.

DRIVE Methodology and its Application to the Steering Column Mounting Bracket Design

This section outlines the DRIVE methodology and its application to the steering column mounting bracket design. The particular application of the component lies within the driver's cabin of an on-highway construction vehicle. A typical installation of a steering column sub-assembly contains several components that are installed as a complete unit within the driver's cabin. Figures 1 and 2 show the actual pictures taken of the driver's cabin entry point and

the steering column bracket sub-assembly located within the cabin respectively. The main focus on the mounting bracket (shown in Figure 2) is centered on the premise that upon gaining entry to the driver's cabin, the driver will pull on the steering wheel to aid in entry to the cab. This results in a force and moment being encountered at the attachment point of the steering column and the mounting bracket.

Figure 1. Photo of the driver's cabin entry point

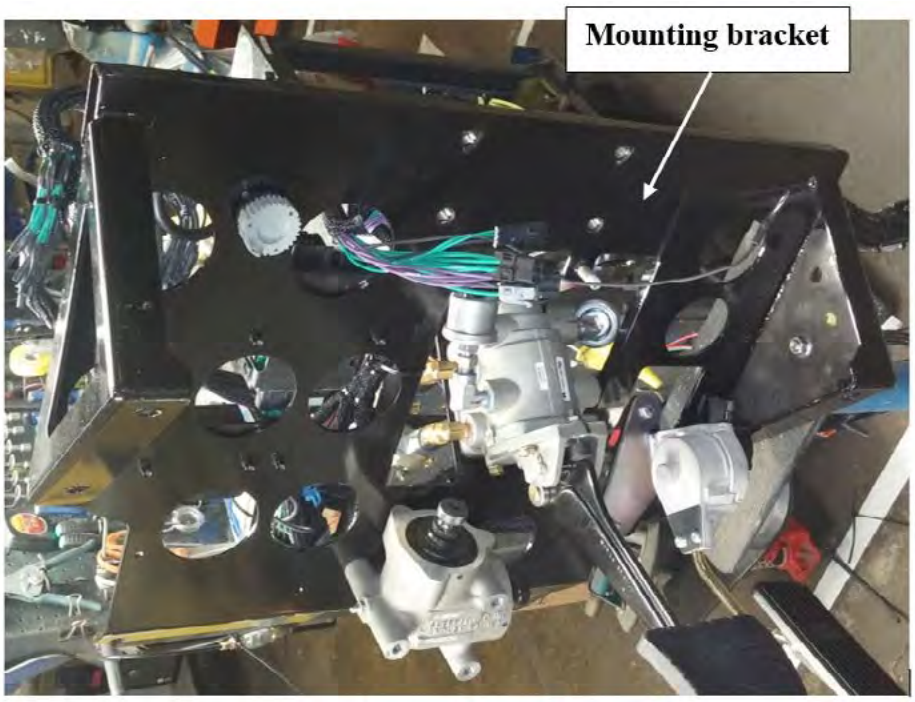


Figure 2. Actual steering column bracket sub-assembly

When an operator attempts to gain entry into the cabin, he or she will tend to grab the steering wheel and utilize it as a grab handle to aid the entry into the cabin. When this process is repeated over multiple ingress and egress cycles, there is an undue stress put upon the base mounting bracket, of which it is not intended to function as the mounting bracket for an impromptu grab handle.

In this case study we use the DRIVE methodology to examine the means by which we can reduce the maximum observed stress within the mounting bracket for a given load. Thus, the response/output variable selected for this multi-factorial experiment was the maximum observed Von Mises stress on the bracket measured in pounds per square inch (psi) units. The design features (factors) chosen to vary within the mounting bracket were: presence of flange radii, increased flange width, and presence of weight reduction holes (shown in Figure 3). Each factor is comprised of only two levels as shown in Table 1. Table 2 summarizes the factor-level combinations (treatments). Three design factors, each with two levels (present/not present) result in 8 unique design alternatives.

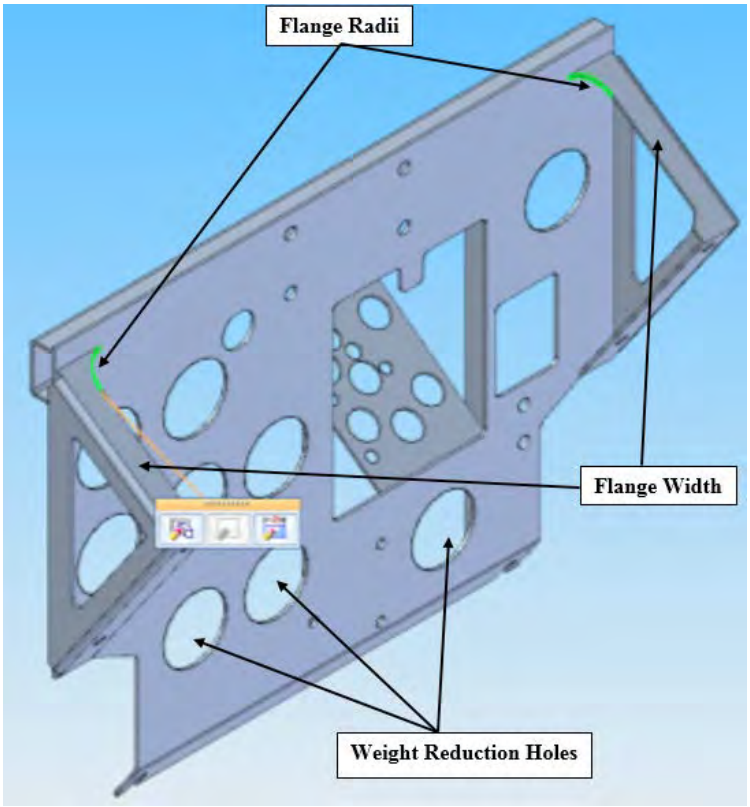


Figure 3. Three design features (factors) within the mounting bracket

Table 1. Summary of design factors and their levels

Design Factor		Levels	
		Low (-)	High (+)
Factor A:	Presence of flange radii	No	Yes
Factor B:	Increased flange width	No	Yes
Factor C:	Removal of weight reduction holes	No	Yes

Table 2. Factor level combinations (treatments)

Design Alternatives (Treatments)	Factors			Description
	A	B	C	
(1)	-	-	-	None
a	+	-	-	Presence of flange radii
b	-	+	-	Increased flange width
ab	+	+	-	Flange radii & increased flange width
c	-	-	+	Weight reduction holes removed
ac	+	-	+	Flange radii & weight reduction holes removed
bc	-	+	+	Increased flange width & weight reduction holes removed
abc	+	+	+	All factors present

Figure 4 shows the three basic phases of the DRIVE methodology. The first phase involves creating three dimensional CAD models of the driver's cabin and the steering column mounting bracket designs using a parametric CAD software package. These designs are based on actual cabin of the construction vehicle and the steering column bracket sub-assembly shown in Figures 1 and 2 respectively.

The second phase involves performing finite element analysis. First step in FEA was to apply boundary conditions and material to the CAD models developed in the first phase. Next, the external loads were applied to the model and simulations were performed.

The third phase involves 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 observed Von Mises stress within the mounting bracket.

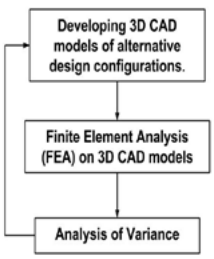


Figure 4. Three basic phases of the DRIVE methodology

Computer Aided Design

Figures 5 and 6 show the developed CAD models of the driver's cabin and the steering column bracket sub-assembly located within the cabin. The eight different combinations of the factor levels (design alternatives) and their associated CAD geometry representations are shown in Figure 7 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.

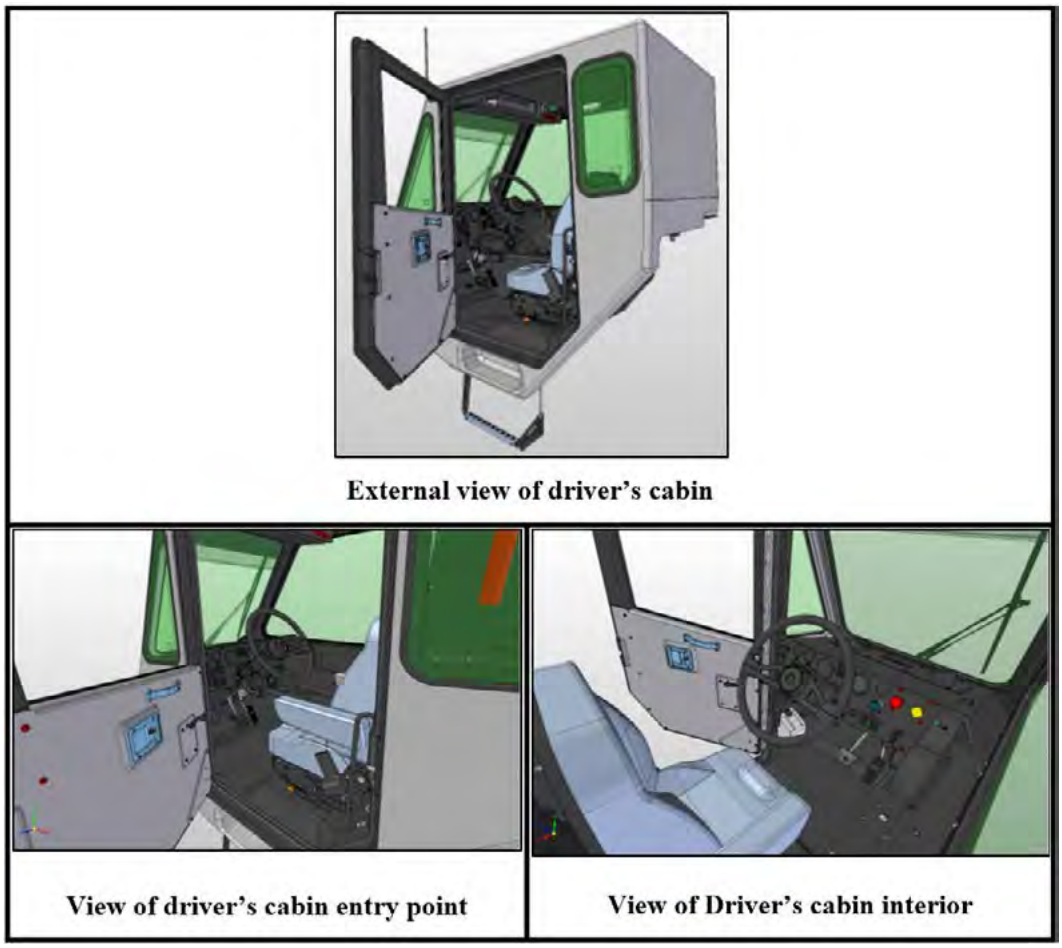
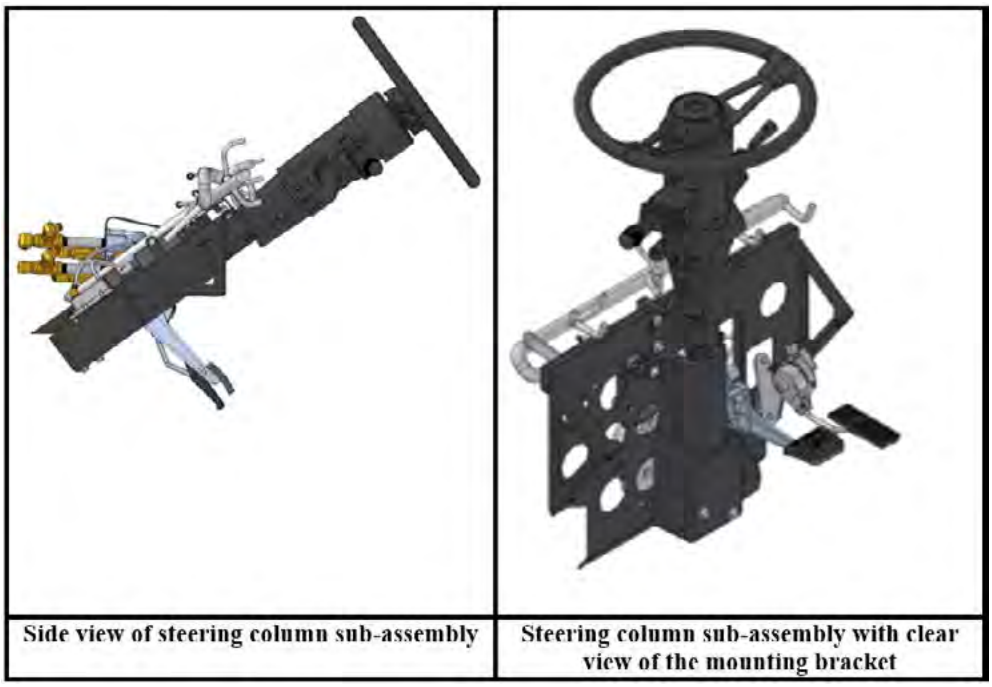


Figure 5. Developed CAD model of driver's cabin



Side view of steering column sub-assembly	Steering column sub-assembly with clear view of the mounting bracket

Figure 6. Steering column sub-assembly CAD model.

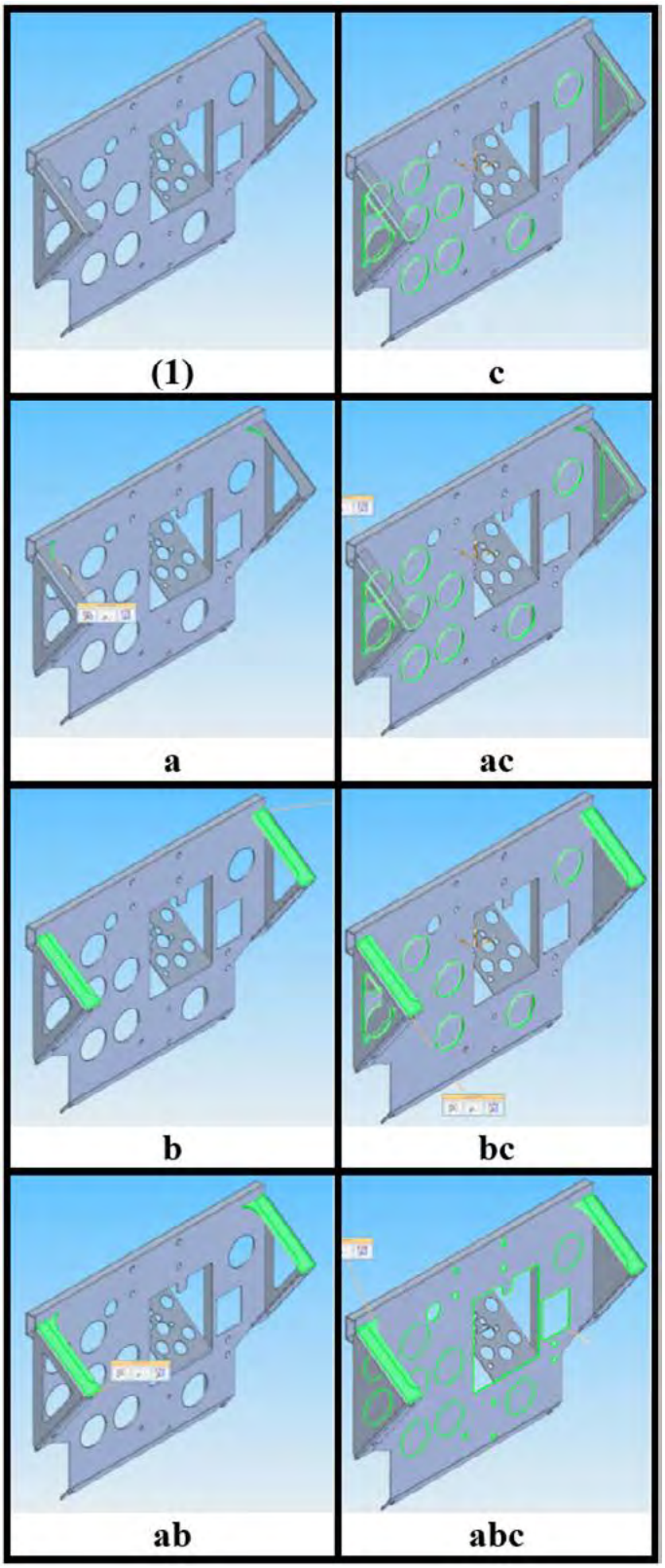


Figure 7. CAD models for 8 unique design alternatives of the mounting bracket

FEA Simulations on 3D CAD models

The selection of three design factors and two levels of each factor created 8 different scenarios for FEA as shown in Figure 7. As can be seen in Figure 5, the mounting bracket has a steering column attached to it. A maximum downward force of 500 lbf was applied to the steering column in order to simulate real life loading conditions. Two replicates were used in the experiment with subjective mesh size factors of 8 and 9 in the simulation software. 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 and optimize the relevant design.

Data were collected on the completed FEA analyses and the subsequent maximum observed stress within the mounting bracket and the factor of safety was recorded for each replicate of each treatment (design alternative) in the experiment. These data are catalogued in Table 3. Figure 8 depicts example FEA simulation results (Von Mises stress diagrams) for the eight design alternatives at mesh size factor of 8. A scale is also provided with units in the kilo-pound per square inch (ksi).

Table 3. Maximum stress observed and factor of safety

Run #	A	B	C	Treatment	Maximum stress (psi)		Factor of Safety	
					Replicate 1	Replicate 2	Replicate 1	Replicate 2
1	-	-	-	(1)	23,700	32,000	1.60	1.19
2	+	-	-	a	17,600	18,500	2.16	2.05
3	-	+	-	b	22,800	25,200	1.67	1.51
4	+	+	-	ab	19,600	19,400	1.94	1.96
5	-	-	+	c	23,600	26,100	1.61	1.45
6	+	-	+	ac	17,800	17,900	2.13	2.13
7	-	+	+	bc	23,300	27,800	1.63	1.37
8	+	+	+	abc	19,300	19,100	1.97	1.99

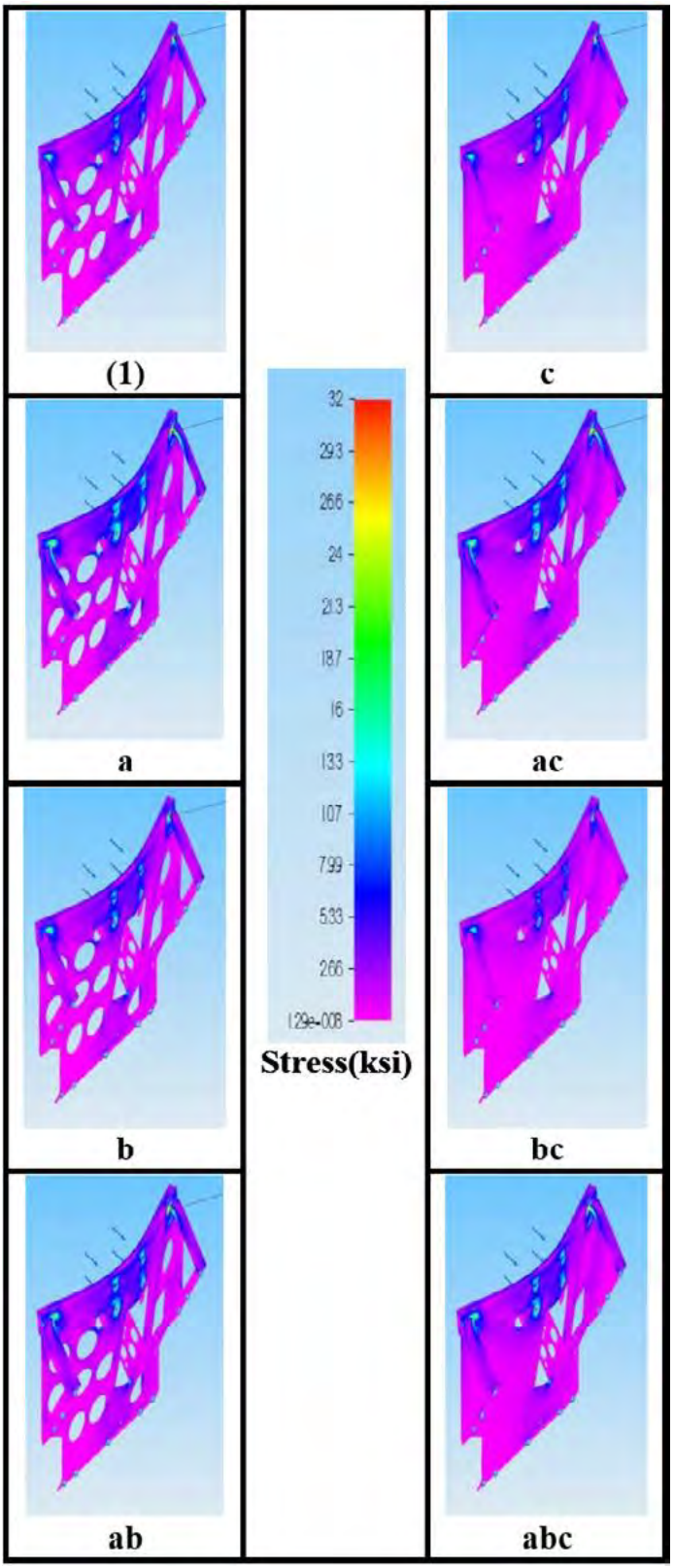


Figure 8. FEA simulation results (Size 8 mesh)

Statistical analysis was performed utilizing Minitab statistical software. The input worksheet was configured for the 2^3 factorial design with two replicates. The data obtained for the maximum observed stress (Table 3) were entered into the worksheet and then the factorial design was analyzed at confidence level of 99% ($\alpha = 0.01$). 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 4, it is clear that only factor that has significant impact on the maximum observed stress within the mounting bracket is factor A, "the presence of the flange radi**i**", since the associated *P* value is less than α value of 0.01. The same conclusion can be drawn from the main effects plot (Figure 9), which indicates that average observed maximum stress within the mounting bracket reduces drastically when flange radii are added to the design.

Table 4. Analysis of variance for maximum observed stress within the mounting bracket

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	7	211544375	30220625	4.74	0.022
Linear	3	192111875	64037292	10.04	0.004
Flange radius	1	191130625	191130625	29.97	0.001
Flange width	1	30625	30625	0.00	0.946
Holes removed	1	950625	950625	0.15	0.710
2-Way Interactions	3	14026875	4675625	0.73	0.561
Flange radius*Flange width	1	8850625	8850625	1.39	0.273
Flange radius*Holes removed	1	225625	225625	0.04	0.855
Flange width*Holes removed	1	4950625	4950625	0.78	0.404
3-Way Interactions	1	5405625	5405625	0.85	0.384
Flange radius*Flange width*Holes removed	1	5405625	5405625	0.85	0.384
Error	8	51025000	6378125		
Total	15	262569375			

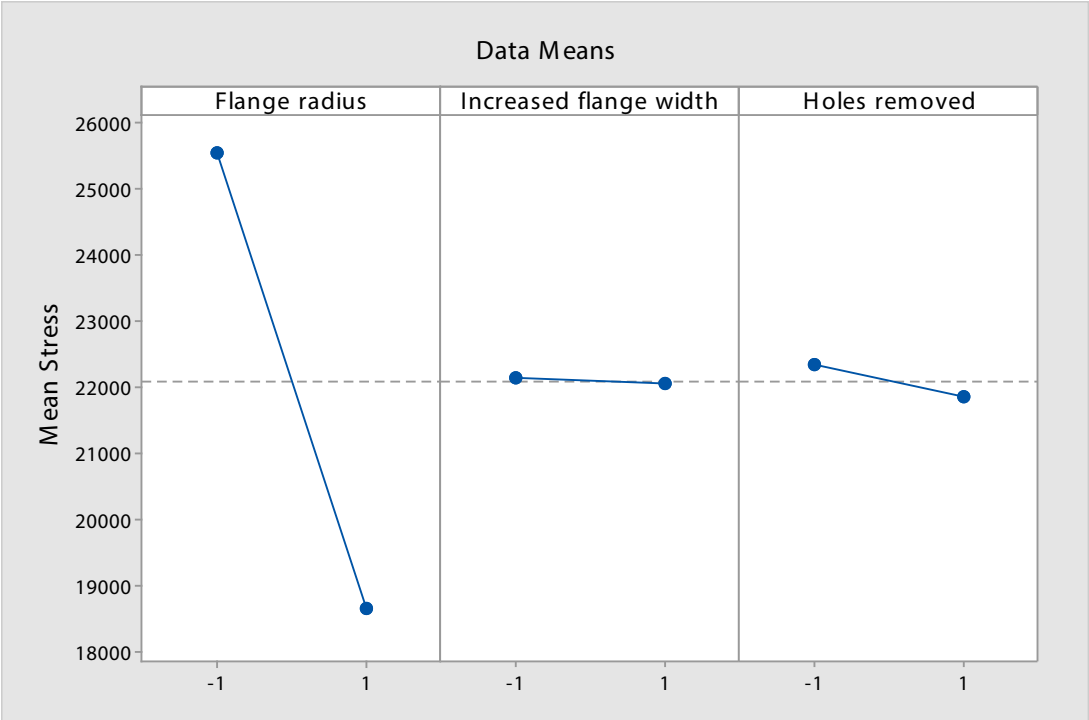


Figure 9. Main effects plot

The residuals from a factorial experiment play an important role in assessing model adequacy. Figure 10 shows four-in-one residuals plots for the experiment. The normal probability plot gives no indication of non-normality or possible outliers. The residuals versus the fitted values plot shows two large residuals towards the right end of the plot. This needs to be investigated further. The two other plots, histogram of residuals, and residuals versus order appear normal. So, based on these plots, the statistical model used appears to be adequate and the results of the experiments are valid.

Figure 11 shows the cube plot which helps in selecting appropriate levels of each of the significant design factors in order to optimize the design, one that will result in reducing the maximum observed stress within the mounting bracket. The cube plot confirms that the minimum stress can be observed when the flange radii are present, which is indicated by the values on the right side surface of the cube plot in Figure 11.

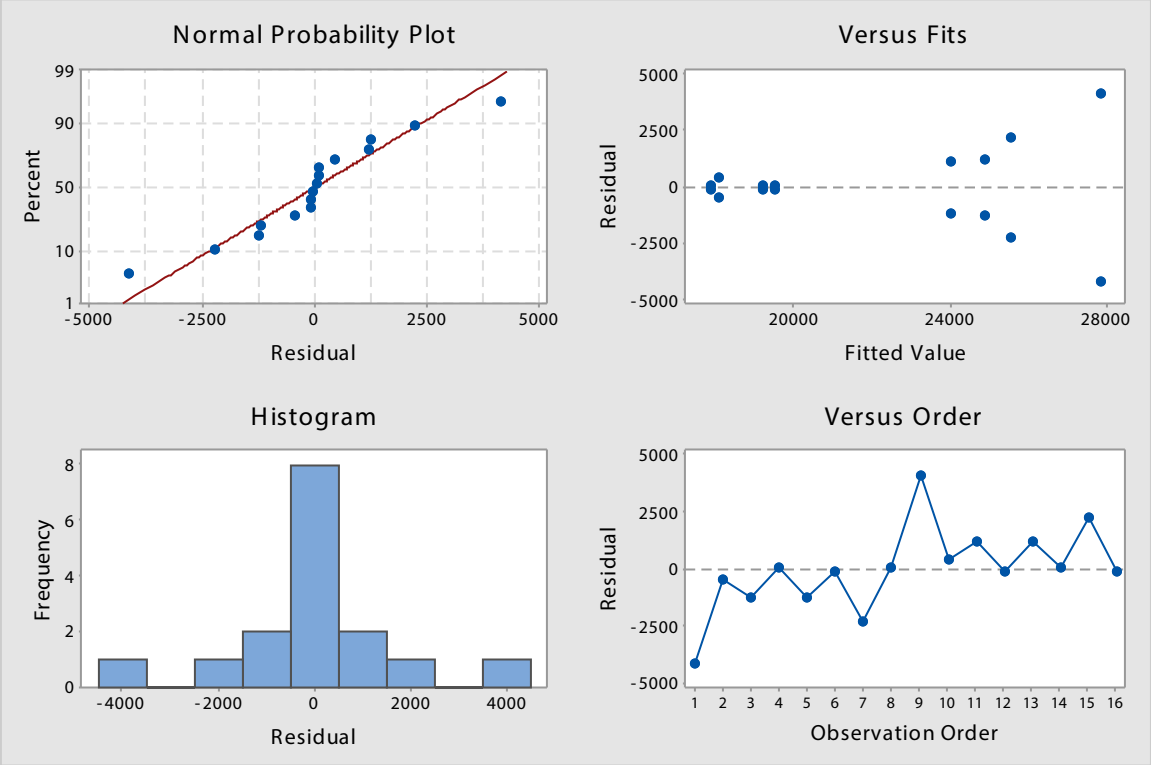


Figure 10. Four in one residual plots for maximum observed stress

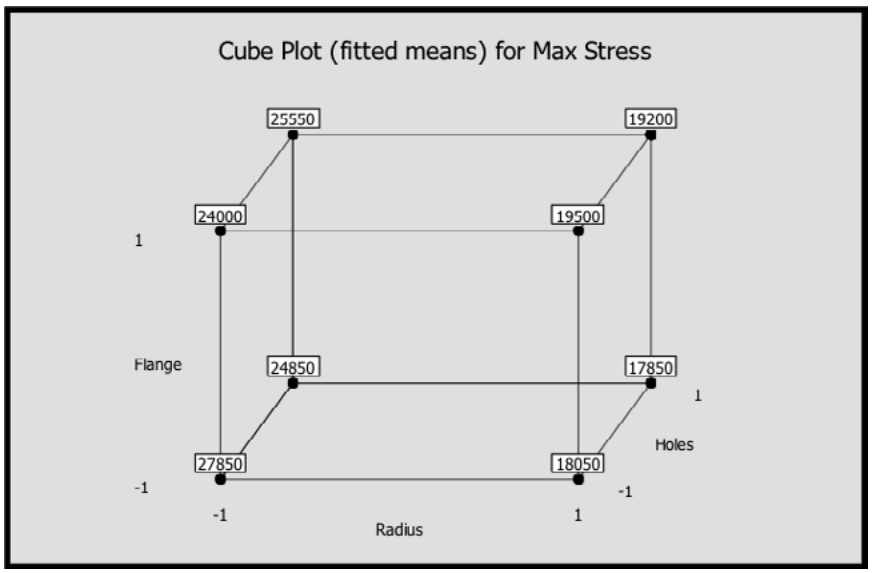


Figure 11. Cube plot for maximum observed stress

Summary

The DRIVE methodology discussed in this paper accomplished its objective of establishing optimal parameters for the design of the mounting bracket. The result suggests that the only factor that has statistically significant impact on design and guaranteed to improve the overall performance of the design is Factor A: the presence of flange radii. Thus, this would be the only feature that should be included in the further refinement of this design analysis. 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 work further extends the recent research efforts by May et al. (2012), Watson and Joshi (2012, 2013), whereby design simulations were combined with CAD modeling to address critical design issues. By synergistically integrating the elements of CAD, FEA, 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 are both objective and definitive to aid in the decision making.

References

Budynas, R. G., Nisbett, J. K., & Shigley, J. E. (2008). Shigley's Mechanical Engineering Design. Boston, MA: McGraw-Hill.

Earle, J. E. (2000). Graphics for Engineers (5th ed.). Upper Saddle River, NJ, Unites States: Prentice Hall.

Hutton, D.V. (2004). Fundamental of Finite Element Analysis (1st ed.). Boston, MA: McGraw-Hill.

May J., Joshi N.N., & Nair R. (2012). Application of design simulation and experimental design methodologies to the study of coronary stent designs. *Computer-Aided Design and Applications*, 9(4):439-455.

Montgomery, D. C. (2012). Design and Analysis of Experiments (8th ed.). Hoboken, NJ: John Wiley & Sons, Inc.

Watson C. M., & Joshi N. N. (2013). CAD/CFD-based experimental designs for analysis of HVAC componentry in industrial equipment. *The Association of Technology, Management and Applied Engineering (ATMAE) Annual Conference Proceedings Papers*, New Orleans, LA.

Watson, C. M., & Joshi, N. N. (2012). Integrated CAD/CFD Analysis of HVAC fresh air intake system design of an on-highway crane. *ATMAE Annual Conference Proceedings Papers*, Nashville, TN.

2015 Conference Proceedings

Management

Adoption of Food Safety Modernization Act: A Six Sigma Approach to Risk Based Preventive Controls for Small Food Facilities

Mr. Abhay K. Grover, Iowa State University, Ames, IA
Dr. Shweta Chopra, Iowa State University, Ames, IA
Dr. Gretchen A. Mosher, Iowa State University, Ames IA

Introduction

According to the Center for Disease Control (CDC, 2010), 17% of Americans are at risk from food borne illnesses leading to 325,000 hospitalizations and about 3000 deaths every year. There have been several occasions in past during which these outbreaks have posed serious health concerns such as E. coli 0157:H7 in spinach - 2006, Salmonella Saintpaul in pepper - 2008, Salmonella Typhimurium in peanut butter - 2008, and Salmonella Enteritidis in eggs - 2010 (Haglund, 2011; Pouliot, 2012). As a result food businesses have lost billions of dollars in recall of contaminated food such as 500,000 bushels of soybean had to be destroyed in a Nebraska elevator after contamination from 500 bushels of soybean already affected by engineering corn. Similarly Starlink corn, not approved for human consumption, entered the food supply chain triggering a recall of more than 300 food products affecting food supply chain seriously (Laux, Hurburgh & Mosher, 2008). These incidents suggest that the American food safety[1] system at that time was unorganized and ill equipped to counter potential food hazards (Becker & Porter, 2007).

As a result, Food Safety Modernization Act (FSMA) was enacted as a public law on January 4th, 2011, amending Title 21 of United Sates Code on Food and Drugs. As per the Food and Drug Administration (FDA), FSMA was introduced to ensure holistic safety of U.S. food supply chain by shifting existing food safety focus from a reactive approach to a preventive controls emphasis.

FSMA is an attempt to strengthen the existing food safety net by providing FDA with increased authority to inspect food products and authorize mandatory recalls for contaminated goods. FSMA (Public Law 111-353) rules are divided into four Titles: (1) Improving capacity to prevent food safety problems, (2) Improving capacity to detect and respond to food safety problems, (3) Improving the safety of imported food, and (4) Miscellaneous provisions (e.g., employee protection and budget details). Section 103 under Title 1 (Improving capacity to prevent food safety problems) illustrates requirements of Hazard Analysis and Risk Based Preventive Controls (HARPC) (Kheradia & Warriner, 2013), which introduces a framework requiring all food facilities to implement a preventive food safety system (FDA, 2011). The food safety plan under HARPC requires the stakeholders in charge of a food facility to evaluate the potential hazards, identify solutions, implement preventive controls, monitor performance of these controls, and maintain records to minimize the occurrence of evaluated hazards using a scientific methodology (FDA, 2015). HARPC is a shift from the existing food safety management system, because it mandates a logical pre-assessment of safety hazards which was previously less prevalent.

1 As per WHO, 2011 Food Safety is defined as a commitment by stakeholders of food value chain to consumers that food will be devoid of physical, chemical, and biological hazards.

On the other hand, legislative requirements of new regulations can be challenging, especially for small food facilities[2] (Levin & Newslow, 2013). Historically, these facilities lack resources to build capacity for new requirements. Literature recognizes these challenges as lack of understanding of guidelines, lack of qualified and experienced staff, limitations related to finances, restricted technical know-how, and lack of infrastructure (Bas, Yüksel & Çavusoglu, 2007; Dzwolak, 2014; Sansawat & Cook 2014). Table 1 enlists challenges highlighted by literature while adopting different quality management systems in food industry across the world. According to Layton (2009), FSMA is going to impact everyone in the food production chain, and hence effective implementation of FSMA depends on integrated participation by all stakeholders, especially the small food facilities. And since almost all large facilities already have extensive experience with other quality management systems for satisfying the safety requirements of the buyers, therefore the most considerable benefits of HARPC rules will be derived from small business adopting preventive controls (Heinzerling et. al., 2013).

To our knowledge there is no known research which analyzes different adoption challenges for HARPC requirements of FSMA specific to the small food facilities. Purpose of this research is to apply tools of six sigma to identify and prioritize major challenges faced by small facilities in United States and recommend potential guidelines while adopting selected components of the law. Some of the small food facilities are exempt[3] from HARPC requirements of FSMA (FDA, 2015). This study is applicable to potentially non-exempt small food facilities who will have to comply with either partial or full requirements of preventive control regulations.

Table 1

Challenges faced by food facilities while adoption of different quality management systems as cited in literature

Challenges	Quality System	Facility size	Country	Source
Understanding of requirements	FSMA	Small, Large	United States	AIB[a] (2015)
Lack of Prerequisite programs, Lack of Infrastructure, Time, Employee motivation	HACCP[b]	Small, Large	Turkey	Bas, Yüksel & Çavusoglu (2007)
Understanding of guidelines, Employee engagement, Lack of Finance, Infrastructure	HACCP	Small	Poland	Dzwolak (2014)
Understanding expectations, Lack of trainings, No guidelines	HARPC	Small, Large	United States	FDA (2011)

2 As per FDA small and very small facilities are defined as organizations employing fewer than 500 persons and having less than $1 million in total annual sales respectively; for the purpose of this research small facilities refer to both small and very small facilities.

3 The following small & very small business facilities are partially or fully exempt from the HARPC requirements:

a.) Involved with low risk manufacturing, packaging or storage activities for specific food products on farm (e.g. jams, jellies, honey & maple syrup).

b.) Facilities who are only involved in manufacturing of juice, seafood, alcohol, or low-acid canned foods

c.) Facilities such as grain elevators and warehouses that store only raw agricultural commodities (other than fruits and vegetables) intended for further distribution or processing.

Lack of Prerequisite programs, Lack of Infrastructure, Time, Employee motivation	HACCP	Small, Large	Turkey	Bas, Yüksel & Çavusoglu (2007)
Understanding of guidelines, Employee engagement, Lack of Finance, Infrastructure	HACCP	Small	Poland	Dzwolak (2014)
Understanding expectations, Lack of trainings, No guidelines	HARPC	Small, Large	United States	FDA (2011)
Lack of qualified managers, Third party consultants	Quality systems	Small	Greece	Karipidis et. al. (2009)
Lack of system experts, Employee engagement, Lack of quality culture	Quality systems	Small, Large	United States	Kheradia & Warriner (2013)
Understanding of requirements, Employee training	HACCP	Small, Large	United States	Levin & Newslow (2013)
Lack of Infrastructure, Supplier partners, Lack of clear regulations	FSMA	Small, Large	United States	Sansawat & Cook (2014)

[a] American Institute of Baking, [b] Hazard Analysis and Critical Control Point

Six Sigma and Food Industry

Six sigma is a methodological approach to improve processes, products, and services for delivering customer value (Houston, 2008). It is a systematic method to drive continuous improvement and deliver high quality products. It is based on previously developed quality control tools and techniques (Quality Glossary ASQ, 2013).

There are several six sigma methodologies available, one of them being DMAIC (define - measure – analyze – improve – control). It has been used in past for manufacturing processes in food industry to improve product & process quality (Hung & Sung, 2011). Hung and Sung (2011) have successfully demonstrated application of DMAIC for improvement of process in a food company in Taiwan by decreasing shrinkage defects in small custards. Peariso (2006) emphasized a much deeper relationship of food safety, six sigma, HACCP and plant profitability by suggesting a more integrated approach to these tools. Six sigma tools have been suggested to augment HACCP system by including the non-critical control points, reducing variation, and driving process improvement. Cutler (2007) highlights different challenges with food industry when it comes to six sigma adoption such as competition, variability, perishable raw material, and complex regulatory guidelines.

Thus literature highlights a need for addressing adoption concerns of HARPC in small food facilities using a more systematic approach such as DMAIC. Even though six sigma is data driven approach authors have demonstrated use of a qualitative framework to delineate project objectives, identify challenges, assess baseline, find root cause, and suggest possible solutions. (Crow 2002; George, 2002; Hung & Sung, 2011; Zhen, 2011).

4. HACCP is a widely accepted management system in which food safety is addressed through the critical analysis of potential hazards during production, procurement, handling, manufacturing, distribution, and consumption of the finished products (FDA, 2011).
5. The FDA is still working to finalize guidelines for preventive control of FSMA and final rules will be issued in August 2015

Methodology

This research study is based on a verifiable premise that small food facilities might face challenges to adopt HARPC requirements of FSMA. The literature and participants of this study have reaffirmed the premise. The application of various stages of six sigma (DMAIC) for this project are demonstrated in Figure 1.

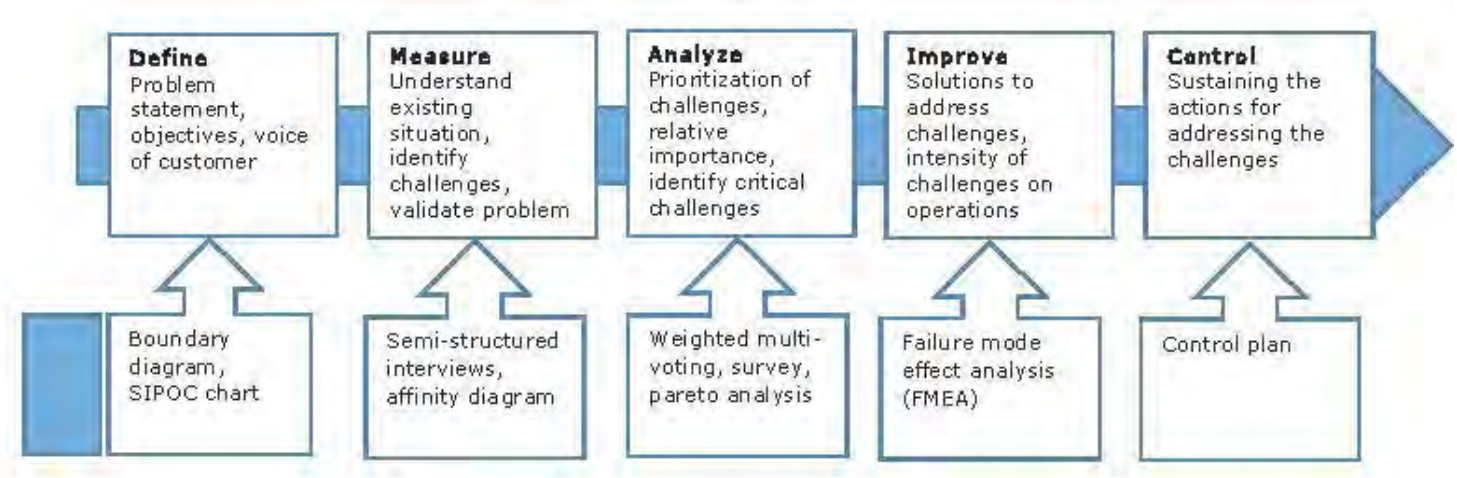


Figure 1. Project flowchart for DMAIC

Define

In define phase the problem statement, stakeholders, objectives and scope of the study were clearly outlined (Prasad, Subbaiah, & Padmavathi, 2012). SIPOC chart (supplier, input, processes, output and customer) was used to map the process. In our study, FDA was considered as customer or end beneficiary of implementation of HARPC in small food facilities. FDA has enlisted all requirements of HARPC in Public Law 111-353, which acts as Voice of Customer (VoC). Specific measurable targets for goal statement were identified. Based on the literature review, the authors aimed at identifying 6~8 challenges and prioritizing them into 2~3 challenges.

Measure

Measure phase was used to understand the intensity of problem statement and explore potential factors affecting adoption of HARPC requirements by small facilities. Challenges were identified using semi-structured interviews of representatives from food industry and academia. For semi-structured interviews, contextual questions were designed by referring published FSMA guide of American Institute of Baking (AIB, 2015) and by transcribing the minutes of FDA public meetings (FDA, 2011). Interview queries included contextual questions such as general perception of individuals about HARPC requirements of FSMA, and major challenges of small facilities while

6. Authors wanted to utilize both perspectives of industry representatives and academicians, because the FDA worked closely with them to phrase and mend requirements of the law (FDA, 2011).

implementation of HARPC as perceived by the participants. Affinity diagram was used to identify challenges by observing common themes in interview data. It was used for organizing ideas into categories based on underlying similarity of data generated during interviews (Pyzdek, 2003; Shafer, Smith, & Linder, 2005). Thirty four seemingly different challenges were grouped into six themes which were later used for multi-voting or prioritization. Table 1, which enlists all the challenges from literature, was used to validate and refine the problem statement.

Analyze

Analyze phase was used to establish significance of the six identified themes. This phase facilitated identification of those challenges which had greatest impact on implementation of HARPC requirements for small food facilities. These six themes were prioritized using weighted multi-voting which was disseminated using Qualtrics® survey software. Survey questions were divided into two categories i.e. (1) demographic information and (2) contextual questions regarding prioritizing the set of challenges. Participants had to compare all the listed challenges and then based on their perception, distribute six points among these challenges. They had the flexibility to assign all points to any one challenge, which they felt was the most critical challenge, or distribute these points among relevant choices accordingly. The sum total of all the points assigned to each theme by the participants helped in rank ordering of these six themes. Results of multi-voting was analyzed using Pareto diagram which helped authors identify challenges that deserve immediate attention.

Improve

Improve phase was used to identify possible solutions to eliminate or reduce the intensity of potential challenges. Failure mode and effect analysis (FMEA) was used to evaluate possible consequence of these challenges on operational status of small food facilities. It helped in identifying actions to eliminate chance of potential failure. The FMEA tabular form included parameters such as prioritized challenges, potential failure mode, potential effects of failure, SEV – severity, potential causes of failure, OCC – occurrence, DET – detection, RPN – risk priority number, and recommended action for small facilities (Prasad, Subbaiah, & Padmavathi, 2012). Possible solutions were also discussed with the participants during semi-structured interviews.

Control

Control phase was used for sustaining actions for addressing these challenges. Recommendations were made for counteractions through control plans for sustaining the recommended solutions.

Results and Discussion

A six sigma team was formed comprising of authors and other stakeholders. Experts were continuously involved to overlook the project details. Project selection was done based on literature review and previously available data. Considering the time constraint scope of the study was narrowed down. The boundary diagram in Figure 2 shows the project outline. Authors focused on Title I, section 103 of FSMA applicable for food industries which had already implemented HACCP or other quality management systems. Measurable goal and primary index of the project was identification of 6~7 challenges, prioritization of these challenges into 2~3 issues, and suggesting potential solutions. SIPOC chart in Figure 3 shows that final output of process is HARPC regularized business units, FDA being the direct customer. A baseline analysis demonstrated key requirements of the customer. Table 2 enlists the HARPC requirements taken from Public Law 111-353 as an input for Voice of Customer.

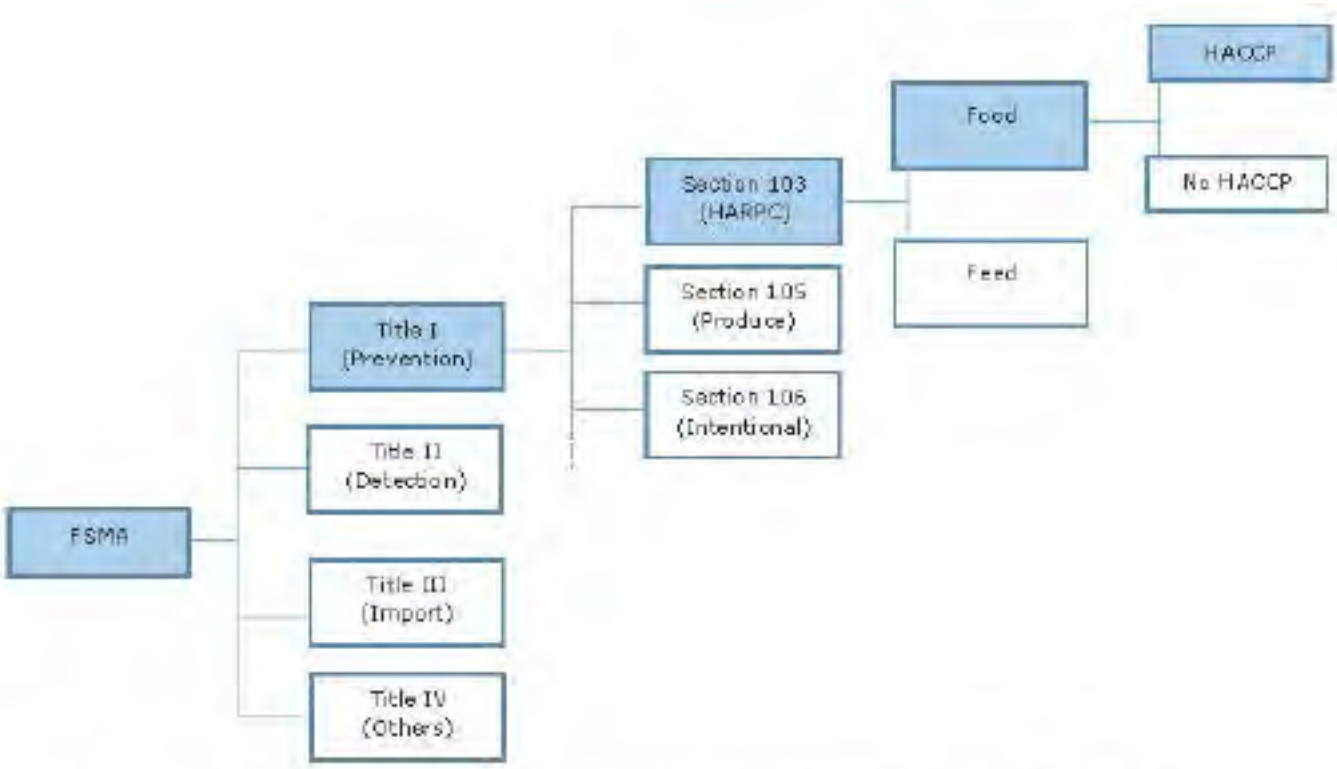


Figure 2. Project boundary diagram (Highlighted blocks represent the schematic flow of the project)

Figure 3. SIPOC diagram

Table 2
Baseline comparison of existing system and new requirements

Existing system	HARPC requirements

1. Unstructured, nonintegrated, reactive food safety approach	1. Structured, integrated preventive food safety approach
2. HACCP , food Safety plan voluntary	2. HARPC, food safety plan mandatory
3. Focus only on CCP[a] and critical limits	3. Comprehensive focus on CCP[a], PRP[b], GMP[c]
4. Hazards include physical, chemical, and biological	4. Hazards include physical, chemical, biological, allergens, and radiological
5. HACCP team– no justification required	5. HARPC team - qualified individuals, justification mandatory
6. Focus on CCP[a] effectiveness and verification	6. Focus on effectiveness, record keeping, proactive approach
7. Focus only on unintentional hazards	7. Focus on intentional hazards as well
8. Onus limited to quality team	8. Onus on all motivated employees

[a] Critical control point, [b] Prerequisite program, [c] Good manufacturing practices

Semi-structured interviews were useful to measure existing challenges of small food facilities while adoption of HARPC requirements of FSMA. In all 13 out of 19 industry and academic representatives participated in the study. The participant profiles for semi-structured interviews are listed in Table 3. Out of all the participants 53.8% were from academia and 46.2% were from the industry. Most of the participants had an extensive exposure to quality management and food safety systems with small food industry. The participants were classified as industry or academic representative based on their present engagement only. The participants were mostly from the Midwest region of United States as this region is known to have high concentration of small food facilities. These participants were interviewed to identify potential challenges.

So 34 identified challenges were combined into six themes. Figure 4 shows different broad themes and all the identified challenges. This study enumerated the following six challenges for small food facilities in adoption of HARPC requirements of FSMA as “employee preparedness”, “absence of quality culture”, “timeline for implementation”, and “employee willingness”, “cost of implementation” , “understanding the FSMA requirements”. The list is not exhaustive and is based on all the input from interviews and archival research.

Table 3
Profile of participants

Participant code	Age (range in years)	Education qualifications	Experience with food safety in industry (range in years)	Kind of training in QMS[a]
AN[b] – 1	More than 60	Masters	11 – 15	Company training, others
AN[b] – 2	31 – 35	PhD	0 – 5	HACCP
AN[b] – 3	36 – 40	PhD	0 – 5	Company training
AN[b] – 4	41 – 45	PhD	11 – 15	ISO 9001, six sigma, certified technology manager, company training
AN[b] – 5	26 – 30	PhD	0 – 5	No certification
AN[b] – 6	36 – 40	Masters	0 – 5	No certification
AN[b] – 7	51 – 55	Masters	6 – 10	Certified quality manager, company training
IR[c] – 1	26 – 30	Bachelors	6 – 10	HACCP, company training, ISO 9001
IR[c] – 2	Choose not to answer	Masters	0 – 5	Company training
IR[c] – 3	More than 60	Bachelors	6 – 10	No certification
IR[c] – 4	51 – 55	Bachelors	More than 30	HACCP, company training
IR[c] – 5	56 – 60	Bachelors	26 – 30	HACCP, ISO 9001, certified quality manager, company training
IR[c] – 6	More than 60	Masters	More than 30	HACCP, others

[a] QMS (Quality Management Systems), [b] AN (Academician), [c] IR (Industry Representative)

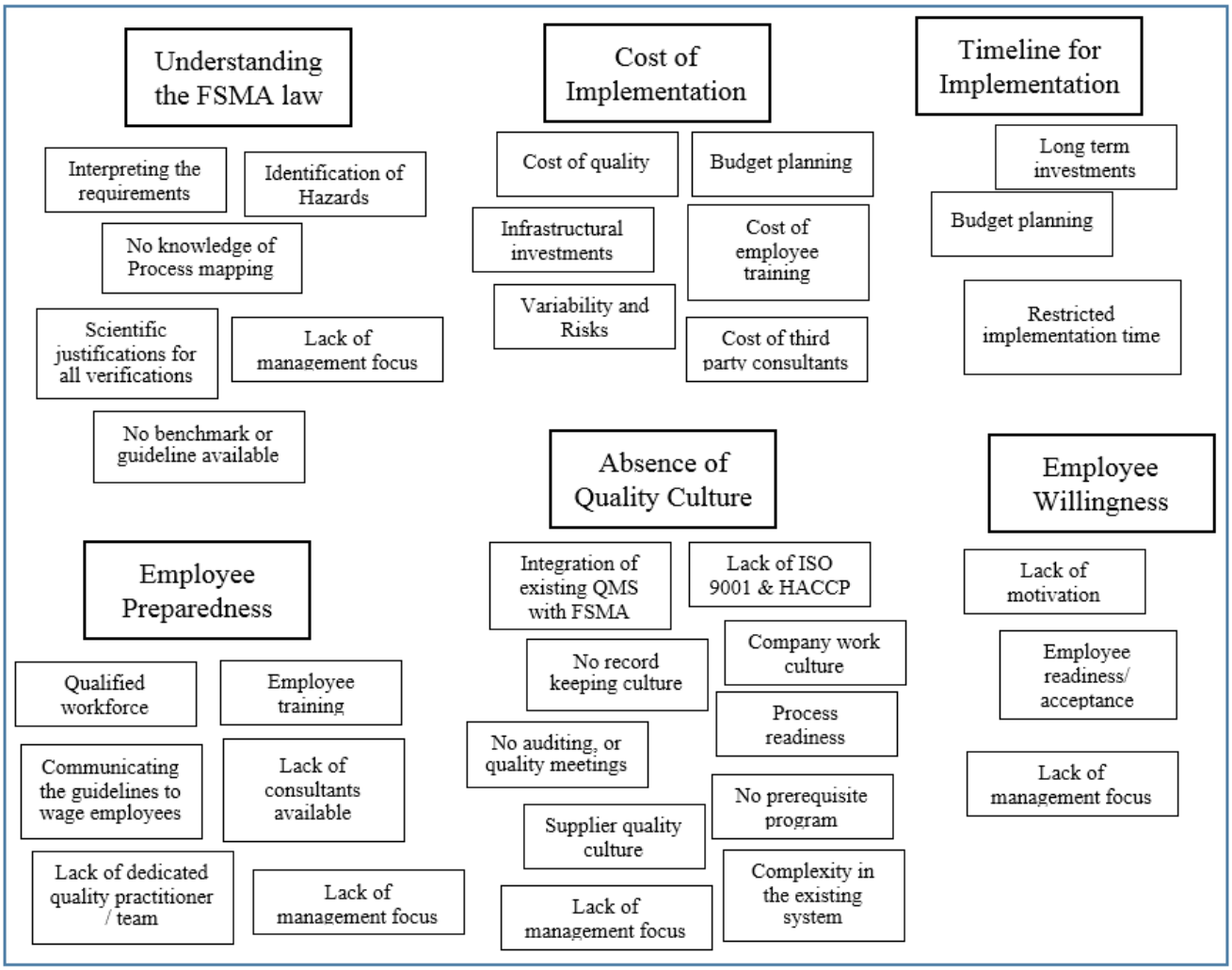


Figure 4. Affinity diagram

Participants listed in Table 3 also voted for multi-voting survey for prioritizing the identified challenges. The challenges were ranked in the following order of significance by the participants using the methodology as mentioned in "analyze" phase: Understanding of the FSMA guidelines, cost and timeline for implementation, employee preparedness, absence of quality culture, and employee willingness. As shown in Figure 5, "understanding of the FSMA law" received maximum vote share. Many industry representatives highlighted that "language of law" and "clarity of guidelines" is a major barrier in understanding the expectations of FSMA for small food industries. This might be because several of such small facilities lack necessary resources for a dedicated quality management team or a third party consultant to interpret expectations of the law (Levin & Newslow, 2013). In this study, cost of implementation was voted as the second most significant challenge facing the implementation of HARPC as these requirements will call for increased investment in upgrading infrastructure, preparing employees, hiring third party consultants, developing a quality culture and motivating employees (Bas, Yüksel & Çavusoglu, 2007; Dzwolak, 2014). Timeline for implementation was voted as the third significant challenge. Participants of the survey suggested that timeline might be a challenge for the small food facilities as evolution of employee capabilities and skills will take time beyond the expected deadlines[4] (Karipidis et. al., 2009; Bas, Yüksel & Çavusoglu, 2007).

Table 4 shows the failure mode effect analysis (FMEA) for three prioritized challenges. It also enlists recommended actions or solutions for counteracting these challenges. It is observed that a gradual investment of resources in building a strong quality culture in the organization, beginning with implementation of ISO 9000, ISO 22000 guidelines and then advancing to others, will help small food facilities overcome these challenges as it brings in more discipline among employees and steadily prepares them for new requirements. Out of all the semi-structured interviews in "measure" phase, one of them was conducted with a small food facility in Iowa; the quality managers of the facility recollected their experience while implementation of HACCP in their facility and drew a parallel with HARPC requirements of FSMA. They are quoted as:

> "If we had not implemented ISO 9000 and ISO 22000 guidelines, assimilation of quality management system would have been difficult in our facility. The sudden transition to a different quality system [HACCP] might have expected a huge budget investment. Moreover internal culture and employee acceptability would have been a challenge. With ISO 9001:2015 and HACCP in place we are not worried about the implementation of HARPC requirements of FSMA which might not be the case for other small food facilities."

Thus sudden transition to higher quality systems will expect huge budget investments (Levin & Newslow 2013). So a continuous nurturing of a quality culture in the organization is a sustainable solution.

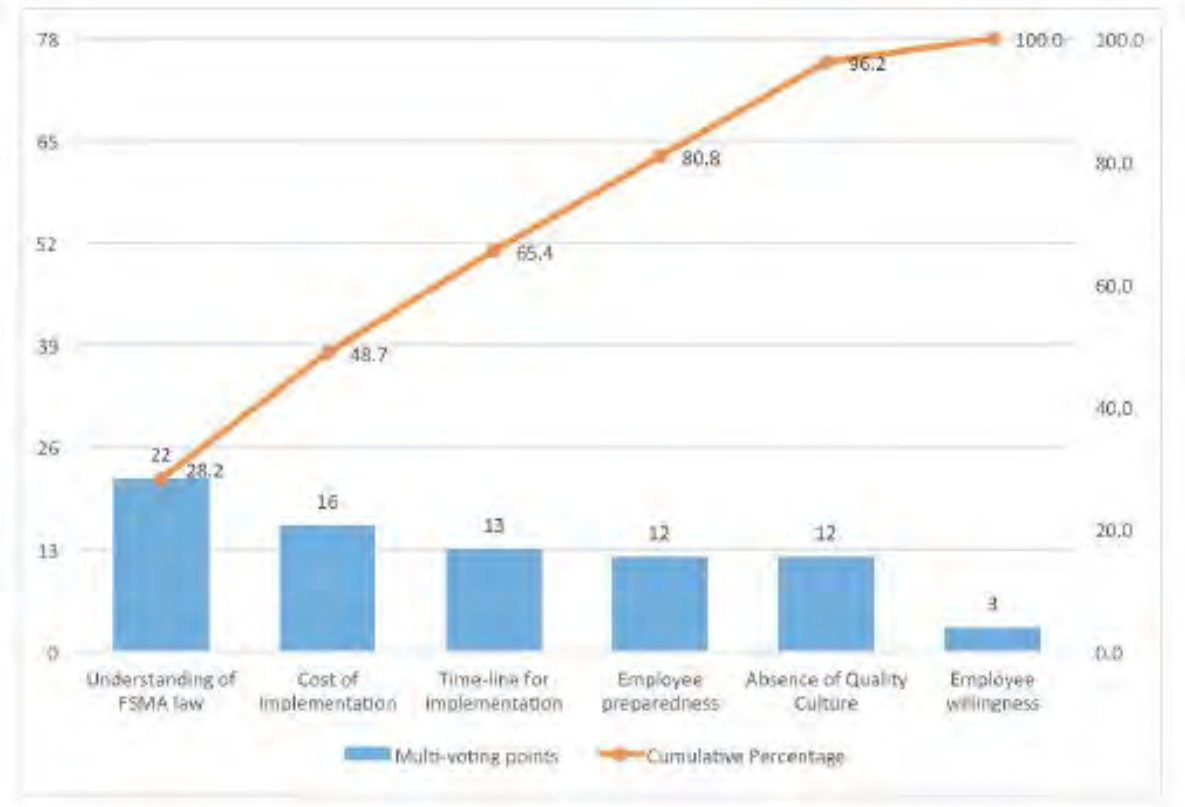


Figure 5. Pareto chart

7. Small businesses, as defined in introduction, will have two years to comply, very small businesses must comply within three years, and other businesses would have to comply within one year after publication of the final rules.

Table 4
FMEA of the prioritized challenges and recommended action plan

Prioritized challenges	Potential failure modes	Potential effects of failure	SEV	Potential causes of failure	OCC	DET	RPN	Recommended action for small facilities
Understanding of FSMA law	Less/no clarity of guidelines/ expectations	Wrong investments, not meeting regulations	9	No quality management team, typical language of law, less trainings or communication by FDA	7	3	189	FDA needs to address this by imparting trainings. Small facilities should increase engagement through common forums GEAPS[a] , NGFA[b]
Cost of implementation	Diverting investments from business for training employees, upgrading infrastructure, developing quality culture	Less profitability, financial liabilities	7	Scale of business is small, financial know how is limited	7	3	147	Gradual implementation of quality management system will help facilities avoid a sudden burden on their treasuries.
Timeline for implementation	Timeline pressure, diverting resources	Not meeting compliance dates, wrong investments	7	Lack of resource, lack of quality management system	7	3	147	Developing a quality culture is imperative.

[a] Grain Elevator and Processing Society, [b] National Grain and Feed Association

Conclusion

Six sigma (DMAIC) approach helped the authors to systematically design project flow (Quality Glossary ASQ, 2013). It exhibits a significant potential for future use in policy adoption studies in food industry. The authors identified six set of thematic challenges and ranked them using multi-voting in the following order as "understanding the FSMA requirements" , "cost of implementation" , "timeline for implementation", "employee preparedness", "absence of quality culture" and "employee willingness". Based on the study authors conclude that a strong quality culture in the organization can help facilitate easy adoption of new requirements. Despite the adoption challenges, participants of this study have recognized the importance of preventive controls of FSMA law and feel that FSMA is a much needed set of regulations.

There are several limitations of the study that inherently restrict the outcome. One of them being that it is an observational study, owing to which the results cannot be generalized across all small food facilities in United States. With preliminary findings, this qualitative piece will be horizontally extended to several small food facilities across Midwest to gather quantitative data in future.

References

American Institute of Baking. (2015).What you need to know about FSMA. AIB FSMA guide, 15 (4), 1 – 13.

Bas, M., Yüksel, M., & Çavusoglu, T. (2007). Difficulties and barriers for the implementing of HACCP and food safety systems in food businesses in Turkey. Food Control, 18, 124–130.

Becker, S. G., & Porter, D. V. (2007). The federal food safety system: A primer. CRS report for Congress USDA, 1 – 6.

Center for Disease Control and Prevention. (2010). Estimates of foodborne illness in the United States. Retrieved February 21, 2015 from http://www.cdc.gov/foodborneburden/.

Crow, K. (2002). Failure modes and effects analysis (FMEA). Retrieved March 20, 2015 from http://www.npd-solutions.com/fmea.html.

Cutler, R. T. (2007). Food manufacturing and six sigma. Technology management for decision-makers, 2, 20-22.

Dzwolak, W. (2014). HACCP in small food businesses – the Polish experience. Food Control 36, 132 – 137.

Food and Drug Administration. (2011). Public meeting on the food safety modernization act: Focus on preventive controls for facilities. Minutes of Public Meeting – FDA, 1 – 129, retrieved February 21, 2015 from http://www.heraldnet.com/article/20110812/NEWS01/708129837.

Food and Drug Administration. (2015). FSMA proposed rule for preventive controls for human food. Retrieved February 21, 2015 from http://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm334115.htm.

George, M. (2002). Lean six sigma: Combining six sigma quality with lean speed. McGraw-Hill, New York, NY.

Haglund, N. (2011). Two kids test positive for e. coli at lynnwood day care. Retrieved February 21, 2015 from http://www.heraldnet.com/article/20110812/NEWS01/708129837

Heinzerling, L., McGarity, T. O., Shapiro, S., Steinzor, R., & Patoka, M. (2013). Current good manufacturing practice and hazard analysis and risk-based preventive controls for human food. Comments, the Center for Progressive Reform, 1 – 51.

Houston, D. (2008). Rethinking quality and improvement in higher education. Quality Assurance in Education 16 (1), 61 – 79.

Hung, H.C., & Sung, M.H. (2011). Applying six sigma to manufacturing processes in the food industry to reduce quality cost. Scientific Research and Essays, 6(3), 580-591.

Karipidis, P., Athanassiadis, K., Aggelopoulos, S., & Giompliakis, E. (2009). Factors affecting the adoption of quality assurance systems in small food enterprises. Food Control, 20, 93 – 98.

Kheradia, A., & Warriner, K. (2013). Understanding the food safety modernization act and the role of quality practitioner in the management of food safety and quality systems. The TQM Journal, 25(4), 347 – 370.

Laux, C., Hurburgh, C., & Mosher., G. A. (2008). Using quality management systems to meet food traceability requirements of the bioterrorism act of 2002. NAIT 2008 Conference Proceedings Paper, 81 – 88.

Layton, L. (2009). House approves food-safety bill; Law would expand FDA's power. The Washington Post. Retrieved February 21, 2015 from http://www.washingtonpost.com/wpdyn/content/article/2009/07/30/AR2009073003271.html.

Levin, B., & Newslow, D. (2013). From HACCP to HARPC – what's best in class and how to get there? Webinar and interview – FoodSafetyTech. Retrieved February 21, 2015 from https://www.youtube.com/watch?v=v-2VoBMgd0lU

Peariso, D. (2006). Bridging the quality control gap: How six sigma can increase plant food safety and profitability. Food Safety Magazine, 28, 2-17.

Pouliot, S. (2012). Food safety: Background, analysis and recommendations. American Enterprise Institute for Public Policy.

Prasad, K. G. D., Subbaiah, K.V., & Padmavathi, G. (2012). Application of six sigma methodology in an engineering educational institution. Int. J. Emerg. Sci., 2(2), 222-237.

Pyzdek, T. (2003). The six sigma handbook. McGraw-Hill, New York.

Quality Glossary. (2013). American Society for Quality. Retrieved February 21, 2015 from http://asq.org/glossary/a.html.

Sansawat, S., & Cook, J. (2014). Understanding the US food safety modernization act. Discussion Paper – SGS, 1–24.

Shafer, S. M., Smith H. J., & Linder, J. C. (2005). The power of business models. Business Horizons, 48, 199 – 207.

Zhen, Y. (2011). Food safety and lean six sigma model. Master's Thesis, Department of Safety Science, University of Central Missouri.

Management

Zero Positional Tolerance at Maximum Material Condition: A Workforce Development Priority

Dr. Sharon M. Rouse, Mitchell Community College, Statesville, NC
Dr. Robert A. Chin, East Carolina University, Greenville, NC

Introduction

Geometric Dimensioning and Tolerancing (GD&T) is a system used to characterize part features and their allowable variation. A portion of the GD&T system was created to improved part assembly or interchangeability of parts using positional tolerancing of part features. Zero Positional Tolerance at Maximum Material Condition (ZPT at MMC) was one of the approaches developed to characterize position tolerances. The literature suggests that the proper use of ZPT at MMC will greatly increase the acceptance rate of useable parts, create less waste, provide more flexibility to the assignment of tolerances, and therefore can reduce overall production costs.

The purpose of this inquiry was to examine why manufacturers are or are not using this approach, despite the many purported benefits. The following questions guided this inquiry:

- Why is ZPT at MMC being used or why is it not? Both Cogorno (2011) and Krulikowski (2012) have indicated that there are many benefits to using ZPT at MMC, including more flexibility for manufacturing. Moreover it prevents the rejection of usable parts. Both reduce manufacturing costs. They also agree there are many who do not understand ZPT at MMC.
- Where have manufacturing personnel received training on ZPT at MMC? Foster (1982), Wilson (2010), and Mehta (2012), all indicate a need for educating users on the fact that zero tolerance is an absolute value and that perfection is expected for the part feature.
- What are the educational and employment levels of the users? Cogorno (2011) and Foster (1982) indicate design engineering usually understands the method, but are not using it because they think that manufacturing staff will not understand it or will not use it properly.
- Does the use of attribute or functional gaging suggest an understanding of ZPT at MMC? Mehta (2012), Foster (1982), Griffith (2002) and Valentino and Goldenberg (2008) state that the potential exists for reducing manufacturing costs through the use of attribute gaging, which requires much less time to implement than variable gaging.
- What other factors, such as type of manufacturing, influenced whether or not ZPT at MMC is used? This question was asked to identify any outliers that may not have been identified in the literature review.
- Do manufacturers that use ZPT at MMC feel there is better communications between design and manufacturing departments? Cogorno (2011) and Foster (1982) indicate a lack of communication exists between design engineering and manufacturing personnel because of the psychological barrier of zero tolerance.

Method

A mixed methods convergent parallel research design using a survey and interviews (Creswell & Clark, 2011) was used to determine the predominant reasons for the use of ZPT at MMC. This approach assumes that collecting multiple forms of data provides a more complete understanding of the problem. The design integrates two databases to show how data converge or diverge (Creswell, 2014). It combines qualitative and quantitative approaches in research to mitigate bias and other weaknesses. Validation comes from the convergence of the qualitative and quantitative data, and a confirmation by independent measurement procedures (Campbell & Fisk, 1959).

In this study, quantitative data were collected through a survey. The survey was constructed and administered to local chapter members of American Society for Quality (ASQ), American Society of Mechanical Engineers (ASME), and SME (formerly the Society of Manufacturing Engineers) in the states of Virginia, North Carolina, and South Carolina. The qualitative data were collected by means of interviews, emails, and discussion threads. Figure 1 provides a graphic depiction of the mixed method convergent parallel style showing the progression of the method.

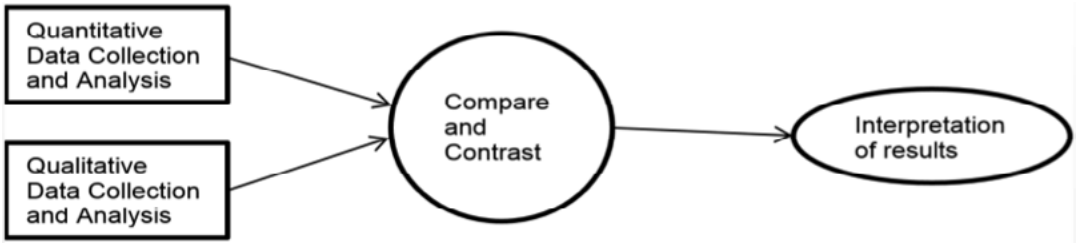


Figure 1. Convergent Parallel Mixed Method. From "Research Design Qualitative, Quantitative, and Mixed Methods Approaches" by Creswell 2014, p.203. Reprinted with permission.

Results

Demographics

The physical location of the participants is presented in Table 1. In addition to being located in Virginia, North Carolina, and South Carolina, some participants were physically located in Florida, Illinois, New York, Texas, California, Oregon, Michigan, West Virginia, and Maryland.

Table 1

Location of survey participants

Answer options	Response percent	Response count
Virginia	21.9	7
North Carolina	31.3	10
South Carolina	3.1	1
Other (please specify)	43.8	14

The participants' affiliation is presented in Table 2. While the participants could indicate more than one affiliation, most affiliated with ASQ. SAE international, none, and Theta Tau professional engineering fraternity were among the other affiliations.

Table 2

Professional affiliation of survey participants

Answer options	Response Percent	Response Count
American Society of Quality	45	14
Society of Manufacturing Engineers	26	8
American Society of Mechanical Engineers	36	11
Other	10	3

The type of manufacturing the participants were associated is presented in Table 3. The participants were permitted to choose multiple options and were permitted to add responses in the 'other' category.

Table 3

Type of manufacturing sector of survey participants

Answer options	Response percent	Response count
Aerospace parts	25.8	8
Automotive parts	29.0	9
Medical parts	48.4	15
Military parts	16.1	5
General part production	32.3	10
Other	25.8	8

The 'other' responses for type of manufacturing included oil and gas parts, education, mining and drilling industry components and assemblies, precast, nuclear reactor parts, HVAC, nuclear, and environmental/gas conditioning systems. These answers were examined and put into general manufacturing since they were not clearly one of the other types.

Table 4 indicates that most of the participants responded with "local" as their current business verses international or both. International business would suggest the possibility that ZPT at MMC was part of a broader use outside of the three states chosen for the inquiry.

Table 4.

Current business of survey participants

Answer options	Response percent	Response count
Local	45.2	14
International	22.6	7
Both	32.2	10

Type of Manufacturing

Does the type of manufacturing affect the use of ZPT at MMC? For this study, the medical group was found to be more likely to use ZPT at MMC when compared to the other types of manufacturers (aerospace, automotive, military, general part production, and "other"). From Table 5, the lowest p-value of 0.037, suggests a strong likelihood that the medical manufacturers use the method of ZPT at MMC at a higher rate than other manufacturers.

Table 5

Test Statistic for Other Industries

Type of Manufacturer	Proportion Yes	"Other" Industries' Yes Rate	p-value
Aerospace	75	11/26 (42)	0.22
Automotive	56	12/25 (48)	1.00
Medical	73	6/19 (32)	0.037
Military	80	13/29 (45)	0.34
General	70	10/24 (42)	0.26
Other	44	13/25 (52)	1.00

Functional or Attribute Gages

Of fifteen respondents, two-thirds (n=10) indicated that functional or attribute gages were used to check ZPT at MMC—see Table 6. A positive response rate of 10 out of 14, or 71%, suggested an association and an understanding of ZPT at MMC and use of attribute or functional gages. Functional and attribute gages made to the ZPT at MMC condition was understood more by the engineering group, than by any other group of personnel involved in manufacturing.

Table 6

Functional or Attribute Gages and ZPT at MMC Use

Answer options	Response percent	Response count
Neither functional or attribute gages are used at your facility	6.60	1
Functional or attribute gages are used, but NOT to check ZPT at MMC	26.7	4
Functional or attribute gages are used to check ZPT at MMC	66.7	10

Level of Employment

For this study, the results indicated that design engineering, one of the levels of employment, was more likely to use ZPT at MMC than any other the levels of employment. General shop floor personnel were least likely to use ZPT at MMC as indicated by no overlap in their respective upper and lower bounds. Other levels of employment, found in the study, were not significantly different from each other as shown in Table 7.

Table 7

Level of Employment and ZPT at MMC

Employment level	Responses	Proportion	Variance	Standard deviation	Lower bound	Upper bound
General Shop Floor	3	17.6	0.9	9.3	0	35.8
Design Engineering	11	64.7	1.3	11.6	42	87.4
Mfg. Engineering	9	52.9	1.5	12.1	29.2	76.7
Quality Assurance	10	58.8	1.4	11.9	35.4	82.2
Machinist	5	29.4	1.2	11.1	7.8	51.1

Level of Education

Table 8 shows the educational levels of personnel who use ZPT at MMC. The educational level of ZPT at MMC users tend to include higher levels of academic preparation.

Table 8

Educational levels of ZPT at MMC users

Answer options	Response percent	Response count
Trade school	25.0	4
On the job training	43.8	7
2 year degree	37.5	6
2 year degree with on the job training	50.0	8
4 year degree	50.0	8
4 year degree with on the job training	56.3	9
Other (please specify)	12.5	2

Two "other please specify" responses were recorded by two participants. These were "master's degree in Industrial education" and "mixed".

The results of statistical tests indicated the automotive manufacturers exhibited the largest range of education levels of personnel that use ZPT at MMC, from on the job training to four year degreed personnel using ZPT at MMC. Overall, on the job training for ZPT at MMC was the predominant means by which all participants learned about ZPT at MMC.

Training

The survey data suggests that on-the-job training was the level at which the majority of participants learn about the use of ZPT at MMC—see Table 9. This appears to be consistent across the different manufacturing sectors. Some of the participants who were recent graduates and therefore new to manufacturing, indicated they had not had any coursework on the subject as indicated in the qualitative phase of the research.

Table 9

Level of Education When ZPT at MMC was Learned

Answer options	Response percent	Response count
Trade school	25.0	4
On the job training	75.0	12
2 year degree	18.8	3
2 year degree and on the job training	31.3	5
4 year degree	25.0	4
4 year degree and on the job training	43.8	7
Other	6.3	1

Summary of Qualitative Data

From the email interviews and discussion thread responses, the following themes were found: most newly graduated engineers do not know about ZPT at MMC, so the concept of ZPT at MMC is usually learned on the job. Also general shop floor personnel and new engineers usually do not know about the concept and how it works. Shop floor personnel indicate this by their confusion regarding tight tolerances. The email interviews and discussion thread responses also disclosed that experienced engineers are more likely to understand ZPT at MMC and its benefits.

The qualitative data tend to support the findings drawn from the analysis of quantitative data, which strengthens the internal validity of the research study. That is, if the qualitative data suggests the same outcome as the quantitative data then internal validity is assured. Creswell (2011) stated that the use of the two different methods of quantitative and qualitative data collection is used to triangulate between data and so researchers use a compare and contrast between the data for validation purposes. Key themes in the results are (a) the lack of knowledge about the method of ZPT at MMC; (b) misunderstanding about zero tolerance; (c) and the different levels of employment and education where ZPT at MMC is used. These themes support the observations made in the literature review and by Mr. Gene Cogorno, GD&T consultant and trainer in the process of member checking, which adds to the external validity of the study.

Discussion

The Reasons for Using ZPT at MMC

The main benefits found by using ZPT at MMC as indicated by both the survey and email and discussion thread data is the reduction in scrap and rework, which reduces manufacturing costs. Another benefit included improved communication between design engineering and shop floor personnel. One participant out of twenty-seven from the qualitative data also indicated improved communication between suppliers and customers when the method is used.

The Reasons for Not Using ZPT at MMC

The reasons for not using ZPT at MMC stemmed from not knowing about ZPT at MMC or from a misunderstanding of how it works. Other reasons are possible misuse of the method, or its application when it is not needed, such as for threaded fasteners. Another reason identified in the study is the belief among design engineering personnel that others do not or would not understand ZPT at MMC.

Implications for Workforce Development

From the findings of this study, it is obvious that a lack of understanding on how ZPT at MMC works is the main barrier to wider use of this cost saving method. Where it is understood and used appears to be found mostly at the design stage and is lost once it leaves engineering to go to the production floor, or to the supplier. The subject is usually broached as part of the on-the-job training experience which is indicated by new engineers now knowing about the topic and many indicating they learned about the method on the job. The level of employment also appears to be part of the equation when there are indications that shop floor employees are typically not informed of the method and its benefits.

Clearly there is a need to educate students on GD&T, and in particular on the subject of ZPT at MMC and Least Material Condition or LMC to enable the method of tolerancing for assembly to be more readily adopted by more manufacturing organizations, but only if there is enough need by industry. Once the student becomes an employee, the job of the consultant or industry trainer comes into play, but again only if there is enough need for the training.

If the goal of manufacturing is to increase profits, then one must find ways to reduce cost. This concept is embraced by industrial practitioners such as Goldratt (1989), Ohno (1988), and Taguchi (1988). If a method such as a simple shifting of tolerance from one characteristic to another, would result in reduction of scrap and rework, all without sacrificing quality, fit, form and function, then more manufacturers should investigate the use of Zero Positional Tolerance at Maximum Material Condition.

References

Campbell, D., & Fiske, D. (1959). Convergent and discriminate validation by the multitrait-multimethod matrix. Psychological Bulletin, 56(2), 81-105.

Cogorno, G. R. (2011). Geometric dimensioning and tolerancing for mechanical design (2nd ed.). New York, NY: McGraw-Hill.

Creswell, J. W., & Clark, V. L. (2011). Designing and conducting mixed methods research (2nd ed.). Los Angeles, CA: Sage Publications.

Creswell, J. (2014). Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.). Thousand Oaks, CA: Sage Publications.

Foster, L. W. (1982). Geo-metrics II: (2nd ed.). Reading, MA: Addison-Wesley.

Goldratt, E., & Cox, J. (1989). The goal (Rev.ed.2nd ed.). Great Barrington: North River Press.

Griffith, G. K. (2002). Geometric dimensioning and tolerancing: Applications and inspection (2nd ed.). Upper Saddle River, NJ: Prentice Hall.

Krulikowski, A. (2012). Fundamentals of geometric dimensioning and tolerancing (3rd ed.). Clifton Park, NY: Delmar/Cengage Learning.

Mehta, M. (2012). Promoting awareness in manufacturing students of key concepts of lean design to improve manufacturing quality [PDF document]. Retrieved from http://www.asee.org/public/conferences/8/papers/4265/download.

Ohno, T. (1988). Toyota production system: Beyond large-scale production. Cambridge, MA: Productivity Press.

Taguchi, G., & Elsayed, E. A. (1988). Quality engineering in production systems. New York, NY: McGraw-Hill.

Valentino, J., & Goldenberg, J. (2008). Introduction to computer numerical control (CNC) (4th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.

Wilson, B. A. (2010). GD&T application and interpretation (5th ed.). Tinley Park, IL: Goodheart-Willcox Co.

Manufacturing

Manufacturing and Non-Manufacturing Students' Perceptions on the Applicability of the Four Pillars

Dr. Muhammad P. Jahan, Western Kentucky University, Bowling Green, Kentucky
Dr. Mark Doggett, Western Kentucky University, Bowling Green, Kentucky

Introduction

The Four Pillars of Manufacturing Engineering was developed and supported by the Society of Manufacturing Engineers (SME), the Association of Technology, Management, and Applied Engineering, (ATMAE), and the Accreditation Board for Engineering and Technology (ABET). A group of manufacturing educators created it in 2011 as part of a strategic plan to reverse negative trends in manufacturing education and improve manufacturing competitiveness (Mott, Raju, & Stratton). The Four Pillars consist of foundational knowledge areas that represent a typical Manufacturing Engineer's Body of Knowledge. In addition, it provides the recommended content for academic programs related to manufacturing and articulates the fundamental knowledge required by manufacturing engineering professionals.

The concept of the Four Pillars is to design curricula that provide adequate academic preparation for students seeking gainful employment in manufacturing or manufacturing-related firms. While the Four Pillars could prove useful in addressing the gaps in existing manufacturing programs as it requires the development of rigorous instructional materials for use in classrooms, laboratories, and projects, the extent of the academic preparation could also be applicable to non-manufacturing programs. Thus, the theory tested in this research is that the Four Pillars Manufacturing Engineering is applicable to more than just manufacturing programs. The Four Pillars knowledge areas are relevant across a broad spectrum of technical-managerial disciplines.

ATMAE accredited educational programs emphasize a mix of technical and managerial skill sets. The applied nature of the curriculum typically distinguishes ATMAE programs from pure engineering and business programs. The required knowledge and competencies for an entry-level technical manager are important. The required competencies and knowledge of a manufacturing engineering manager are thought to be closely related to the required competencies and knowledge for an entry-level technical manager. ATMAE accredited programs include both manufacturing and non-manufacturing programs such as drafting, construction, and computer networking.

The technical education received by students in ATMAE accredited programs in four-year institutions should prepare students for entry-level technical-managerial positions in industry. This research sought to capture the perceptions of alumni, students and faculty across multiple programs, both manufacturing and non-manufacturing related. Using the Four Pillars manufacturing engineering foundational knowledge areas, the research addressed the following:

- What fundamental knowledge areas are most important for an entry-level technical manager?
- What fundamental knowledge areas are or were covered in (your) respective major program?
- What additional important competencies should be covered in (your) major field?
- Are the knowledge areas specified by the Four Pillars model applicable to non-manufacturing areas of study?
- Are the knowledge areas specified by the Four Pillars model congruent with what is being taught and what is perceived as important for non-manufacturing programs?

Literature Review

Lowden, Hall, Elliot, & Lewin (2011) assessed the perceptions of employers and higher education institutions with regard to graduates' employable skills and knowledge. All organizations expect graduates to possess both the technical and discipline-related competencies of their acquired degrees. Employers also expect graduates to have skills such as teamwork, leadership, communication, critical thinking, and problem solving abilities. Educational programs that produce these types of graduates who have both experiential and work-related learning are likely to thrive.

Slota (2011), an educational applications engineer, asserted that non-manufacturing students are being exposed to computer integrated manufacturing environments without even knowing it. Computer-aided design (CAD) and computer-aided manufacturing (CAM) software are used in departments that don't necessarily teach manufacturing skills. The Radio Astronomy Department at the University of Massachusetts uses this software to design and build their own mesoscale research components. Large numbers of students may be engaged in manufacturing who might not realize it. Manufacturing labs on campuses are being used for non-manufacturing purposes such as Auburn University where CAM software is used for research in material science and exotic materials formation.

As far back as 1993, the Institute of Management Services found that traditional ways of working were becoming obsolete, as high-quality lean and just-in-time production required a more highly skilled and flexible work force. Companies found they needed to pay this new type of worker based on their skill sets rather than their job title. This skill-based pay structure gained significant acceptance and is being used now in both manufacturing and non-manufacturing environments.

Duverger (2012) found that voice-of-the-customer techniques, used extensively in the manufacturing industry, could also be used to produce viable ideas in the context of service innovation. One such technique is electronic brainstorming (EBS), which is used for gathering innovative ideas. EBS allows participants to stay anonymous and suggest ideas using asynchronous web-based mediums to increase participation and reduce and fear of evaluation.

Using survey research and case studies, Antony, Coleman, Montgomery, Anderson, and Silvestrini (2011) built a strong argument for the use of design of experiments (DOE) in non-manufacturing areas. DOE has been widely applied in manufacturing, but its use is not well documented in other areas. The potential application of DOE in service environments include key service process and design variables that influence system performance; response time to customer complaints; errors on service orders; service delivery time in banks and restaurants, and patient report turn-around time in healthcare. The actual benefits of DOE were reported in a utility company, an accounts receivables department, information technology services, a hospital, a web-based retailer, and a financial services company among others. DOE was used to reduce data entry errors, speed debt collection, and improve emergency department performance.

The control charts used primarily in manufacturing have the potential to be applied to many different areas, especially non-manufacturing and service sectors such as supply chain management, security, office administration, disaster management, and the health care industry. In a series of articles, researchers from Singapore, China, UAE, and France proposed the use of the G, TC, GCUSUM, TC-CUSUM control charts to monitor a critical event through the simultaneous testing of its time interval (T) and magnitude (C or X). These charts are more effective for detecting the out-of-control conditions, particularly for those in the service sector where responsiveness is important (Wu, Liu, He, & Khoo, 2010; Yafen, Zhen, Shamsuzzaman, & Zhang, 2010; Qu, Wu, Khoo, & Castagliola, 2013; Qu, Wu, Khoo, & Shu, 2014).

Broad-based, applied learning is a distinctive characteristic of ATMAE manufacturing programs. Knowledge and understanding of manufacturing-related competencies can be useful for non-manufacturing programs. This research sought to capture perceptions about that knowledge and its applicability to programs other than manufacturing.

Methodology

This survey research measured the perception of importance and coverage of the Four Pillars of Manufacturing Management Knowledge as applicable across all major programs in ATMAE accredited department at a comprehensive university. The survey was sent to students, faculty and alumni of advanced manufacturing (AM), construction management (CM), technology management (TM), computer information technology (CIT), industrial education (IE), architectural sciences (AS) and master of science (MS) programs. The responses from each of the programs were compared.

The survey instrument was a modified version of an instrument previously used to collect the perceptions of AM majors with regard to Four Pillars foundational principles applicability to their degree program. Program faculty and alumni reviewed the instrument for face validity. The survey listed 32 of the knowledge areas from the Four Pillars Manufacturing Engineering model. Of the 32 knowledge areas, 14 were from the foundation knowledge area of manufacturing management. The other 18 items were selected from each of the other foundational areas, except mathematics and science, as these are required for all majors in the college. The questions on the survey were the same as the ones given to manufacturing students on the previous study except that all references to manufacturing or production were removed. For example, one of the Four Pillars knowledge areas is Production and Process Planning. This was changed to Process Planning. In addition, the title of the survey was changed from Perceptions of Manufacturing Management Knowledge and the Four Pillars to Perceptions on the Four Pillars of Knowledge.

Respondents were asked to rate each knowledge area twice using a Likert scale from 1 to 5 or "not applicable". For the first set of the 32 knowledge area questions, respondents ranked how they perceived the item's importance with 5 being very important and 1 being not important. In the second set of the 32 knowledge area questions, the respondents ranked how they perceived the item was/is covered in their respective programs. A response of 5 indicated the item was covered comprehensively with 1 representing little to no coverage.

An electronic version of the survey was created using Qualtrics software, an institutionally approved survey package. The population of participants was all majors across all programs in the department. Invitations and consent forms were sent in early April of the spring semester via email to current students, faculty, and recent alumni. A second request was sent one week later with a final request sent seven days thereafter. The invited students included both graduate and undergraduate levels. The total survey population was approximately 600 students, 12 faculty, and 15 alumni. The total number of surveys completed was 86, a response rate of approximately 14%. All collected responses were anonymous. The data was compiled, sorted, and analyzed using descriptive statistics.

Results and Discussion

Overall perceptions of survey participants

A chi-square test of independence found that the responses on the questions for all the Four Pillar knowledge areas had no significant differences. Figure 1 shows the summary of all the responses from all majors. The mean values of responses for questions 1 (Q1) and 2 (Q2) are plotted. The figure shows that most of the key topics from the Four Pillars were perceived as important for an entry-level technical manager. The mean values for all the responses were 3 and above (ranging from 3.2 for materials handling and packaging to 4.52 for problem analysis and solving). The five most important key requirements for an entry-level technical manager perceived by all participants was problem analysis and solving (4.52), interpersonal skills (4.47), safety (4.47), project management (4.44), and written and oral communication (4.38).

In response to Q2 "what knowledge was/is covered in your program", the mean values were lower compared to Q1. Participants did not perceive that all the important topics were covered comprehensively. For the majority of the important topics, the mean value of Q2 was lower than Q1, except materials, materials handling and packaging, and power systems. Several topics had similar means for Q1 and Q2 that indicated agreement on the balance of importance and offerings. Those key topics were engineering science, lifecycle analysis, design management, process research and development, control systems, quality systems and standards, operations research, and supply chain and logistics. However, none of those were considered most important for an entry-level technology manager. The top five key topics perceived covered comprehensively by all majors were project management (4.14), problem analysis and solving (4.03), quality systems and standards (4), education and training (3.97), and materials (3.92). One important observation is that among the five most covered topics, two were perceived as the most important requirement for an entry-level technology manager; problem analysis and solving and project management. Several topics had large differences between the mean values of Q1 and Q2, indicating areas of improvement. Those were interpersonal skills (Q1: 4.47, Q2: 3.38), written and oral communication (4.38, 3.83), human factors (4.19, 3.17), safety (4.47, 3.77), strategic planning (4.17, 3.53), personnel management (4.34, 3.48), human behavior and leadership (4.18, 3.41), labor relations (3.7, 3.09), ethics (4.31, 3.43), and social responsibility (4.14, 3.2).

Perceptions between manufacturing (AM) and non-manufacturing students

Table 1 shows the top five topics perceived as important for an entry-level technical manager by students from each major. No responses were received from IE majors. There are more similarities compared to the differences. For example, all majors considered safety important. All majors, except CIT, considered written and oral communication important. Four out of the six majors perceived project management and problem analysis and

solving as important. Standard, laws, regulations and ethics were found important by AM and CM majors. Besides similarities, there were some differences in the perceptions of AM and non-manufacturing. It was found that only AM perceived quality systems and standards as one of the top five. Interpersonal skills were selected as one of the top five by TM, AS and CIT, but not by AM. MS and CIT perceived ethics as one of top five, whereas other majors did not. However, the most important finding from Table 1 is that all majors considered similar topics important for an entry-level technical manager.

Figure 2 also represents the similarities and differences between the perceptions of AM and non-manufacturing on the requirement for entry-level technical manager. In Figure 2, the ratings of top 5 topics perceived by AM were plotted against the ratings of those perceived by other majors. It can be realized from Figure 2 that other majors disagreed with AM on quality systems and standards, and standards, laws and regulations as most important requirements for an entry-level technical manager. Although, most of the topics indicated in Figure 2 were perceived as top 5 key requirements by other majors as well, there were variations in the ratings among various groups, indicating differences in the perception level as well as relative importance of the topics. Problem analysis and solving, and safety were the two key topics with less variation in ratings, as revealed from Figure 2.

Table 2 shows the perceptions of AM and non-manufacturing majors on Q2 listing the top five topics perceived as not covered comprehensively in their curriculum. There were similarities in the responses as observed from Table 2. Social responsibility (4 times), labor relations (4), human factors (4) and global competition (2) were indicated by AM and other majors. Accounting/finance/economics and human factors were mentioned three times by other majors whereas as control systems, interpersonal skills, and human behavior/leadership were mentioned two times each. However, one important observation from the mean values of Table 1 is that most of the topics perceived not covered comprehensively in Table 2 are also perceived less important. Human behavior/leadership was perceived as both important and not covered by CM. Safety was perceived as both important and not covered by CIT. Table 2 also indicates several areas not in the top five of importance that different majors perceive are not comprehensively covered in their course curriculum. Those are social responsibility for AM, TM, MS and CIT, human factors for AM, MS, CM and CIT, labor relations for TM, MS, and CIT, and interpersonal skills for MS and CM programs.

Analysis of participants' comments

Besides the ratings, the participants were encouraged to provide additional topic areas not listed in the survey or additional comments. Some of the additional areas listed by the participants were estimating, scheduling, company management, computer software, studio projects, and structural design. These topics were closely related to the majors of the respective program. Suggested topics that could be considered across all programs were accountability, quality, research and hands-on experience. In the comments section, the participants commended the department for conducting the survey research and for providing them with most of the skill sets necessary for their career. One comment suggested that the reason Bill Gates dropped out of school was a lack of developing his interests that the programs develop curriculum that provides hands-on training and research opportunities.

Conclusions

The students, faculty and alumni across all majors perceived that the important requirements for an entry-level technical manager were safety, written and oral communication, project management, and problem analysis and solving. Non-manufacturing majors also highly ranked interpersonal skills, personnel management and ethics. Topics perceived by all majors as least covered in the curriculum were labor relations, social responsibility, and human factors. Non-manufacturing majors also perceived accounting/finance/economics and interpersonal skills as least covered.

There were more similarities than the differences in the perceptions of AM and non-manufacturing majors. Most majors' perceived similar skill sets as important for an entry-level manager. Safety was perceived important by all majors. Written and oral communication was perceived in the top five of importance by all majors except CIT. Project management and problem solving and analysis were also two topics ranked highly by majors. One of the major differences in the perceptions was that AM majors perceived quality systems and standards, and standards, laws, regulations as key requirements, which other majors didn't perceive. There were also similarities in the topics perceived least covered. Social responsibility, labor relations, and human factors were ranked highly by both AM and non-manufacturing majors.

Limitations of the research were high standard deviation (SD) values for almost all of the 32 survey items. The SD for Q2 was higher than Q1 indicating greater perception differences of the knowledge covered in curriculum. Moreover, the level of ratings provided by each major varied based on their perceptions.

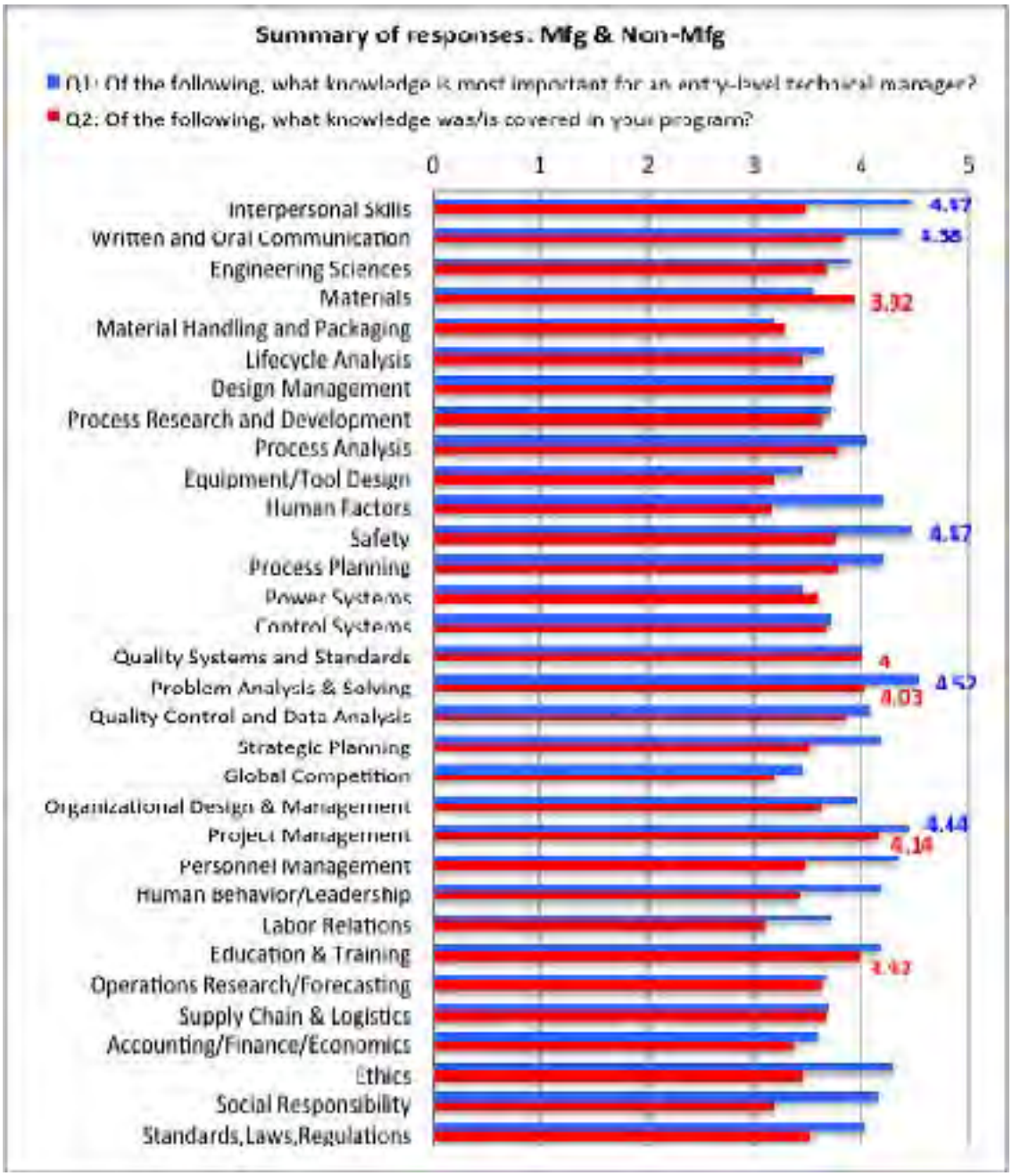


Figure 1. Bar chart showing the mean value of ratings for 32 Four Pillars key topics in response to the two questions sets.

Table 1: Top five topics perceived as important for an entry-level technical manager for all majors. Mean values shown in parentheses (Q1/Q2).

AM	TM	MS
Problem Analysis & Solving (4.25/2.83) Quality Systems and Standards (4.14/3.33) Safety (4.13/3.5) Standards, Laws, Regulations (4.13/2.5) Written and Oral Communication (4.0/2.83) Project Management (4.0/3.33)	Written and Oral Communication (4.69/4.46) Safety (4.69/4.15) Personnel Management (4.69/3.92) Project Management (4.62/4.54) Interpersonal Skills (4.62/4.31)	Problem Analysis & Solving (4.68/4.04) Project Management (4.52/4.35) Safety (4.52/3.52) Written and Oral Communication (4.47/4.17) Ethics (4.45/3.78)
AS	**CM**	**CIT**
Education & Training (4.67/3.8) Problem Analysis & Solving (4.56/4.2) Interpersonal Skills (4.4/4.0) Written and Oral Communication (4.4/3.83) Safety (4.4/4.17)	Written and Oral Communication (4.8/3.4) Project Management (4.8/5.0) Safety (4.6/4.6) Standards, Laws, Regulations (4.6/3.6) Human Behavior/Leadership (4.6/2.8)	Interpersonal Skills (4.64/3.56) Personnel Management (4.55/3.28) Problem Analysis & Solving (4.45/4.0) Safety (4.36/3.22) Ethics (4.36/3.39)

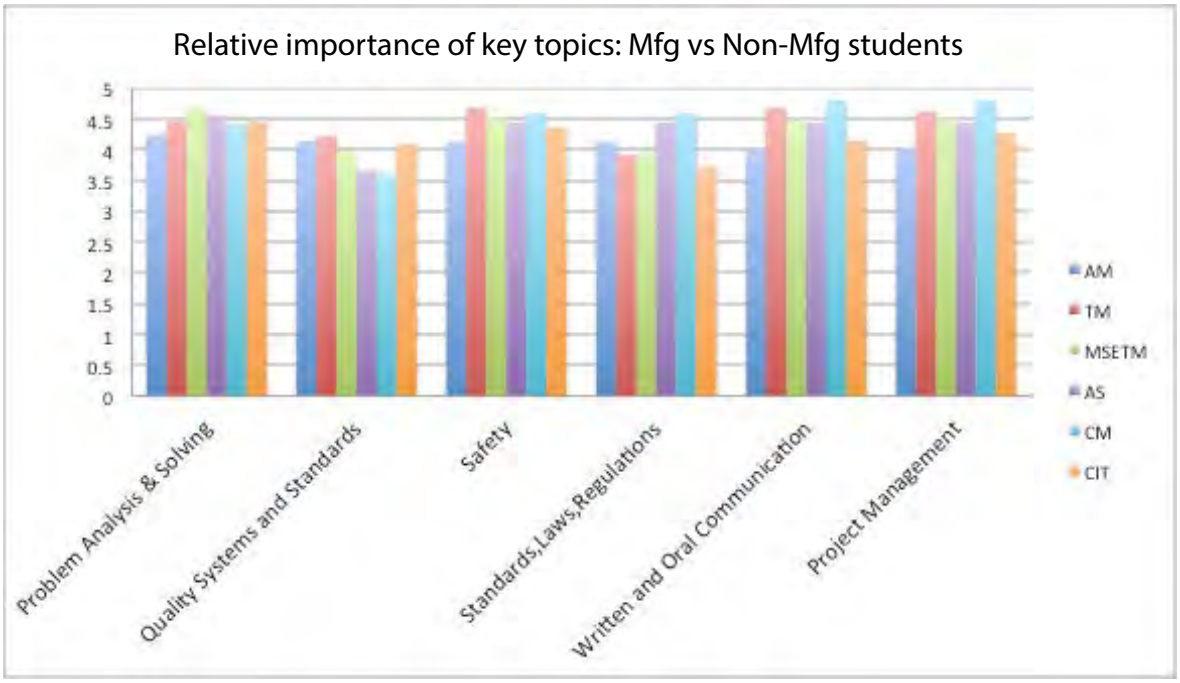


Figure 2: Relative importance of top five key topics selected by AM majors to other majors.

Table 2: Five topics perceived least covered in the curriculum compared to their importance for all majors. Mean values shown in parentheses (Q2/Q1).

AM	TM	MS
Labor Relations (2/3.88) Social Responsibility (2/4) Global Competition (2/3.86) Human Factors (2.17/3.5) Design Management (2.17/3)	Social Responsibility (3.69/4.15) Material Handling and Packaging (3.69/3.77) Human Behavior/ Leadership (3.69/4.23) Equipment/Tool Design (3.83/4.15) Labor Relations (3.85/3.85)	Social Responsibility (3.13/3.97) Labor Relations (3.13/3.74) Human Factors (3.17/4.16) Global Competition (3.43/3.39) Interpersonal Skills (3.45/4.42)
AS	**CM**	**CIT**
Lifecycle Analysis (2/3.56) Accounting/Finance/Economics (2.4/3.89) Supply Chain & Logistics (2.6/4.11) Control Systems (2.6/3.56) Power Systems(2.6/3.56)	Interpersonal Skills (2.6/4.6) Human Factors (2.75/5) Accounting/Finance/Economics (2.8/3.6) Control Systems (2.8/4.4) Human Behavior/Leadership (2.8/4.6)	Labor Relations (2.78/3.68) Human Factors (2.83/4.05) Accounting/Finance/Economics (2.89/3.5) Social Responsibility (3.22/4.09) Safety (3.22/4.36)

References

Antony, J., Coleman, S., Montgomery, D. C., Anderson, M. J., & Silvestrini, R. T. (2011). Design of experiments for non-manufacturing processes: Benefits, challenges and some examples. Proceedings of the Institution of Mechanical Engineers, Part B. *Journal of Engineering Manufacture, 225*(11), 2078-2087. ISSN 0954-4054.

Duverger, P. (2012). Using dissatisfied customers as a source for innovative service ideas. *Journal of Hospitality & Tourism Research, 36*(4), 537-563 DOI: 10.1177/1096348011413591

Institute of Management Services. (1993). How to use pay to open up skill blockages. *Management Services, 37*(3), 12. Retrieved from http://search.proquest.com/docview/234280109

Lowden, K., Hall, S., Elliot, D., & Lewin, J. (2011). Employers' perceptions of the employability skills of new graduates. Edge Foundation, University of Glasgow, SCRE Center. Retrieved from http://www.edge.co.uk/media/63412/employability_skills_as_pdf_-_final_online_version.pdf

Mott, R., Jack, H., Raju, V., & Stratton, M. (2011). The four pillars of manufacturing engineering. In *Proceedings of the 2011 SME Annual Meeting.*

Qu, L., Wu, Z. Khoo, M., & Castagliola, P. (2013). A CUSUM scheme for event monitoring. *International Journal of Production Economics, 145*(1), 268-280. ISSN: 0925-5273

Qu, L., Wu, Z. Khoo, M., & Shu, L. J. (2014). A new control chart for monitoring the event frequency and magnitude. *European Journal of Industrial Engineering,* 8(6), 789-813. ISSN: 1751-5254

Slota, W. (2011). Manufacturing's demise is greatly exaggerated. *Manufacturing Engineering, 146*(2), 96.

Wu, Z., Liu, Y., He, Z., & Khoo, M. C. (2010). A Cumulative Sum scheme for monitoring frequency and size of an event. *Quality & Reliability Engineering International*, *26*(6), 541-554. doi:10.1002/qre.1076

Yafen, L., Zhen, H., Shamsuzzaman, M., & Zhang, W. (2010). A combined control scheme for monitoring the frequency and size of an attribute event. *Journal Of Applied Statistics*, *37*(12), 1991-2013. doi:10.1080/02664760903207324

Appendices

Table A1

What knowledge is most important for an entry-level technical manager?

Topic	Mean	SD	Responses
Interpersonal Skills	4.47	0.7	95
Written and Oral Communication	4.38	0.89	95
Engineering Sciences	3.89	0.94	96
Materials	3.56	1.02	94
Material Handling and Packaging	3.2	1.12	95
Lifecycle Analysis	3.63	0.97	96
Design Management	3.76	0.98	96
Process Research and Development	3.72	1.07	96
Process Analysis	4.06	0.77	95
Equipment/Tool Design	3.44	1.1	94
Human Factors	4.19	0.8	96
Safety	4.47	0.82	96
Process Planning	4.2	0.78	95
Power Systems	3.44	1.17	96
Control Systems	3.7	1.12	96
Quality Systems and Standards	3.99	0.94	95
Problem Analysis & Solving	4.52	0.79	96
Quality Control and Data Analysis	4.09	0.84	95
Strategic Planning	4.17	0.88	95
Global Competition	3.47	1.15	93
Organizational Design & Management	3.95	0.98	95
Project Management	4.44	0.83	96
Personnel Management	4.34	0.89	96
Human Behavior/Leadership	4.18	1.02	96
Labor Relations	3.7	1.07	96
Education & Training	4.17	0.91	94
Operations Research/Forecasting	3.67	1.05	96
Supply Chain & Logistics	3.68	1.08	96
Accounting/Finance/Economics	3.6	1.05	96
Ethics	4.31	0.98	96
Social Responsibility	4.14	0.97	96
Standards, Laws, Regulations	4.04	0.99	96

Table A2

What knowledge was/is covered in your program?

Topic	Mean	SD	Responses
Interpersonal Skills	3.48	1.31	75
Written and Oral Communication	3.83	1.15	77
Engineering Sciences	3.66	1.35	76
Materials	3.92	1.32	77
Material Handling and Packaging	3.29	1.59	76
Lifecycle Analysis	3.46	1.47	76
Design Management	3.71	1.28	77
Process Research and Development	3.62	1.35	74
Process Analysis	3.8	1.22	76
Equipment/Tool Design	3.2	1.62	76
Human Factors	3.17	1.49	75
Safety	3.77	1.49	77
Process Planning	3.79	1.28	76
Power Systems	3.6	1.7	75
Control Systems	3.67	1.57	76
Quality Systems and Standards	4	1.3	76
Problem Analysis & Solving	4.03	1.1	76
Quality Control and Data Analysis	3.86	1.21	76
Strategic Planning	3.53	1.3	76
Global Competition	3.2	1.57	74
Organizational Design & Management	3.61	1.17	77
Project Management	4.14	1.13	76
Personnel Management	3.48	1.37	75
Human Behavior/Leadership	3.41	1.42	76
Labor Relations	3.09	1.6	76
Education & Training	3.97	1.37	76
Operations Research/Forecasting	3.62	1.48	76
Supply Chain & Logistics	3.66	1.54	76
Accounting/Finance/Economics	3.36	1.6	76
Ethics	3.43	1.39	76
Social Responsibility	3.2	1.41	76
Standards, Laws, Regulations	3.53	1.43	76

School Administration

Partnering with Industry: Discussion of the Partnership Leading to, and the Applied Research of an Analysis of Reaction Times in NHRA E.T. Bracket Racing Classes

Dr. Randell W. Peters, Indiana State University, Terre Haute, IN
Dr. Michael A. Hayden, Indiana State University, Terre Haute, IN

University Goals

Our institution's strategic goals include enhancing community engagement and advancing experiential learning. Though not necessarily tied, those goals often go hand in hand when faculty and students work hand in hand with industry. Community engagement and experiential learning are not just trendy buzzwords. Engineering technology and other ATMAE programs have long focused on industry partnerships and hands-on learning to make their programs more relevant to the real world. Recent research (Hall, et al., 2015) has discovered that conscientiousness is a significant predictor of success and retention of engineering students. Conscientiousness includes perseverance, delayed gratification, goal orientation and other behaviors and work habits common in industry and reinforced by internships and other industry partnerships. Other research (Stump, 2014) reveals that engineering students who believe their abilities are innate (you either have it or you don't) when challenged beyond their current limits tend to give up and/or do not utilize knowledge-building behaviors as much as students who have an incremental belief in their abilities (knowledge can be increased via hard work). The real world more closely resembles the hard work model. Experiential learning and industry collaboration reinforce incremental belief students and might encourage entity belief students to use more knowledge-building behaviors.

Over the past several years, local racetrack operations, National Hotrod Racing Association (NHRA) Bracket Racing officials, racing teams, university students, and faculty members have developed closer ties and partnerships. This has led to racers, track owners, and racing officials, teaching courses for our university and serving on our advisory committee. Our students have a racing team. Our faculty members race, operate a racetrack, serve as racing industry officials and committee members, and perform research for the racing industry. This paper summarizes one such research project as an example of how such projects develop. The major goal is not to detail the research but we intend to discuss it and Elapsed Time Bracket Racing enough to provide context and illuminate the example.

Community engagement

Our university defines community engagement as the development of collaborative partnerships between education and outside entities such as business, social services, and government that contribute to the academic mission of the university and directly benefit the community. The purpose of community engagement at our institution includes collaborating with the private sector to enrich scholarship, research, and creative activity. Specific university community engagement goals include the following.

- Assist area private industry and business to develop links with Indiana State University students and faculty.
- Create out-of-class learning experiences for students and faculty.

Examples of community engagement activities from this project include the following.

- Technical assistance and applied research helped increase understanding of an industry problem.
- Learning was extended beyond the university walls and into the community.
- The economic development of small business was enhanced.

Additionally, the broader university-industry collaboration concerning motor sports has led to the following.

- University faculty members and students have served internships, obtained careers within, and served on committees within the racing industry. Conversely, members of the racing community have taught courses for us, served on our advisory committees, and sponsored our racing team.
- Technology has been transferred both directions between industry and our university. Industry and the university have also collaborated on the bidirectional transfer of expertise, advice, equipment, and assistance with research and development.

Experiential learning

Experiential learning requires hands-on at its core. As will be discussed later, racing is very hands-on, whether you are the driver, the vehicle builder or mechanic, the track operator, or the operator of the timer or other mechanisms. However, experiential learning is more than mere hands-on, it is also meant to provide real-world challenging activities that integrate knowledge, skills, and attitudes, and provide more coherence to the student's learning experience. Our university's specific experiential goals include the following.

- Students engaging in experiential learning within their major as part of course work, including class projects, field experiences, and independent study.
- Students engaging in experiential learning related to their major outside of class but university sponsored. This would include student chapters of professional organizations, e.g., the Society of Automotive Engineers. This would also include the student racing team and student membership on advisory committee and other university committees.
- Students engaging in experiential learning related to their major outside of the university. This would include relevant internships and pre-graduation employment. This would also include a variety of participation, in this case, in racing and activities and organizations related to racing.

Many drag racing magazines, internet blogs, and websites suggest that electronic technology specifically designed for starting line enhancement leads to faster and more consistent reaction times. A local dragstrip operator contacted the researchers to ask if they could provide the proof. The researchers of this study, also avid drag racing fans, found no studies of actual track data relevant to bracket racing. The problem was introduced to students of

one of the motorsports classes offered by the university. The students engaged in the development of the study providing key questions and background information in an effort to set up an appropriate study to answer the questions of the track operator. The following study is a result of the collaboration of industry, students, and faculty engaging in applied research.

Research Questions

This study's focus is on winning reaction times. Based on interviews with track operators such as Bill Bader Jr. at Summit Motorsports Park in Norwalk, Ohio, and the NHRA Division 3 Director, Jay Hullinger, the researchers focused this study on the following questions:

- Are the winning reaction times of the three classes (sportsman, pro, and super pro) different? It is commonly thought that sportsman reaction times should be slower than pro reaction times, which are slower than super pro reaction times.
- Do winning reaction times change from earlier rounds to later rounds? At many drag strip facilities, buy-backs are often offered to losing racers of the first one or two rounds. Thus, loser of rounds one and or two may return to racing action for a fee. Once beyond the third round, only winners would advance. Knowing if there is a difference between earlier rounds and later rounds could provide key insight.

Elapsed Time Bracket Racing

The theory of bracket racing is simple: a pair of similarly equipped vehicles is handicapped at the starting line by virtue of a staggered start so that they reach the finish line at precisely the same time creating a near photo finish (Miller, 2012). In theory, a vehicle that can traverse the distance in 7.00 seconds could be paired with a vehicle that could travel the distance in 6.00 seconds and both could reach the finish line at the same time if the 7.00-second vehicle was given a 1.00-second head start. A handicapped start system according to a dial-in was developed to do just that (NHRA, 2009).

Christmas Tree

The Christmas Tree, or tree, is the starting signal to the racers (NHRA, n.d.). Each side of the tree consists of a set of pre-stage and stage bulbs; three amber bulbs; a green light; and a red light (NHRA, 2009). Once the first amber LED bulb is lit, the following two are lit in sequence 0.500 seconds apart (Slavik, Flannagan, Sato, Traube, & Aoki, 1993). The green floodlight is lit 0.500 seconds after the last amber providing the racer did not leave the stage beam. If the vehicle moves too soon and trips the stage beam before the green light cycles on, the green light will not illuminate and a red light will be lit in its place (McKenna, 2008).

Reaction Time

As Super Pro racer Kynon Dinkel explained in an interview on February 8, 2014, the goal for every racer is to have the better reaction time without tripping the red light. The goal is to stage the car exactly the same way every time and take off at the same point every time to keep the reaction time as close to .000 as possible without going under. In this system, the best reaction time is a .000, which means the front tires uncovered the infrared or laser stage beams at precisely the same time as the green light was activated (Miller, 2012).

Winning

A racer attempts to leave the starting line as soon as possible and run as close to the dial-in without breaking out. Reaction times determine who left the line first, in relation to when they were supposed to leave. The track timers start when the stage beam is tripped and end when the finish line beam is tripped. There are two keys to winning: a driver's reaction time and their dial-in (Miller, 2012). As long as neither driver red-lights or breaks out, the first one to the finish line is the winner. If both drivers red-light, the first driver to red-light loses (NHRA, n.d.). In this situation, there may be an advantage to being the faster vehicle as the slower car leaves first. If both drivers break out, the driver who breaks out the least is the winner. The 'first-or-worst' rule applies: a red-light always loses to a break out. If breakouts are the only fouls, the worst break out always loses (Hand, 2014). There are many more rules, but these rules are important to this study (NHRA, 2014).

Classes

The rules of the three classes of elapsed time bracket racing are explained relative to reaction time (NHRA, 2014).

Sportsman. The sportsman class best resembles a stock street-legal vehicle. Drag racing slicks are allowed. No starting line enhancers are allowed. The driver leaves the starting line by releasing the brake with the foot and stepping on the gas pedal. No vehicle in this class can go faster than 7.50 seconds in the 1/8th mile or 12.00 seconds in the ¼ mile.

Pro. In the pro class, vehicles are much faster, but still mostly resemble street-legal vehicles. In addition to other modifications, the vehicles are allowed a trans brake system for improved reaction times. This trans brake effectively locks the transmission in first gear and reverse gear at the same time. This feature allows the driver to have the gas pedal pushed to the floor while not applying the brakes. Instead of starting the vehicle with two feet in a coordinated action, the driver need only release a button to launch the vehicle (Magnante, 2003). Vehicles in this class must dial-in no faster than 5.70 seconds in the 1/8th mile or 9.00 seconds in the ¼ mile.

Super Pro. Highly modified vehicles make up this class, which allows dial-ins as low as 4.50 seconds in the 1/8th mile and 7.00 seconds in the ¼ mile. Along with many performance advantages and safety devices, the driver is allowed another important starting line enhancement: a delay box. The delay box takes into account the differences in the dial-in between the two competitors and the reaction time of the vehicle (Oberauer, n.d.). The driver can program the delay box to delay the release of the trans brake solenoid from the time of activation. The driver can then concentrate on staging the vehicle the same every time and letting off the trans brake button at the moment the driver sees the first amber (Magnante, 2003). In this class, the driver concentrates on the top section of the tree, paying close attention to how and when both vehicles turn on the stage lights and then reacting to the first amber that will light within two seconds (Oberauer, n.d.).

Methodology

Track Selection

A full multi-track membership in 1320go.com that includes access to run data from all classes and all tracks using 1320go.com (1320go, 2014) was used to collect data. All NHRA member tracks were parsed out from the list of tracks and sanctioning bodies (NHRA, 2013). Ten tracks with complete data were used in the study.

Variables

The dependent variable is reaction time; it is measured on an interval scale. In this situation, .000 is considered a perfect light. Any number greater than .000 indicates the time from green light activation to the tripping of the stage beam. Any negative number indicates a red-light foul start meaning the stage beam was tripped before the green light was activated. The independent variables are class and round. *Class* refers to the three racing classes of sportsman, pro, and super pro; these are ordinal (ranked) categories. *Round* refers to the elimination round or trial. Because the numbers of trials vary, with better drivers much more likely to have more than 2 rounds (losing drivers don't advance), and because some tracks have buy-backs in rounds one and or two (described earlier) the first and second rounds were pooled into one group and rounds three and higher into another group. This grouping allows the testing of the effect of being in a higher round compared to a lower without the complications of dealing with nine rounds, each with a diminishing sample size.

Statistical Method

The null hypotheses that (a) there is no difference among classes, (b) there is no difference between rounds, and (c) there is no interaction between round and class was tested with a 2x3 ANOVA. Fisher's LSD test was used for the *post hoc* analysis of differences among classes.

Results of the Study

Table 1 displays the means and medians of winning reaction times broken down by class and round. Class was highly significant, $F(2; 17{,}901) = 1{,}214$, $p < .001$. The partial *eta* squared value of approximately 12% is the variance explained by class after excluding the variance explained by other terms. As a rule of thumb, this is a moderate effect size. The *post hoc* multiple comparison analysis of class found that all classes are highly significantly different from each other. Pro class winners have faster reaction times than the sportsman class. The super pro class has faster reaction times than the pro class.

Round was highly significant, $F(1; 17{,}901) = 115$, $p < .001$. Upper rounds have faster reaction times than lower rounds. Though round is highly significant, its effect size is weak. The authors do believe, based on their racing experience, the relatively small differences in reaction time due to round, e.g., a .024 difference in the mean reaction time of sportsman lower and upper rounds, are of practical significance.

The interaction of class and round was highly significant, $F(2; 17{,}901) = 11.8$, $p < .001$. While all three classes have faster reaction times in upper rounds than lower rounds, it appears that sportsman reaction times improve in upper rounds more than pro and super pro do. See Figure 1. The effect size of the interaction is very weak.

Table 1
Means and Medians of Winning Reaction Times

		Mean	Median
Sportsman	Lower Rounds	.086	.031
	Upper Rounds	.062	.047
	All Rounds	.079	.056
Pro	Lower Rounds	.052	.037
	Upper Rounds	.046	.032
	All Rounds	.050	.035
Super pro	Lower Rounds	.028	.019
	Upper Rounds	.028	.018
	All Rounds	.028	.019
All Classes	Lower Rounds	.052	.033
	Upper Rounds	.044	.028
	All Rounds	.050	.031

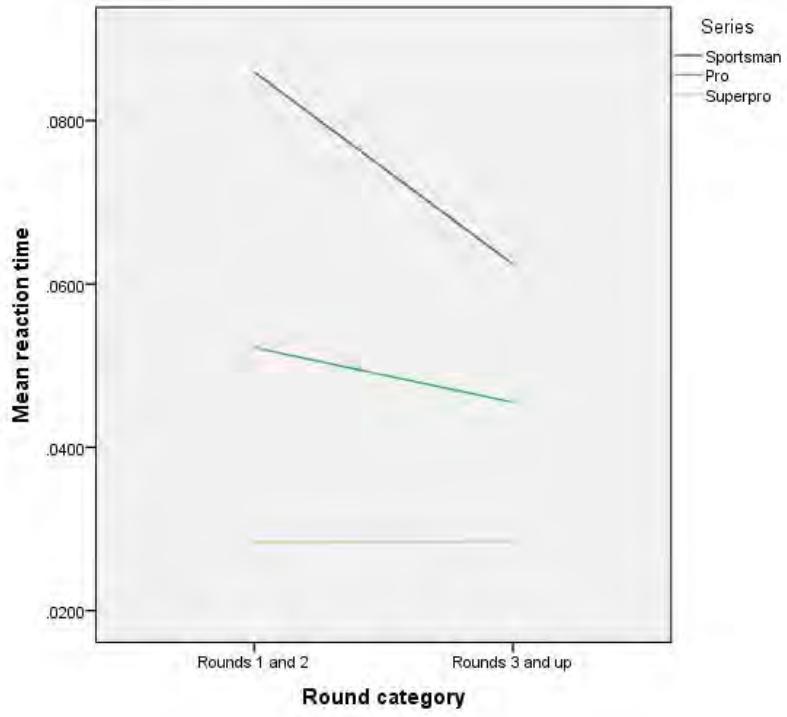


Figure 1.
Plot of Class vs Round Winning Reaction Times

Discussion and Summary of the Study

The results indicated a statistically significant difference exists between classes in the order of the allowed starting line technology for each class. While this was hypothesized, the actual difference was more than expected. The results from early rounds to late rounds are also statistically significant for each class. This was also expected as losers are eliminated each round leaving the better racers in continuing in competition. As figure 1 indicates, the sportsman class improved more than pro and pro more than super pro from early to late rounds. This too is expected. Because the desired or targeted reaction time is as close as possible to .000 (without going under) and because sportsman racers are further away from the target, the sportsman class racer has more room to improve than pro and super pro. Likewise, because the margin for improving is less for super pro, as they are much closer to the targeted reaction time of zero, it is logical they would improve the least in later rounds.

The results of the study indicate the levels of starting line technology allowed in each class may have an impact on the improved reaction times. In drag racing, where races are often won by total margins of victory less than .001 seconds, and where dial-ins of vehicles are written to .01 (hundredth) of a second, a .01 second difference in reaction time is of statistical and practical significance.

With over 35,000 elimination runs in 2013, from 10 of the 117 NHRA member tracks, across 3 of the 7 NHRA Divisions, the data shows super pro racers have nearly twenty thousandth's of a second (.020) better reaction times than pro racers and pro racers have nearly the same twenty thousandth's of a second (.020) better reaction times than the sportsman racers. To a racer, a .020 seconds average starting line advantage can easily be the difference in winning and losing.

Improving the Current and Future Status of the Industry

Bracket racing is the most popular participant form of NHRA drag racing. Bringing statistical evidence to the sport in this form of run data helps to promote and validate the sport.

This information could be useful to many stakeholders including the NHRA sanctioning body, track operators, racers, and after-market equipment manufacturers. For the NHRA rules committee, they have statistical data to reinforce and validate that the rules currently in place help create distinctively different classes.

When considering the approved technology for each class, the handicapped system of bracket racing has created an entire aftermarket electronics industry helping drivers take the fullest advantage of the Christmas Tree system for launching their cars (NHRA, 2009). Aftermarket manufacturers can use this information to tailor the marketing of their products to certain class racers. The information presented may add statistical validity to those claims. In addition, the manufacturers can more effectively market that every racer in a particular class should have every starting line enhancement allowed by the rules.

Racers could use this information to help determine what class they wish to run in and what equipment they wish to install to maximize their starting line advantage. Maybe a sportsman racer will be encouraged by knowing the average reaction time of winning pro racers and will try the higher class because the technology allowed may create the faster reaction time, not necessarily the skill of the driver.

The track promoter could use this information to market bracket racing participation to the racers who come out on street nights, fun nights, or grudge racing nights. These racers typically just come out to have fun by making multiple timed passes in their vehicles without actually racing anyone. The reaction time information from this study could be presented to show how quick of a reaction time the average winning bracket racer has in a particular class. The racer who participates on open night might learn he or she has similar reaction times to the sportsman winners. With encouragement by the management, the open night racer could be converted into a weekly bracket racer contributing more to the bottom line of the successful racetrack.

Further Study

This study has been an enlightening experience for the researchers. Since the completion of the study took longer than the semester, the students were essentially unaware of the results. The study is being turned into a case study to be used in the same course thereby introducing future students to the possibilities of engagement with the motorsports industry. Further studies should be conducted to help understand other factors of bracket drag racing. It is suggested that experimentation studies be conducted to discover all the significant variables that influence winning and their causal relationships.

References

1320go. (2014, March 20). *Multitrack Membership Option*. Retrieved from 1320go: http://1320go.com/racers/multitrack.php

Hall, C., Kauffmann, P., Wuensch, K., Swart, W., DeUrquidi, K., Griffin, O., & Duncan, C. (2015). Aptitude and Personality Traits in Retention of Engineering Students. *Journal of Engineering Education, 104*(2), 167-188. doi:10.1002/jee.20072

Hand, J. (2014, March 20). *Drag Racing with Jim Hand - Part 9: Reaction Time Rollout*. Retrieved from Dapa: http://www.dapa.org/drag-racing-with-jim-hand-part-9-reaction-time-rollout/

Magnante, S. (2003, February 25). *Trans Brake Tech - Stall Speed Surgery.* Retrieved February 24, 2015, from Hot Rod: http://www.hotrod.com/how-to/transmission-drivetrain/113-0205-tci-trans-brakes-review-tech/

McKenna, K. (2008). *How to Drag Race.* North Branch: CarTech, Inc.

Miller, D. (2012). *How to Hook and Launch: Traction Mods for Street and Strip.* North Branch: CarTech, Inc.

NHRA (Director). (2009). *On the Throttle DVD Collection: the First Fifty Years* [Motion Picture].

NHRA. (2013, November 17). *Member Track Locator*. Retrieved from NHRA 101: http://www.nhra.com/nhra101/membertracks.aspx

NHRA. (2014). *2014 NHRA Rulebook*. Retrieved March 20, 2014, from NHRA: http://www.nhra.com/userfiles/file/2014%20ET%20Rule%20Book_120413.pdf

NHRA. (n.d.). *NHRA Glossary of Drag Racing Terms*. Retrieved March 20, 2014, from NHRA: http://www.nhra.com/glossary.aspx

Oberauer, K. (n.d.). *Delay Box 101*. Retrieved February 24, 2015, from Just Drag Racing: http://justdragracing.com/drag-racing-tech/33-drag-racer-aids/17-delay-boxes-101

Slavik, M., Flannagan, M., Sato, T., Traube, E. C., & Aoki, M. (1993). *Reaction Times to Neon, LED, and Fast Incandescent Brake Lamps* . Ann Arbor, Michigan: University of Michigan Transportation Research Institute.

Stump, G. H. (2014). Engineering Students' Intelligence Beliefs and Learning. *Journal of Engineering Education, 103*(3), 369-387. doi:10.1002/jee.20051

Teaching Innovations

Teaching Engine Diagnostics and Monitoring via Customized Microcontroller Board

Dr. Yuetong Lin, Indiana State University, Terre Haute, IN
Mr. Scott Livengood, Indiana State University, Terre Haute, IN
Dr. Phillip Cochrane, Indiana State University, Terre Haute, IN
Dr. M. Affan Badar, Indiana State University, Terre Haute, IN

Introduction

Electrical components and computers are ubiquitous in automobiles. It is estimated the cost of electronics of a mid-sized vehicle will rise by nine to 16 percent each year(Berger, 2002). As consumers become more and more concerned about fuel efficiency, safety and convenience, it is expected that the advances in electrical, electronics, controls and software technologies will be the driving force for developing better automobiles in a sustainable future (Gharavi, Prasad, & Ioannou, 2007). College graduates with fundamental knowledge and experience in vehicle electronics and computer systems will have a noticeable advantage in the very competitive job market.

The Accreditation Board for Engineering and Technology (ABET) program criteria emphasizes the importance of design and application experience in automotive engineering technology (AET) curriculum, in particular the needs to include the component of "the application of computers in analysis, design, manufacturing, and operation of facilities"(Commission, 2009). Despite the consensus that AET curriculum needs more mechatronics material both in theory and experiential learning, vehicular electronics and control systems have yet been systematically integrated into core AET courses, and the lab facility and hardware are still heavily mechanical. Considering the laboratory experiences are vital to engineering and technology education, there is a pressing need to develop new educational equipment and material to bridge the gap between classroom learning and industry knowledge base.

Engine systems and controls is a core course in automotive engineering curriculum that teaches students the theory and application of on-board diagnostics and monitoring system. The nature of the course requires a heavy hands-on laboratory component. Currently, the most common tool in use is the engine diagnosis software from commercial vendors. These software, though providing nice complement to classroom lectures, do have some significant shortcomings that hinder teaching effectiveness:

- They only offer textual rather than graphical interface, which is inadequate to help students visualize the engine status;
- They can only passively display the engine parameters without providing the means for instructors or students to alter values in order to observe pertinent responses;
- They are all proprietary and cannot be easily adapted to different engine types and models

To address the weakness of commercial products and offer better lab support for teaching this important subject, we are interested in building easy-to-use lab equipment so that: a) engine sensors can be monitored and their readings can be accurately displayed in real time; and b) the sensor readings can be adjusted to produce "fake" signals to be fed into the real engine control unit (ECU) to allow students witness projected control actions.

In this paper, we report preliminary results of this effort that focuses on developing customized microcontroller (MCU) boards accompanied with lab modules to engage students in MCU-based, engine-targeted measurements, communications and controls. To this end, we assembled a team that consists of faculty and students from AET, computer engineering technology (CET), and mechanical engineering technology (MET). There has been a renewed emphasis recently on design as a major and distinctive element of engineering education(Froyd, Wankat, & Smith, 2012). In particular, more and more schools are interested in design teams to be comprised of students from different programs. Our project reflects this new trend of practice so that: a) CET students gain practical experience to apply microcontrollers in solving real-world problems; b) AET students will exercise basic auto control actions and learn to collect sensor readings. The project and its assessment data can provide reference on how a multi-disciplinary team can help enhance students' learning experience in engineering design.

Methods

The engine that we work with is General Motors (GM) LS2(*LS2 Engine Horsepower Guide*, 2014). The design of the engines was intended to be the same as the V-8 engines used on GM line of rear wheel drive vehicles. Table 1 shows the key engine sensors and their electrical characteristics.

We take a modular approach for the lab development. Individual modules will be structured to progress from an introduction, to hands-on experience, and then to problem solving. Such an approach has both field and pedagogical justifications:

- Engine's connection to multiple electrical or mechanical sub-systems means that it needs inputs from, and also generates outputs to different units that are highly integrated yet functionally independent. This feature provides the practical foundation for these functions to be built in individual modules.
- Because of their functions, no single course is capable of covering these sub-systems in detail. The AET core curriculum is designed to dedicate one course to one key system. The lab modules can be flexibly integrated into these courses to serve the teaching needs.

Table 1: LS2 Engine Sensors Data

Sensor	Input	Output	Commentary
Crank position sensor	5-Volt reference signal	Frequency modulated pulses	On/off DC pulses of varying frequencies depending upon engine speed
Cam position sensor	5-Volt reference signal	Frequency modulated pulses	On/off DC pulses of varying frequencies depending upon engine speed
Throttle position sensor	5-Volt reference signal	5-Volt return voltage	Two variable resistors; acting with pedal position sensor

Pedal position sensor	5-Volt reference signal		Two low voltages and two 5-Volt reference signals
Manifold absolute pressure sensor	5-Volt provided by ECU	ECU monitors voltage drop across sensor	As manifold pressure changes, voltage drop across sensor changes
Engine coolant temperature sensor	5-Volt provided by ECU	ECU monitors voltage drop across sensor	Thermistor type temperature sensor
Intake air temperature sensor	5-Volt provided by ECU	ECU monitors voltage drop across sensor	Thermistor type temperature sensor
Knock sensor 1 and 2	5-Volt reference signal	5 - 18 kHz	high frequency, short duration signals
Engine oil pressure sensor	5-Volt reference signal	1.0 - 3 Volts	
Ignition coil trigger	Pulse input	Used to generate trigger signals	Supplied to the ECU using the crankshaft position sensor
Heated O2 (HO2) A1	No input	0.3 - 1.0 Volt	Continuously varying with 0.45 Volt as the midrange
Heated O2 B1			

The modular approach has been proven to be effective for single-subject curriculum development (Ashby, 2008; Janz & Moore, 2007; Leang, Pannozzo, Zou, & Devasia, 2007; Zhu et al., 2013). We extend this strategy to address the unique challenge caused by the multi-disciplinary nature of the lab modules to enable the seamless integration into the core courses of all three programs. Each module will balance the depth and scope of its subject concepts to assure that students with different backgrounds can all find their niche. The use of modular structure also facilitates the use of the product by industrial training, as instruction manual can be tailored for specific needs.

In current stage, we focus on designing MCU hardware and software for the Engine Coolant Temperature (ECT) sensor, although as the project continues, it is our ultimate goal to develop separate boards for other selected sensors.

ECT sensor is mainly used by the ECU to monitor engine temperature and adjust ignition timing to avoid detonation. It provides a critical input to the on-board computer regarding the engine running status. Picking the appropriate MCU boards to simulate actual ECT's interaction with ECT sensor (and other engine sensors whose modules to be developed down the road) is critical for the lab development. There are numerous microcontroller board products on the market, yet all of them lack the support for applications that target automotive students as users:

- General-purpose off-the-shelf MCU development kits normally have only core components assembled on the board (Merkel & Fisher, 2006). Students need external circuitry and delicate wiring when interaction is needed between peripheral devices and on-board components. This configuration is indispensable for CET students as they need to learn building the system from scratch, but for AET majors, the primary beneficiaries of this project, it creates unnecessary work load and distracts their attention from studying and operating the system as a whole.

- There are special-purpose boards for automotive environment such as Silicon Lab's C8051F5XXDK kits. Each board, limited by its specific target application and dimension, does not have the needed flexibility to extend to broader applications.
- Besides commercial products, there also exist training systems developed by educational institutions. The boards however, are still intended to serve computer engineering students and lack the support for the automotive mechatronics elements.

It was based on these conclusions that we decided to use the widely-used Arduino board as the base platform. Using Arduino/shield is a novel approach since it offers greater flexibility and adaptability for both project development and dissemination comparing with existing methods. First, Arduino's open-source design allows the boards to be quickly adopted by interested peers or even modified to suit their specific needs. Second, the shield is ideal to accommodating the need of manipulating multiple sensors: each sensor has its own signal conditioning shield; there is no need to alter the Arduino main board; and multiple shields can be stacked to allow different sensors to be processed simultaneously. Finally, Arduino is well supported by its own library and third-party software, which makes developing front-end user-friendly GUI very easy.

Sensor manipulation has been shown to be an effective method in both engine testing and development, and is used to investigate fuel delivery, spark timing, boost pressure, top speed, redline, or other factors. Using the Arduino microcontroller board with customized shield as the signal conditioning (SC) circuitry, we developed the sensor manipulation device along with lab modules to help the automotive students connect classroom learning with real-world problem solving.

The key for sensor manipulation is to create a false virtual reality around the engine control unit (Hartman, 2004). To achieve this, our board is designed to be an input interceptor. As shown in Figure 1, instead of letting engine connect directly to the ECU, we re-wire the cables to lead the engine sensor readings to the customized microcontroller board. A graphical user interface (GUI) that runs on a host PC displays the conditioned engine sensor signals out of the Arduino/shield combination. Not only the students can visualize the engine dynamics through various graphing tools in GUI, more importantly, they are allowed to change the sensory data to strategically "lie" to ECU about the status of one or more engine sensors under certain conditions in such a way that the ECU's standard logic provides modified engine management.

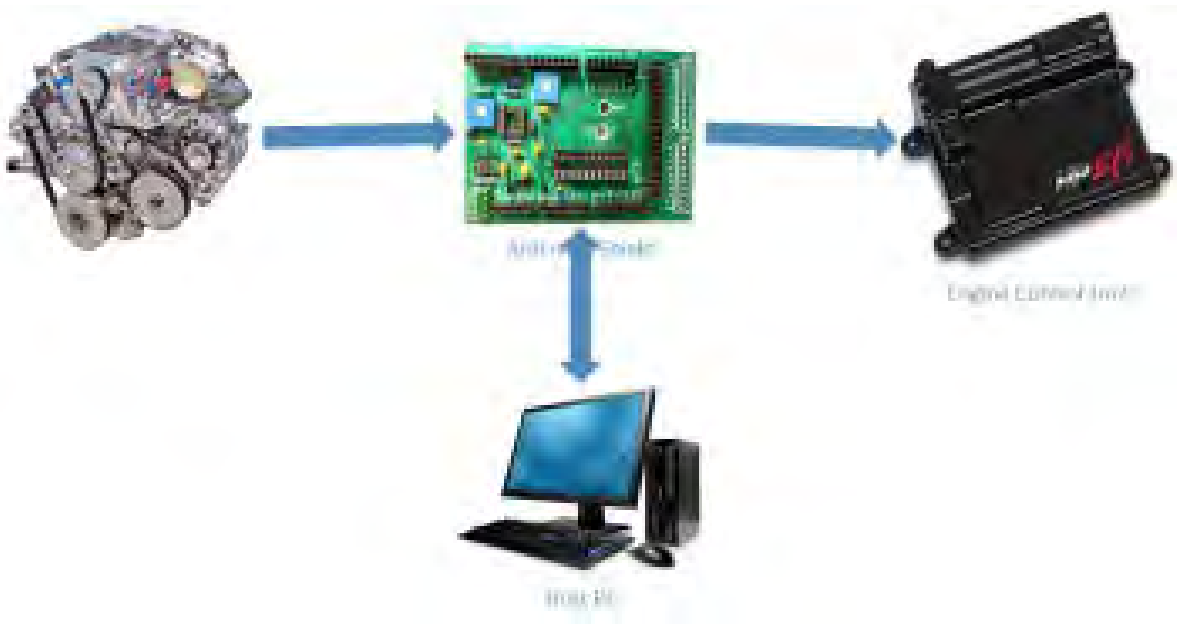


Figure 1: Sensor Manipulation through Arduino/Shield

Results

Figure 2 and Figure 3 show the schematic of the shield design and the final shield board, respectively. This is a single sided board with a "ground pour", i.e., the ground plane surrounds everything. The thermistor is hooked up remotely on engine. It can be anywhere as the board/shield has screw terminals. We had originally used a standard 10k thermistor as the design target for the board. The actual sensor is quite different, and we had to change both the gain from 1.5 to about 5.9, and also the offset. The board will work with just about any resistance type sensor by simply making some resistor changes to set gain and offset. Power (5V and Ground) and the output (V_{out}) to the ADC on the Arduino are on J_2.Pin 3 goes to the analog input.

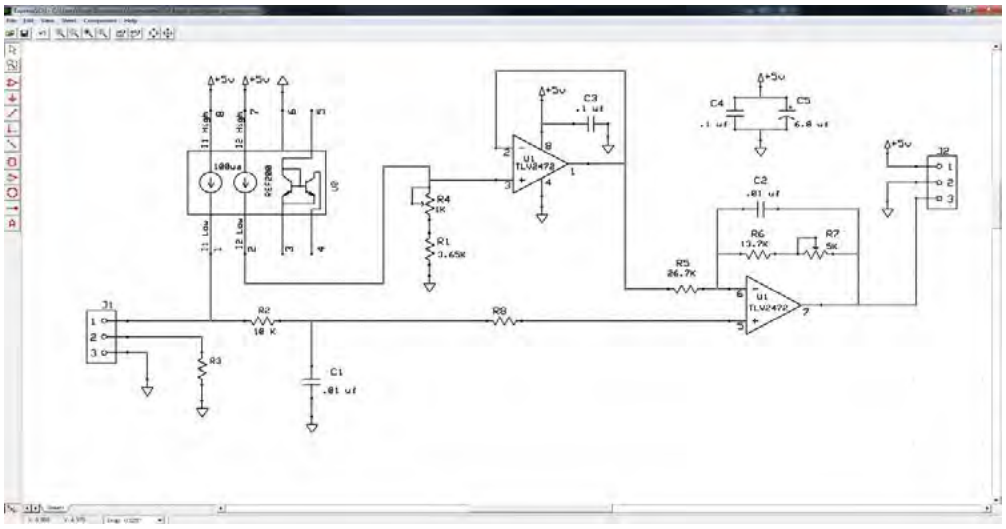


Figure 2: Schematic for Arduino Shield for LS2 Engine Coolant Sensor

Figure 3: Arduino Shield for LS2 Engine Coolant Sensor

The main reasons for us to use this circuit are: a) it will give a full span of 5 Volts, and b) it has a low pass filtering, where C_2 controls the roll off frequency of the low pass filter. Changing the value to 0.47µf creates a filter that drops off everything above 20 Hz. The .01µf capacitor shown in the schematic leads to a cut-off frequency of 1K Hz. C_1 and R_2 also act as a low-pass filter.

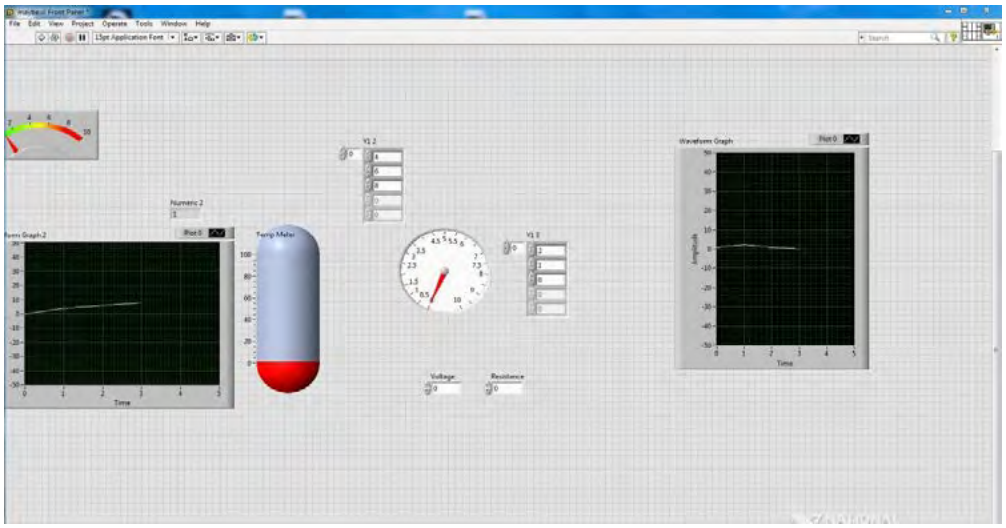


Figure 4: LabVIEW Interface for Arduino Shield

In Figure 4, we show the front panel of the LabVIEW VI for displaying ECT sensor readings in real time. Although Arduino has its own library that could be used to design interface for monitoring and control, we still opted for using LabVIEW because of the professional support and product stability. Also LabVIEW is readily available to most of the engineering programs, which makes the interface development and maintenance almost cost-free.

Discussion

In this paper, we present preliminary progress on using Arduino open-source MCU board with customized shields to collect, monitor, and communicate engine sensor signals. Our test shows the MCU can collect actual engine temperature accurately. The next step is to allow the signals to be altered through the high-end user interface before they are passed on the real ECU to complete the closed-loop control system.

Acknowledgment

This work was supported by the National Science Foundation under Grant DUE-1140748. Any opinion, findings, and conclusions or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

Ashby, J. E. (2008). *The effectiveness of collaborative technologies in remote lab delivery systems.* Paper presented at the Frontiers in Education Conference, 2008. FIE 2008. 38th Annual.

Berger, I. (2002). Can you trust your car? *IEEE SPECTRUM, 39*(4), 40-45.

Commission, A. T. A. (2009). Criteria for Accrediting Engineering Technology Programs: October.

Froyd, J. E., Wankat, P. C., & Smith, K. (2012). Five major shifts in 100 years of engineering education. *Proceedings of the IEEE, 100*(Special Centennial Issue), 1344-1360.

Gharavi, H., Prasad, K. V., & Ioannou, P. (2007). Scanning advanced automobile technology. *PROCEEDINGS-IEEE, 95*(2), 328.

Hartman, J. (2004). *How to Tune and Modify Engine Management Systems*: Motorbooks International.

Janz, K. D., & Moore, M. (2007). *Envisioning new learning spaces: creating a center for visualization at Indiana State University.* Paper presented at the Proceedings of the 35th annual ACM SIGUCCS fall conference.

Leang, K. K., Pannozzo, G., Zou, Q., & Devasia, S. (2007). *A Collaborative Approach to Teach Modeling and Control of Smart Actuators in the Mechanical Engineering Curriculum.* Paper presented at the ASME 2007 International Mechanical Engineering Congress and Exposition.

*LS2 Engine Horsepower Guide*2014). Retrieved from http://www.ebay.com/gds/LS2-Engine-Horsepower-Guide-/10000000178258867/g.html.

Merkel, C. T., & Fisher, D. S. (2006). *Improvements to a mechanical systems course for mechanical engineers.* Paper presented at the Illinis-Indiana and North Central Indiana Joint Section Conference, Indiana Univesity-Purdue University Fort Wayne (IPFW).

Zhu, Y., Tracy, J. B., Dong, J., Jiang, X., Jones, M. G., & Childers, G. (2013). Teaching a Multidisciplinary Nanotechnology Laboratory Course to Undergraduate Students. *Journal of Nano Education, 5*(1), 17-26.

Teaching Innovations

Creating and Sustaining High-Quality Senior Capstone Experiences

Dr. Gretchen A. Mosher, Iowa State University, Ames, IA

Introduction

The 2011 Outcomes Assessment Model for accreditation by the Association of Technology, Management, and Applied Engineering (ATMAE) requires coursework in both management and technical areas of technology, with a "reasonable balance" between the practical application of "how" and more conceptual application of "why" (ATMAE Outcomes Assessment Model, 2013). One way to meet this requirement is with a senior capstone course. Capstone courses focus on the integration and application of technical skills and knowledge along with consideration of multiple realistic constraints. A high quality capstone experience has many positive outcomes for the student, faculty, and department. However, capstone courses can be challenging for both students and faculty.

This paper will outline the challenges and best practices learned in the development and implementation of a senior-level capstone course with technology undergraduates. Specifically, strategies for sourcing student projects, student team formation and management, and options for ensuring accountability among student teams will be discussed.

Senior Capstone Courses

Although capstone courses are an important part of the engineering and engineering technology curriculum, the course structure and format varies widely across educational institutions and degree programs (Pembridge & Paretti, 2010). The emphasis of capstone courses generally give students the opportunity to apply technical tools, techniques and knowledge learned in the classroom to an open-ended, realistic, and creative problem-solving experience (Friesen & Taylor, 2007). The senior capstone course is a fitting experience for graduating seniors in engineering technology as it gives broad exposure to the 4 Pillars of Manufacturing body of knowledge, identified by ATMAE, ABET, and other organizations as the primary quality improvement tool in manufacturing engineering and technology degree programs (Society of Manufacturing Engineers, 2012).

The capstone experience described in this paper is part of an engineering technology program in an agricultural and biosystems engineering department. The department includes four majors: two engineering programs accredited by ABET and two technology degree programs, accredited by ATMAE. The author leads one of two sections of senior capstone courses in engineering technology (which includes the majors of agricultural systems technology and industrial technology) offered by the department. Technology students complete the required two-course sequence in the final year of their baccalaureate degree programs. Teams of three to four students work industry-sponsored projects that are assigned in the middle of the first semester and completed by the end of the second semester.

Historically, the number of students enrolled was approximately 20 students per semester. The author has taught the course for four years, but in that time the enrollment has increased dramatically, as shown in Figure 1.

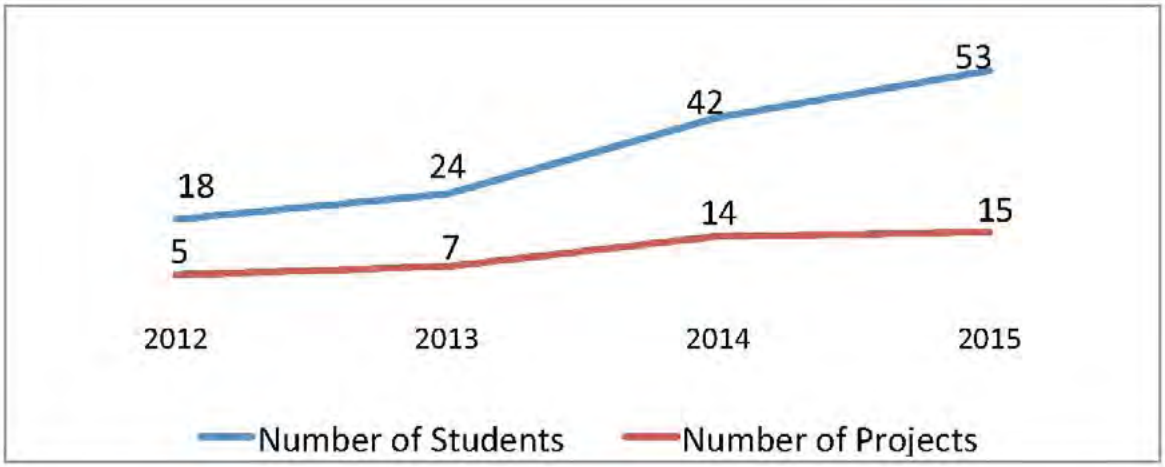


Figure 1. Number of capstone students and projects: 2012 through 2015

Increased enrollments have influenced the way the senior capstone course is taught, but the overriding goal is to keep the hands-on, problem-solving nature of the course, even when the number of students and projects is larger than in the past.

Industry Projects

The use of industry-sponsored projects is the tradition in the author's department. Although the "real-life" aspects of industry-sponsored projects appeal to both faculty and students, these types of projects have both advantages and disadvantages. Advantages to industry-sponsored projects include: students can work a realistic problem, financial support from industrial partner is generally available, student motivation is often higher, and faculty have the opportunity to observe students working in non-academic environments (Magleby et al., 2001; Friesen & Taylor, 2007). Industry-sponsored projects also facilitate outreach from the academic department to industrial stakeholders and provide the mechanism for external and expert opinion needed to validate student learning, as required by many accreditation bodies.

However, industry-sponsored projects also have negative aspects. These include: challenges to sourcing and recruiting students projects, risk of failure has higher stakes, faculty often must work outside of their expertise area, and intellectual property and other administrative issues must be resolved between the academic institution and the industrial partner (Magleby et al., 2001; Friesen & Taylor, 2007). Even with the potential negatives listed here, previous researchers have found that the majority of capstone courses taught in engineering fields utilize industry-sponsored projects (Todd et al., 1993; Howe & Wilbarger, 2005).

To address the issues identified by previous educators concerning the use of industry-sponsored capstone projects, several actions have been taken at the program, department, and college level. The first of these is a project form. The project form describes the engineering technology capstone program to potential clients and helps guide the

thought process of industrial sponsors on project development. The form is circulated among external stakeholders and clients. In addition, when contact is made with the University's service unit for short-term projects, the form is sent to prospective clients, who in turn complete the form with a potential project idea or ideas. Project concepts are submitted to the faculty leading the capstone course. He or she will then vet the projects and present the resulting project ideas to the students for consideration and eventual selection.

The use of the project form addresses several challenges identified by the National Academy of Engineering in 2012. First, all projects are vetted by the instructor or instructors before being accepted as a potential capstone project. This allows for projects to be appropriately scaled for the time period allowed, which is one area of challenge identified by the National Academy of Engineering in their 2012 best practices report.

A second advantage of the project forms is that they require prospective clients to think about the scope of the project before agreeing to participate in the capstone course. Early planning and engagement of industry partners at the beginning of the capstone process is also recommended by the National Academy of Engineering (2012). In this case, project forms are distributed to potential industrial partners at every possible opportunity, including to groups such as the alumni association, the departmental advisory council, and other external units. Project ideas are accepted from prospective clients 12 months a year, and efforts are made to develop relationships with industrial partners that go beyond a one-time course project.

A third advantage of the project forms is that they identify key contact person at each company where projects take place. As suggested by Magleby et al. (2001), the forms allow the instructor to review the project to ensure it is a good fit with University policies, timelines, and resources. Additionally, concerns with intellectual property and liability can be addressed up-front rather than in the middle of the project.

Lastly, the project forms facilitate a strong and structured administration and communication plan between the industrial client and the university. Friesen and Taylor (2007) identify this as a key component for the success of university and industry collaborations. These recommendations also reflect earlier conclusions by Todd, Sorensen, and Magleby (1993) on the design of capstone projects for industrial clients.

Student Team Formation and Project Selection

A second challenge of capstone courses is that the majority of courses are taught using student learning teams (Shuman et al., 2005; Dym et al., 2005). Team selection has been discussed by previous researchers (Pembridge & Paretti, 2010; Dym et al., 2005; Bacon et al., 1999), specifically in terms of most positive classroom outcomes. Although each method has its advantages in certain environments, for long-term projects that have high stakes (as is the case with capstone projects), instructor-selected teams are the recommended method of team selection. To assist with the difficult task of assigning students to teams and then assigning the teams to projects, a method was developed for use in the capstone classroom (Mosher, 2014).

Early in the semester, students must complete a learning styles survey. This activity is more for the students' benefit than for the instructor - students often do not understand how they best learn and this activity gives them a chance to think about and reflect upon on their preferred learning style. Students also complete a detailed form where they identify which courses they have taken, what project management activities they enjoy, and how they handle deadlines and large projects. In class, work styles and project management concepts are discussed and students are prepped for the project assignment process.

As part of the project and team assignment process, students are required to submit a written "bid" that outlines the top three projects they are most interested in completing for their senior capstone project. Information on the projects, the clients, and project background and requirements are presented to the class by the instructor earlier in the semester. Students are required to explain their background and working style and how these skills and abilities would support their work on a specific project. Students may select more than three projects if they wish. They may also explain which projects they would rather not work on.

As part of the written bid assignment, students are allowed to indicate fellow classmates they would like to have as teammates. Students may also identify classmates they would prefer not to work with. Although it is not always possible to honor every request to work with a specific classmate, requests to not work with a certain classmate are always honored. As shown in Table 1, most of the students did not indicate a specific person to work with or not work with. Therefore, student preferences and ultimate assignments were driven almost entirely by their project requests.

Table 1. Student project selection process data for 2014* and 2015**

Action	Met	Not met
Specific teammate request	9 (2014) 20 (2015)	6 (2014) 7 (2015)
Teammate Non-request (requesting to not work with someone)	12 (2014) 9 (2015)	0 (2014) 0 (2015)
Assigned to one of top 3 project choices	41 (2014) 52 (2015)	1 (2014) 1 (2015)

*n=42 total students; **n=53 total students

The entire process for project and team selections lasted approximately three weeks. Although the process of assigning teams and projects closely resembled putting a gigantic jigsaw puzzle together from an instructor standpoint, the final outcome has been very positively received by students. While students have some say in whom they work with and which capstone project they work, the instructor makes the final selection. The process also is inclusive for students who may not have friends or acquaintances in the course. All students receive a project that they already feel some ownership and connection with.

Ensuring Accountability of Students

Fair and consistent assessment of students is always challenging, but the capstone course adds even further challenges (Dutson et al., 1997; Brackin et al., 2011). The evaluation criteria of capstone courses include multiple aspects, some of which cannot be controlled by students or faculty. Brackin et al. (2011) argue that a failed capstone project does not always mean that no learning has occurred. For this reason, evaluating a project simply on its "success" as perceived by the instructor is not always the best practice. Ensuring individual accountability on student teams is also a challenge (Bacon et al., 1999).

Integrating team activities while keeping individual accountability can be facilitated through peer evaluation (Freeman & Dyrenfurth, 2004). The basis for peer evaluation is to counteract the tendency toward "social loafing" – a phenomenon that occurs when individuals lower their effort when working in a team, assuming that other members will pick up their work tasks (Bacon et al., 1999). Michaelsen et al. (2004) suggest that a single peer evaluation is not as effective as multiple evaluations that occur throughout the course. Peer evaluation provides team members the ability to indirectly address low performers on their team. Poor team performance, even of a temporary nature, will negatively impact the grade in this case, as the peer evaluation scores given by teammates constitute approximately 25% of the final grade.

A second way to enhance individual accountability is by using low-stakes assignments (Elbow & Sorcinelli, 2011). In this course, students are required to individually submit a "memo" to their instructor after each instructor and team meeting, summarizing the meeting highlights. Instructor and team meetings occur approximately every two weeks. By providing a synopsis of the content covered in the meeting, students accomplish two tasks: 1) forced record-keeping on project details and 2) providing an indication of accountability for both attending and remaining engaged during the instructor/student meeting. The assignment also gives students the opportunity to summarize what they perceive as the important components of the meeting – completing the learning competencies of evaluation and synopsis – both of which are at the highest levels of Bloom's Taxonomy (Bloom, 1969). The individual meeting synopses comprise approximately 25% of the final grade.

Together with the peer evaluation scores, nearly 50% of the grade is based on individual contributions and the quality of team contributions. A third component of team projects is the management of conflict (Brackin et al, 2011). Remembering that students generally do not have the skills to remediate major conflict within their team, effective mentoring from the instructor is important. For this reason, providing a clear path for expectations and the structure of the course assists students and provides the basis for actions taken by the instructor in response to low student performance.

Implications for Technology Faculty

The use of capstone courses in technology degree programs has many benefits, but adding a capstone course to the degree program can be challenging. The overriding goal of capstone course projects is student learning and this must drive all decision choices regarding project selection, management, and evaluation. A failed project does not necessarily mean that no learning occurred, however, a challenging but positive experience provides benefits to all parties.

The following are primary considerations for faculty in developing and leading a high-quality capstone course for technology undergraduates:

- Appropriate scoping and planning of the project with the client ahead of time
- Ownership and buy-in from students through controlled project and team selection
- High tolerance for ambiguity and uncertainty as students work through the details of the project
- Balanced methods of individual and group accountability

Although leading a capstone course can be challenging, it can also be very rewarding for students, faculty, and industrial clients and remains one of the best ways to evaluate how well students have learned to apply the technical content they have been taught.

References

Association for Technology, Management, and Applied Engineering. (2013). 2011 Outcomes assessment model. Accessed on June 18, 2015 from: www.atmae.org/resource/resmgr/docs/handbook_2011_outcomes_asses.pdf.

Bacon, D.R., Stewart, K.A., & Silver, W.S. (1999). Lessons from the best and worst student team experiences: How a teacher can make the difference. *Journal of Management Education*, 23(5), 467-488.

Bloom, B. S. (1969). *Taxonomy of educational objectives: The classification of educational goals; handbook*. New York, NY: D. McKay Co.

Brackin, P., Knudson, D., Nassersharif, B., O'Bannon, D. (2011). Pedagogical implications of project selection in capstone design courses. *International Journal of Engineering Education*, 27(6), 1164-1173.

Dutson, A.J., Todd, R.H., Magleby, S.P., & Sorensen, C.D. (1997). A review of literature on teaching engineering design through project-oriented capstone courses. *Journal of Engineering Education*, 86(1), 17-28.

Dym, C., Agogino, A.M., Eris, O., Frey, D.D., & Leifer, L.J. (2005). Engineering design thinking, teaching, and learning. *Journal of Engineering Education*, 94(1), 103-120.

Elbow, P. & Sorcinelli, M.D. (2011). Using high-stakes and low-stakes writing to enhance learning. A chapter in *McKeachie's Teaching Tips (13th ed.)*, by M. Svinicki and W.J. McKeachie. Wadsworth: Belmont, CA.

Freeman, S.A. & Dyrenfurth, M.J. (2004). Using peer assessments in team activities. *Journal of Industrial Technology*, 20(1), 2-8.

Friesen, M. & Taylor, K.L. (2007). Perceptions and experiences of industry co-operators in project-based design courses. *International Journal of Engineering Education*, 23(1), 114-119.

Magleby, S.P., Todd, R.H., Pugh, D.L., & Sorensen, C.D. (2001). Selecting appropriate industrial projects for capstone design programs. *International Journal of Engineering Education*, 17(4/5), 400-405.

Michaelsen, L.K., Knight, A.B., & Fink, L.D. (2004). *Team-based learning: A transformative use of small groups in college teaching*. Stylus Publishing: Sterling, VA.

Mosher, G.A. (2014). Enhancing team-based senior capstone projects: Opportunities and challenges. American Society of Engineering Education, North Midwest Regional Conference Paper, October 2014, Iowa City, Iowa.

National Academy of Engineering. (2012). Infusing real world experiences into engineering education. National Academy of Engineering: The National Academies Press, Washington, D.C. Downloaded July 25, 2014 from: www.nae.edu/File.aspx?id=65103.

Pembridge, J.J. & Paretti, M.C. (2010). The current state of capstone design pedagogy. Presented at the *American Society of Engineering Education Annual Conference and Exhibition*. Louisville, KY.

Shuman, L.J., Besterfield-Sacre, M., & McGourty, J. (2005). The ABET "professional skills" – Can they be taught? Can they be assessed? *Journal of Engineering Education*, 94(1), 41-55.

Society of Manufacturing Engineers. (2012). Four pillars of manufacturing knowledge. Downloaded July 6, 2015 from: www.sme.org/fourpillars.

Todd, R.H., Sorensen, C.D., & Magleby, S.P. (1993). Designing a senior capstone course to satisfy industrial customers. *Journal of Engineering Education*, 82(2), 92-100.

Wilbarger, J. & Howe, S. (2005). Current practices in engineering capstone education: Further results from a 2005 nationwide study. Paper presented at the *36th Annual Frontiers in Education Conference*, October 2006, San Diego, CA.

2015 Conference Proceedings

Correction Page

Thursday, November 12 - 3:45pm - 4:30pm

Management

An Overview of Working Capital Management and Its Impact on Profitability of U.S. Manufacturing

Authors: Dr. Nilesh Joshi, Morehead State University, Morehead, KY
Dr. Hans Chapman, Morehead State University, Morehead, KY
Dr. Yuqiu You, Morehead State University, Morehead, KY

Need: Historically, a lot of research has been done on lean systems and just-in-time philosophies. But majority of these research efforts were within the realm of academia. Did actual industry, particularly the manufacturing industry, benefit from these developments? Ideally, the desired effect of implementing such philosophies should reflect in working capital management efficiency of most firms. Thus, it is imperative to examine how working capital management efficiencies have evolved over the years in the US manufacturing industry and how they have impacted the overall profitability of the industry.

Overview: In this research, we examined working capital management trends in the US manufacturing industry during the last decade. The data is collected from financial statements of the last ten years for a sample of ten large-cap manufacturing companies in the US. The key factors calculated and used in the analysis are days sales outstanding, days inventory outstanding, payables period, cash conversion cycle, receivables turnover, inventory turnover, fixed assets turnover, and asset turnover. The two metrics: return on assets (ROA) and the return on invested capital (ROIC) are used to assess the profitability of individual companies. Multiple regression analysis is used to examine the impact of working capital management efficiency as indicated by various efficiency ratios on the profitability of individual companies as well as overall profitability of the industry.

Major Points:

- Overview of US manufacturing industry.
- Data collection for a sample of ten large-cap manufacturing companies for the last ten years.
- Historic trends in working capital management.
- Formulation of a multiple regression analysis model.
- Presentation and analysis of results.
- Impact of working capital management on profitability of the US manufacturing industry.

Summary: This presentation provides an overview of working capital management trends in the US Manufacturing Industry during the last decade. The relationship between various efficiency ratios and overall profitability of the industry is also examined using a multiple regression model. The presentation will be of interest to academicians and industry professional in operations management areas.