Equipping Students with an Engineering Toolbox in a Capstone Design Course

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The Need for a Toolbox

- Preparation for student transition into industry
- Meeting ABET (a) – (k) outcomes
- Address weaknesses identified by Todd et al.[1]

Survey: Weaknesses in Graduates[1]

- Technical arrogance,
- No understanding of manufacturing processes,
- A desire for complicated and "high tech" solutions,
- Lack of design capability or creativity,
- Lack of appreciation for considering alternatives,
- No knowledge of value engineering,
- Lack of appreciation for variation,
- All wanting to be analysts,
- Poor perception of the overall project engineering process,
- Narrow view of engineering and related activities,
- Not wanting to get their hands dirty,
- Manufacturing work considered as boring,
- No understanding of the quality process,
- Weak communication skills
- Little skill or experience working in teams, and
- Being taught to work as individuals.

Course Description

- **Overall goal:** students experience modern engineering design practice and product development process with team oriented, open ended, industry sponsored design projects
- Design teams formed, concepts visualized, alternative solutions, evaluated, and geometry created using CAD systems
- Prototypes built and tested or existing equipment modified and tested
- Students operate in team-based industrial environment with "real-life" industrial projects

Engineering Toolbox

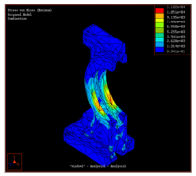
Product Design
PRO/Engineer, 3-D Solid Modeling
Finite Element Analysis (FEA)
Reliability Engineering
Structural Design
Statistical methods in design
Design of Experiments
Quality Engineering
Design for Manufacturing
Design for Worldwide Markets
Intellectual Property

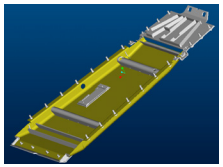
Personal Development
Personal Financial Management
Successful Interviewing
Career Planning

Product and Project Economics
Engineering Economics
Economic justification of designs
Design for Cost
Project Budgeting

Project Management
Project Scheduling
Product Development
Product liability
Product Safety
Product/Project Evaluation

Interpersonal Skills and Ethics
Team Building
Ethical Issues in Engineering Practice





Toolbox Knowledge and Skills

- Engineering design skills
  - Product design
  - Process/system design
- Engineering control skills
  - Production control
  - Cost control

- Problem solving skills
  - Problem definition
  - Solution generation
  - Decision analysis
  - Solution implementation
  - Risk analysis
  - Economic analysis
- Organizational skills
  - Management
  - Communication
  - Interpersonal
  - Leadership
  - Decision making

Meeting ABET Outcomes

- "Hard" skills[2]: Outcomes 3a-c, e, k
- "Professional" skills[2]: Outcomes 3d, f-j
- Engineering toolbox addresses all outcomes, but is strongly focused on "professional skills" that typically are not emphasized elsewhere in curriculum
- Examples: Design for worldwide markets-> 3h
  Product safety and liability -> 3f

Course Evaluation

•Internal evaluation: campus-based, focus groups, mid-term and end of semester surveys

•External evaluation: industry partner project and student evaluation, product adoption for commercialization, student employment by industry partner, continued project sponsorship

Conclusions

•Industry-linked capstone design course provides smooth transition into industry environment

•Toolbox concept provides compendium of topics that arm students with additional knowledge and skills that help them to be effective practicing engineers

•Toolbox is a vital part of course curriculum that helps students create a product that has a high probability of being put into production by the industry sponsor

References

1. Todd, R.H, C.D. Sorensen, and S.P. Magleby, 1993. "Designing a Senior Capstone Course to Satisfy Industrial Customers," Journal of Engineering Education, 82(2): 92-100.
2. Shuman, L.J., M. Besterfield-Sacre, and J. McGourty, 2005. "The ABET 'Professional Skills' -Can They Be Taught? Can They Be Assessed?" Journal of Engineering Education, 94(1): 41-54.