

Community Engagement Activities in Engineering Design

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USING SOCIETAL ISSUES TO RECRUIT AND RETAIN STEM STUDENTS –
IINSPIRE PEDAGOGY WORKSHOP

Context: Engineering Design @ Wartburg

Engineering Science @ Wartburg

- Full 4 year BA program
- General Engineering – strong foundation for industry or graduate school specialization
- 50-70 students
- 2 Faculty



Engineering Design @ Wartburg

- Goal: Create a product, component, or process that solves an identified problem
 - Constrained by resources and customer requirements
 - Uses technical engineering, scientific, and mathematical knowledge and skills
- Design Sequence
 - ES 151 – Freshmen – ½ semester design, build, test project – motivation for the major
 - ES 350 – Introduction to Design – Juniors – full semester design project – learn design method
 - ES 360/460 – Senior Design – 2 semester design, build, test, deliver project – apply design & technical skills, project management
 - All projects are motivated by real world clients – senior Design provides service to non-profits.

ES 151 – Freshman Design Project

Pedagogy Goals:

- Introduce Engineering Design
- Motivate future technical classes
- Begin to form strong team work skills & cohorts
- Excite students about Engineering – hands on, helpful, fun

Approach

- Abbreviated design process based on Six Sigma
 - No technical engineering knowledge required
- 3.5 hours each week – introduce methods + team work time
- Full project: design, build, test
- Teams assigned based on requests and skills

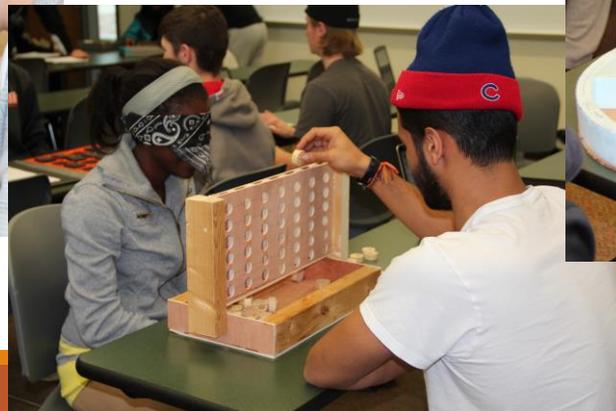
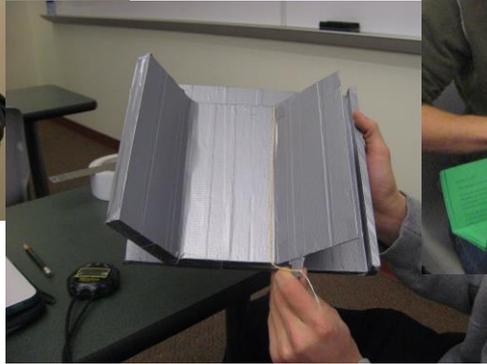
Schedule:

- Week 1: Defining the problem, customers, and their requirements
- Week 2: Developing and selecting ideas
- Week 3: Designing the selected idea
- Week 4 & 5: Fabrication
- Week 6: Testing
- Week 7: Review, Revise, Reflect, Report

Problems – Service Inspired

- 2011-2014: Design a mechanical device to assist elderly with paper folding
- 2015 – current: Redesign a children’s game for disabled child (limited sight, limited hand motion)

ES 151 – Freshmen Examples



ES 350 – Introduction to Design (Junior)

Pedagogy Goals:

- Learn the Six Sigma (DMADV) approach to Engineering Design
- Apply knowledge from previous classes
- Develop team work skills
- Appreciate Engineering as a service profession

Approach

- Modified design process based on Six Sigma
- Partial Project – Design only
- 3.5 hr class – tool lecture + team work time + one-on-one team meetings with instructor
- Teams assigned anonymously based on skills

Schedule

- Week 1: Intro, team selection, project ideas
- Week 2: **Define** the problem
- Week 2 & 3: **Measure** customer requirements & engineering specifications
- Week 4 – 6: **Analyze** possible solutions, predicting specs, selecting approach
- Week 7 – 10: **Design** the solution (technical predictions, specifications, fabrication methods, economic feasibility, etc)
- Week 11 – 12: **Verify** through testing plan, **report**, and reflect

Project – Service Inspired

- Create a device that would improve life in the third world (and is powered by a bicycle)
 - Appropriate for a micro-economy set-up

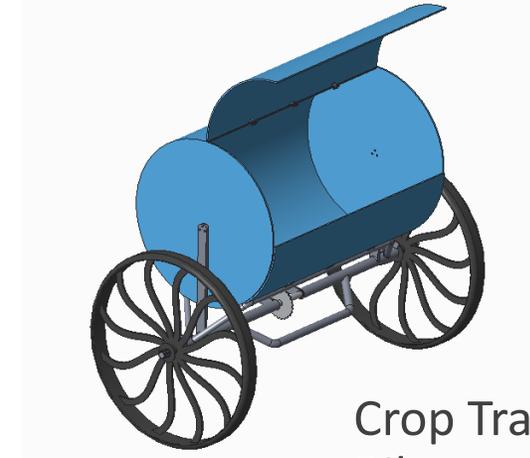
ES 350 – Intro to Design Examples



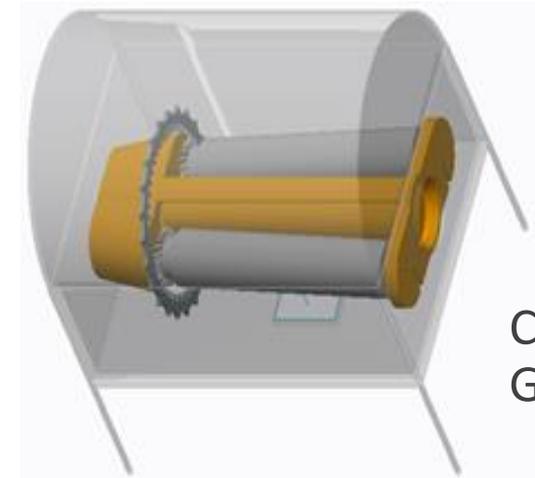
Pediatric Prosthetic Arm



Grain Grinder



Crop Transportation
Bike attachment



Corn Cob
Grinder

ES 360/460 – Senior Design

Pedagogy Goals:

- Provide students with “real world” experience in engineering design
 - Real constraints & consequences
 - Examples and stories for interviews
- Experience with team and project management
- Culmination of Engineering curriculum – tie it all together

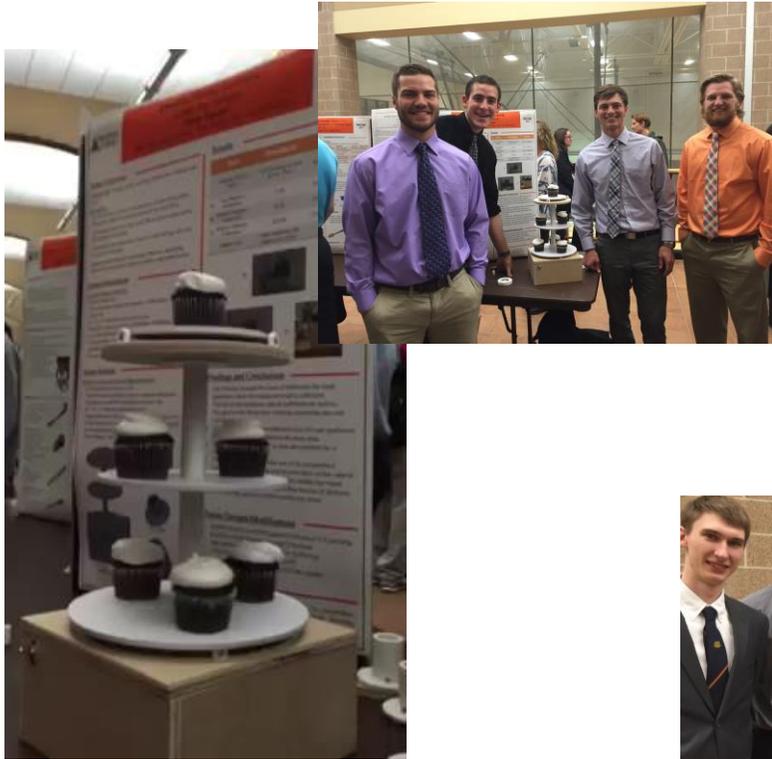
Approach:

- Year long project for real non-profit partner
 - Design, Build, Test, Deliver
- Student run project – weekly meetings with instructor
 - Use tools from previous design classes & technical knowledge from curriculum + self-learning

Primary Components:

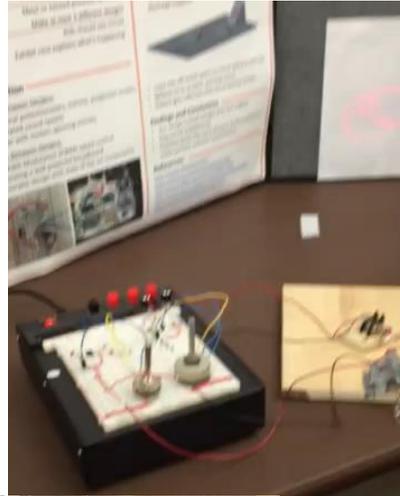
- Long term non-profit partners
 - New project each year – match student interests & partner needs
 - Regular interaction & feedback
- Student managed project
 - Communication, timeline, team management, etc
 - Professional interactions – partner/client & instructor
 - Weekly check-in with instructor (manager)
- ~~Writing~~ Communication intensive
 - Memos, reports, presentations, meeting records, DMADVR workbook, CAD files, etc
- Assessment/Grading
 - Regular feedback, changes allowed until end of semester
- Reflection
 - Discussion, memos, and peer review

Senior Design Examples (2015)



Rotating Cake Stand

- Dr. Penni Pier



Laser Spirograph

- Grout Museum, Imaginarium, Waterloo



Bike Check-out Racks

- Wartburg Sustainability & Library

Long Term Partnership Examples - Larrabee



Larrabee Center

- “Assist persons with disabilities and the elderly to become or remain valued members of their community”
- Vocational and Residential services

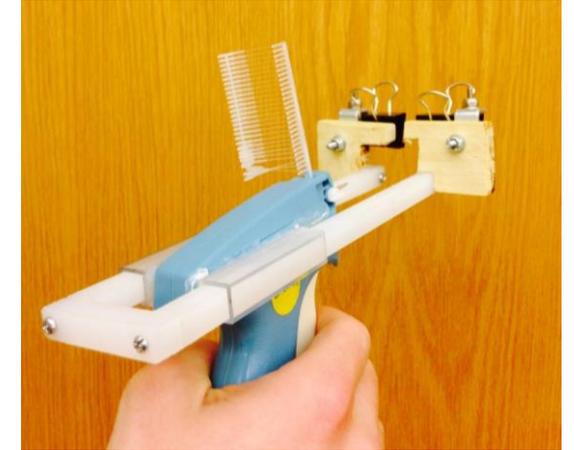


Assistive Glove

- Weak hand, Wheel chair
- Hook & pocket

Quad-cane tray

- Right side paralysis
- Common falls
- Kitchen transport



Modified Tag Gun

- Trinkets & Togs
- Shaky hands = common injuries
- Forward clamps remove fingers from needle range

Conclusion - Reflection

Benefits – Students

- Motivating
- Valuable experiences for the future
 - Team work, time management, design process, addressing set-backs, professionalism
 - Interview discussion topics
- Fun

Benefits – Professor

- Closer/Different relationship with students
- Different work load expectations
- See students with variety of gifts thrive
- Fun

Challenges – Students

- Open ended projects (determining direction)
- Time management
- Contributing to a team

Challenges – Professor

- Can not be “the expert” – model life long learning
- Dealing with ineffective teams
- Maintaining partner relationships while giving students primary responsibility
- Funding