Design, Prototype, & Build: The Engineering Technology Capstone Experience

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What are Design, Prototype, & Build classes?

- **They are variants of two HIP-types:**
  - *Project-Based Learning*
  - *Capstone/Milestone* Experiences
- **"Real world" learning opportunities**
  - Engaging, hands-on, open-ended projects
  - Poorly defined/articulated at front end
- **Lots of Self-Direction in Project Choice**
  - Student buy-in => ***Engagement***

Engineering Technology (ET) Multiple Design/Prototype/Build Classes:

- **ENTC 3710—Manual CNC Programming**
- **ENTC 3600—Manuf. Technologies (AKA "Guitar Building")**

- **ENTC 4600—Tech. Practicum (Dept)**
- ***ENTC 4357—CIM Apps (Programmatic)***

ENTC 4357—CIM Apps Capstone Class

- **Programmatic capstone (3 ET Concentrations)**
  - Manufacturing Engineering Technology (128 cr/ABET)
  - Product Development (128 cr) &
  - Industrial Technology (120 cr)
- **Multidisciplinary (MGMT 4357)**
  - Business majors (mostly from MGMT/MKGT areas)
- **Two dedicated faculty from each discipline**
  - Hemphill – ENTC (since late 1990s)

ENTC 4357—CIM Apps Programmatic Capstone Class

- **The first ENTC course to adopt the "Design, Prototype, Build" project model**
- **Team-based, Student-lead**
- **Deliverables:**
  - Product—Min: 20 units plus group members
  - Business plan & *FULL* product build & tooling data
  - Individual: End of semester paper (*The Goal*)

ENTC 4357—CIM Apps Capstone Class

- **Multi-step Process:**
  - Student teams determine, design, & prototype product ideas for competition
  - Students/Faculty vote & product teams realigned
  - Product refinement
  - Tooling design, fabricated, & tested
  - Limited “pilot production” of deliverable parts

ENTC 4357—CIM Apps Capstone Class

"My job is to manage the chaos & then add to it"

- **Features & Options**
- **Continuous, Incremental Change**
  - Watch for feature creep & sub-optimization:
    - "Better is the enemy of good enough"
    - "Don't get bit by the high-tech dumba**."

ENTC 4357—CIM Apps Capstone Class

- **Prerequisites:**
  - CADD
  - CAM/CNC
  - Principles of Electronics
  - Project Scheduling
  - Other classes including Supervision & Safety
- **Course is really about *PROCESS* not part.**

"The meaning is in the search."

ENTC 4357—CIM Apps Capstone Class

- **For ETs: Two primary topic areas:**
  - Engineering Documentation Configuration Mgmt
    - Understand, master, & control engineering change
    - Multiple revisions
  - Use of standards and best practices
    http://faculty.etsu.edu/hemphill/pdf/ETSU_Standards-CADD_CAM_CNC-RevF.pdf
    Google ***"standards CADD CAM CNC Layer Naming"***

"Named Layers" Embedded Design & Manuf. Data

Examples:

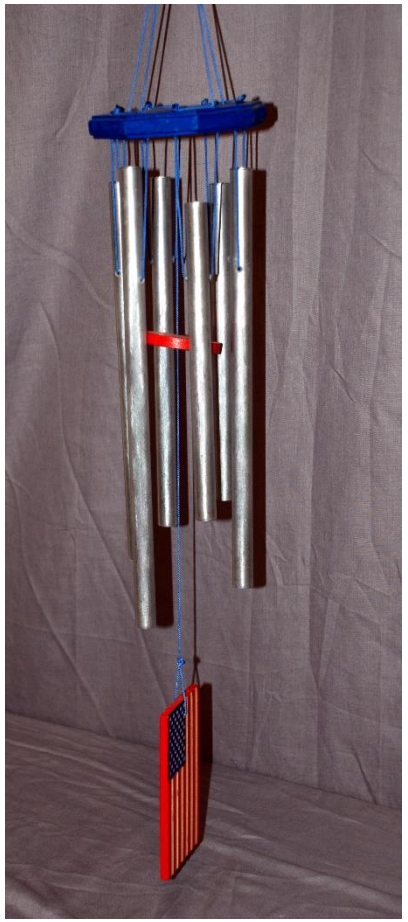
CPB_0500-Cavity_Deep	**C**enterline (tool) **P**ath, **B**ottom side, ***½" DIA*** cutter for the ***deep cavity*** pocket
CPB_TL_0500-T_Nut_Flush_Rough	**C**enterline (tool) **P**ath, **B**ottom side, **T**oo**L**ing **½" DIA** cutter for the **T-Nut** rim (**Flush** mount pocket); **Rough**ing pass
CPT_0188-Hole_Vol_Tone_Pot	**C**enterline (tool) ***P***ath, ***T***op side, ***3/16" DIA*** cutter for THRU holes for the ***Vol***ume & ***Tone Pot***s
CPZ-Cover-Lucy_4-Vector_Cut	**C**enterline ***P***ath, ***Laser***; ***Cover*** for a model ***4 Lucy*** (semi-hollow electric guitar), ***Vector Cut*** data
EDB-Cavity-Deep	***ED***ge, ***B***ottom side of the ***Deep Cavity*** pocket
EL-Humbucker_Generic	***EL***ectronics, **G**eneric Humbucker
EL-Switch-6_Position_Rotary-StewMac	***EL***ectronics, ***6-Position Rotary Switch***, ***(Stew***art ***Mac***Donald, vendor)
REF-Fret_21_of 25500 String_Length	***REF***erence data: Location of ***21st Fret*** of ***25-½" String Length***

National STEM Guitars Project & ETSU's ENTC 3600 "Milestone" Class

- **Best "STEM Engagement" Idea *Ever***
- **Design/prototype/build custom electric guitars**
- **Very "press" and social media-friendly**
  - Great for recruiting, outreach & "branding"

www.Facebook.com/ETSUGuitars

Examples of Student Work



Examples of Student Work

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Features

- Direct Wall Mount
- Magnetic Wall Mount
- Magnetic Surface Mount Option
- Strong magnet to catch bottle caps (approximately 20)

DPB Classes: Lessons Learned

- **All of these particular classes are**
  - Memorial learning experiences (students)
  - Pedagogically sound (employer & alumni feedback)
  - Resource hogs:
    - State of the market equipment (i.e. cost money)
    - Real raw materials (i.e. cost money)
    - Huge out-of-classroom time commitments (students and faculty)

Departmental Fee (Program Fee)

- **Engineering Technology students pay *$60/credit hour* programmatic fee**
- **Department Chair & Program Coordinators coordinate spending**
  - "Procard" (Visa): raw materials & consumables
  - Chair's E-mail: "Stop spending. Immediately."

"Rotating Equipment"

- **Our equipment is dangerous**
  - Serious liability issues
- **Training is required**
- **100% oversight is required**
  - Faculty, GAs, and appropriate staff

DPB Class Implementation—Negative Issues

- **All classes use the same equipment**
  - One CNC router ($55K, 2003)
  - One abrasive waterjet ($220K, 2011)
  - One 75W CO_2 laser engraver/cutter ($75K, 2014)
- **Difficulty scheduling & coordinating in-class & out-of-class access (multiple majors)**

DPB Class Implementation—Negative Issues

- Multiple “Single Points of Failure”
- All major equipment is “mission critical”
- Tremendous amount of activity and guidance outside of class
- Custom designs require custom feedback

ENTC 4357—CIM Apps Negative Issues

- Multiple teams vying for equipment access ALL. THE. TIME.
- Secure storage for raw materials, WIP, & finished goods.
- Cost sharing required between ENTC Fee and Dean's office (MGMT).

Summary

- Design, Prototype, Build HIP classes are relevant, meaningful & desired by Engineering Technology students and their potential employers.
- Despite the real & significant costs, the rewards of the DPB HIP classes are well worth the effort and financial investment.

Questions?

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