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:
  o Project-Based Learning
  o Capstone/Milestone Experiences

• “Real world” learning opportunities
  o Engaging, hands-on, open-ended projects
  o Poorly defined/articulated at front end

• Lots of Self-Direction in Project Choice
  o 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:
  o Product—Min: 20 units plus group members
  o Business plan & FULL product build & tooling data
  o Individual: End of semester paper (The Goal)
ENTC 4357—CIM Apps Capstone Class

• Multi-step Process:
  o Student teams determine, design, & prototype product ideas for competition
  o Students/Faculty vote & product teams realigned
  o Product refinement
  o Tooling design, fabricated, & tested
  o 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
  o 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:
  o CADD
  o CAM/CNC
  o Principles of Electronics
  o Project Scheduling
  o Other classes including Supervision & Safety

• Course is really about **PROCESS** not part.
  “The meaning is in the search.”
• For ETs: Two primary topic areas:
  o Engineering Documentation Configuration Mgmt
    ▪ Understand, master, & control engineering change
    ▪ Multiple revisions
  o Use of standards and best practices
    Google "standards CADD CAM CNC Layer Naming"
“Named Layers”
Embedded Design & Manuf. Data

Examples:

CPB_0500-Cavity_Deep ................................................. Centerline (tool) Path, Bottom side, ½” DIA cutter for the deep cavity pocket
CPB_TL_0500-T_Nut_Flush_Rough .................................. Centerline (tool) Path, Bottom side, Tooling ½” DIA cutter for the T-Nut rim (Flush mount pocket); Roughing pass
CPT_0188-Hole_Vol_Tone_Pot ........................................... Centerline (tool) Path, Top side, 3/16” DIA cutter for THRU holes for the Volume & Tone Pots
CPZ-Cover-Lucy_4-Vector_Cut .......................................... Centerline Path, Laser; Cover for a model 4 Lucy (semi-hollow electric guitar), Vector Cut data
EDB-Cavity-Deep .......................................................... Edge, Bottom side of the Deep Cavity pocket
EL-Humbucker_Generic ................................................... Electronics, Generic Humbucker
EL-Switch-6_Position_Rotary-StewMac ............................ Electronics, 6-Position Rotary Switch, (Stewart Mac Donald, vendor)
REF-Fret_21_of_25500_String_Length ............................... Reference 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

[Images of various woodworking projects and a wind chime]
Examples of Student Work
Examples of Student Work
Examples of Student Work
Examples of Student Work
Examples of Student Work
Examples of Student Work
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Examples of Student Work

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
  o “Procard” (Visa): raw materials & consumables
  o Chair’s E-mail: “Stop spending. Immediately.”
“Rotating Equipment”

• Our equipment is dangerous
  o Serious liability issues
• Training is required
• 100% oversight is required
  o 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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