

CSE 453
Hardware/Software Integrated System Design
Project Overview

The Tracks

- Industry
- Research

The Projects

- Real World Project
- Real Client
- Deliverable Project
 - ☞ The deliverable will be used!
- The Bottom Line...

The Project MUST Work!

Industry Track

- Requires develop of user documentation on the product
- Great option for those considering industry after graduation

Laptop Controlled Device to Provide Communication & Environmental Control for an ALS Patient

- Problem
 - ☞ People with severe physical disabilities rely on others for every aspect of their lives
 - ☞ Communication
 - ☞ Comfort
 - ☞ Basic Needs
- The Client
 - ☞ Tim
 - ☞ Late stage ALS patient
 - ☞ Resides at Elderwood at Williamsville
 - ☞ Two small children
 - ☞ This project will significant increase the quality of this family's life
- Solution
 - ☞ Design a system that will allow an patient in the late stages of ALS to control items in his room & text/e-mail his wife and kids
 - ☞ TV
 - ☞ Fan
 - ☞ Call Light
 - ☞ Must integrate with his computer
 - ☞ Sony version of the Microsoft Surface
 - ☞ Must utilize the input device he utilizes
 - ☞ Sentry Eye Tracker – Steelseries

↳ <https://steelseries.com/gaming-controllers/sentry>

STEM

- What is STEM?

- ↳ Science
- ↳ Technology
- ↳ Engineering
- ↳ Math

- Why is STEM Important?

- ↳ Shortage of STEM related professionals in the United States
- ↳ National Security Impact
 - ↳ Department of Defense (DOD)
- ↳ We need to remain at the forefront of technology to remain strong
- ↳ The United States is not there right now
 - ↳ We used to be
- ↳ The federal government realizes this problem
 - ↳ Influx of federal funds to solve this problem

The Next Three Projects

- Problem

- ↳ Shortage of STEM Professionals
 - ↳ Projected to become more pronounced in the future

- Solution

- ↳ Generate interest in STEM fields among children (K12 population)
 - ↳ How?
 - ✓ The WOW Factor
 - ✓ Hands-on Learning
 - ✓ Inquiry Based Learning

- Impact

- ↳ Generate excitement among children so that they take more of an interest in STEM fields
- ↳ Systems will be used in local schools to generate interest in STEM
- ↳ Systems will be used in various outreach events in local school districts
 - ↳ Alden
 - ↳ Depew
 - ↳ Warsaw
 - ↳ Buffalo

The Tank

- Based on Last Year's Cannon

- ↳ Cannon's Problem Statement
 - ↳ PHET is used as a teaching tool
 - ✓ <http://phet.colorado.edu/en/simulation/legacy/projectile-motion>
 - ↳ Simulations are not engaging enough
 - ↳ Bring the simulation to life!

- Based on Last Year's Cannon

- ☞ Solution

- ☞ Build the Canon

- ✓ Pneumatic
 - Computer controlled pressure
 - ✓ Variable barrel angle
 - ✓ Fires tennis ball sized projectiles
 - ✓ Fully instrumented
 - ✓ Safety is paramount

- ☞ Goal

- ✓ Repeatedly hit a target
 - ✓ Repeatability
 - ✓ Accuracy

- Here's what the cannon team came up with...



- The Problem

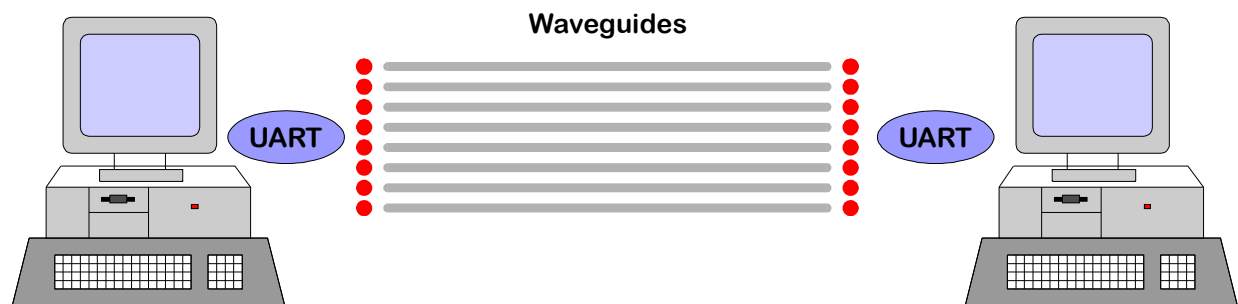
- ☞ The cannon is a prototype
 - ☞ It needs to be ruggedized
 - ☞ The cannon is too hard to move

- Solution

- ☞ Turn the cannon into a tank
 - ☞ Place it on a movable platform that can be driven remotely
 - ☞ Cannon must be ruggedized to withstand the student/teacher use without interaction from the technical team
 - ☞ Rewiring
 - ☞ Hardening
 - ☞ Addressing Glitches
 - ☞ Additional feature could be added
 - ☞ Rotating Turret
 - ✓ Allows the barrel to be aimed left or right

Interactive Learning Tool to Demonstrate Using Light to Transmit Information

- Problem
 - ☞ Teaching electrical & computer concepts to a youngster can be challenging
 - ☞ Why?
 - ✓ You can't see electricity
 - ✓ It is difficult to fathom how information can be transmitted & processed so quickly
 - ☞ Develop a System to Teach & Reinforce:
 - ☞ How light can be used to transmit information
 - Target Audience
 - ☞ Elementary & Middle School Students
 - Solution
 - ☞ Build a system so students can visualize the following concepts



- ☞ How data is transmitted using optical fiber
 - ✓ Single Shot Mode
 - Transmit a character in ASCII
 - Kids see the LEDs representing 1's and 0's
 - ✓ Message Transmission Mode
 - Synchronous System
 - Variable Period
 - Slow Speed → Kids can see transmissions
 - High Speed ☐ Kids can begin to realize how data can be transmitted quickly
- ☞ Goal
 - ☞ Inquiry Based Learning
 - ☞ Meets Next Generation Science Standards
 - ✓ NGSS

Robotics & Programming

- Problem
 - ☞ CS For All Initiative
 - ☞ Lack of STEM Professionals
 - ☞ Make Programming Fun & Engaging for Students
- Solution
 - ☞ A programming framework that uses robots to introduce high school students to programming

- Client
 - ☞ Depew High School
- Flexibility
 - ☞ The client is trying to figure out an innovative way to address this
 - ☞ Input from us is invited

The Automated Locker

- The Problem
 - ☞ K12 students with physical impairments may not be able to use a locker
- The Solution
 - ☞ Enable these students to use a locker
 - ☞ Innovative approach is needed to open the lock
 - ☞ Finger Print Scanning
 - ☞ Can the team incorporate a feature that allows the student to attempt to open the locker, but after so many failed attempts it opens with a fallback method?
 - ☞ Encourages student to try, developing physical skills
- Side Note
 - ☞ Students in a Creativity Class the idea
 - ☞ Part of the project will be interacting with them
 - ☞ They will learn more about
 - ✓ The design process
 - ✓ Product development process
- Client
 - ☞ Alden Middle/High School
 - ☞ Jenna Ziegler
 - ☞ Mary Beth Marko
 - ☞ Creative Class
 - ☞ Special Ed Students

Device to Assist Teachers in Preventing a Special Needs Student from Wandering Away

- The Problem
 - ☞ Special Education student likes to 'run'
 - ☞ She wanders off from her class
- The Solution
 - ☞ Develop a system that
 - ☞ Provides feedback for her to return to her class
 - ☞ Allows faculty & staff to determine her whereabouts if she wanders off
- Client
 - ☞ Alden Primary School

Teddy Bear Talker

- **Problem**

- ☞ A girl with a developmental disability cannot communicate
- ☞ She is 5 to 6 years old, but cognitively she is where a 1 year old might be

- **Solution**

- ☞ Integrate sensors, a microprocessor, speaker, GPS (and possibly WiFi) into a stuffed animal
- ☞ When she hugs the bear, it speaks
 - ↳ **The harder she hugs, the louder it speaks**
- ☞ Speech output determined by location and time of day, a programmed by her teachers
 - ↳ **Programming interface for teachers/family required**
- ☞ Must have ability to add a touch screen so the bear can grow with her

Rowing Machine

- **Problem**

- ☞ A rowing machine is being developed which takes transducer input, processes the data, & creates an image on a computer display to simulate a real rowing environment

- **Solution**

- ☞ Involves designing & developing bridge circuits, noise filters, routines for data analysis, display, & gaming

- **Client**

- ☞ Sharp Tooling

Northrup Grumman Bird Chirp Classifier

- **EAS 494 (Interdisciplinary Senior Design)**

- **Industry Project**

- ☞ Northrup Grumman Amherst Systems

- **Problem**

- ☞ Develop a system to identify bird types from the sound of their chirps from digital audio input
- ☞ Trade Study Required
 - ↳ Research & analyze machine learning algorithms, tools, & architecture for implementing said algorithms

- **Solution**

- ☞ Software & FPGA frameworks
- ☞ Should run without Internet access
- ☞ Deliverable system

- **Team**

- ☞ EE & CEN

Lockheed Quadcopter

- EAS 494 (Interdisciplinary Senior Design)
- Industry Project
 - ☞ Lockheed Martin
- Problem
 - ☞ Send a targeting quadcopter to operational area
 - ☞ Identifies drop zones
 - ✓ Laser?
 - ☞ Payload quadcopter delivers payload to identified area
 - ☞ Multiple payloads (up to 4) are possible
 - ✓ Must be within one meter of target
 - ☞ Uses only a remote video feed
- Solution
 - ☞ Use only commercially available hardware & flight control software
 - ☞ Emphasis
 - ☞ Remote sensing
 - ☞ Communication
 - ☞ Payload release
- Team
 - ☞ 3 ME, 2 EE & 2 CEN

Bike Simulator

- University Project
 - ☞ UB SEAS Driving Simulation Lab
- Problem
 - ☞ Develop a fully functional bike simulator
 - ☞ User rides stationary bike
 - ☞ Visuals updates (based on speed/maneuvers)
- Solution
 - ☞ Must be fully functional, integrating sensors, DAQ system/microcontroller, & VR platform
- Team
 - ☞ 3-5 ME, 2 CEN, 3 CS

2D CubeSat Attitude Control System Testbed

- University Project
 - ☞ Inspired by a project from the NASA-Goddard Space Flight Center
- Problem
 - ☞ Develop a 2 dimensional control test bench
 - ☞ Allows for algorithms or systems that would normally be simulated to be physically tested

- **Solution**
 - ☞ Gyroscope system allows free rotation along two axis of rotation
 - ↳ Requires in depth analysis on flywheels
 - ☞ Sensor input used by microcontroller to calibrate factors that affect the CubeSat
- **Variant**
 - ☞ Create an educational outreach kit for high school through graduate school exemplifying the engineering principles learned in college.
- Previous three projects (EAS 494) must be filled for this one to become a reality
- **Team**
 - ☞ 3 ME, 2 EE & 1 CS/CEN

Research Track

- May result in a research paper instead of user documentation on the product
- Great option for those considering graduate school or academia

AutoDietary II

- **Problem**
 - ☞ Wearable necklace records eating sounds via a microphone & transmits data to an Android device via NFC or BLE for processing.
 - ☞ App must be developed using the aforementioned hardware to analyze & visualize eating information & statistics
- **Solution**
 - ☞ Hardware development
 - ↳ Necklace
 - ↳ 3D Printing the necklace itself
 - ☞ Software Development
 - ↳ App & Drivers
 - ↳ **Android Programming Required**
- **Client**
 - ☞ Dr. Wenyao Xu, CSE Assistant Professor

Better Brains for RC Servos in Robotics

- **Problem**
 - ☞ Motors are essential for building robots.
 - ☞ High-grade Actuators
 - ↳ Integrate high precision encoders, motor drivers, and load sensors
 - ↳ Expensive
 - ☞ Hobby RC servos
 - ↳ Low cost alternative
 - ↳ Raw power can approach the power of robotics actuators

- **Solution**
 - ☞ Replace the driving circuits for an RC servo
 - ↳ Turn it into a high-grade actuator
 - ☞ **Required Key Features**
 - ↳ Addressable via serial protocols
 - ↳ Run in different control modes (position, velocity)
 - ↳ Can measure/limit current
 - ☞ **Starting Point**
 - ↳ Some similar open source projects (e.g. OpenServo) exist.
 - ☞ **Upon Completion**
 - ↳ Project will be immediately incorporated into a robot used in research.
- **Impact**
 - ☞ **Inexpensive Robots**
 - ↳ Provide for increased integration into our daily lives
 - ☞ **Improved quality of life for many people in our society**
 - ↳ Helping the disabled live more independently
 - ↳ Reducing the risks for first responders
- **Client**
 - ☞ Dr. Nils Napp, CSE Assistant Professor

Integrating Robots with 3D Printed Environments

- **Problem**
 - ☞ Integrating things like capacitive switches & conductive ink into 3D printed environments to create an environment that the robot can operate in to perform some specific task(s)
- **Solution**
 - ☞ Involves 3D printing the environment in which the robot will operate
 - ☞ The robot will have to be programmed and outfitted to perform the desired task in the environment
- **Client**
 - ☞ Dr. Nils Napp, CSE Assistant Professor

Combination of the Previous Two Projects

- It is possible that the previous two project can be combined into a single project, especially if there is enough interest

Summary

● Industry

- ☞ The Tank
- ☞ Interactive Learning Tool to Demonstrate Using Light to Transmit Information
- ☞ Robotics & Programming
- ☞ Teddy Bear Talker
- ☞ Laptop Controlled Device to Provide Communication & Environmental Control for an ALS Patient
- ☞ Device to Assist Teachers in Preventing a Special Needs Student from Wandering Away
- ☞ Automated Locker
- ☞ Rowing Machine
- ☞ Bird Chirp Classifier
- ☞ Quadcopter
- ☞ Bike Simulator
- ☞ 2D CubeSat

● Research

- ☞ AutoDietary II
- ☞ Better Brains for Servos in Robotics
- ☞ Integrating Robots with 3D Printed Environments