UMassAmherst

College of Engineering
Electrical and Computer Engineering

Senior Design Project
SDP21

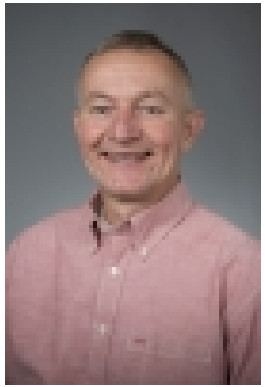
Lecture 1

C.V. Hollot
24th August'20

Outline

- Organization
- Design Process
  - Problem Statement
  - System Specifications

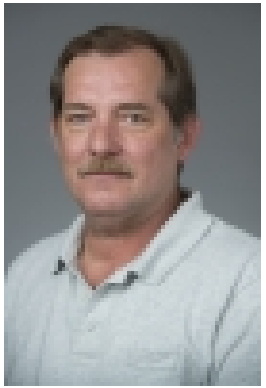
Instructional Team



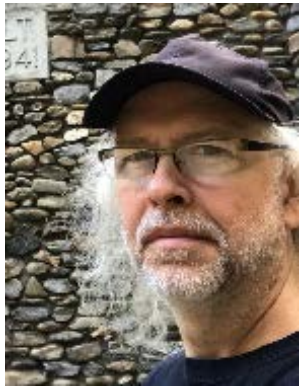
Fran Caron

Shira Epstein

Kris Hollot



Keith Shimeld



Baird Soules

SDP21 Reviews

Problem Definition and Design

Working Subsystem Prototypes

Working Prototype

Working Product

Preliminary Design Review (PDR) **Sept**

Midway Design Review (MDR) **Nov**

Comprehensive Design Review (CDR) **March**

Final Project Review (FPR) **April**

SDP Demo Days **23rd, 24th April**

SDP21 Deliverables

- Review Presentations
  (PDR/MDR/CDR/FPR slide decks)
- Project Website
- Written Report (MDR & Final)
- Demo Poster
- Final Product

SDP21 Process

- Teams of 4 students
  - Identify a team coordinator
- Advisor
  - Each team chooses its own ECE faculty advisor (due 11th Sept)
- Meetings
  - Weekly team meetings
  - Weekly advisor meetings
  - Course meetings
- Project budget: $500
  - Some parts available in SDP lab or M5
  - We encourage students to secure outside support; e.g., free samples, sponsorships, competitions, … .

SDP21 Advisors

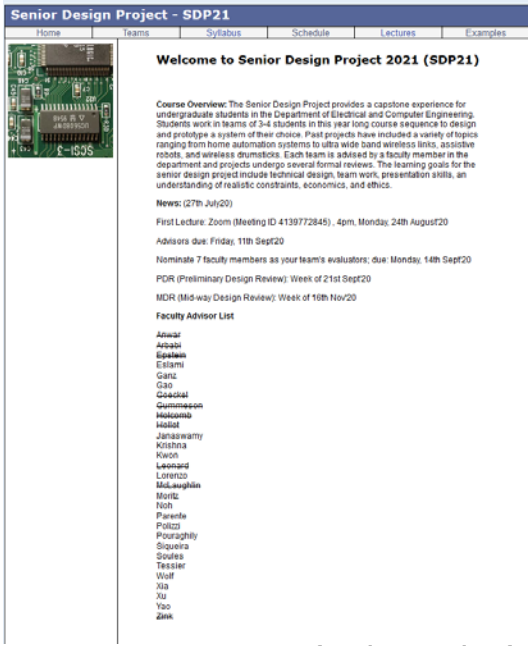
~~Anwar~~
~~Arbabi~~
~~Epstein~~
Eslami
Ganz
Gao
~~Goeckel~~
~~Gummeson~~
~~Holcomb~~
~~Hollot~~
Janaswamy
Krishna
Kwon
~~Leonard~~
Lorenzo
~~McLaughlin~~
Moritz
Noh
Parente
Polizzi
~~Pouraghily~~
Siqueira
Soules
Tessier
Wolf
Xia
Xu
Yao
~~Zink~~

Review and Grading Process

- Reviews (PDR, MDR, CDR, FPR)
  - Two ECE faculty evaluators (different from advisor). **Teams nominate seven by 14th Sept.**
  - 20/30 min presentation by team + 20 min Q&A

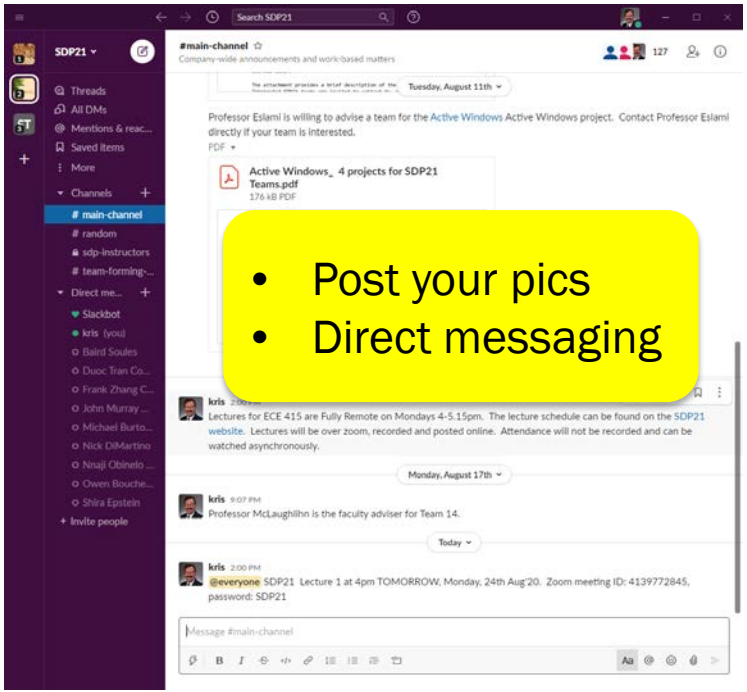
- The final grade for ECE 415 (and ECE 416):
  - Advisor grade (50%): Given at the discretion of the advisor
  - Evaluators grade (30%): Average of review grades
  - Course Coordinator grade (20%): Based on project documents and performance
  - Team member graded individually.

Course Website and Slack Workspace



http://www.ecs.umass.edu/ece/sdp/sdp21/

http://www.ecs.umass.edu/ece/sdp/sdpxx/



SDP21@slack.com

Senior Design Project - SDP21

Schedule

This schedule shows the main events for SDP21. Please note that the schedule is subject to change.

August/September 2020

Sun	Mon	Tue	Wed	Thu	Fri	Sat
23	24 Lecture 1	25	26	27	28	29
30	31 Lecture 2	1	2	3	4	5
6	7 Lecture 3	8	9	10	11 Advisors due	12
13	14 Check-in #2 evaluators due	15 Check-in #2	16 Check-in #2	17 Check-in #2	18	19
20	21 PDR	22 PDR	23 PDR	24 PDR	25 PDR	26
27	28 Lecture 4	29	30			

Brainstorming with Shira

Shira Epstein 7:13 PM

Hi all! Here's a 2 page document I've written up to help with SDP idea generation & refinement. I'm also happy to chat with you about your ideas and provide feedback if you go through the guidelines in the document. https://docs.google.com/document/d/1uTM7V8eyiHYm-_R68uUUHsRjAtVq5fmIZnA4EkzLVFE/edit?usp=sharing

Active Windows (Smart Building) Project(s)

BuildingBus: Multiple devices talking to each other over two wires within a building.

Electronics Connecting BuildingBus to Fans and Dampers within Ducts: Connecting fans and dampers in ducts to BuildingBus network allows room temperature control and air movement without central HVAC system.

Professors Eslami, Pouraghily, Soules and Vouvakis are interested in advising these projects.

Outline

- Organization
- Design Process
  - Problem Statement
  - Specifications

Design Process: From Idea to Final Product

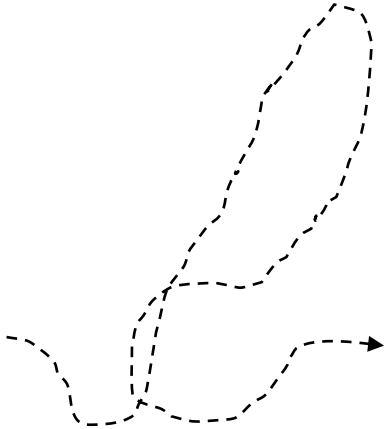
- Do great projects just happen?

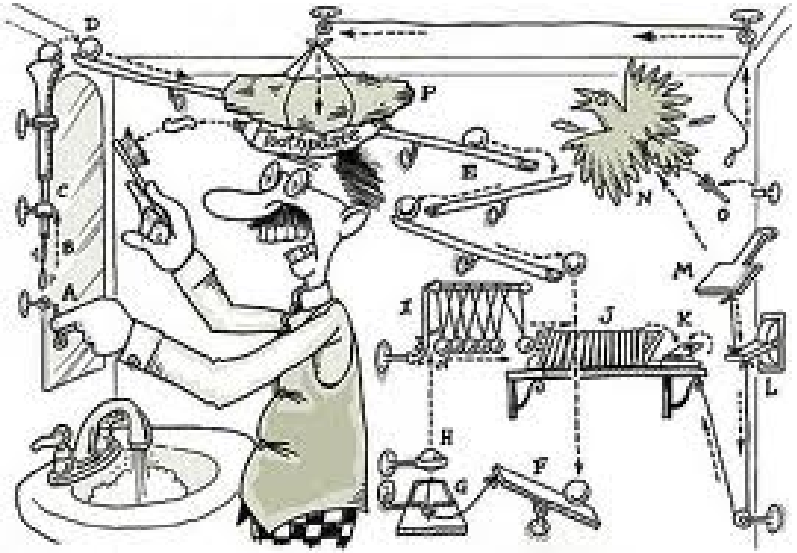
- Unfortunately, no!
- They require planning, design, execution, testing, redesign, and more testing

"Place and Paste"
SDP12

How to a Avoid a Big Mess

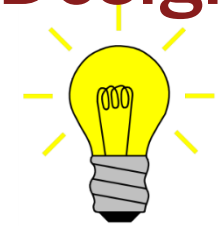
- Many great ideas go off track





- How does this happen?
  - No open and honest discussion
  - No decision making
  - No planning
  - Lots of procrastinating

Design Process



assess needs

Problem Statement

analyze requirements

System Specifications

design system

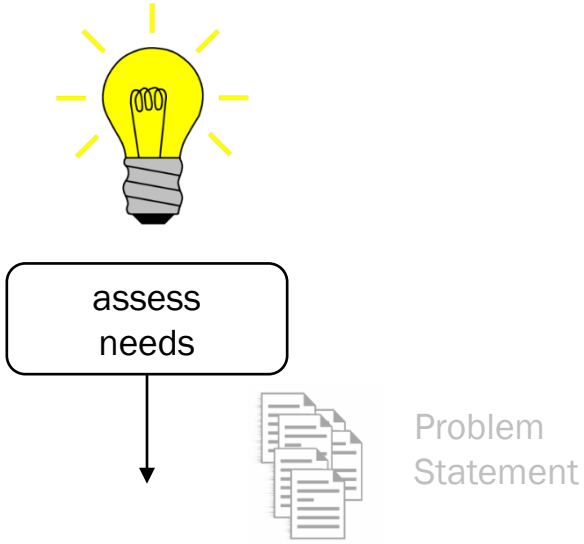
Block Diagram

detailed block level design and test

functioning subsystems

system integration and test

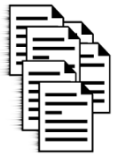
Assess Needs (Problem Statement) - 1



- The assessment and problem statement have the following attributes:
  - Relatively nontechnical
  - Language of the customer
  - Straightforward
- Example assessment: Place and paste
  - Students cannot properly squeeze toothpaste
  - Unable to apply appropriate amount of toothpaste
  - Teachers must assist students every time they need to brush
  - Students must be independent in maintaining their daily hygiene

Assess needs (Problem Statement) - 2

assess needs



Problem Statement

- Sections of the problem statement:
  1. Background
  2. The design
  3. Deliverables of the design project
- Place and paste
  1. Difficult for disabled people to brush their teeth without assistance
  2. Automated system that doesn't make a mess. Easy to use.
  3. Functioning system that can easily be used by a disabled person without external assistance.

Problem Statement (Paste and Place)

Students with severe disabilities face many challenges with tasks that we perform every day with little thought. For one student in the “Life Skills” program in West Springfield schools, his limited fine motor skills make it impossible for him to squeeze tooth paste onto his toothbrush. Our “Place and Paste” system will offer him independence by allowing him to brush his teeth without assistance. An easy-loading system will secure the toothbrush, move it under the toothpaste, squeeze the toothpaste, and present the toothbrush for use.

Analyze Requirements (System Specifications)

assess needs

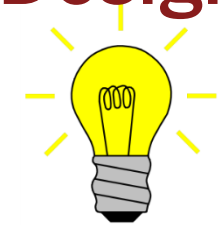
Problem Statement

analyze requirements

System Specifications

- The **System Specifications** can be thought of as a technical version of the problem statement. *It should not propose a solution.*
- Place and Paste
  1. Dispense pea-sized toothpaste onto brush
  2. Will hold toothbrush such that the machine and toothbrush will stay sanitary
  3. Toothbrush will be placed in a way such that users lacking fine motor skills can insert toothbrush
  4. Product will take no longer than 20 seconds from when toothbrush is correctly inserted to return loaded toothbrush
  5. Product size will not obstruct normal use of school's single occupancy bathroom
  6. Product will be designed such that it will guide toothbrush motion once it is placed into holder

Design Process



assess needs

Problem Statement

analyze requirements

System Specifications

design system

Block Diagram

Competing Solutions in Marketplace?

detailed block level design and test

functioning subsystems

system integration and test

Existing Product - 1

This product will not meet:

Specification 3: Toothbrush will be placed in a way such that users lacking fine motor skills can insert toothbrush

Specification 6: Product will be designed such that it will guide toothbrush motion once it is placed into holder

Existing Product - 2

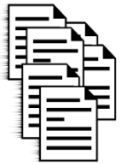
This product will not meet:

Specification 2: Will hold toothbrush such that the machine and toothbrush will stay sanitary

Specification 3: Toothbrush will be placed in a way such that users lacking fine motor skills can insert toothbrush

Design Process Summary

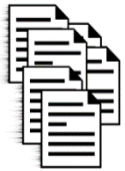
assess needs



Problem Statement

- relatively nontechnical
- language of the customer
- straightforward

analyze requirements



System Specifications

technical restatement
of the problem statement
It should not propose a solution

design system

Block Diagram

Weather Box (Team 3)

Tina Maurer, Anthony Mendez, Stephan Kim, Christian Norton

20th November 2019

Problem Statement:

As part of pre-flight preparations, drone operators must check the local weather conditions to ensure a safe and successful flight. While commercial weather stations can effectively collect data for a specified area at the macroscale, weather conditions in that area at the microscale can vary greatly. Since flight conditions can be greatly affected by these constraints, drone operators need a more accurate localized weather map reading for the area of flight. Weather Box will create this localized map in a network of low power sensor modules to provide drone users with the required information via an easily readable interface. Our product will allow operators to quickly decide whether the conditions are suitable for safe drone flight.

System Specifications:

1. Each sensor package will take measurement at its location and the web server must create a map of at least 75x50 m^2 based on data from sensor packages
2. Each sensor package must be mountable and weighs less than one pound
3. Each sensor package must measure wind, temperature, barometric pressure, humidity, dust, and air quality with 95% confidence
4. Each sensor package must have a battery life of at least 24 hours
5. Sensor package must be operable in the range of 20 degrees Fahrenheit to 100 degrees Fahrenheit
6. Each sensor package should be able to transmit sensor data to a web server via WiFi
7. Each sensor package must be manufacturable for at most $120

Team 6: **CORDIC Resolve** J. Andrade, M. Hardin, W. Hobby, K. McWherter

Problem Statement:

At present, the angular position of a rotating instrument is measured with a resolver. The output of a resolver is unintelligible to a computer, so a resolver-to-digital (RDC) converter is needed. This translates the resolver signal into machine-readable language. There are two customers for this SDP project: L3 Harris KEO and the UMass Amherst MIRSL Lab. For L3, this project will be an RDC proof-of-concept. For MIRSL, the project will be a flexible system to quickly and accurately convert any resolver signal for use in weather radar tracking. Attached to a single or dual resolver, the final product will output a measured angle to the user over multiple communication methods.

Final System Requirements:

Specification	Value	Notes
Input Communication	Bare Wire	Direct connection to resolver output
Output Communication	Ethernet/Serial	Support Ethernet and a Serial Output
Excitation Frequency	Variable, including 60Hz and 8kHz +/- 10%	Programmable excitation frequency for supporting various resolvers
Excitation Amplitude	Variable, including 4V and 120V RMS +/- 10%	Programmable excitation amplitude for supporting various resolvers
Reporting Frequency	100Hz	MIRSL Specification
Precision	Precision within 6 arcmin, 95% of the time	MIRSL Specification
Reporting Modes	Polling, Broadcast	Allow passive vs active reporting
Reporting Format	Binary Encoded Angle	L3 Specification

Clover (Team 9 LH4)

Brandon Zeng, Omar Yacteen, Tucker Chaisit, Tim Zhang

November 18th, 2019

Problem Statement:

Many homeowners with plants don't know how much water and sunlight their indoor plants need. It can be difficult having to track all their plants to ensure they are well maintained. Plants can die from too little water, too much water, too little sunlight, and other easily preventable conditions. Clover can monitor plant health and notify owners of issues to make plant keeping easier for busy homeowners. It will be measuring the critical factors for a plant's well-being, such as soil moisture and light intensity then informs the owner when care is necessary.

System Specification:

1. Compact form factor fits into most plant enclosures.
    a. 3 x 2 x 7 inches
    b. Portable
2. Low Power
    a. Battery is charged via solar cell
    b. 45mW average power draw
3. Product will notify users when the plant requires attention
    a. Effective sensor Bluetooth transmission range: 40m with 90% success rate
4. Product is able to provide accurate sensor measurements
    a. Capacitive soil moisture sensor range from 200-2000
5. IP64 dust and water resistance rating
6. Programmable Plant Library
    a. Tracks and stores records of active plants
    b. Supports 10 different plant classes (flowering, palm, foliage, etc.)

Smart Coaster (Team 16/ LH 14)

Jonathan Capozzi, Joshua Howell, Angus Mo, Timothy Shum

19 November 2019

Problem Statement: At restaurants, reputation relies immensely on customer satisfaction and responsiveness of customer service. Waiters/waitresses often juggle serving several tables at the same time, making it difficult to efficiently monitor the needs of each table in real time. Inadvertently, managing multiple tables will lead to slower and less responsive service. In these situations, it is commonplace for at least one of these customers to finish his or her drink without a waiter/waitress to refill the drink in a timely manner. To keep more customers' cups filled, a system should be implemented to easily allow a waiter/waitress to identify when a customer would want a new drink/drink refill.

System Specifications:

1. Classifies an "empty cup" correctly with >95% accuracy
2. Incorrectly classifies an "empty cup" in <1% of trials
3. Operates for longer than a single business day (>12 hour battery life)
4. Recharges before next business day (<5hr recharge time)
5. Maximum coaster thickness <2cm
6. Connectivity supports usage of multiple coasters

Team 26 - DemocraSafe

Rishabh Singhvi, Joshua Wolfman, Hung Nguyen, Samuel Allen

Problem Statement:

We intend to design and build a secure, easy-to-use, affordable, transparent voting system. This system should allow voters to verify that their ballots are cast as they intended. It should be easy to audit. It should protect voter privacy and prevent voter fraud.

System Specifications:

1. Open-source hardware and software
2. Protect voter privacy
3. Voter-verifiable ballots without trusting computer
4. Easy to audit paper record
5. Tamper-resistant equipment with minimal attack vectors
6. Access control mechanisms to prevent multiple votes
7. Detection and monitoring of tampering/unauthorized activity
8. Easy to use with minimal voter error
9. Affordable

Check-In #2

Week of 14th Sept'20

One-pager template for Benchside Meetings

Place 'n Paste (Team 17)

Team Member 1, Team Member 2, Team Member 3, Team Member 4

25th September 2019

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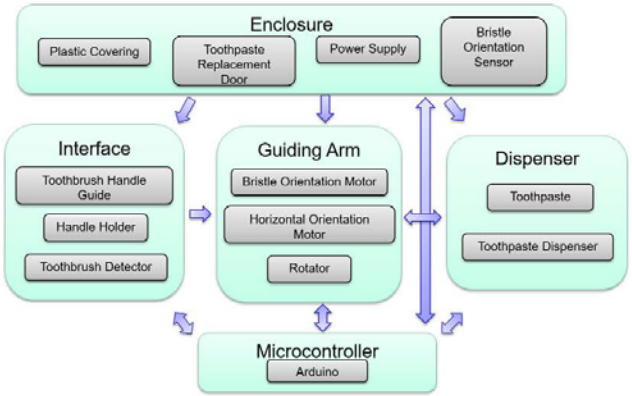

To Do List

- Post your pics on SDP21@slack.com
- Converge to a project idea
- Connect with a faculty adviser (due 11th Sept'20)
- Establish weekly team meetings
- Establish weekly advisor meetings
- Nominate 7 faculty members for your two evaluator slots (due 14th Sept'20)
- Develop problem statement and system specifications

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College of Engineering

Electrical and Computer Engineering

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