SDP22
Lecture 3
13 September 2021
Goals, Specs & Testing

SDP16, Team 15


UMASS
AMHERST
UMass Amherst Electrical and Computer Engineering Alumni & Friends
Listed group

PDR Coming Soon

PDR

27 Sep – 1 Oct

~~27 days~~

~~20 days~~

13 days

Team To-Do List

1. Sign-up for lab bench (Keith Shimeld, Marcus 08A)
2. ~~Set day/time for weekly team meetings (team only)~~
3. ~~Set day/time for faculty advisor meetings (team + adviser)~~
4. ~~Faculty Advisors: due Wed, 8 Sep~~
5. ~~Project proposal: due Fri, 10 Sep~~
   - ~~use slack team channel to communicate with course coordinators~~
6. ~~Evaluator nominations (7 names): due Fri, 10 Sep~~
7. Fill out progress in Google Form
   - Link: https://forms.gle/coEdivPmemJrFSeV6
8. ~~Sign-up for~~ Check-in 2, 6.30-8.30pm, Mon-Thu, 13-16 Sep'21, Zoom

Agenda

PDR

10% Presentation

20% Problem Statement, Specifications & Verification Plan

10% Survey of Similar Existing Solutions

40% Preliminary Design

10% MDR Deliverables

5% Project Expenditures

5% Project Management

Last Time

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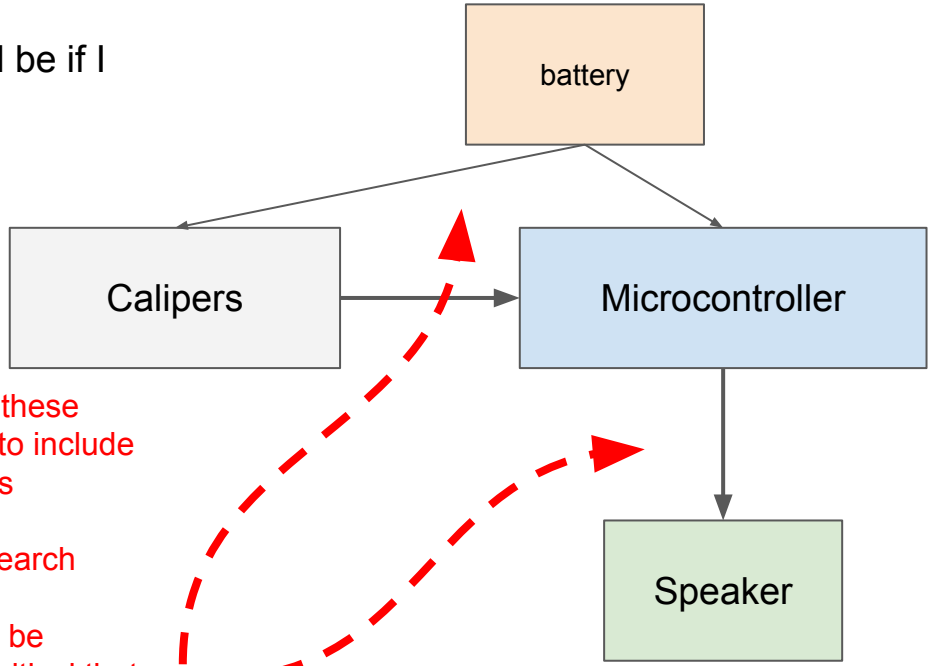
Preliminary Design Process

7 Powerful Slides

What my block diagram would be if I hadn't done my research



I am not familiar with these systems so I neglect to include important submodules

I should do some research

Level of detail should be consistent with how critical that part is to the design work that will go into my project

Since I'm designing this part, I need to flesh it out

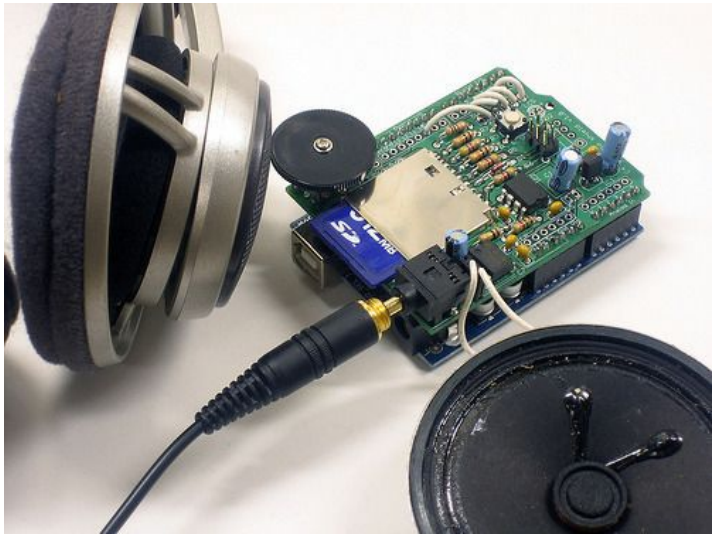
Suggestion: go “virtual shopping”

- Get a sense for the kinds of things that you might end up needing even though you aren’t ready with a design/bill of materials yet.
    - What kinds of sensors are for sale?
    - What kind of microcontrollers, single board computers are for sale?
    - What kind of actuators, motors, and mechanical assemblies are for sale?
    - What breakout boards/development boards exist?

Doing some research to fill in the gaps in my knowledge

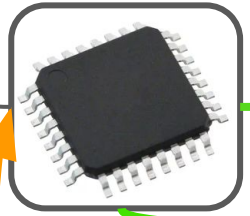
Adafruit's Wave Shield Kit is an Arduino Shield meant to provide hobbyists with an easy solution to adding audio to their Arduino projects. As with all of Adafruit's designs, the full documentation including a detailed write-up and schematic are available, making it an excellent place to learn.

https://learn.adafruit.com/adafruit-wave-shield-audio-shield-for-arduino

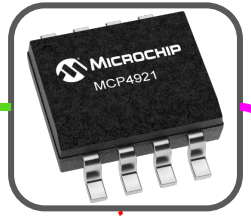


My proto-block diagram, a kind of visual list of parts with edges showing signal and power connections

Momentary Switch



Microcontroller

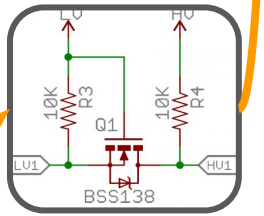


DAC

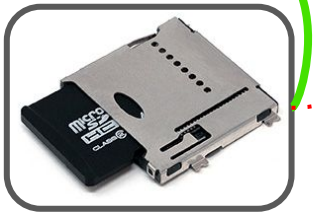
Amplifier

Speaker

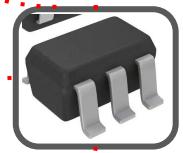
Headphone jack



Level shifter



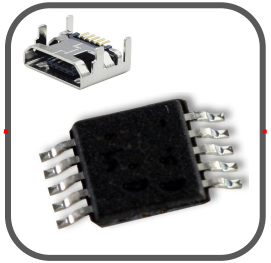
SD Card/Reader



3.3V regulator

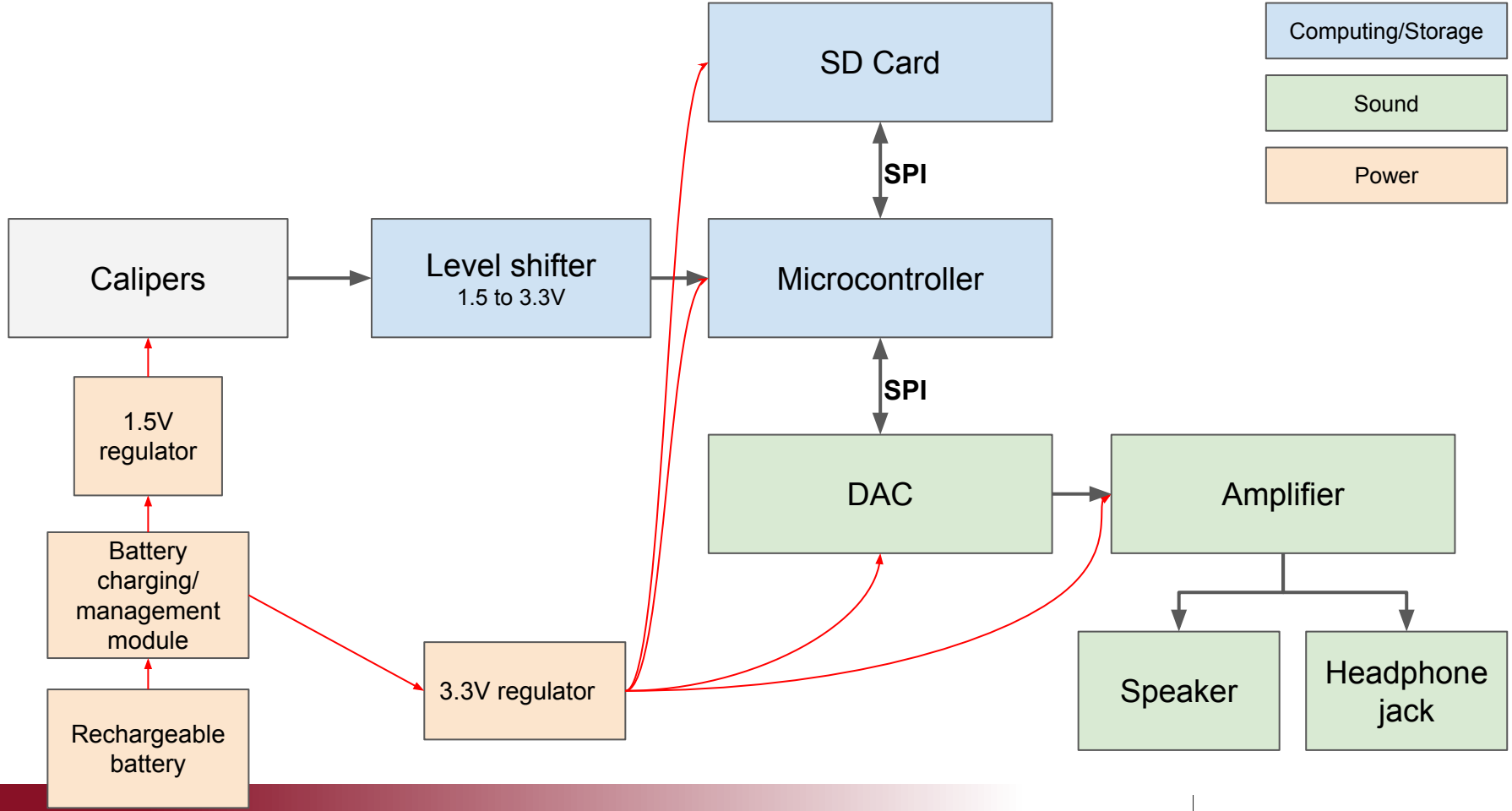
Digital Calipers

1.5V regulator



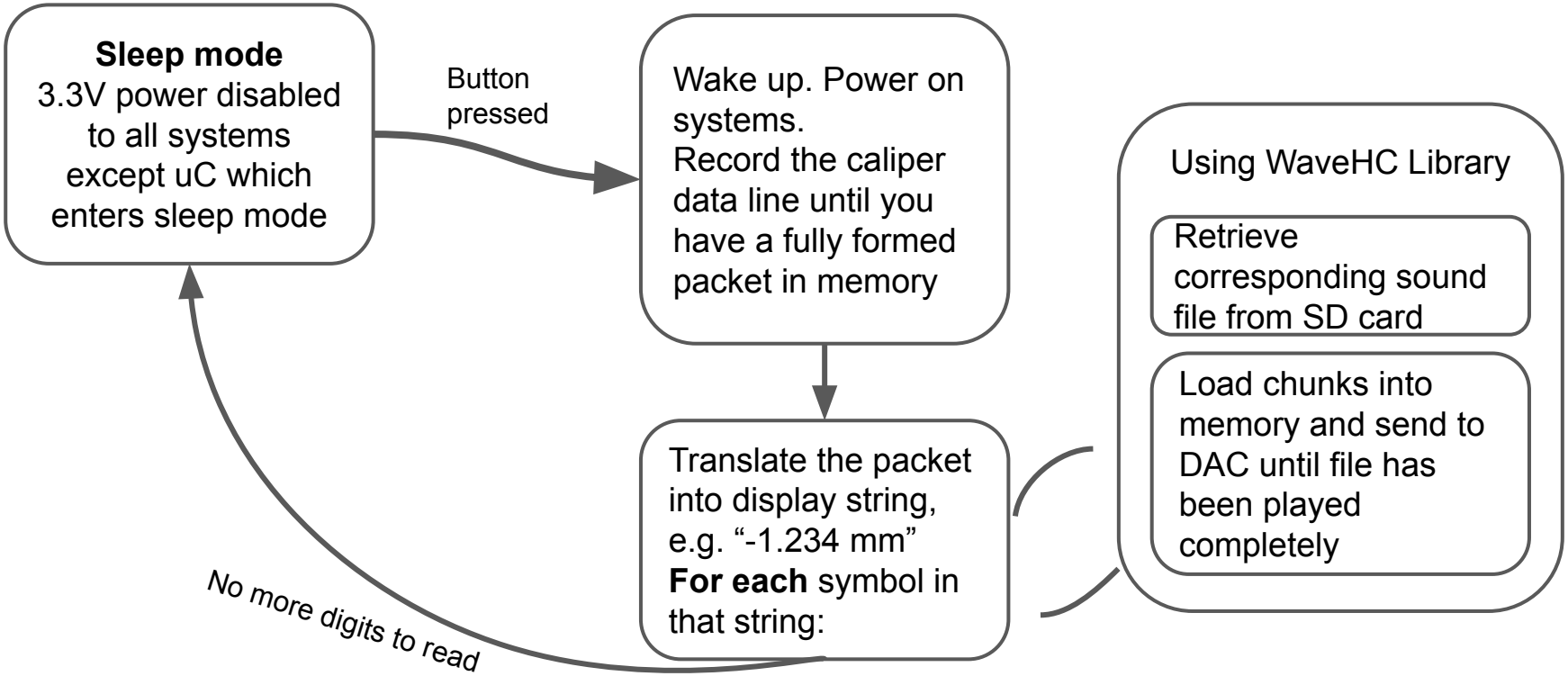
Charging/monitoring module, USB

Rechargeable Battery

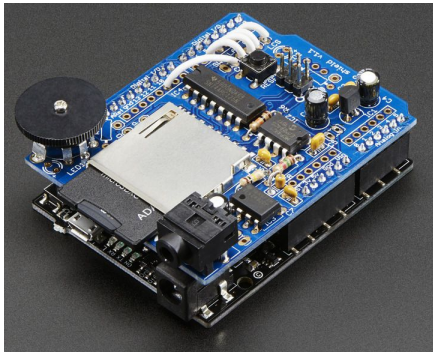

Computing/Storage
Sound
Power
SD Card
SPI
Calipers
Level shifter
1.5 to 3.3V
Microcontroller
SPI
1.5V
regulator
DAC
Amplifier
Battery
charging/
management
module
3.3V regulator
Speaker
Headphone
jack
Rechargeable
battery

...but wait! What does the software do?

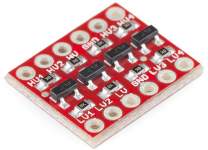
Software diagram



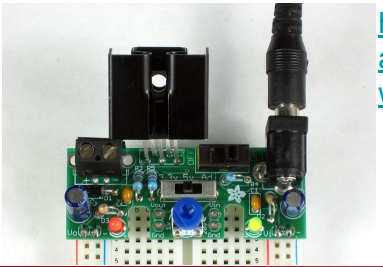
Fast forward -- show the functioning subsystems for MDR



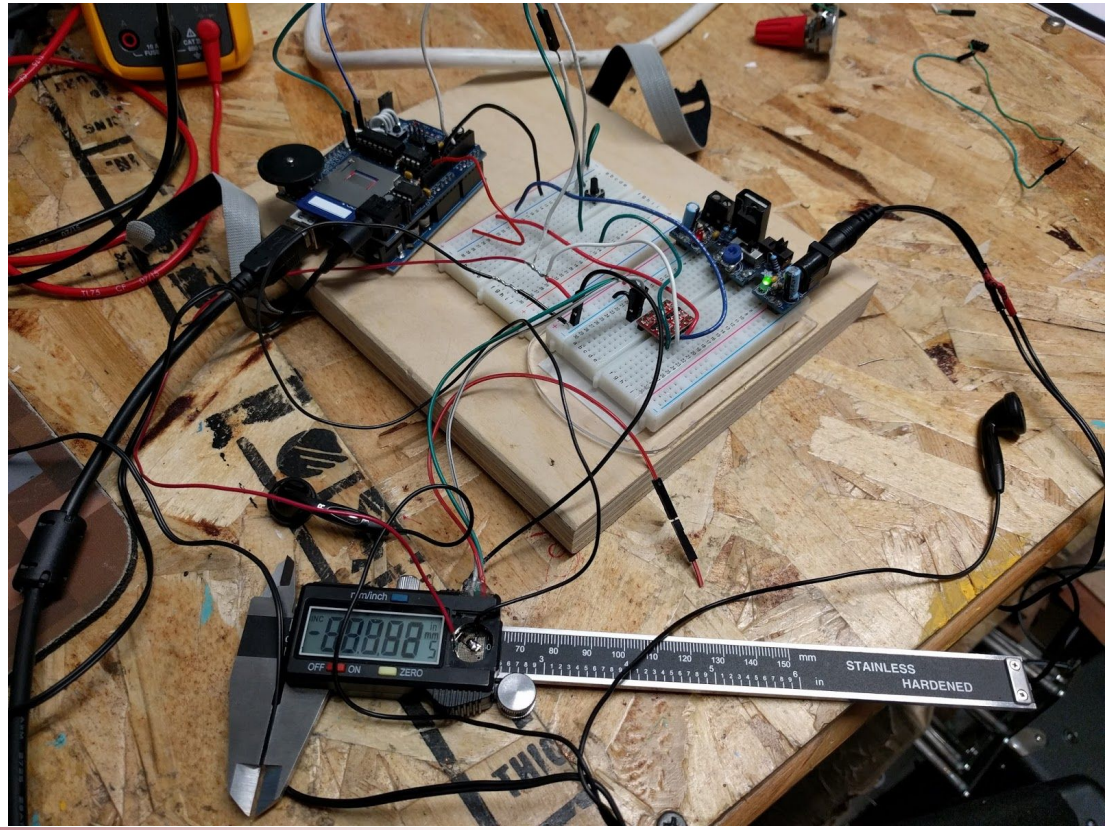
https://www.adafruit.com/product/94



https://www.sparkfun.com/products/12009



https://learn.adafruit.com/adjustable-breadboard-power-supply-kit/overview



PDR

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- What's needed?
- What are we trying to create?

assess needs

Problem Statement

- relatively nontechnical
- language of the user
- straightforward

- What functions must it perform?
- How well?

analyze requirements

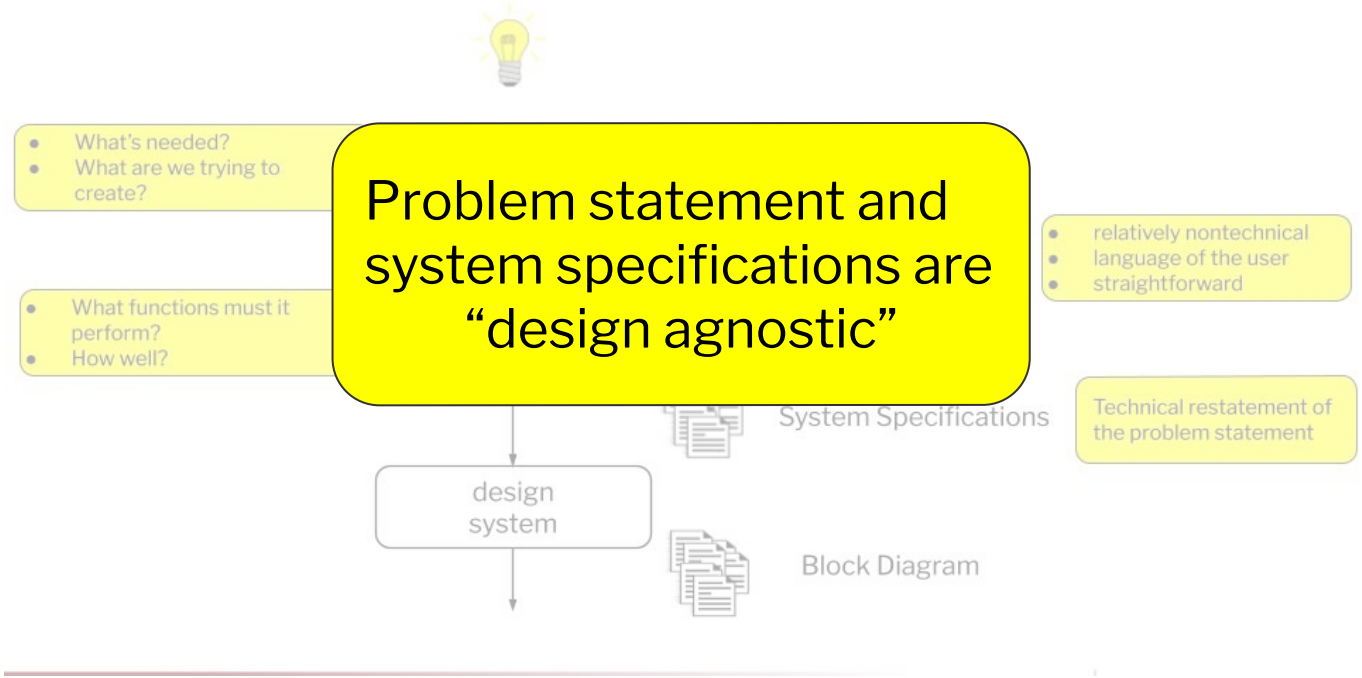
System Specifications

Technical restatement of the problem statement

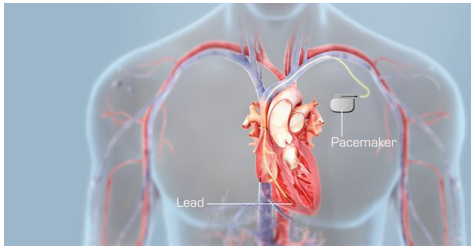
design system

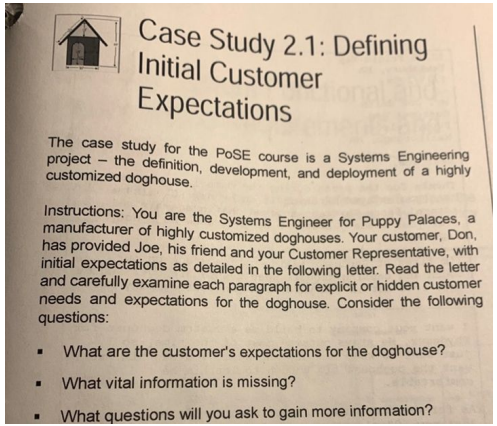
Block Diagram

Important characteristic of problem statement and specifications?



JDP (Problem Statement & Specifications)





Case Study 2.1: Defining Initial Customer Expectations

The case study for the PoSE course is a Systems Engineering project – the definition, development, and deployment of a highly customized doghouse.

Instructions: You are the Systems Engineer for Puppy Palaces, a manufacturer of highly customized doghouses. Your customer, Don, has provided Joe, his friend and your Customer Representative, with initial expectations as detailed in the following letter. Read the letter and carefully examine each paragraph for explicit or hidden customer needs and expectations for the doghouse. Consider the following questions:

- What are the customer's expectations for the doghouse?
- What vital information is missing?
- What questions will you ask to gain more information?

- Cardiac Pacemaker
- Puppy Palace
- Paste and Place

SDP12

JDP Project

Project Specification: You are to design, build, and test an electronic system to manage access to a room based on occupancy and the health status of entering persons. Your system shall automatically detect individual persons approaching the door to a room from both the inside (person exiting) and the outside (person entering). The system shall control a door lock. The lock shall open to permit persons to exit. It shall also open to allow healthy persons to enter, provided the maximum room capacity is not exceeded. The maximum room capacity will be a number between 5 and 50 and set at compile-time. Persons wishing to enter the room will be asked to certify that they do not have covid-19 symptoms. The electronic system shall measure the body temperature of such self-certified persons, and those who exhibit a non-elevated (ie, "normal") body temperature shall be allowed to enter the room provided the room capacity is not exceeded. Your system shall continuously display LEDs, visible to persons entering and exiting, to indicate "low room occupancy" (e.g., a green LED when occupancy is < 40%), "medium occupancy" (e.g., a yellow LED with occupancy is 41-80%) and "high occupancy" (e.g., a red LED when occupancy >81%). During the semester, you will complete two full iterations of the design/build/test/demonstration of your system. For your first iteration, use of the Arduino Uno development board and the Arduino Integrated Development Environment (IDE) is encouraged. For your second iteration, use of an ATmega328P xplained mini development board programmed in ANSI C (i.e., no Arduino Code) using the ATMEL Studio Version 7 IDE is required.

Problem statement and system specification were given

JDP: Exercise of forming specifications

1. System firmware shall set the room capacity to a value between 5 and 50 at compile-time
2. Inspection of code.
3. System shall automatically detect persons wanting to exit (exiting persons).
4. System shall provide a means for persons wanting to enter (entering persons) to indicate their desire to enter.
5. System shall provide a means for entering persons to self-certify that they do not have COVID-19 symptoms.4. System shall measure the approximate body temperature of entering persons.
6. System shall simulate the action of a door lock or door opener using a small DC motor.
7. System shall activate the motor for exiting persons when they are within 3 feet of the door.
8. System shall activate the motor for Healthy Entering Persons if there is available room capacity.
9. System shall provide a visual display indicating whether the room is at low, medium, or high room capacity. Display shall be visible to entering and exiting persons from a minimum distance of 5'.

Amped-Up: Project Idea

To create a system that attaches to an amplifier and controls its knobs in order to provide musicians with a more powerful interface to control it and create new sounds

Amped-Up: Background -Amps

Fender Hot Rod Deluxe - a basic and extremely popular tube combo amplifier

Line 6 Modelling Combo Amp - popular beginner amplifier with digital processing to achieve gain and effects

Hughes and Kettner TriAmp Mark 3 Tube Amp Head - Expensive and premium amp head with programmable presets and variable wattage - requires speaker cabinet ($4000!)

Amped- Up: Background - Tonal Parameters

- Most amplifiers contain a set of similar tonal parameters
- These include (but are not limited to):
  - Volume
  - Equalization
  - Gain/Distortion
  - Reverb/Specific effects
  - “Presence”

- The amp that we have access to has 8 knobs to represent the above

Amped-Up: Background - Tone Shaping

- Vacuum tubes are preferred for their vintage clipping behavior
- Solid state clipping has become popular in certain genres of music but fails to create the authentic tube sound
- Digital modelling amps use DSP to attempt to recreate vintage drive, to widely varying degrees of success
- Modern solutions offer conveniences like presets and external control
- In the end many guitarists chose to stick with older, authentic amplifiers

*** Effects pedals are a different tool that go before or after the preamp in the signal chain in order to offer a specific desired quality like echo, reverb, octave change, custom gain profiles *and hundreds more* …

Amped-Up: Assessing Needs - Interviews

- Met with 10 People (8 Interviews and 2 filled questionnaires), Questioned about what types of amps they used and what they like/disliked about amps in general
- During live play, it is desirable to be able to just “plug and play” without having to fight with knobs
- During practice, “tone exploration” seemed more common and was described as a positive experience
- Most people are disinclined to buying another amp, so something that attaches to an existing one is ideal

Amped-Up: Assessing Needs - Interview Quotes

- "... [favorite amps] all have a different tonal flavor. They take the characteristics of your guitar, and they do their own thing with it, without compromising the identity of your guitar. That's what really makes a great amp."

- "In a live situation, it's not so easy to make adjustments [to parameters]"

- "[tweaking] can take a while because there's a lot of trial and error... it's kind of hard to know exactly what it'll be. And then if you change one thing then it will change the original thing you were happy with... they're all codependent on each other."

Amped-Up Problem Statement

Guitar amplifiers typically feature a number of parameters that musicians can adjust to change the sound of their guitar. Existing amplifiers present these settings to users as a static interface, with a set of knobs to control each parameter. Because of this, guitar amplifiers are unable to react to the signals they receive and recalling presets is a feature rarely seen on vintage or cost effective amplifiers. Our solution will address these issues by acting as an electromechanical bridge between an existing amplifier and a remote user interface.

Amped-Up: Preliminary System Specifications

- Is compatible with existing amplifiers, allows manual override
  - Electromechanically can control at least 8 knobs
  - Able to respond(adjust a knob) in at most 80 ms from extreme to extreme
- Controls tone shaping parameters for guitar sound, including:
  - Gain
  - EQ
  - Post-amp Effects
  - Volume
  - Channel Selection
- Supports locally saving and recalling user configurations (10+ configurations)
- Can produce dynamic sounds by modulating the amplifier's tone shaping parameters in real-time
- Supports arbitrary automations to control the amplifier parameters according to:
  - Guitar signal volume
  - Guitar signal frequency
  - Mathematical functions
  - Expression pedal
  - Generic footswitch
- Features user interface to interact with customizable functions
  - Must be robust enough to adequately control all features of the amplifier

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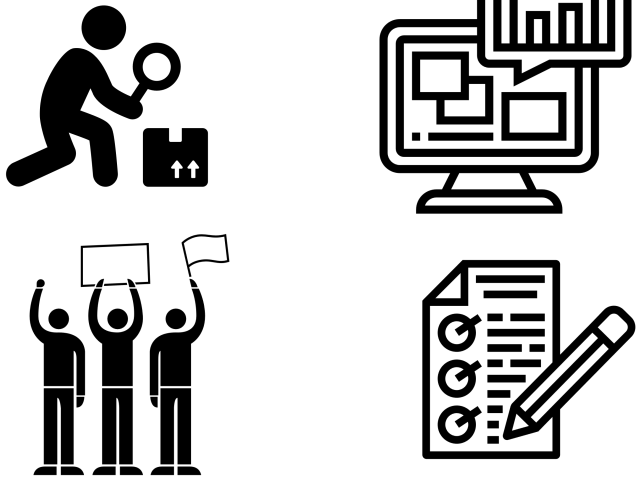
Verification (1)

Verification:

- Was the final prototype realized correctly?
- Does the final prototype meet the specifications?
- Does the final prototype function with the specified performance?

Verification (2)

Verification is typically performed in one of four ways:



1. Inspection
2. Analysis
3. Demonstration
4. Testing

JDP: Verification

1. System firmware shall set the room capacity to a value between 5 and 50 at compile-time
Inspection of code. demonstration of code build &upload.

2. System shall automatically detect persons wanting to exit (exiting persons).
Demonstration or test.

3. System shall provide a means for persons wanting to enter (entering persons) to indicate their desire to enter.
demonstration

3. System shall provide a means for entering persons to self-certify that they do not have COVID-19 symptoms.
demonstration

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test

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demonstration

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test

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test

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demonstrate or test

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Survey of Similar Existing Solution

- Extensive survey of relevant solutions (including partial solutions)
- References and citations provided (include links)
- Comparisons drawn and implications for the project

Amped-Up: Existing Solutions: Hook Wizard

- Tube amp head with motorized knobs
- Saves and recalls static presets
- Accepts MIDI control
- Robust cabinet simulation interface
- 2,850 Euros (including VAT) equivalent to $3,350

Image Source: https://hookamps.com/product/wizard/

Amped-Up: Existing Solutions: Black Spirit 200 Floor

- 2, 20 and 200 watt selectable solid state amplifier
- Proprietary “Bionic Spirit Tone Generator” - uses analog circuitry to replicate tube characteristics
- 128 programmable presets
- Remote control via iOS and Android app
- MIDI, Bluetooth, Aux inputs
- $1,119 USD

http://hughes-and-kettner.com/products/spirit/black-spirit-200-floor/

Amped-Up: Existing Solutions: Chase Bliss Automatone Preamp MKII

- Foot controlled floor preamp
- Motorized faders
- Accepts expression pedal for fader control
- Adjusts features automatically based on 30 presets.
- Variable diode clipping control
- Requires power amp and cabinet for live play
- $750 USD

https://www.chaseblissaudio.com/shop-pedals/preamp-mkii

Existing Solutions: Recap

	Storable Presets	Works with Existing Amp	Custom and Dynamic Tone Adjustment	Reactive Tone Adjustment	Comprehensive User Interface
Hook Wizard					
Black Spirit 200 Floor					
Automatone Mk II					
Our Design					

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