FAMU-FSU College of Engineering

Senior Design Team 103
Biosense Webster Catheter

Sarah Churchwell & Diana Shaughnessy

Team Introductions

Vivian Bernard
Biomedical Engineer

Sarah Churchwell
Mechanical Design Engineer

Lauren Kazzab
Biomedical Engineer

Katelyn Kennedy
Biomedical Engineer

Zach Leachman
Biomedical Engineer

Samuel McMillan
Electrical Engineer

Diana Shaughnessy
Mechanical Design Engineer

Hunter Walsh
Electrical Engineer

Sponsors and Advisors

Development Mentor
Charles Lindholm
Director of R&D

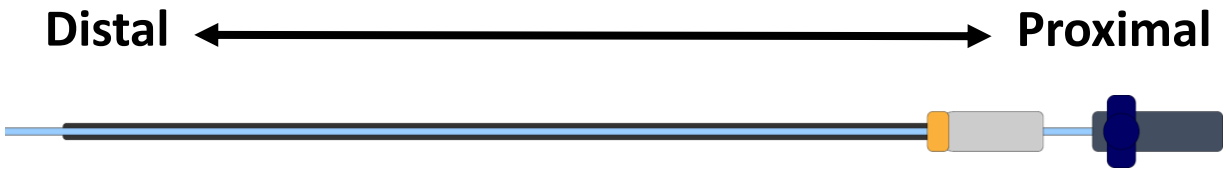
Engineering Mentor
Amar Patel
R&D Engineer II

Academic Advisor
Stephen Arce, Ph.D.
BME Professor

FAMU-FSU College of Engineering

Objective

Build a measurement device that measures manual inputs and evaluates those inputs against a 1:1 promise.



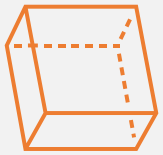
Background

- Cardiac catheterization is one of the most common medical procedures to treat heart conditions.

- Biosense Webster altered one of the early-stage production materials within the catheter build.

- This alteration has ultimately affected end-stage performance and resulted in unpredictability.

Key Goals



Develop a testing arena that will be broken down and stored away.

Read the signals of angular deflection with a +/- 0.5° of freedom.

Assumptions

Demographic that will benefit from the success of the project will be those with heart issues. (ex. Atrial Fibrillation)

Design completed for Senior Design Day. (April 4, 2024)

Measuring Device will only be designed to be applied to the Biosense Webster Catheters.

FAMU-FSU College of Engineering

Stakeholders

Engineering Mentor
Shayne McConomy, Ph.D.
ME Senior Design Coordinator

Engineering Mentor
Jerris Hooker, Ph.D.
EE Senior Design Coordinator

Development Mentor
Charles Lindholm
Director of R&D

Sponsor Company
Johnson & Johnson
Family of Companies

Customer Needs

Compatibility

Compatibility allows for a more concise and efficient way to measure across multiple Biosense Webster catheters.

1:1 Rotational Promise

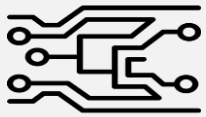
Ensure that rotation at proximal end matches output at distal end.

Simulated Environment of Veins

Allows for more real-life augmented prototyping and testing.

Customer Needs

Non-invasive Electronics

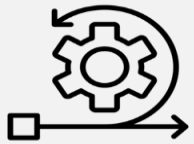


Electronics will not interfere with the user's ability to use the catheter.

Collect & Analyze Data

Procedure will be developed to allow for consistent, reliable, and valid results.

Maintain Functionality



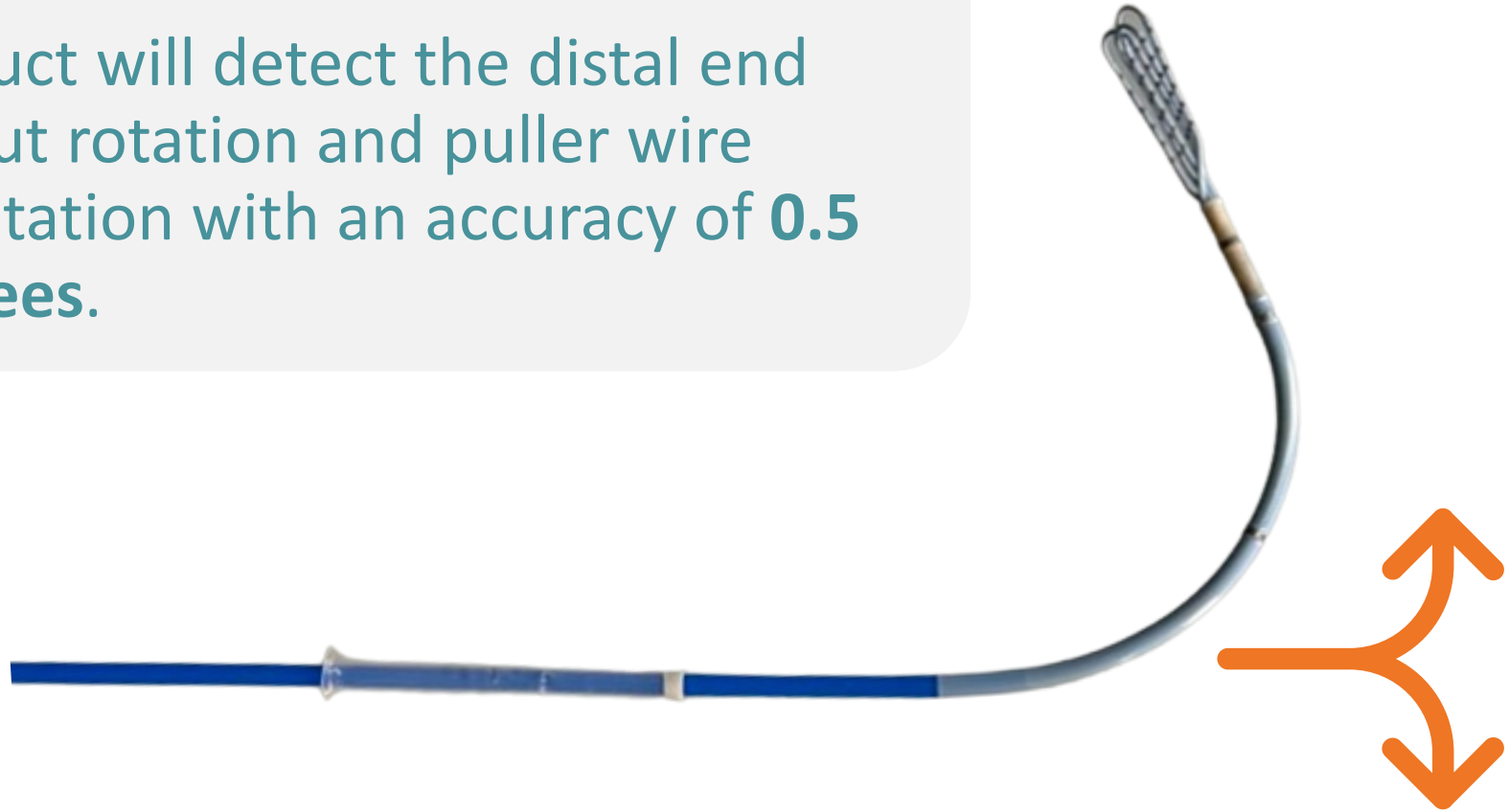
Measuring device does not interfere with the catheter's current functions/abilities.

Sensor Durability

Sensors can withstand movement through the vein and in the heart without getting deteriorated.

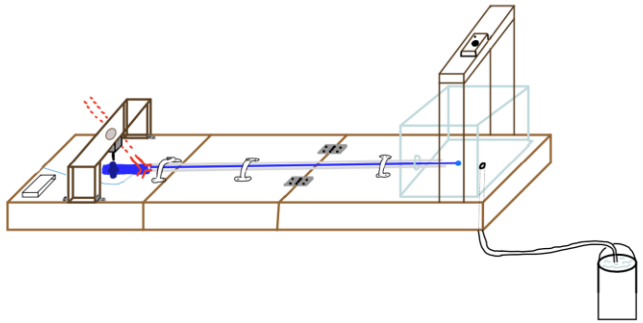
Targets

- Detect rotation
  - Product will detect the distal end output rotation and puller wire orientation with an accuracy of **0.5 degrees**.



Targets

- Stabilization
  - Develop various options for the testing area to be made from.
    - Product will be made wood to ensure a firm foundation to test within.
    - Metal fasteners secure catheter and tube in place to platform.



Targets

- Replicability
  - Simple design for Biosense Webster Team to reproduce multiple products.
- Repetitive
  - Product will be able to be used **more than once**.
  - Materials will be able to be used more than once.

Final Design Selection

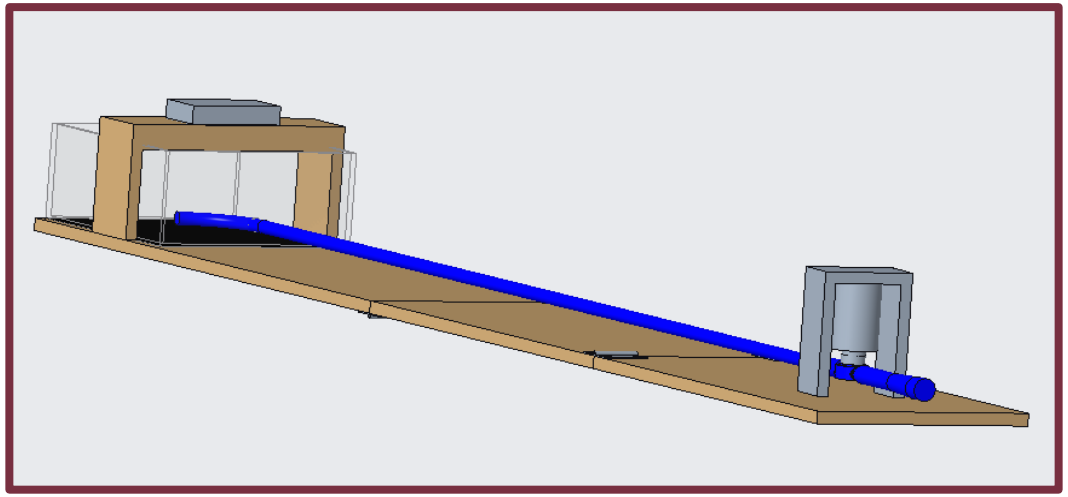
Wooden Box

Image Processing

Bluetooth Connection

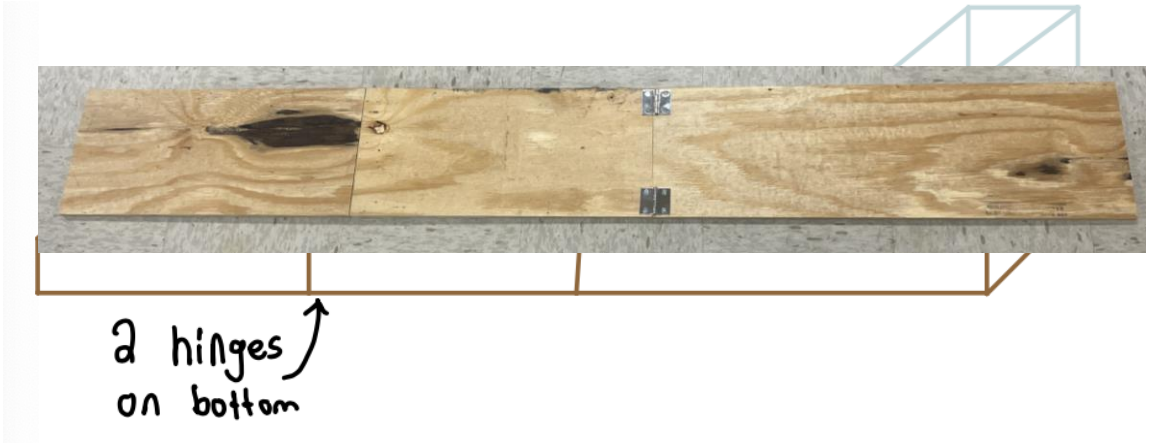
Corn Syrup + Water

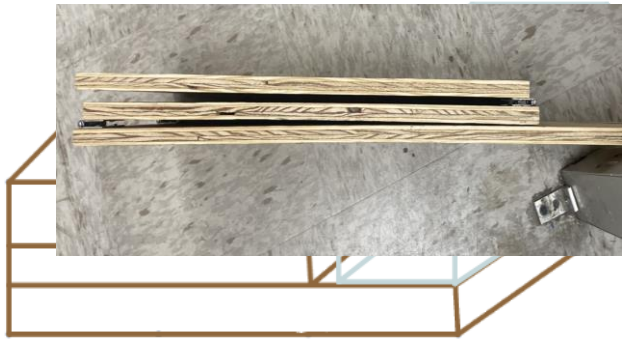
MATLAB



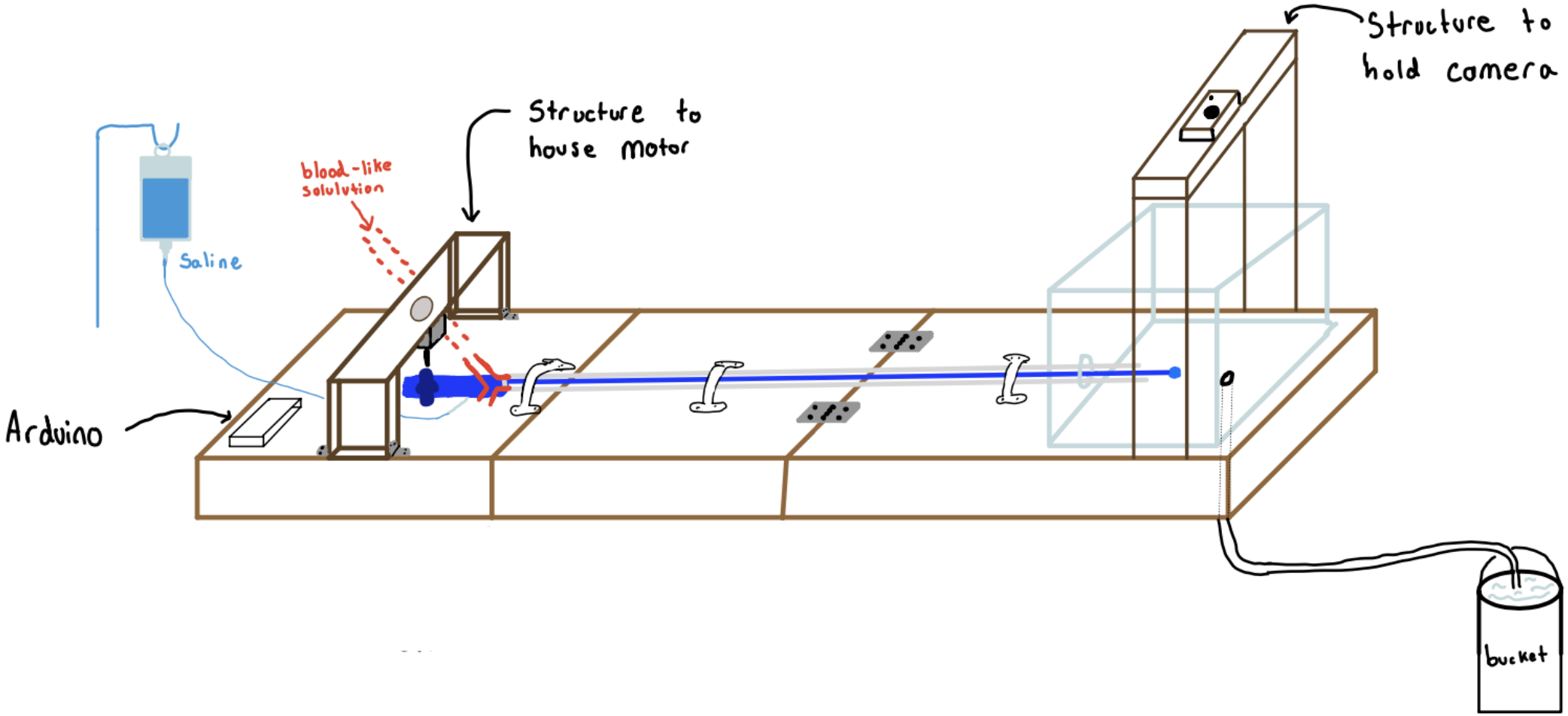
Wooden Platform

Platform collapses with 2 sets of hinges to allow for compact storage.



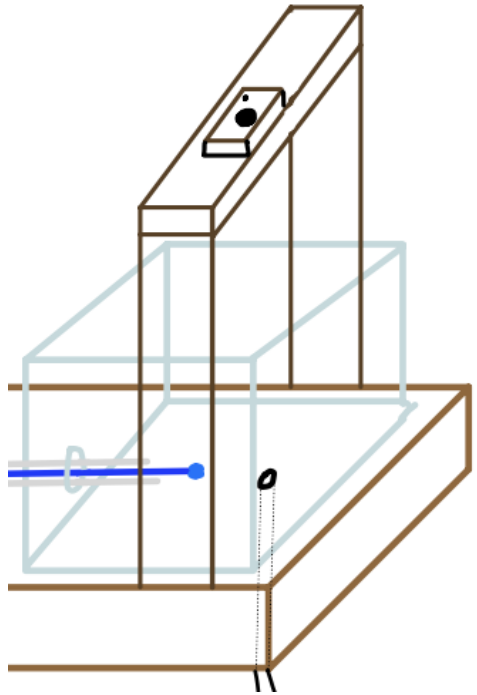


Prototype in Production



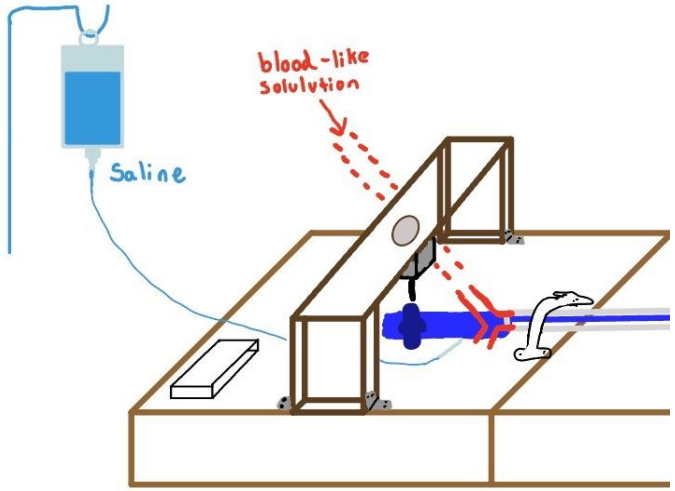
Acrylic Box Progress

- 1/2" thick acrylic.
- Sealed with aquarium grade silicon sealant.
- 9.5" width x 7" length.
  - Allows for full range of motion of catheter deflecting.
- “Carve out" box shape on wood to secure acrylic box.



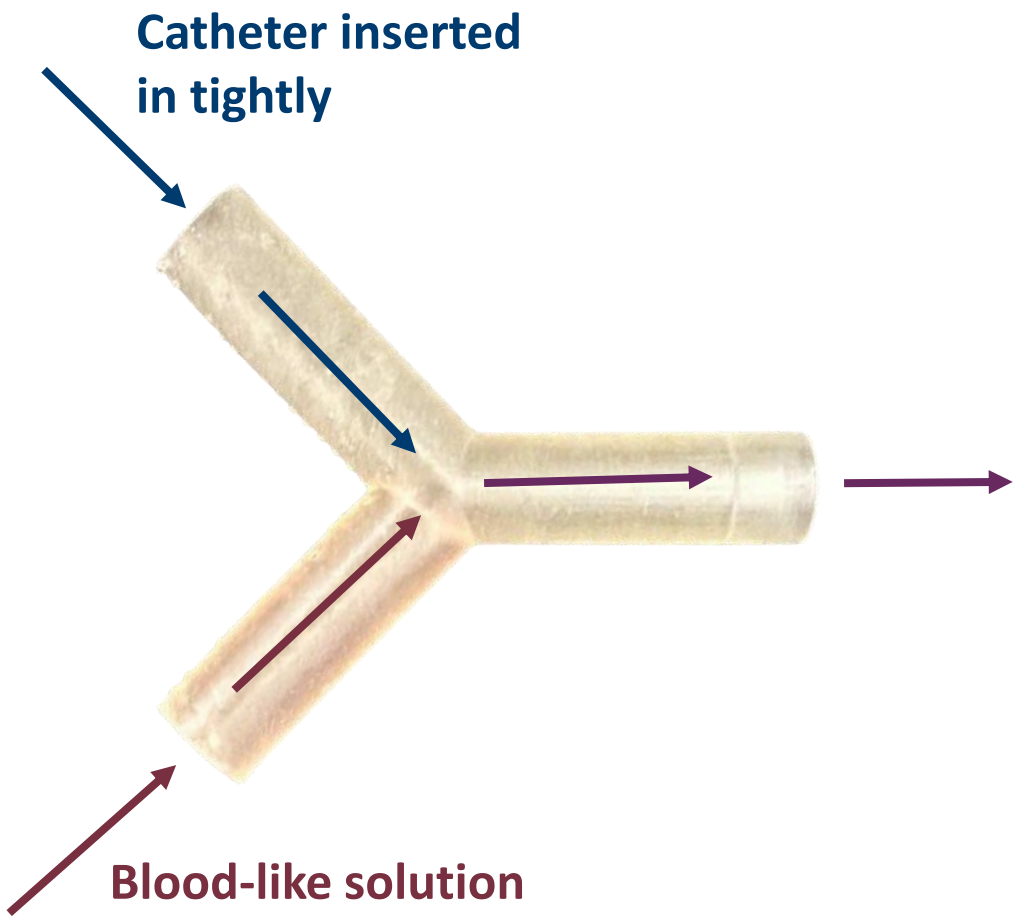
Liquid Progress

- Saline solution flows inside catheter.
  - Prevents coagulation.
- Bucket or sink to drain fluids from acrylic box.
- Laminar flow allows for no ripples.
  - Allows camera to easily identify points on catheter tip without distortion.
- Laminar flow achieved by setting pump flow rate = fluid draining out.
  - Constant volume in box.



Liquid Progress

- "Blood" solution (glycerol) and water flows between "vein" Polyurethane Rubber tube and sheath.
- Water from pump feeds into combiner tube with use of a pump.
  - Pump allows water and "blood" solution to replicate blood moving through veins.



Update on image processing

- Concise MATLAB code.
- Catheter is flat. (zeroed out)
  - X, Y coordinates analyzed.
- Data collected must be saved and be available for further statistical analyzes.
- 4 dimensions to code.
  - X, Y, time, RGB. (color pixels on tip marked by paint)
- Device must have connection points on Proximal-End and Distal-End modules to extract data.

Variations of colored paint on tip of catheter for RGB identification

Sony Hx99

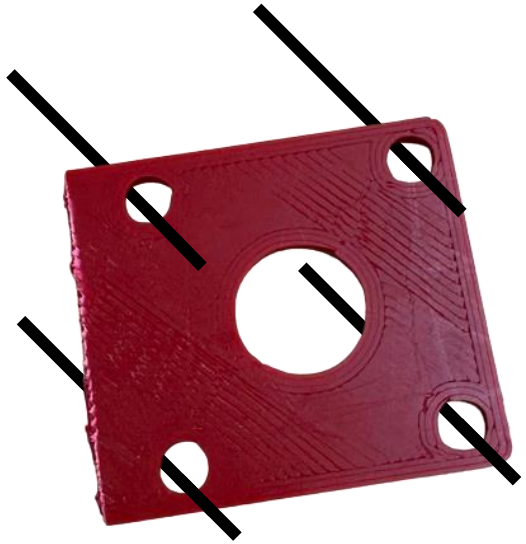
Electronic Parts

- Trouble shoot stepper motor code. (MATLAB)
- Confirmed phase sequence of Nema 17 Stepper Motor.

Nema 17 Stepper Motor

Electronics Progress

- Created 3D printed attachment for the motor shaft to attach to knob using pins to turn.
- Created a mount for the motor to sit oriented directly above catheter's handle.



Knob attachment with pins

Motor mount

Funding

- Through Emily. (Biomedical Lab Coordinator)
- Biomedical Engineers have access to an order sheet.
- Provided from Biomedical Engineer Department's set amount of funds.

Future Work

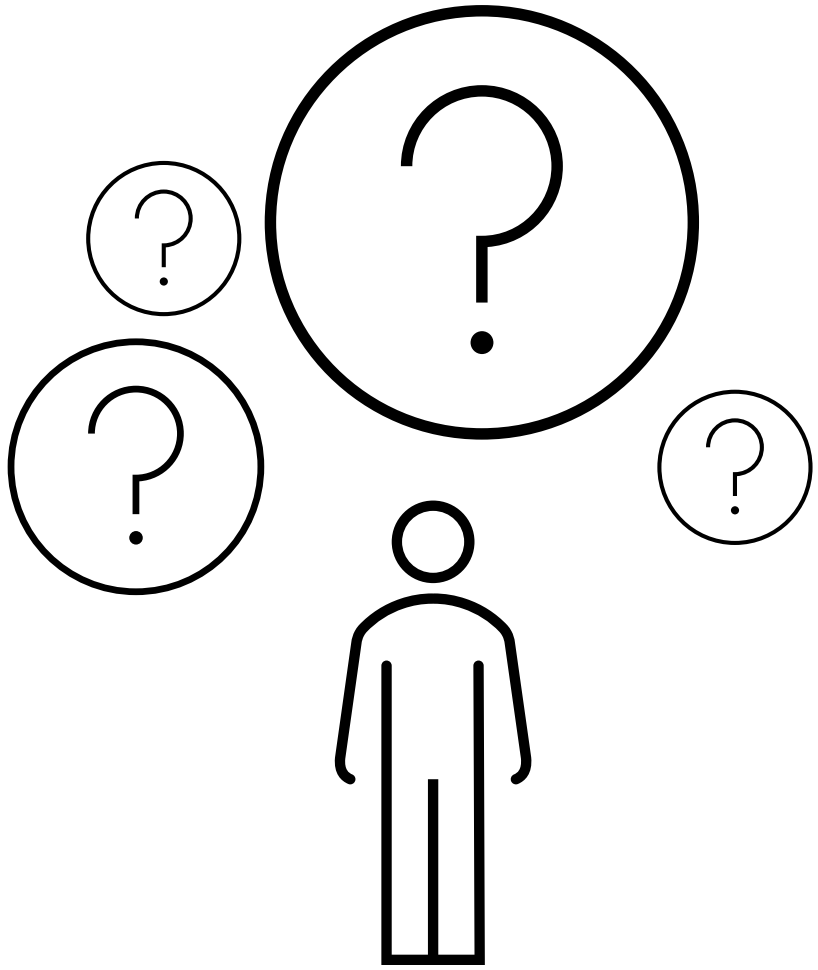
- Trip to Gainsville for live procedure of catheter ablation.
- Finalize dimensions of prototype.
- Finish designing handle stabilizer.
- Finish vein fasteners.
- Design and build camera structure.
- Design and build stepper motor structure.

Future Work

- Model liquid (blood) through vein tube using COMSOL.
  - Analyze pump velocity of liquid to control volume of liquid in acrylic box.
- Pump mass flow rate in vs out to keep liquid volume in acrylic box constant.
- Test and finalize Arduino and stepper motor set-up.
- Test image processing code.
- Track colored markers on catheter.

Questions?

Thank you for listening!



words

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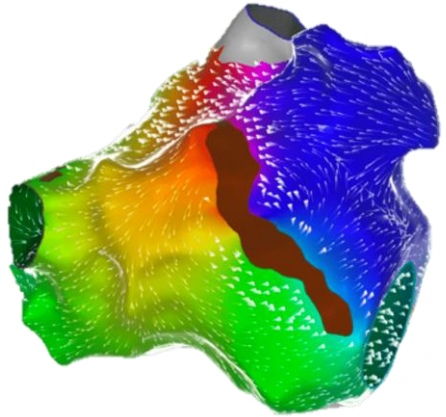
Biosense Webster

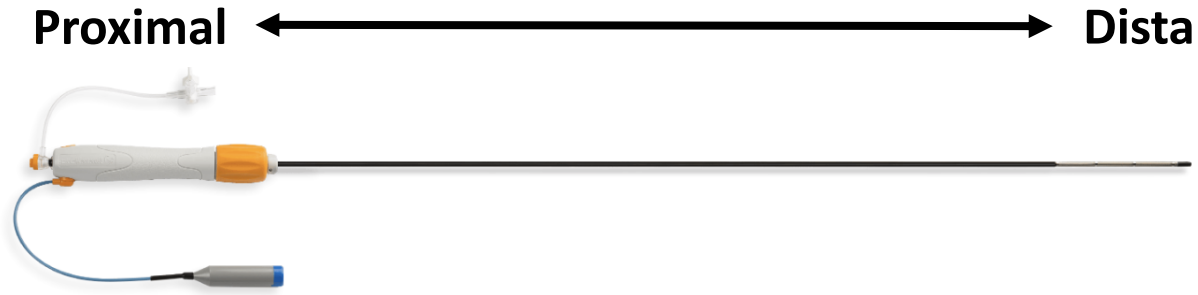


Biosense Webster®
PART OF THE Johnson & Johnson FAMILY OF COMPANIES

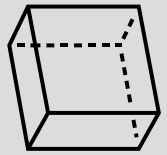
"At Biosense Webster, Inc. we have one goal –
To help those with cardiac arrhythmias live the lives they want."

Objective

Design, build, and test a measurement device that measures manual inputs at the proximal end of a catheter and evaluates those inputs against a promise of a 1:1 translation of those inputs at the distal end.



Key Goals



Develop the testing arena that will be utilized for all proceeding manners

Determine the torsional deflection using the developed measuring system

Read the signals of angular deflection with a +/- 0.5° of freedom

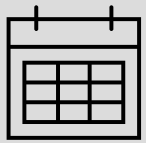
Sarah Churchwell=

Primary & Secondary Markets

Primary			Secondary
Cardiac Surgeons	**Cardiology Researchers**	**Cardiology Centers**	**Biotech Resell Companies**
			

Assumptions

Demographic that will benefit from the success of the project will be those with heart issues (ex. Atrial Fibrillation)



Prototype will be design and in-production by the end of Fall 2023

Measuring Device will only be designed to be applied to the Biosense Webster Catheters

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ME Senior Design Coordinator

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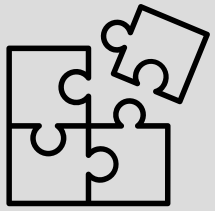
Customer Needs

Compatibility

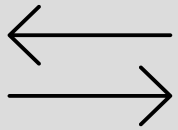


1:1 Rotational

Promise

Measures

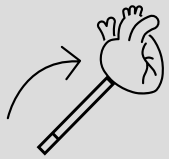
Translation



- Compatibility allows for a more concise and efficient way to measure across catheters
- Ensure that rotation at proximal end matches output at distal end
- Translation is just as crucial to the measurements as rotation

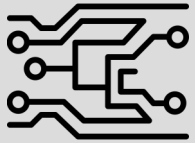
Customer Needs Cont.

Simulated Environment of Veins



Sensor Interchangeability

Non-invasive Electronics

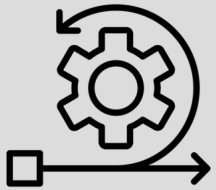


- Allows for more real-life augmented prototyping and testing
- Multiple tips of catheters that the sensors will need to be able to adapt with
- Electronics will not interfere with the user's ability to use the catheter

Customer Needs Cont.

Collect and Analyze Data

Maintains Functionality



Sensor Durability

- Procedure will be developed to allow for consistent, reliable, and valid results
- Measuring device does not interfere with the catheter's current functions/abilities
- Sensors can withstand movement through the vein and in the heart without getting deteriorated

Functional Decomposition

Customer Needs

Main Functions/Systems

Main Functions/Systems

Functions/Subsystems

Environment Simulation

- Veinal Replication
- Sterilization
- Stabilization

Functional Decomposition Table

Functional Cross Reference Table				
	Sensibility	Data Collection	Compatibility	Environment Simulation
Detects Translation	x			
Detects Rotation	x			
Detects Deflection	x			
Data Aquisition		x		
Data Manipulation		x		
Live-Positioning Visual	x	x		
Veinal Replication			x	x
Sterilization				x
Sensor Adjustability			x	x
Reproducibility		x		x
Stabilization	x			x

Function Interrelations

- Live-Positioning Visual
- Sensor Adjustability
- Veinal Replication
- Stabilization

Functional Cross Reference Table				
	Sensibility	Data Collection	Compatibility	Environment Simulation
Detects Translation	x			
Detects Rotation	x			
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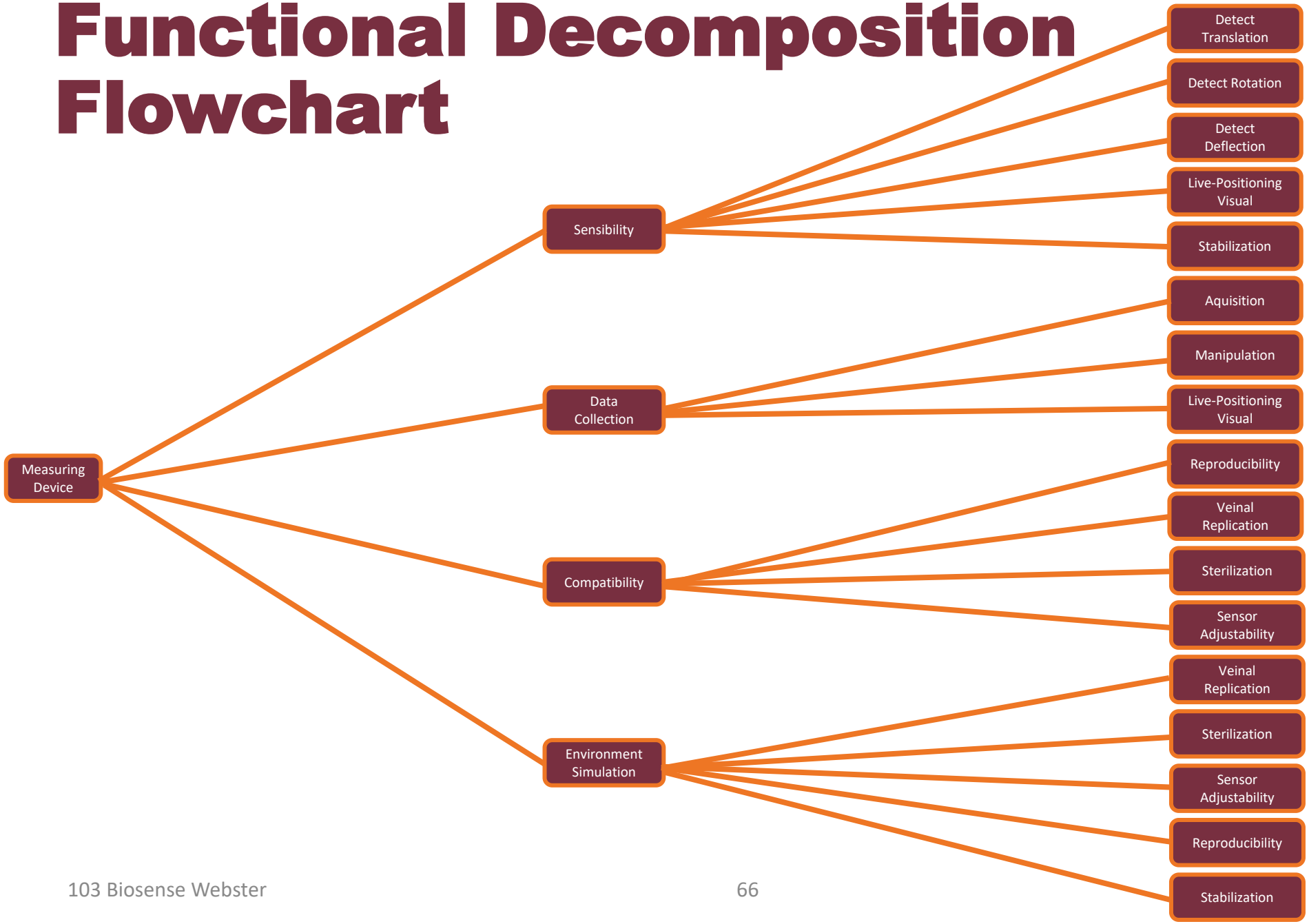
Data Aquisition		x		
Data Manipulation		x		
Live-Positioning Visual	x	x		
Veinal Replication			x	x
Sterilization				x
Sensor Adjustability			x	x
Reproducibility		x		x
Stabilization	x			x

Functional Decomposition Flowchart



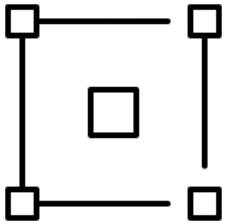
Samuel McMillan

FAMU-FSU College of Engineering

Prioritization

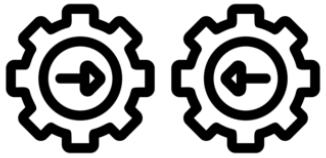
Sensibility

Environment Simulation



Data Collection

Compatibility



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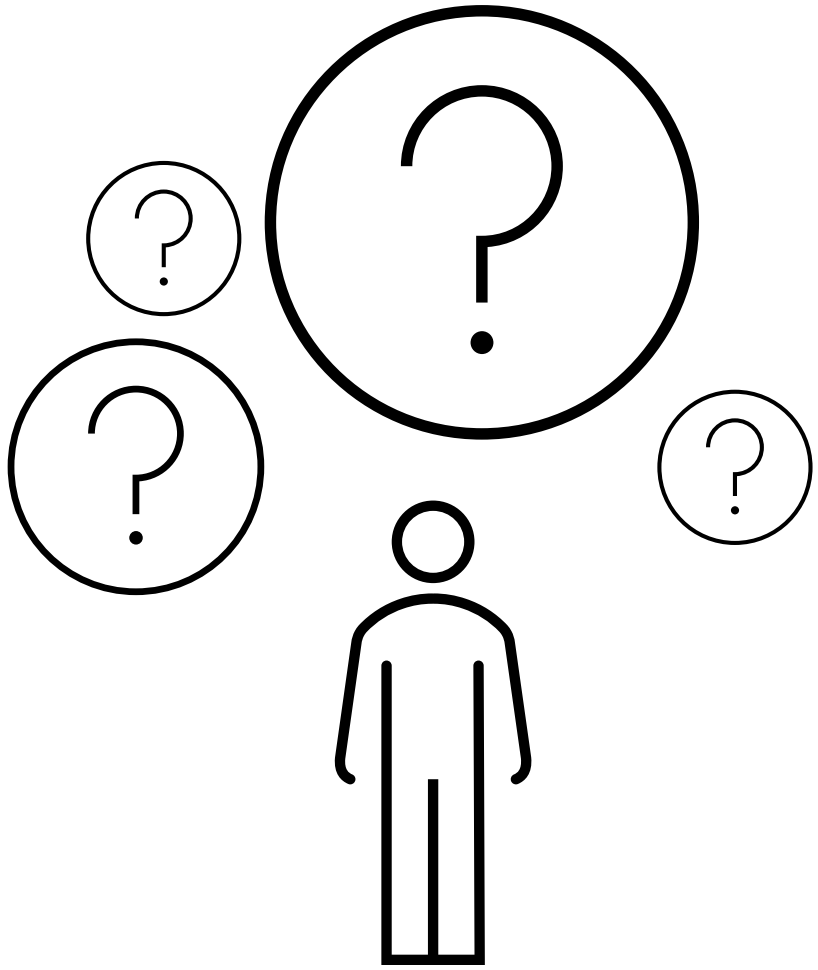

Future Work

- Targets (11/3)
- Concept Generation (11/10)
- Concept Selection (11/10)
- Risk Assessment (11/24)
- Bill of Materials (12/4)
- Spring Project Plan (12/8)