Problem Definition

Overview:

Team Vision for Problem Definition Phase

Plan:

- Specify problem statement
- Contact customer to review project goals
- Establish team roles
- Document all work

Accomplished:

- Conducted customer interview
- Set customer and engineering requirements
- Considered potential use scenarios
- Determined stakeholders
- Established team values and roles
- Created loose project plan and timeline
- Documented all work in Confluence

Project Summary

SailBot is a new portable device that can assist a sailor in steering a sonar. The device converts intense physical labor into a simple, easily controlled method. SailBot is designed to be helpful for sailors with any disability and will be adaptable to match the abilities of each sailor. Currently, any robotic assisted sailing requires a proprietary, expensive boat or takes a long time to set up.

The goals of this project are to create a new device that uses current technologies to make a portable, comfortable control method for a common sonar boat. The expected result is a prototype that is intuitive for the user; and that boathouses can install and remove quickly between sessions.

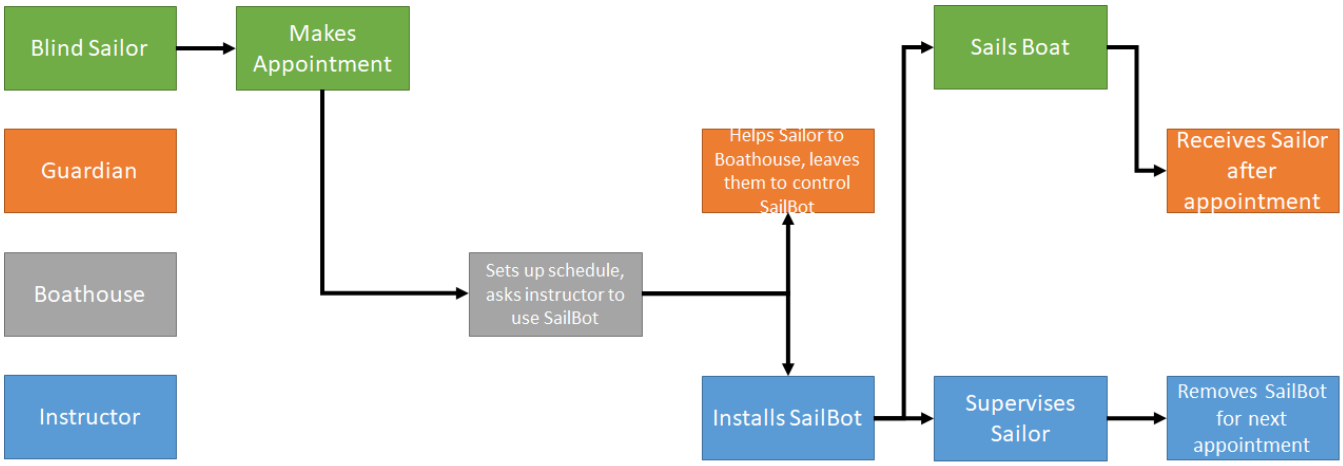
Link to project summary here

Use Cases

Various scenarios of Sailors using SailBot are laid out below. Use scenarios were a tool to help understand feature and requirements needed.

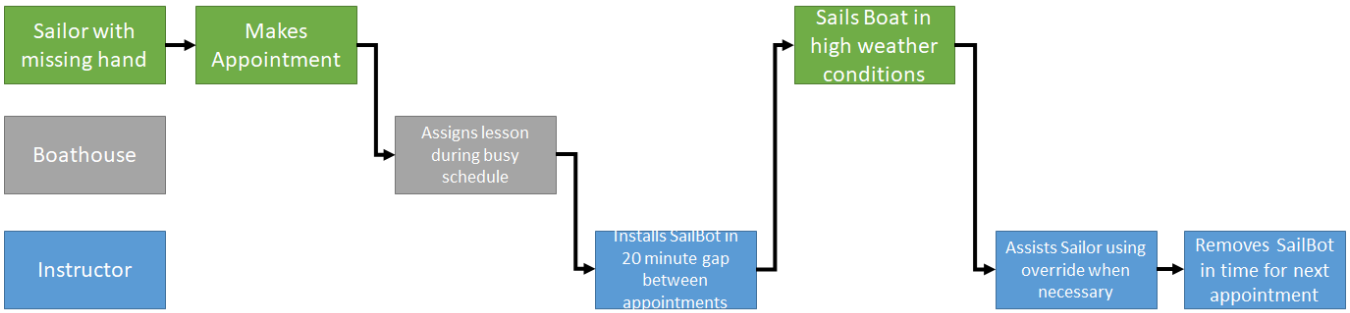
Use Scenario 1:

A blind sailor requests to have a sailing session at 1:00PM one afternoon. The conditions of the ocean are relatively rough waters with 14 knot winds. Between the time the sailor checks in at 1:00 and the time he has to leave at 2:00, he must sign into the boathouse, make his way to a sonar boat with an installed SailBot, get the boat in the water, complete his session, bring the boat back in, and sign out of the boathouse:



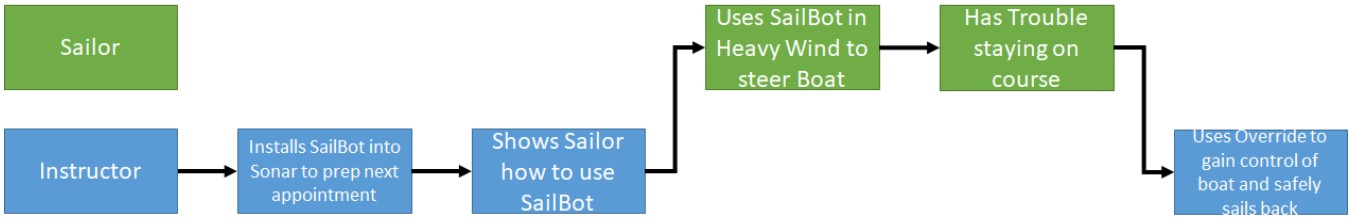
Use Scenario 2:

A sailor with a missing hand wants to go sailing, but can not control ropes in high wind conditions due to the strength required. The sailor makes an appointment with Community Boating to use SailBot to assist them. The Boathouse filled their schedule entirely and the instructor had to quickly prepare between sessions:



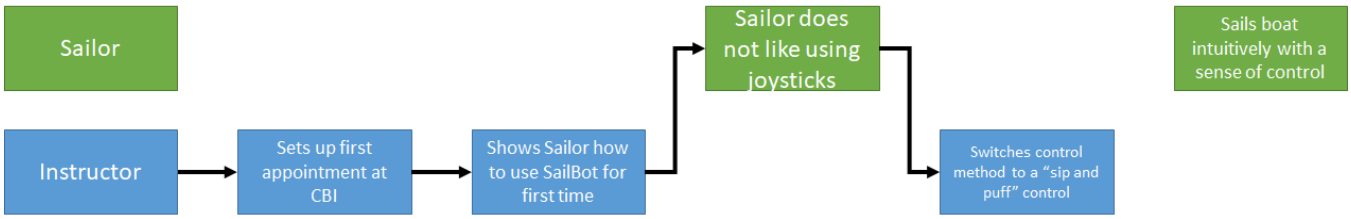
Use Scenario 3:

A Sailor with a disability sets an appointment to use SailBot. Conditions are very tough and the Sailor has trouble staying on course. The instructor is able to override and assist the sailor in safely navigating to the dock:



Use Scenario 4:

A first time Community Boating member sets an appointment to use SailBot. The user does not find Joysticks comfortable and wants to control the boat using a different method. The instructor uses SailBot's "sip and puff" control method to steer the boat instead of a joystick.



Project Goals and Key Deliverables

- Portable steering device with joystick control system (and possibly "Sip and Puff" alternative method)
- Designed to be compact and installed by 1-2 people in less than 20 minutes
- Includes override options in case of emergency
- Powered by a removable battery
- Compatible with Sonar boats

Customer Requirements (Needs)

Requirements based off of Use Case scenarios in addition to interviews with the Director of UAP, Sam Peirson. We discussed common issues with their current joystick controlled Sailing, and also any desired features that customers have requested.

Number	Rank	Requirement	Comment
1	9	Comfortable	Sailor should not experience any level of strain or discomfort during use
2	9	Intuitive	Easy to use for sailor
3	9	Override Failsafe	Ability to disconnect system, with seamless transition to full manual control
4	9	Durable	Can function in 12-20 knot winds for a 1.75 hour session, anywhere between early April to late October in Boston
5	9	Tiller Operation	Provide power assisted control over the boat's tiller
6	9	Joystick Control	Control operations by method of joystick
8	9	Discreet Override	Small corrections by instructor during session, without sailor knowing
7	6	Installation Time	Be able to install quickly, ideally < 20 minutes
9	6	Waterproof	Should not be damaged by direct water contact, such as rain or high humidity
10	6	"SipnPuff" Control	Control operations by method of straw
11	6	Portable	Two people maximum carrying unit to and from boat
12	6	Compatible	Minimal modifications to existing Sonar boat
13	6	Removable Battery	Prevent battery damage during winter storage
20	6	Joystick Centering	Tiller returns to center position when no controls are being sent
14	3	Floats	Prevents unit sinking in case dropped in water
15	3	Intuitive Installation	Any person with no prior knowledge would be able to fully install and repair
17	3	Multi-boat Compatibility	Device can work with Keel Mercuries
16	1	Boom Operation	Provide power assisted control over the boat's main sail
18	1	Touch Control	Operator can touch on a phone where to go (map of water)

A working customer requirement document can be found here

Engineering Requirements (Metrics & Specifications)

Engineering Requirements were created from the customer requirements. Engineering Requirements added specific metrics to give SailBot targets to achieve. This can objectively show if SailBot has achieved its requirements.

Engineering Requirements #	Customer Requirement(s) #	Features	Metric	Target	Direction	Ideal Goal
ER1	CR5	Tiller Operation	Has Tiller Control	Yes	N/A	Yes
ER2	CR4	Battery Powered	Battery Life	2 Hours	Higher	4 Hours
ER3	CR2, CR6, CR10, CR18	Intuitive	Familiar electric control	1 Control Method	Higher	3 Control Methods
ER4	CR4	Durable	Function in High wind	15 Knots	Higher	20 Knots
ER5	CR7, CR15, CR17	Easy to Install	Weight	80 Lbs	Lower	50 Lbs
ER6		Time to Install	Installation time between appointments	20 Minutes	Lower	5 Minutes
ER7		Used on different boats	Number of boats functional on	1 Boat	Higher	2 Boats
ER8	CR3, CR8	Overrides	Has Disconnect Override	Yes	N/A	Yes

ER9		Has Joystick Override	Yes	N/A	Yes	Yes
ER10	CR9	Waterproof	Water resistant to splashes/rain	Yes	Higher	Water resistant to full submersion
ER11	CR1	Comfort	Wires, actuators, components, etc. do not need constant readjustment or interfere	Yes	N/A	Yes
ER12	CR11	Portable	Collapsed/folded/stored volume	4x3.5x2.5 feet	Lower	3.5x3x2 feet
ER13	CR12	Compatable	Attachment method	Standard nuts/bolts	Lower	Damage free snap-on/stick method
ER14	CR13	Removable Battery	Battery installation method	Yes	N/A	Yes
ER15	CR14	Buoyant	Able to float if dropped in water	Room for possibility	N/A	Yes
ER16	CR16	Boom Operation	Ability to control mainsail	Room for possibility	N/A	Yes
ER17	CR19	Crash Aversion	SailBot can autonomously steer to avoid collisions	Room for possibility	Higher	Ability to detect and steer
ER18	CR20	Joystick center	Tiller returns to center position when no controls are being sent	Yes	N/A	Yes
ER19	CR5	Tiller Range	Angle off of center that tiller can turn in either direction	60 Degrees	Higher	80 Degrees
ER 20	CR5	Tiller Speed	Time that tiller should take to move between max positions	1 Second(s)	Lower	0.5 Second(s)
ER 21	CR8, CR15, CR17	Easy to Install	Tools required to install SailBot	1	Lower	0
ER 22	CR12	Modifications	Number of mounting points	6	Lower	4

A working engineering requirements document can be found here

Constraints

1. We are limited to testing at the Rochester Yacht Club, where we may not be able to modify their boats to the extent we need for thorough testing.
2. Due to the facility limitations and uncertain Rochester weather patterns, it is a possibility that testing will not accurately reflect the conditions SailBot will ultimately be used in.
3. Not concerned with capsizing of boat, as sonars are already unlikely to capsize and any hazard of doing so is out of our scope.
4. We were not provided an initial funding estimate from the sponsor and must propose our own budget with efficient use of all available resources.
5. Our product only focuses on controlling the tiller; as per the customer requirement, we are not concerned with controlling the sails.

House of Quality

P20032 SailBot House of Quality

Customer Requirement #	Customer Rank	Direction of Improvement Increase ↑ Decrease ↓ Target N/A / Engineering Requirements / Customer Requirements	Has Tiller Control	Battery Life	Familiar electric control	Function in High wind	Weight	Time to Install	Used on different boats	Has Disconnect Override	Has Joystick Override	Water resistant to splashes/rain	Comfort	Collapsed/folded/stored volume	Attachment method	Battery installation method	Able to float if dropped in water	Ability to control mainsail	Crash Aversion	Joystick Centering	Tiller Range	Tiller Speed	Tools to Install SailBot	Number of Mounting Points	Raw Score	Weighted Score
		Direction of Improvement Increase ↑ Decrease ↓ Target N/A	N/A	↑	↑	↑	↓	↓	↑	N/A	N/A	↑	N/A	↓	↓	N/A	N/A	N/A	↑	N/A	↑	↓	↓	↓		
CR1	9	Comfortable			9								9	6						3					27	4%
CR2	9	Intuitive			9				6				6		6					6					33	4%
CR3	9	Override Failsafe	6			6		6		9					9			6							42	5%
CR4	9	Durable	6	9		9	3					6		6	6	3	3	6				3			60	8%
CR5	9	Tiller Operation	9	6	3	6		6	3			6	6	6	9				3	6	9	9			87	11%
CR6	9	Joystick Control	6	3	9			6			9	6	9		3					9	3	3			66	9%
CR7	9	Discreet Override									9				3					9					21	3%
CR8	6	Installation Time	3				6	9	6					6	9	3				6			6	6	60	8%
CR9	6	Waterproof										9					6								15	2%
CR10	6	"SipnPuff" Control	6	3	9			6				6	9		3					6					48	6%
CR11	6	Portable					9							9	3	6							6		33	4%
CR12	6	Compatable							6					6	9						6			9	36	5%
CR13	6	Removable Battery		6			9	6				6				9									36	5%
CR14	6	Joystick centering			6								9							9	6	6			36	5%
CR15	3	Floats					6					9		3			9								27	4%
CR16	3	Intuitive Installation						3							6								6	6	21	3%
CR17	3	Multi-boat Compatibility							9	9				9	9										36	5%
CR18	1	Boom Operation		6			6			9		6		6	9			9							51	7%
CR19	1	Touch Control		6	9																				15	2%
CR20	1	Crash Aversion		6															9						15	2%
		Raw Score	36	45	54	21	39	42	30	27	18	54	48	57	84	21	18	21	12	54	24	21	18	21		
		Weighted Score	5%	7%	8%	3%	6%	6%	4%	4%	3%	8%	7%	8%	12%	3%	3%	3%	2%	8%	4%	3%	3%	3%		
		Units	N/A	Hours	Control Methods	Knots	Lbs	Minutes	Applicable Boats	N/A	N/A	N/A	N/A	ft	N/A	N/A	N/A	N/A	N/A	N/A	Degrees	Second(s)	# of Tools	# of Mounting Points		
		Target Values	Yes	2	1	15	80	20	1	Yes	Yes	Water Resistant	Yes	4x3.5x2.5	Standard Hardware	Yes	Room for Possibility	Room for Possibility	Room for Possibility	Yes	60	1	1	6		
		Ideal Values	Yes	4	3	20	50	5	2	Yes	Yes	Full Submersion	Yes	3.5x3x2	Damage Free	Yes	Yes	Yes	Detect and Steer	Yes	80	0.5	0	4		

Legend	
9	Strong Relationship
6	Morderate Relationship
3	Weak Relationship

The House of Quality chart above displays the relative importance of each engineering and customer requirement for the SailBot device. The most important qualities of the device are that the tiller operation and joystick control are durable and functional in the sailing conditions and that the user finds the device easy and comfortable to use.

A working House of Quality document can be found here.

A copy of our first revision of a comprehensive risk management chart can be found here.

Design Review Materials

Links to:

- Pre-read
- Presentation

Plans for next phase

- Communicate with Rochester Yacht Club about using their facilities and boats for testing
- Submit finalized financial proposal to Community Boating for approval
- Begin concept generation
- Begin feasibility analysis and making test plans
- Update deliverables in Confluence

Link to the current draft schedule looking ahead to phase 2 here

Three week plans for each individual team member linked below:

Amit Rogel

Matthew Miller

Max Messie

Mike Robinson

Thomas Davis

Erica Kabat

Peer Evaluations

Peer evaluations were completed for all team members for phase 1 following the problem definition review.

Peer evaluations link