P21389: Bug Torch

Phase 4: Detailed Design Review
May 2021

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PRELIMINARY DETAILED DESIGN ACTION ITEMS

CLOSED:
Confluence Meeting with Client

REMAIN OPEN:
N/A

TEAM VISION FOR DETAILED DESIGN

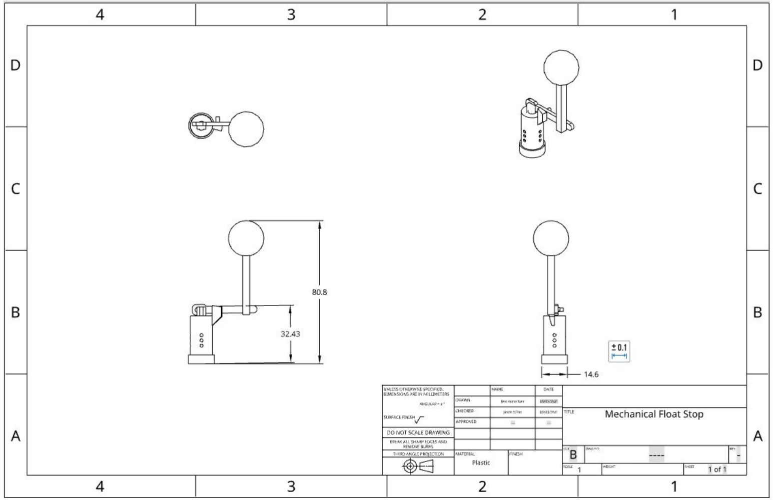
Team Plan:

- Further refine design
- Order long lead time items
- Continue improving mathematical models and documentation

PROGRESS REPORT

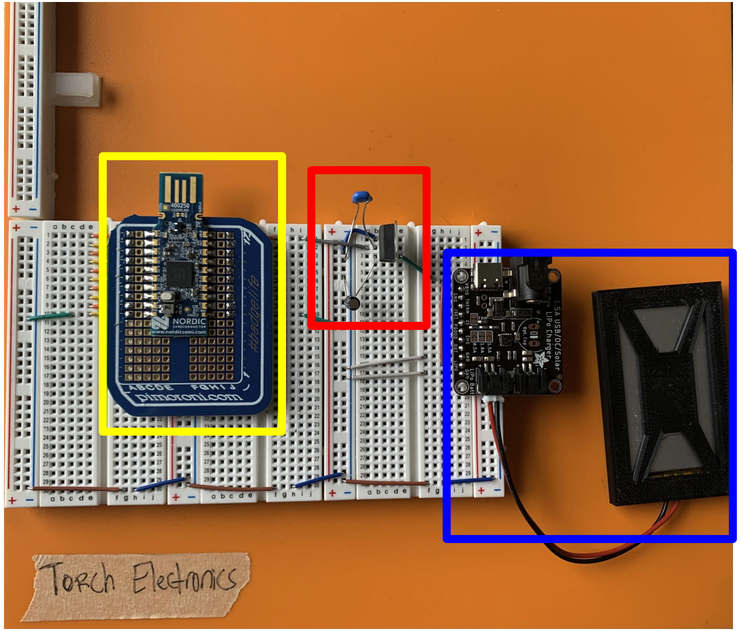
Discipline	Detailed Design Phase Tasks	Description	Owner	Completion Status
Mechanical	3-D Model of "Inverted Level Valve"	Build CAD model of valve planned to use for individual torch reservoirs	Ben	Completed
Mechanical	Print Prototype Valve Parts	Using 3-D model, 3-D print prototype of valve	Ben	Completed
Mechanical	Part Drawings	Finish all CAD-Models for Detail Design	Jason/ Ben	Completed
Mechanical	Fluid Calculations	Revise existing fluid model to determine pump size for benchmarking	Jason	Completed
Mechanical	Subject Matter Expert Review: Fluid Calculations	Meet with Professor Landschoot to verify the calculations are representative of the system	Jason	Postponed until MSD II due to scheduling issues
Electrical	Pump Power Calculations	Using specification of pump, complete power draw calculations to verify preliminary power design is feasible	Bryn	Blocked for Majority of Phase, no longer necessary
Electrical	Prototype Electronics	Integrate microcontroller and power electronic subsystems; demonstrate feasibility of electronic design	Owen	In Progress, continue during MSD II
Electrical	Subject Matter Expert Review: PCB Sensor Design	Work with Carlos Barrios to verify sensor modifications (PCB design) prior to sending out for manufacturing over the summer	Owen	Completed
Electrical	Benchmark Power Supply	Design and spec out solution for powering ESP32 Gateway controller	Owen	Completed
Electrical/Mechanical	Update System Flow Charts	Update pre-existing documentation to reflect the system flow	Bryn	Completed
Computer	App Design Research	Research with intent to suggest how to incorporate an app into our system design	Yoon	In Progress- Made suggestion but will make decisions in MSD II
All	Review Risks	Revise Risk Table	Yoon	
All	Test Plans for MSD II	Collaborate with the team to develop mechanical and electrical test procedures that will reflect the achievement of engineering requirements	Jason/Owen	Completed
Purchasing	Update Bill of Materials	Continue to keep an accurate record of items purchased for Bill of Materials	Yoon	Completed- Long Lead items ordered for MSD II
Administrative	Environmental Health & Safety (EHS) Paperwork	Draft and send letter to EHS personnel seeking approval to use citronella oil or other liquid of similar viscosity to use for testing	Bryn	In Progress- Planned to complete prior to 5/15
Administrative	MSD I & II Transition Tasks	Organize Phase and Gate Reviews for the end of the semester and work to select MSD II meeting time to accommodate teammate schedules	Bryn	Completed- Gate Review planned for 5/7/2021 Meeting TuTh 8-9:30am for MSD II
Administrative	Gate Review Paperwork	Complete Gate review page, self-critique, peer reviews, end of the semester checklist, MSD II Gantt chart, registration, etc.	All	In Progress

MECHANICAL FEASIBILITY: PROTOTYPING, ANALYSIS & SIMULATION



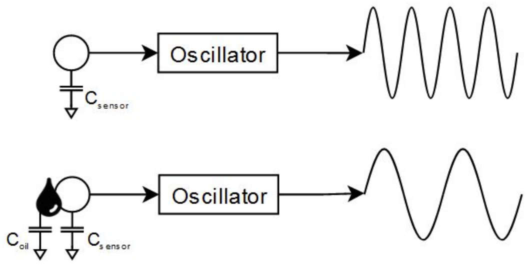
ELECTRICAL FEASIBILITY: PROTOTYPING, ANALYSIS, & SIMULATION

- For the foreseeable future, the electrical design of the system is **complete**.
- The image on the right is of the initial torch electronics prototype. This demonstration indicates the **feasibility** of the final design. Captured in this image are all of the components necessary to construct the final design.
- The base station design is also **complete** and ready for prototype in MSDII. Unfortunately, those parts have a longer lead time and will not arrive until the fall semester begins.
- The full list of components can be found **here**. This list has images of each item and a description of why it was chosen with respect to how it meets or exceeds the customer and engineering requirements.

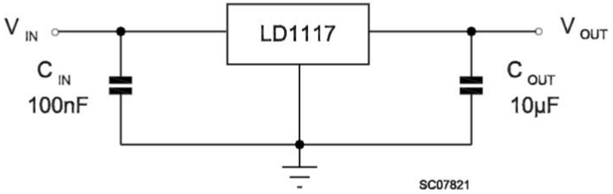


ELECTRICAL FEASIBILITY: PROTOTYPING, ANALYSIS & SIMULATION (cont.)

- Here we see the solar panels in the window with attached multimeter. As is shown, the panels when wired in parallel produce a **steady** voltage that during test ranged from 3.5V to 3.7V depending on angle and strength of the sunlight..



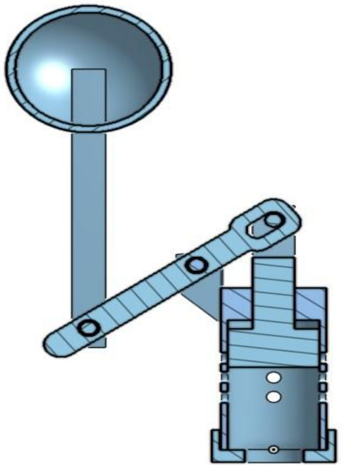
- The next diagram shows the missing sensor module design. In this example copper tape is acting as a capacitor that **will** change its oscillation frequency based on the dielectric near it (oil/air). We will detect this change with the microcontrollers on-board 32KHz oscillator thus detecting the oil level.

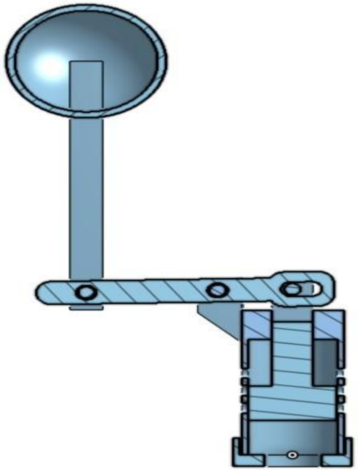


- The last image better describes the regulator circuit needed to ensure the battery and solar panels do not fry the microcontroller. This integrated circuit will take the ~3.7V input and **ensure** it stays at a comfortable 3.3V.

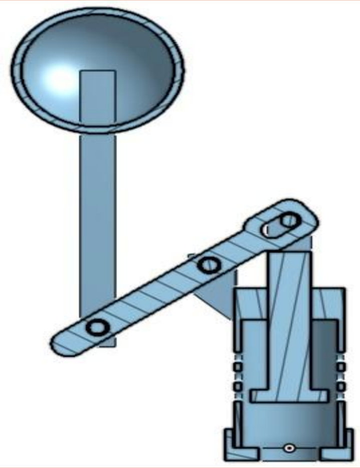
DRAWING, SCHEMATIC, FLOWCHARTS, SIMULATION, ETC.

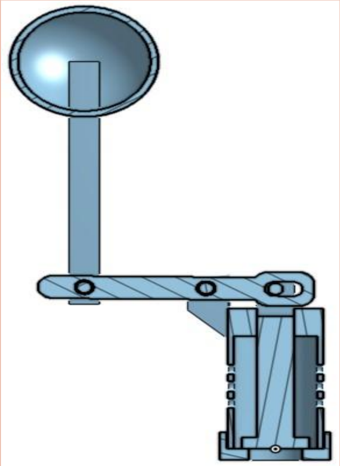
Design 1: Side Close





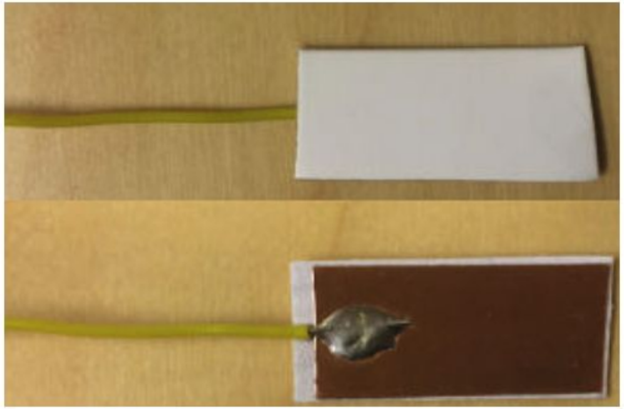
Design 2: Bottom Close





Mechanical Diagrams

- Since last phase and after careful discussion with a subject matter expert the team has decided to **simplify** the sensor design from last phase where we had discussed a custom PCB and sensor with its own controller.
- By making the inner torch tank plastic the sensor no longer needs to be inside the tank. By doing this we discovered that a **simple** piece of copper tape paired with the microcontrollers on-board oscillator **will** be capable of measuring the oil level.
- If given the time over break the PCB design may be explored again but for the moment it was not feasible and introduced too many **risks**.



Electrical Diagrams

BILL OF MATERIALS/BUDGET

Budget Spreadsheet		Budget	Spent	Left
Total	Date	$4,000.00	$299.53	$3,700.47
Electronics				
Main MCU (digi-key)	3/29/21		$8	-$8
Jumper wires	3/29/21		$50	-$50
Protoype Board	3/29/21		$5.30	-$5.30
Main MCU (Mouser)	4/1/21		$30	-$30
Jumper wires MF	4/1/21		$4.40	-$4.40
Jumper wires MM	4/1/21		$4.40	-$4.40
Prototype board	4/1/21		$3	-$3
Solar Panels	4/7/21		$34.26	-$34.26
Solar lithum Charger	4/7/21		$19.90	-$19.90
3.3V Voltage Regulator	4/7/21		$1.77	-$1.77
LiPo Batter 1200mAh	4/7/21		$9.95	-$9.95
LiPo Batter 350mAh	4/7/21		$5.95	-$5.95
Wire kit	4/19/21		$13.40	-$13.40
Male DC Power adapte	4/19/21		$4.00	-$4.00
ESP 32	5/3/21		$24.00	-$24.00
Copper Tape	5/3/21		$27.00	-$27.00
PSU for base station	5/3/21		$9.52	-$9.52
Mechanical				
				0
				0
Shipping				
Mouser	3/29/21		$7.99	-$7.99
Digi-key	3/29/21		$4.99	-$4.99
Digi-key	4/7/21		$6.99	-$6.99
Ada-fruit	4/7/21		$8.86	-$8.86
Ada-fruit	4/19/21		$8.86	-$8.86
Digi-key	4/19/21		$6.99	-$6.99

BILL OF MATERIALS/BUDGET

Item #	Qty.	Mfr.	Part #	Description	Cost	Total Cost	Link
1	1	Espressif Systems	ESP32-C3-DevKitM-1	esp32 for central contol	$8.00	$8.00	Mouser
2	0.00154	Bertech	2363-CFT-1-ND	Copper tape for making capacitive sensor. (*108' roll only need ~2" per sensor	$27.00	$0.04	Digikey
3	1	Mean Well	709-RS15-3.3	120V to 3.3V panel power supply.	$8.83	$8.83	Mouser
4	1	MOSTPLUS	12182	Pump for oil	$10.97	$10.97	Amazon
Note: This does not include the cost of wires.					Base Cost:	$27.84	

Key
Microcontroller/Sensor
Power
Pump

Item #	Qty.	Mfr.	Part #	Description	Cost	Total Cost	Link
1	100	Espressif Systems	ESP32-C3-DevKitM-1	esp32 for central contol	$8.00	$800.00	Mouser
2	0.15432	Bertech	2363-CFT-1-ND	Copper tape for making capacitive sensor. (*108' roll only need ~2" per sensor	$24.00	$3.70	Digikey
3	100	Mean Well	709-RS15-3.3	120V to 3.3V panel power supply.	$8.83	$883.00	Mouser
4	100	MOSTPLUS	12182	Pump for oil	$10.97	$1,097.00	Amazon
Note: This does not include the cost of wires.					Base Cost:	$2,783.70	
					Cost per Base:	$27.84	

Key
Microcontroller/Sensor
Power
Pump

Item #	Qty.	Mfr.	Part #	Description	Cost	Total Cost	Link
1	1	McMaster Carr	7933K34	Valve by pump	$18.44	$18.44	
2	1	Everbilt	#HKP002-PVC0	half inch tubing (200ft)	$70.00	$70.00	
3	300 grams	Alibaba	N/A	PLA plastic for use in 3-D printers	$0.15/gram	$45.00	
Note: additional fittings and tubing as needed not included.					Total Cost:	$133.44	

Key
Fluid Handling
Construction

BILL OF MATERIALS/BUDGET

Item #	Qty.	Mfr.	Part #	Description	Cost	Total Cost	Link
1	1	Pimoroni Ltd	1778-PIM531-ND	Prototype board	$1.00	$1.00	Digikey
2	1	Nordic Semi.	1490-1073-ND	Main MCU for torches	$10.00	$10.00	Digikey
3	0.00154	Bertech	2363-CFT-1-ND	Copper tape for making capacitive sensor. (*108' roll only need ~2" per sensor	$27.00	$0.04	Digikey
4	3	AnySolar	SM500K12L	IXOLARTM High Efficiency Solar Panels	$5.71	$17.13	Digikey
5	1	Adafruit	BQ24074	Adafruit Universal USB / DC / Solar Lithium Ion/Polymer charger - bq24074	$9.95	$9.95	Adafruit
6	1	Adafruit	258	LiPo Battery 1200mAh	$9.95	$9.95	Adafruit
7	1	Adafruit	369	2.1mm adapter	$2.00	$2.00	Adafruit
8	1	TDK Corporatior	445-173153-1-ND	10uF Cap	$1.27	$1.27	Digikey
9	1	KEMET	399-4264-ND	0.1uF Cap	$0.24	$0.24	Digikey
10	1	STI	LD1117V33	3.3V Voltage Regulator	$0.59	$0.59	Digikey
Note: This does not include the cost of wires.					Torch Cost:	$52.17	

Key
Microcontroller/Sensor
Power
Voltage regulation

Item #	Qty.	Mfr.	Part #	Description	Cost	Total Cost	Link
1	100	Pimoroni Ltd	1778-PIM531-ND	Prototype board	$1.00	$100.00	Digikey
2	100	Nordic Semi.	1490-1073-ND	Main MCU for torches	$10.00	$1,000.00	Digikey
3	0.15432	Bertech	2363-CFT-1-ND	Copper tape for making capacitive sensor. (*108' roll only need ~2" per sensor	$24.00	$3.70	Digikey
4	300	AnySolar	SM500K12L	IXOLARTM High Efficiency Solar Panels	$4.12	$1,236.00	Digikey
5	100	Adafruit	BQ24074	Adafruit Universal USB / DC / Solar Lithium Ion/Polymer charger - bq24074	$9.95	$995.00	Adafruit
6	100	Adafruit	258	LiPo Battery 1200mAh	$9.95	$995.00	Adafruit
7	100	Adafruit	369	2.1mm adapter	$1.60	$160.00	Adafruit
8	100	TDK Corporatior	445-173153-1-ND	10uF Cap	$0.75	$75.00	Digikey
9	100	KEMET	399-4264-ND	0.1uF Cap	$0.09	$9.00	Digikey
10	100	STI	LD1117V33	3.3V Voltage Regulator	$0.37	$37.00	Digikey
Note: This does not include the cost of wires.					Sum Torch Cost:	$4,610.70	
					Cost per Torch:	$46.11	

Key
Microcontroller/Sensing
Power
Voltage regulation

TEST PLANS

Mechanical test plans:

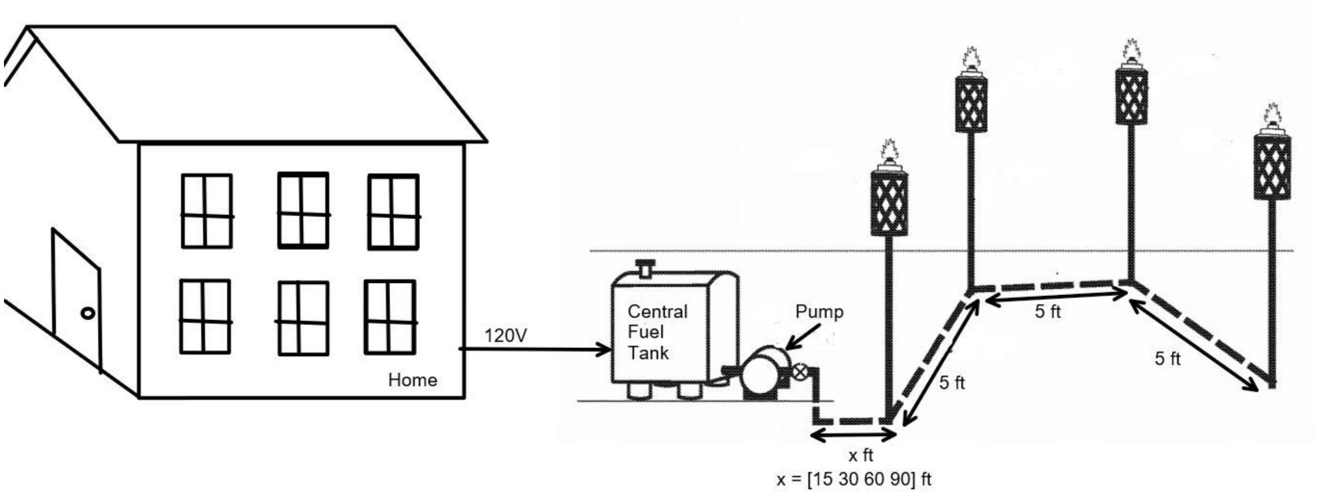
ER	Plan
Valve seals completely to avoid overfill/leakage.	Model valve, run water through in closed position, check for leaks.
Valve closes when tank is full.	Mode valve and float, "full height" measurement same as that in the fuel tank.

Electronic test plans:

CR	Plan
System has no ground wires.	We know that this design will not have ground wires therefore no test is required.
Automatic ignition of the torch head.	To shorten the scope of the project the team had already decided that we will not be exploring automatic ignition of the torch so no test is required there as well.
System is monitored by an app.	There are several available methods for testing an app but the best way is to design and debug. If it is able to detect and monitor the torches then the app will be successful.
Measures individual fuel levels.	To test if the individual fuel levels are being measured goes with the prototyping of the system. It is a binary test that can be shown to work when there is a difference between the sensor I/O when the torch tank is full or low.

- A more detailed description of these test can be found on our engineering requirements table where values were created to measure the success of each requirement.

SYSTEM DESIGN



ENERGY

- 120V sourced from house for pump and base controller
- incorporate solar panels to eliminate wires on individual torches

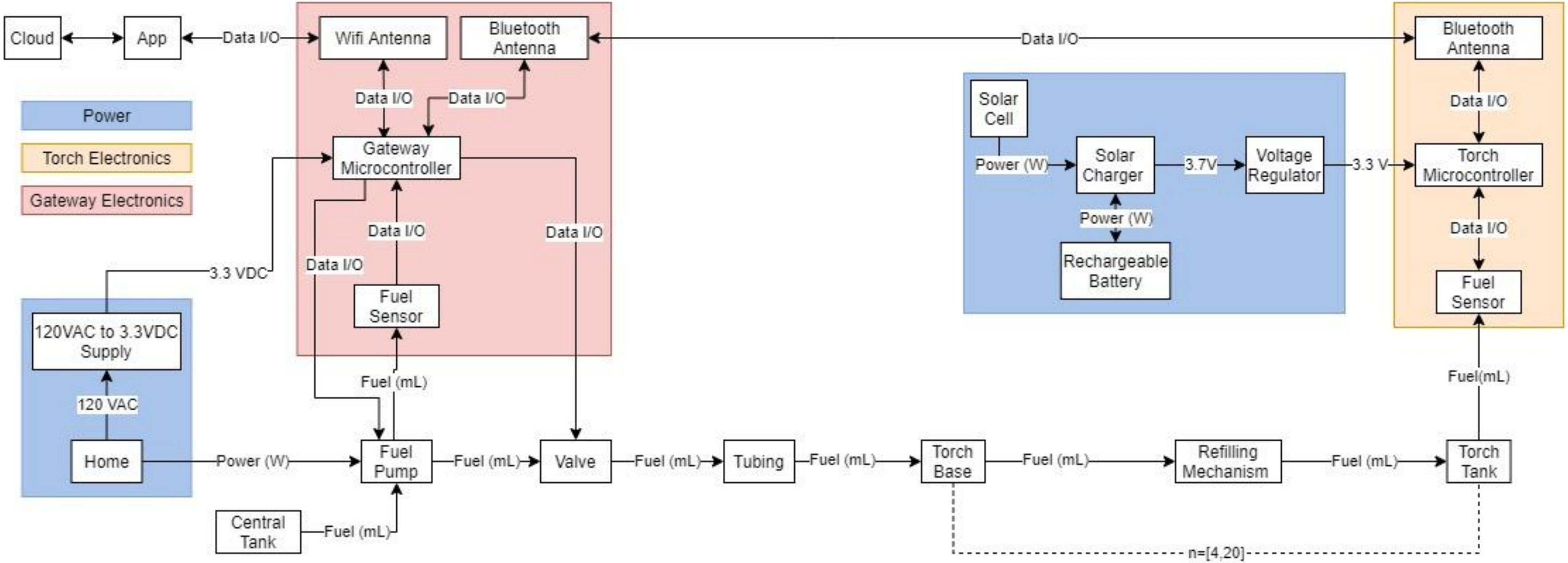
PUMP TO TORCH

- variable distances meant to model different customizable set-ups
- understand how fluid transport is affected by linear distance

TORCH TO TORCH

- 5 ft distance
- based on typical 1ft effective range for citronella oil

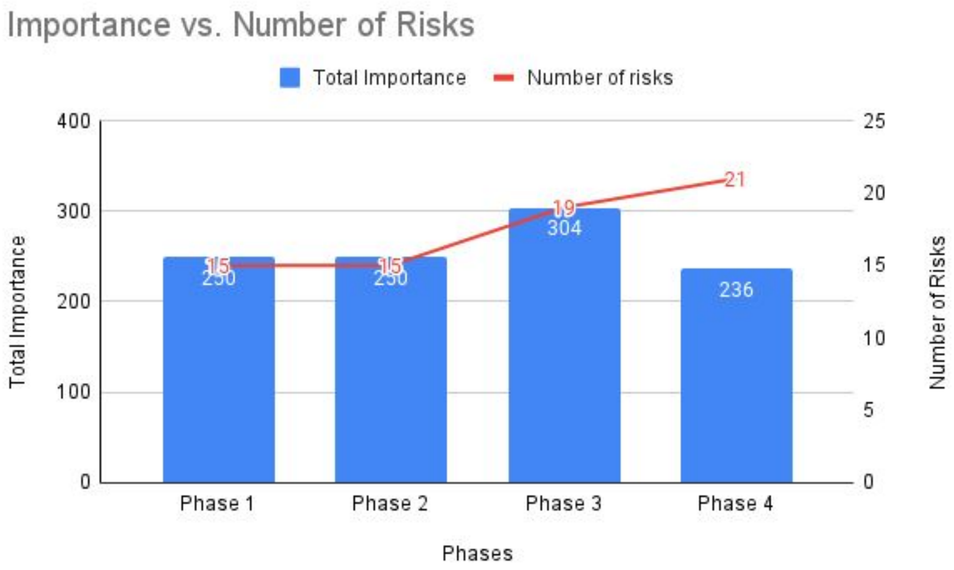
SYSTEM FLOWCHART/BLOCK DIAGRAM



RISK ASSESSMENT

Team #:	P21389	Team Name:	BugTorch
Date:	2/8/2021 8:41	Document Owner:	Owen Straub
Revision #:	1		

ID	Environmental/Social	Risk Item	Effect	Cause	Likelihood	Severity	Importance	Action to Minimize Risk	Owner
	What type of risk is this?	*Describe the risk briefly*	*What is the effect on any or all of the project deliverables if the cause actually happens?*	*What are the possible cause(s) of this risk?*	*L*	*S*	*L*S*	*What action(s) will you take (and by when) to prevent, reduce the impact of, and/or transfer the risk of this occurring?*	*Who is responsible for following through on mitigation?*
1	Environmental	Torch Oil Spills/leaks	Saftey standard violations	Bad seals/ lack of gaskets	3	3	9	accept	Ben
2	Safety	Fire/burn hazards	team members harmed	Carelessness or Incompetence	1	1	1	Prevent	Jason
3	Safety	electrocution hazard	team members harmed	Carelessness or Incompetence	3	1	3	Prevent	Owen
4	Resource-related	dev kit costs	Could quickly expend budget	Frivolous spending	1	1	1	Reduce	Yoon
5	Social	Market for the product	Product might not sell	Ugly/expensive torches	3	9	27	transfer	Bryn
6	Safety	Covid	Project progress could slow down	Covid spreads	3	1	3	Take safety precautions	All team members
7	Environmental/Social	Loud pump noises	Can be annoying/distracting	Faulty pump	3	1	3	Possible sound muffling box	Jason
8	Technical	Keep sensors away from oil	Possible failure of parts	Not designing around this issue	1	3	3	Being careful with design	Ben
9	Resources	Internet connectivity	Limit productivity	Energy provider and possibly weather	1	3	3	Accept the risk because it is beyond our control	all team members
10	Social	Team not all being in-person	Limit productivity	Covid and transportation	3	1	3	Communciate with team to prevent impact	Bryn
11	Safety/ Technical	Weather Hazards	Part failures and broken system	Weather (i.e. snow, rain, lightening, earthquakes)	9	9	81	Test for weather impact in a secure enviroment	Bryn
13	Technical	Limited knowledge of app development and fluids	May prevent team from reaching project deliverables	Lack of knowledge/education on topic	3	3	9	Discuss with experts and ask for advice when encountering issues to prevent risks	All team members
14	Technical	Make overall price of torch low	Could make system too expensive	Needing to buy more expensive materials	1	9	9	Taking consideration of parts cost	Yoon
15	Resource	Reliance on custom-built components	Delays, failure to finish prototype	Delays or cancellation of mid-long lead time parts	3	3	9	Order custom parts with significant lead time	Yoon
16	Technical	Sensor PCB can't withstand oil errosion	Sensor will decay and malfunction	Natural relationship between oil and silicon	3	9	27	Find a form of protective coating that minimizes erosion	Owen
17	Resource	Solar power does not meet power requirements	Could fry controllers or make system fallible	Unexpected power draw or clouds/etc...	1	9	9	Look into power alternatives or using a wired system	Bryn
18	Resource	Delay in ordered parts	Delay in prototyping or testing components	Parts out of stock or shipping delay	3	3	9	Making sure to be quick with ordering and checking quantity	Yoon
19	Technical	Mechanical parts not being compatible with other parts	Needing to find another part to fit our solution	Not having enough information about torch	3	3	9	Making sure torch measurements are finished and checked with other parts	Ben/Jason
20	Technical	Using water/oil and how that affects our test	It could possibly not give us accurate data	using water instead of citronella oil	3	3	9	Trying our best to use citronella oil for accurate data	All team members
21	Technical	Bluetooth mesh links failing	Communication between MCU's could get affected	something happens to MCU	3	3	9	Making sure each link in the mesh has different paths to communicate	Yoon/Owen/Bryn



RISK ASSESSMENT

PLAN FOR NEXT PHASE

- Finalize test plans
- create MSD 2 roadmap
- Ensure long lead items are on schedule
- Create full technical drawing package

Questions?