

P21389: Bug Torch

Phase 2: System Level Design
March 2021

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PROBLEM DEFINITION ACTION ITEMS

CLOSED:

Vision for Phase II
Individual Three Week Plans
Revisit Customer Requirements
Clean Up Figures and Tables
Reorganize Confluence

REMAIN OPEN:

N/A

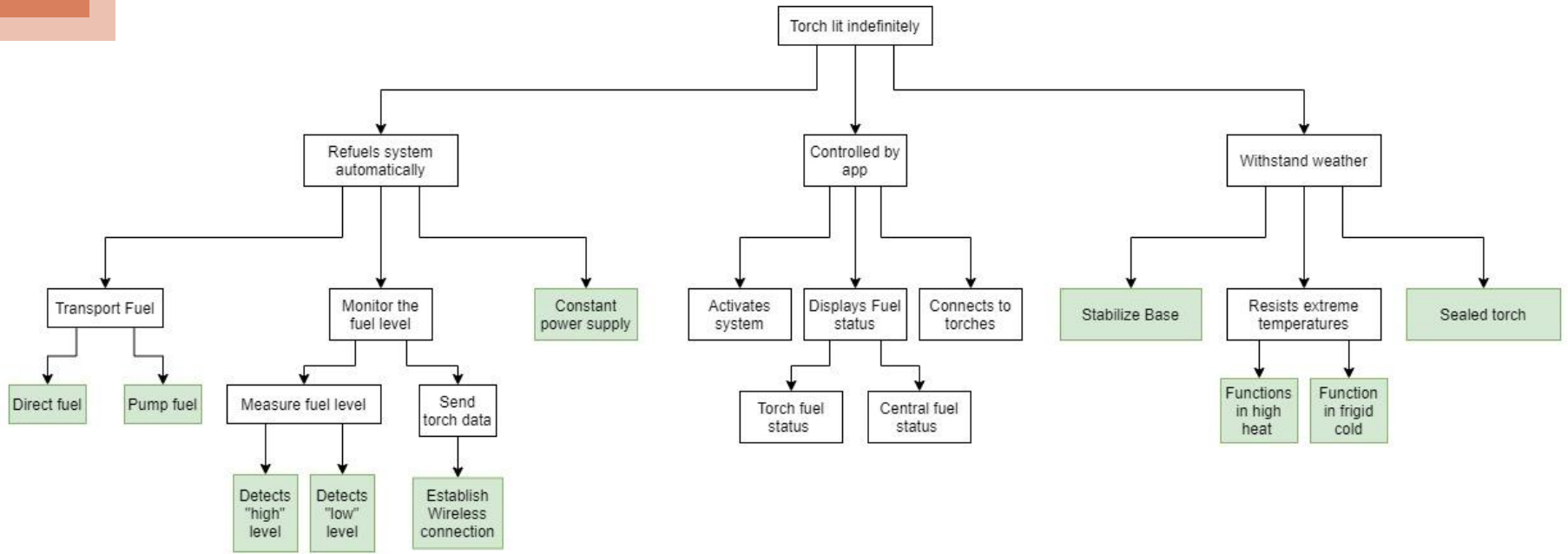
TEAM VISION

Team Plan:


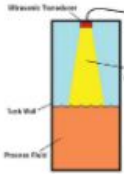
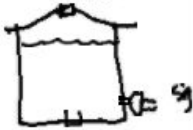











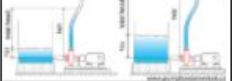
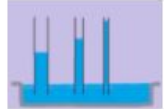
- The team wanted to examine and analyze the full BugTorch System.
- We wanted to also go over our customer and engineering requirements to see if there needed to be any adjustments.
- The team will choose different concepts and each member will create benchmarks for those concepts.

Accomplishments:



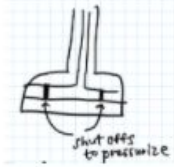
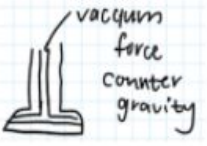











- The team reviewed our customer and engineering requirements and with the modifications, we created a functional decomposition chart.
- We created some concepts of possible solutions along with benchmarks for those concepts.
- We created a systems architecture and a design and flowchart for the system.
- Finally, we went over our risk assessment and our plans for the next phase.



FUNCTIONAL DECOMPOSITION

Solutions Functions	1	2	3	4	5	6
System detects high/low oil level	<p>Float attached to switch.</p> 	<p>Ultrasonic Transmitter.</p> 	<p>Differential pressure sensor.</p> 	<p>Laser Transmitter.</p> 	<p>Displacer.</p> 	<p>Capacitive Sensor.</p> 
Establish wireless connection	<p>uses wifi</p> 	<p>uses bluetooth</p> 	<p>uses zigbee</p> 	<p>uses z-wave</p> 	<p>uses ir</p> 	
Direct Fuel (Tubing -> Torch)	<p>butterfly valve</p> 	<p>one way valve</p> 	<p>"Pressure" sensitive valve that closes at certain tank volume</p> 	<p>"Maximum Head" pump cannot pump fuel higher than a certain point</p> 	<p>capillary action</p> 	

MORPHOLOGICAL CHART

Solutions Functions	1	2	3	4	5	6
Pump Fuel (Tank-> Tubing)	Hand Pump 	Mechanical vacuum device 	Pressure 	Natural Suction. 	Electric Pump 	Irrigation Pump 
Stabilize Base	Fill with concrete, gravel, sand, etc 	Bury in ground 	Nail down/Stakes 	Magnetize it 		
Sealed System	FlexSeal 	Caulk 	Pipe dope 	O-rings 	Gaskets 	

MORPHOLOGICAL CHART (cont.)

CONCEPT DEVELOPMENT

Concept	Solutions	Description
Concept #1	Float w/ switch	This initial concept was designed to be the least ideal design. Each of the solutions presented are either too difficult to achieve within the projects time constraints or do not fully fulfill the customers requirements. It was made this way to show how other concepts will prove to be successful.
	Z-wave	
	capillary action	
	hand pump	
	bury base	
	flex seal	
Concept #2	Differential Pressure sensor	This concept borders on the realistic and effective. The team made sure that with this concept the customer would see their requirements met within a reasonable amount of time and resources.
	Wifi / BT combo	
	butterfly valve	
	electric pump	
	Fill Base w/ etc..	
	o-rings	
Concept #3	Ultrasonic	Concept three is another realistic design goal. The team broke this one down similarly to the previous in order to have several possibilities to choose from and remain somewhat direct solution independent.
	Zigbee	
	One way valve	
	electric pump	
	nail down/stakes	
	caulk	
Concept #4	Laser Transmitter	Once again this concept borders on the realistic. Each solution is somewhat reasonable and chosen to achieve success within the customers requirements.
	IR	
	Pressure sensitive valve	
	Natural Suction	
	Magnetize base	
	Pipe dope	
Concept #5	Ultrasonic	This concept was generated as a result of a discussion with mentors and experts. The team came to the realization that a differential pressure sensor may not work the way we intended the design to in Concept #2. This concept compares to the description of Concept #2 as well
	Wifi / BT combo	
	butterfly valve	
	electric pump	
	Fill Base w/ etc..	
	o-rings	
Concept #6	Capacitive	This concept was generated as a result of a discussion with mentors and experts who suggested a capacitive sensor. This concept compares to the description of Concept #2 as well.
	Wifi / BT combo	
	butterfly valve	
	electric pump	
	Fill Base w/ etc..	
	o-rings	

FEASIBILITY: PROTOTYPING, ANALYSIS & SIMULATION

As of the time of the Phase II Design Review, the shipment from the customer containing concept torch designs and other parts to be used in designing the system has arrived. The team has plans to pick up the shipment tomorrow. Since the team was previously unable to work with these materials, we were unable to move forward with meaningful prototyping until now.

Based of a torch concept that utilizes a Bluetooth/WIFI combination for data transfer, solenoid valve for fluid control, solar/rechargeable batteries for power, ultrasonic/capacitance for fuel level monitoring, and o-rings for sealant runs these prices as a preliminary check:

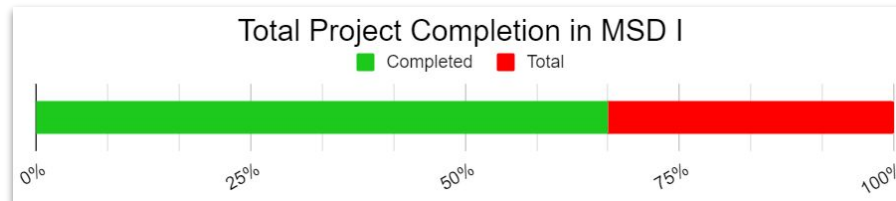
- Wireless Connector - \$5-\$25
- Solenoid Valve - \$3-\$100
- Power Source - \$10-\$30
- Fuel Monitor - \$4-\$20
- Sealant - ~\$0.05 per o-ring

Concept #5	Ultrasonic
	Wifi / BT combo
	butterfly valve
	electric pump
	Fill Base w/ etc..
	o-rings
Concept #6	Capacitive
	Wifi / BT combo
	butterfly valve
	electric pump
	Fill Base w/ etc..
	o-rings

Minimum total price per torch - ~\$22

If the team is able to source all necessary parts at minimum, we should be able to keep the price per torch below \$25.

The customer's goal is to have the BugTorch system to be available on the market in early to mid 2021. In the portions of the project covered by MSD I, the team is either on or ahead of schedule.



CONCEPT SELECTION

Selection Criteria	Category	Concept #1	Concept #2	Concept #3	Concept #4	Concept #5	Concept #6
Time	Constraints	0 ▾	0 ▾	0 ▾	0 ▾	0 ▾	0 ▾
Cost		0 ▾	- ▾	- ▾	- ▾	- ▾	- ▾
Power		0 ▾	- ▾	- ▾	- ▾	- ▾	- ▾
Residential Planning		0 ▾	0 ▾	0 ▾	0 ▾	0 ▾	0 ▾
Regulations		0 ▾	+ ▾	+ ▾	+ ▾	+ ▾	+ ▾
Safety		0 ▾	+ ▾	+ ▾	- ▾	+ ▾	+ ▾
Temperature		0 ▾	+ ▾	0 ▾	0 ▾	+ ▾	+ ▾
Sound		0 ▾	- ▾	- ▾	- ▾	- ▾	- ▾
Visually appealing	CR	0 ▾	+ ▾	+ ▾	+ ▾	+ ▾	+ ▾
No human interaction		0 ▾	+ ▾	+ ▾	+ ▾	+ ▾	+ ▾
Central fuel reservoir		0 ▾	0 ▾	0 ▾	0 ▾	0 ▾	0 ▾
Capable of remaining in the ground year-round		0 ▾	+ ▾	0 ▾	- ▾	+ ▾	+ ▾
No routine maintenance		0 ▾	+ ▾	+ ▾	0 ▾	+ ▾	+ ▾
Sum +		0	7	5	3	7	7
Sum 0		13	3	5	5	3	3
Sum -		0	3	3	5	3	3
Net Score		0	4	2	-2	4	4
Rank		5	1	4	6	1	1
Assumptions	All of the concepts generated met the following customer requirement and therefore removed from the Pugh chart: Refills torches evenly Measures individual fuel levels No underground wires Scalable to and beyond 20 torches						

BENCHMARKING

General Concepts

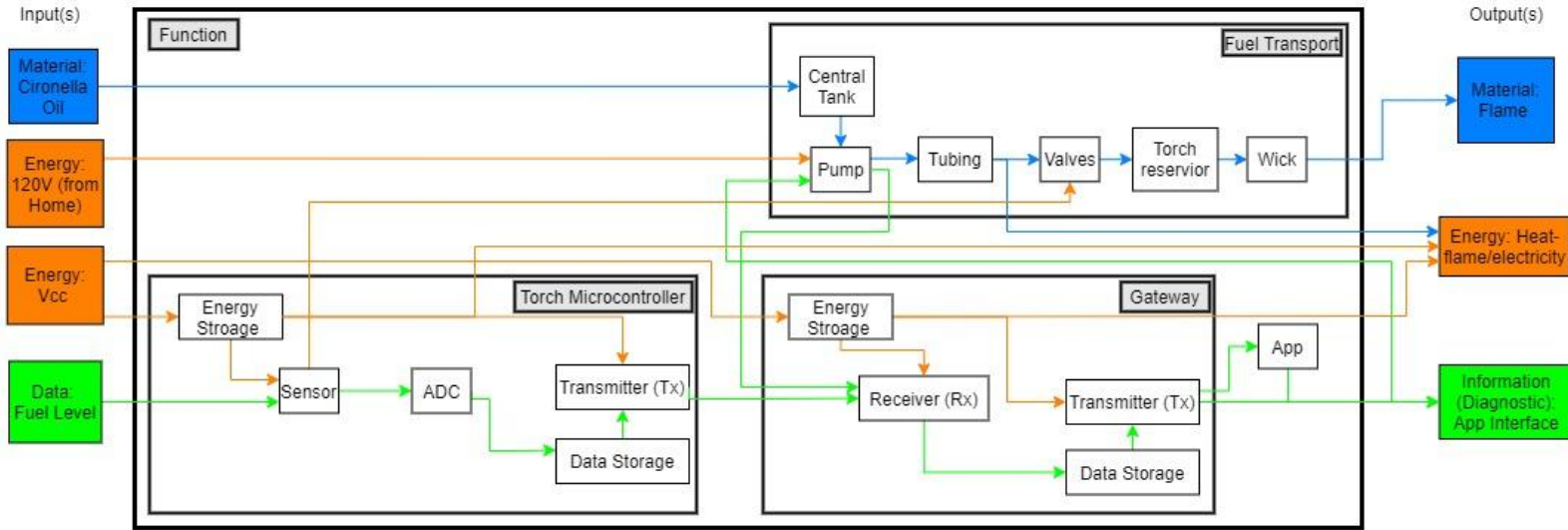
[See here for benchmarks.](#)

Electronics

Fuel Control

Stability

SYSTEMS ARCHITECTURE



MATERIAL

Citronella Oil to Flame

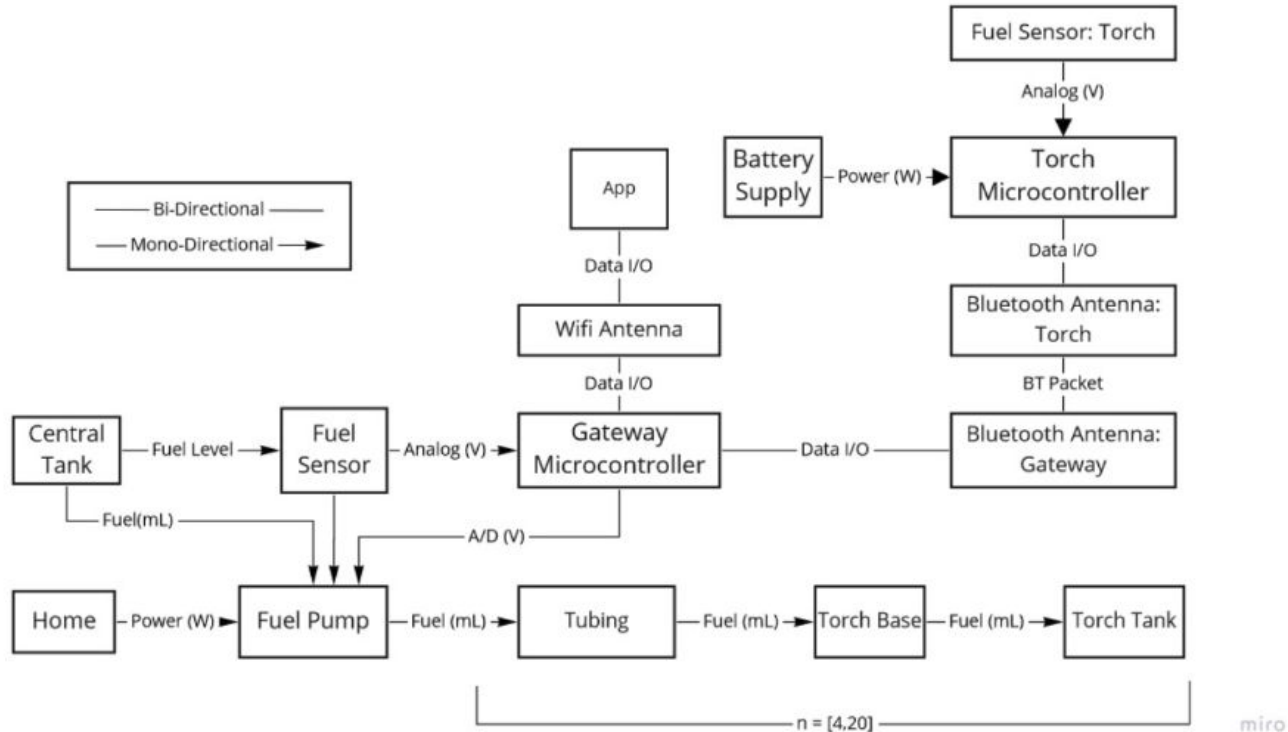
ENERGY

120 V/Vcc to Thermal
Energy from flame and
electricity

DATA

Fuel level to Diagnostic
Information on App

DESIGN AND FLOWCHARTS



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
	<i>What type of risk is this?</i>	<i>Describe the risk briefly</i>	<i>What is the effect on any or all of the project deliverables if the cause actually happens?</i>	<i>What are the possible cause(s) of this risk?</i>	L	S	L*S	<i>What action(s) will you take (and by when) to prevent, reduce the impact of, and/or transfer the risk of this occurring?</i>	<i>Who is responsible for following through on mitigation?</i>
1	Environmental	Torch Oil Spills/leaks	Safety standard violations	Bad seals/ lack of gaskets	2	2	4	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	2	1	2	Prevent	Owen
4	Resource-related	dev kit costs	Could quickly expend budget	Frivolous spending	1	2	2	Reduce	Yoon
5	Social	Market for the product	Product might not sell	Ugly/expensive torches	3	3	9	transfer	Bryn
6	Safety	Covid	Project progress could slow down	Covid spreads	2	2	4	Take safety precautions	All team members
7	Environmental/Social	Loud pump noises	Can be annoying/distracting	Faulty pump	2	1	2	Possible sound muffling box	Jason
8	Technical	Keep sensors away from oil	Possible failure of parts	Not designing around this issue	1	2	2	Being careful with design	Ben
9	Resources	Internet connectivity	Limit productivity	Energy provider and possibly weather	1	2	2	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	2	2	4	Communicate with team to prevent impact	Bryn
11	Safety/ Technical	Weather Hazards	Part failures and broken system	Weather (i.e. snow, rain, lightning, earthquakes)	3	3	9	Test for weather impact in a secure environment	Bryn
13	Technical	Limited knowledge of app development and fluids	May prevent team from reaching project deliverables	Lack of knowledge/education on topic	3	2	6	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	3	3	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	2	2	4	Order custom parts with significant lead time	Yoon

PLANS FOR NEXT PHASE

3	Preliminary Detailed Design	16 Mar 2021	8 April 2021
3.1	Proof of concept work (analysis, simulation, prototyping of critical systems)	3/16/21	3/23/21
3.2	Subsystem requirements	3/16/21	3/23/21
3.3	Design output (simulations, schematics, diagrams)	3/23/21	3/31/21
3.4	Risk assessment and mitigation plans	3/25/21	4/1/21
3.5	Updated test plan	3/30/21	4/5/21
3.6	Preliminary detailed design review	4/6/21	4/8/21

The plans for next phase are indicated by the above capture of our Gantt chart. By taking a deeper look at the dates above most of our time will be spent on design output, which includes compiling all our information on concepts and prototypes and beginning to finalize a complete BugTorch system.



Questions?