

AIAA HART Closeout

Senior Design 44x

Jessica Jiang, jiangje@oregonstate.edu
Samuel Villegas, villegsa@oregonstate.edu
Spencer Carlson, carlsp@oregonstate.edu

Engineering Design Instructor: Donald Heer
Project Instructor: Ingrid Scheel
Communication Instructor: Rachael Cate

April 2021

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Design Impact Assessment 2

Public Health, Safety, and Welfare Impacts

Our team's system does pose a safety risk due to the large amount of propellant on board and the potential for a recovery system failure. Launch sites are typically far from any roads or houses and lots of work is put into minimizing the possibility of damaging property or injuring individuals. Several design reviews are conducted with various [OROC officials](#) to approve the safety and recovery systems to minimize the possibility of a ballistic re-entry. Additionally, simulations are run with the upper limit of allowable wind to determine potential drift.

The biggest risk is to those on the launch site as launchpad failures can occur and ballistic re-entries don't tend to drift far. There are many regulations surrounding launchpad safety and it is taken into consideration when designing user interactable components.

Cultural and Social Impacts

The team goal is to reach 150,000 feet which would allow for it to be seen from very far on a clear day. As seen recently by the [unexpected Starlink re-entry over the west coast](#), some people can be alarmed by the sight if not informed about what it is. While this is a minor concern with little possibility of lasting consequences, it is still something to consider and is taken into mind when choosing a launch site. On the other hand, many people enjoyed the sight and were inspired by it. The SpaceX spectacle was all over social media following the event. It can promote the public enthusiasm behind space exploration.

Environmental Impacts

[E-waste](#) is a growing issue in the world today and with any hardware-related project, it is easy to contribute to the problem. With innovation rapidly accelerating in fields across the board, hardware that is just a year or two old can be thrown out. Our team has developed several PCBs as well as maintained existing hardware. Designs change over time and older iterations become irrelevant. Existing hardware also breaks over time especially after encountering the harsh forces applied during flight. As such a large amount of unused hardware has collected in storage over the years. We can reduce this impact by taking old components to electronic recycling centers or mailing them to places where they can be properly recycled.

There is also the possibility of the rocket not being found after launch. The airframe would remain at its initial landing site until someone finds it which can be years in some cases. This would contribute to the level of pollution and waste in the area surrounding the launch site.

Our rocket also leaves a negative environmental footprint due to the components we use to create it. The [PCB boards](#) alone release toxic fumes during their production. Sulfur dioxide (SO₂), nitrogen oxides (NO_x), contribute to acid rain, while carbon dioxide (CO₂), and particulates cause smog and increase the amount of greenhouse gasses. Mercury, and other heavy metals may cause neurological and developmental damages in humans and animals. The batteries are also included under [heavy metals](#) when thrown away as waste, and exposure over extended amounts of time can cause adverse health risks like cardiovascular disorders, neuronal damage, renal injuries, cancer, and diabetes.

Economic Factors

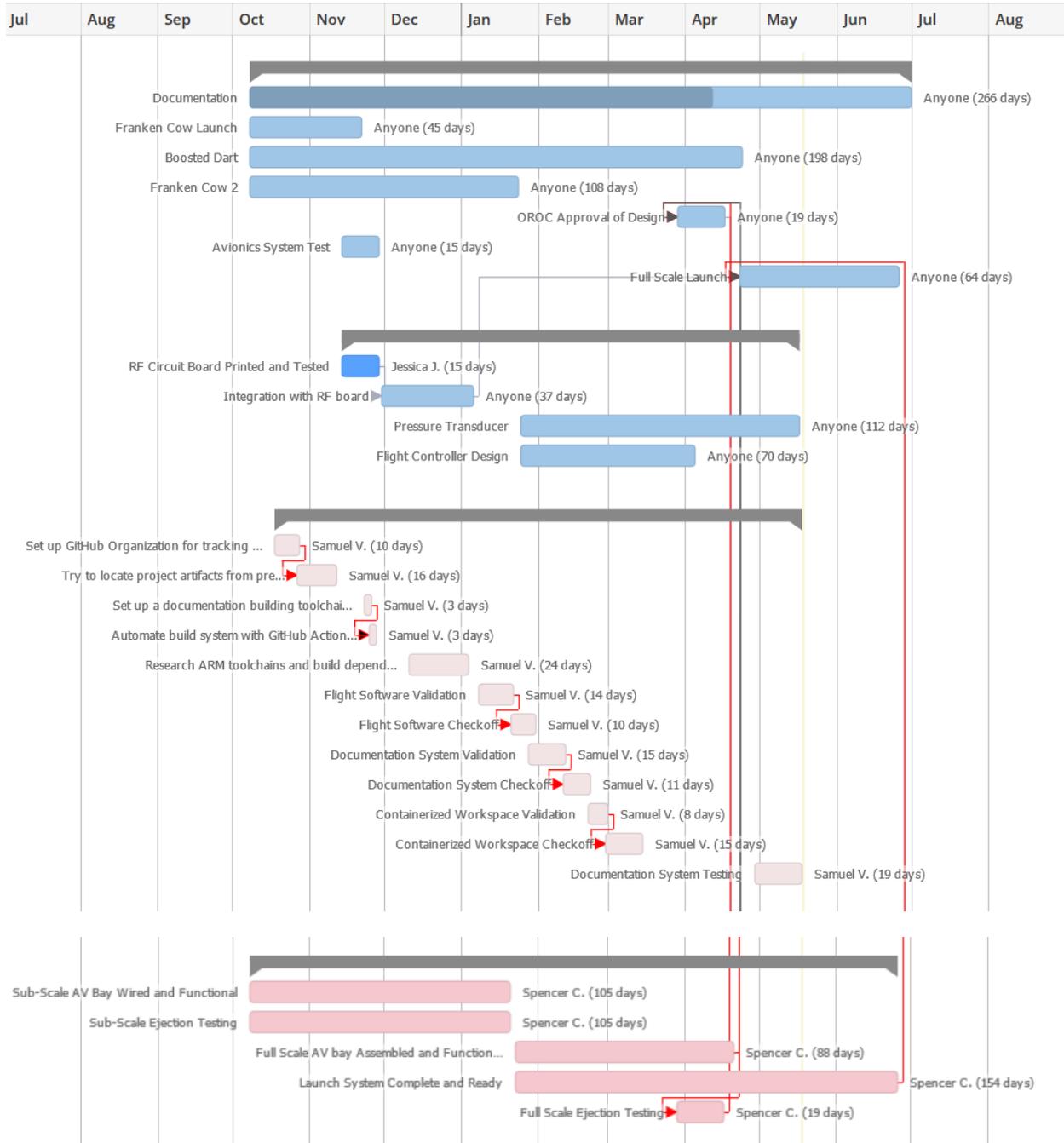
The team is funded by Oregon State University and is able to use those funds to purchase components, materials, and schedule launch sites. The budget is not particularly large and does not pose a considerable cost to the university. However, in the case of a catastrophic failure that results in damage, [Tripoli insurance](#) will have to foot that bill. If the rocket were to come down with no recovery, it can cause serious damages. Reports from Keith Packard have mentioned airframes being embedded 10 feet underground proving that such an event could cause serious damage. If a failure leads to damages or an injury, Tripoli could be responsible for a significant sum of money in order to repair damages.

Although our rocket has no visible economic impact in society, it may impact the future of our society's economics. Space has always been the future, and our multi-deployment rocket is paving the way for future engineers that strive to go into space. As the direction goes towards space exploration and exploitation, the number of spaceports and launch services will increase, as well as a large volume of [space related imports/exports](#).

Additional Impacts

The rocket launches produces a loud sound as well as a considerable amount of smoke which could disturb local wildlife. Because of the need for a launch site far from any buildings or roads, there is a higher possibility of it being in areas inhabited by animals.

Project Timeline



Scope and Engineering Requirements Summary

Name	CR	ER	Verification Method	Test Process	Test Pass Condition	Evidence Link
Avionics Hardware	Have functional flight hardware	The system will activate deployment charges and sustainer igniter (3.7v 0.2amps).	Analysis	<ol style="list-style-type: none">1. Establish remote connection to AV bay2. Fire deployment charge3. Observe deployment	Deployment charges are successfully ignited.	https://media.oregonstate.edu/media/t1_g0gw4zm4

Documentation System	Next year's capstone team should have a better idea of what they can do.	The system must publish changes to both website and PDF forms of documentation.	Demonstration	<ol style="list-style-type: none"> 1. Commit some changes to the documentation 2. Make a pull request on the official repository's `develop` branch 3. Request reviews on the pull request 4. Revise the changes with any review feedback until the pull request is accepted 5. Wait a little bit for the changes to be deployed to the website 6. Navigate to the documentation website and check to make sure the changes show up 	If the updated changes show up at the public URL and the PDF artifact, this ER has been met.	https://drive.google.com/file/d/1U-XvA2Qf0n8ajg_IKaOBoeWsqfSG7DE/view?usp=sharing
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Flight Controller Design	Have a flight computer design with the following components: USB, Accelerometer, GPS, Antenna, Barometer, Microcontroller, Pressure Transducer input.	The flight controller design has the following components: USB, Accelerometer, GPS, Antenna, Barometer, Microcontroller, Pressure Transducer input.	Inspection	1. Visually inspect the design for: USB, Accelerometer, GPS, Antenna, Barometer, Microcontroller, and Pressure Transducer input.	USB, Accelerometer, GPS, Antenna, Barometer, Microcontroller, and Pressure Transducer input are a part of the design.	https://drive.google.com/file/d/1QvHhSOa5_YfkScNcpqNWjb1REUoVp93r/view?usp=sharing
Launch subsystem	User must be able to ignite booster from safe distance	The system must transmit a user-triggered signal to trigger an igniter at a distance of more than 1000ft.	Test	<ol style="list-style-type: none"> 1. Turn on control and ignition enclosures 2. Verify connection 3. Attach igniter leads to ignition terminals 4. Arm ignition system 5. Move to more than 1000ft away 6. Arm control system 7. Arm remote safety layer 5. Press the launch button 	Igniter ignites with the user more than 1000ft away.	https://media.oregonstate.edu/media/t/1_80ewq1ob

Passive Safety	Upper-stage engine igniter leads are shorted to ground before launch to prevent accidental ignition of the upper-stage engine.	The system will have no more than 1 ohm of resistance between the launch igniter thermals when the ignitor is not charged.	Demonstration	<ol style="list-style-type: none"> 1. Assemble AV bay according to integration checklist 2. Place multimeter leads in sustainer igniter terminals 3. Engage the shunt 4. Power avionics 5. Fire igniter channel 	Igniter leads show <1 ohm of resistance and no power on the multimeter.	https://media.oregonstate.edu/media/t1_jvydymkn
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Pressure Transducer	Motor performance must be measured during flight.	The system will record pressure data from the motor in psi.	Test	<ol style="list-style-type: none"> 1. Connect the Pressure Transducer PCB to a power source and o-scope 2. Connect the Pressure Transducer PCB to the computer 3. Turn on the power source and set it to 0V 4. Check that it corresponds to the 0PSI on the display with 80% accuracy 5. Repeat steps 3 and 4 for 50mV and 100mV and check that it corresponds with 1000 PSI and 2000 PSI respectively. 	The data extracted from microcontroller is within 80% accuracy of the expected pressures.	https://drive.google.com/file/d/1qY9TsSrkbReMvd3hfNf0DVgi17ujWq-L/view?usp=sharing
Pressure Transducer Size	The Pressure Transducer PCB must be smaller or equal to the Telemega	The Pressure Transducer PCB must be smaller or equal to 3.25 x 1.25"	Test	<ol style="list-style-type: none"> 1. Measure the width of the Pressure Transducer PCB 2. Check that the width is less than 3.25 		
3. Measure the height of the Pressure Transducer PCB						

4. Check that the height is less than 1.25"	Pressure transducer PCB is smaller or equal to 3.25 x 1.25".	https://drive.google.com/file/d/1H4ZxxGT4a6Dlr42AYVlwQt7pehow9xzS/view?usp=sharing				
Safety	Have a rocket that is safe enough to launch	The system will be approved by OROC that the system is properly set up to avoid a misfire.	Inspection	1. Draft system documents relevant to safety 2. Submit to OROC officials for system review	The system is approved by OROC that the system is properly set up to avoid a misfire.	https://media.oregonstate.edu/media/t1_g2o6t8lb

Risk register

Include an updated version of the risk register created as a team for the Project Charter. In the figure description include lessons learned and any risks that occurred you did not anticipate.

ID	Description	Type	Prob.	Impact	Performance Indicator	Responsible Party	Action Plan
0	Workload or time requirements are added due to new direction, Policy, or statute.	Scope	90%	H	New AIAA expectation	Ian	Reduce: Speak with the team and see if there is a work around.
1	Customer requirements are conflicting.	Comm.	85%	H	House of Quality: How vs. How has a strongly negative relation	Samuel	Avoid: Bring up conflicting requirements and change them.
2	Next year's team will be	Comm.	75%	M	Unused /	Jessica	Reduce: Properly

	left with disorganized documentation.				outdated files, not being sure which info goes where, difficulty explaining stuff to other sub-teams during meetings		document and organize as we go.
3	Project contains errors due to pressure to complete tasks earlier.	Time	70%	M	Tests defined for system are being skipped or shortcut in some way	Spencer	Retain: There's nothing we can do to avoid this. Due to our stringent time constraints.
4	The deliverables are incomplete.	Time	50%	M	Not meeting milestones on time	Ian	Reduce: Plan ahead and ensure that there is enough time to complete everything. Minimize scope and trim excess tasks.
5	There is resource damage or loss due to theft, weather, fire, etc.	Resource	30%	H	Disorganized or unsafe storage	Ian	Reduce: Properly lock storage after use and keep a close eye out on the weather report and news for any unforeseen circumstances.
6	Avionics don't integrate well into the rocket.	Tech	20%	L	Integration tests failing or reporting	Jessica	Avoid: Meet up and design with other

					an undesirable level of quality		teams to integrate before putting the components into the rocket.
7	There is miscommunication between teams	Internal, comm.	60%	M	One team may bring something to the table other than what was discussed due to a misunderstanding.	Samuel	Reduce: Talk things out and try to use clear, precise language when speaking and presenting.
9	COVID negatively impacts launch.	Unforeseeable	70%	M	The launch site/event is shut down due to COVID	Spencer	Reduce: Stay healthy and practice social distancing.
10	Rocket components are broken or missing.	Unforeseeable	90%	H	Components are either broken or missing	Samuel	Transfer: Ask the leader if they have spares or readily available alternatives. If not, request for new parts in the budget.

Table 1. Risk Register

Future Recommendations

This section needs to be formatted as a table or list consisting of recommendations for a group who will take on this project in the next year. For each recommendation, clearly identify the recommendation (label or enumerate them), the reason for the recommendation, and a starting point for a solution (next steps that are actionable). These recommendations must cover both technical and project management topics. At a minimum present 8 recommendations.

Build the backup Flight Controller

The backup flight controller will give sensor data of our choice without the restrictions of commercial hardware. It can also piggyback off of the commercial hardware and also use Telemega's library to simplify the amount of time needed to code the microcontroller. This way, there is a student-made chip inside the rocket, while still adhering to OROC guidelines. This was part of our initial project, however due to time constraints had to be simplified down to a design instead.

Recommendation

Complete and revise the "Flight Controller Design" Gerber file. Double check all of the connections between the components and ensure that each connection has the necessary voltage and current going into it to function. Also be sure to check what configurations give the settings you need for the final design of the Flight controller. For example, some components have different configurations for SPI and I2C while others have different configurations for high and low power modes. Always refer back to the datasheet when in doubt. Last but not least, plan ahead. Ensure that all components are in stock, or at hand before finalizing the design and print well ahead of time so that there is room to test and revise.

Define the project scope early

Having a clear project scope will ensure a smooth timeline. When we first received the project, we didn't have a clear project scope and had to throw away a lot of semi-complete projects and ideas. As a result, our team had half the time to complete all of our objects resulting in very rushed jobs.

Recommendation

Figure out what the rest of the team needs from your team early on and don't deviate. Each team member should plan to implement about 3 features each with about two weeks to implement each feature.

Be in the loop

Having close contact with the HART team and instructors will ensure that the project goes smoothly and can help plan for any contingencies that may happen. Communication between disciplines is paramount to share a joint vision of how everything will work. This will be evident during integration as work from various teams will have to connect smoothly

Recommendation

Stay in regular contact with the HART team leads as well as the other sub-team leads. Keep them updated on everything you are doing and ask them about what the other teams are doing.

Purchase Components ASAP

Some components such as PCBs can take a long time to reach your door from the time it is ordered. This can delay projects being completed by the time necessary.

Recommendation

Identify parts needed as soon as an Idea comes up. It is often better to find the most viable solution rather than the most optimal solution. There is a large amount of parts already owned by the team. Looking through all of this can save you some time and money by not having to repurchase parts.

Be Flexible

The project will evolve and change over time as some more ideas are made and more testing is done. This can result in substantial changes in systems that may already be in development.

Recommendation

Be ready to make adjustments and change parts of the project if necessary. The team may identify a need for something later in the project so it is important to be transparent with the rest of the team about what is necessary to make that happen.

Document as you go

We had a documentation system that automatically builds and deploys a documentation website and PDF whenever changes get committed to the git repositories, but much of the work we did on the system went undocumented (projects not tracked in git or changes not committed frequently).

Recommendation

If you add, modify, or remove a feature of the system, make sure that change is reflected in the documentation.

Track All Artifacts in Git

We used EasyEDA for designing the PCB's, but having all our files in a cloud application made it difficult to track in Git since it introduced extra steps to download the files from the cloud and put them into a local git repository in order to commit any changes.

Recommendation

Try to stay away from web applications like EasyEDA that require a lot more steps to push, pull, and commit git repositories. Eagle is a good PCB builder alternative.

Use GitHub Projects to Organize Tasks

We set up some GitHub Projects for tracking our work progress on a Kanban board where the tasks are linked to the actual issues and pull requests in the project repositories. However, much of the work we did was not recorded in this system. Making the work more visible to the rest of your team helps increase collaboration between team members by dividing the project up into smaller tasks that they can work on together. This also helps cut down on synchronous meetings by providing an asynchronous means of communicating what everyone on the team is working on.

Recommendation

Add issues for bugs and feature requests and link them to the relevant project boards. Add tasks for research. Make a pull request when you're done making a change and add reviewers to your pull request. GitHub has templates that automatically advance tasks across the Kanban board whenever issues/pull-requests are opened/closed etc.

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