NG Two-Stage Supersonic Rocket

Project Management- 486C

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Spring 2024-Fall 2024

Project Sponsor: Northrop Grumman Space Systems, Launch Vehicles

Faculty Advisor: Carson Pete

Sponsor Mentors: Caleb Feda, Thomas Ortz, Paul Hoeffecker, Victoria Ewert

Instructor: Carson Pete

Project Management - Successes:

The project management successes lied well within the bound of what was required to get baseline design, analysis, and fundraising finished during the first semester of senior design. The team did well working with our sponsor Northrop Grumman on getting feedback on designs and drawings compared to working in the industry. The client's feedback gave us improvements in the launch vehicle design to help meet the project's performance requirements.

- Design Progress
    - "For the class deliverables, each team member was tasked with creating multiple iterations of various rocket components. This approach fostered creativity within the team, resulting in several design versions, including the one ultimately selected for optimal performance. Additionally, our client provided valuable guidance, helping us identify reliable setups throughout the design process.
- Continual Meetings with Client and Customer
    - Regular meetings with the client kept the team aligned with the design process and ensured that we met the client's expectations. If a team member was unable to attend a meeting, the rest of the team promptly updated them on our weekly goals.
- Feedback from Client and SME (Subject Matter Experts)
    - During the meetings, our client contributed valuable insights on key discussion topics, including calculations, resource allocation, and areas of concern. Additionally, their team provided critical feedback on the 3D model, further enhancing the project's quality.
- Fundraising
    - The team chose to utilize GoFundMe as our fundraising strategy due to our demanding schedules. Although the campaign had a slow start, we were initially concerned about meeting the class requirements. However, through the GoFundMe platform and donations from local vendors, we successfully raised the necessary funds.
- Sponsorships
    - The team has received sponsorships from:
        - Nova Kinetics – Carbon Fiber and Resin

Project Management - Room for Improvements:

There is room for improvement in many different aspects of the team. Communication was vague in the beginning and followed throughout the semester. Communication is vital to the success of the project and the outcome of the launch. Deliverables require more detail in all aspects and completion on time. Report and analysis need more fidelity within them to remove all open questions related to the design and how each subsystem functions together.

- Communication
- Deliverable due dates

- Analysis
- Design communications
- Report technical writing

Project Management - Action Items:

Overall, the project design portion is completed with few changes needing to be made. Below are some of the improvements the team can make to improve the workflow and project representation when it comes to presenting and displaying our work. The vehicle will require intense detail-oriented review for safety and overall performance to meet the requirements set by the client and our launch site provider.

1. **Communication**
    - Weekly in-person work meetings: Use this time to communicate and work on tasked items to ensure that they are completed and up to date. These meetings will be separate from any client or class meeting times. The team will start with one weekly meeting and if that is not sufficient to complete the work, more meetings will be added.
    - Tasking items to each member: Items will be delegated weekly with a deadline for completion. These tasks will ensure that the team has a goal to reach every week to help with time sensitive items and deliverables

2. **Deliverable due dates**
    - Deliverables will need to be completed at least two days before the hard due date in class or set by the client. This will allow the team to review and revise any issues found during the review process and ensure that the deliverables meet or exceed the expectations set.
3. **Analysis**
    - More in-depth analysis will be required to answer questions that the client requires and needs more clarification.
    - Analysis to be completed and updated; Simulations, FEA, CFD, and Composite material layup. There are multiple subsystems on the launch vehicle that require this, separation system, avionics, fin structure, and couple moment loads on the full launch vehicle.

4. **Design communications**
    - Design communications need more detail and review. Dimensional wise parts have not matched and will need team review to mitigate any issues before manufacturing.
    - Aspects of the design choices are being mixed and not fully understood by the team. These are causing issues with prototyping and need to be sorted out and checked by more than one team member before final parts are ordered or

manufactured. The design needs to be checked with the top-level CAD of the vehicle. This will ensure that the parts we design are going to fit with the proper GD&T and drawing callouts when the final build and testing is being performed.

5. **Report technical writing**
    - Reports are an item that needs improvement. The technical aspect of the writing is vague and requires more detail, especially in the analysis portion. Details and calculations were very elementary for the level of design this project requires.
    - Completion of all report requirements. All requirements will be reviewed and included in detail.

Remaining Design Efforts:

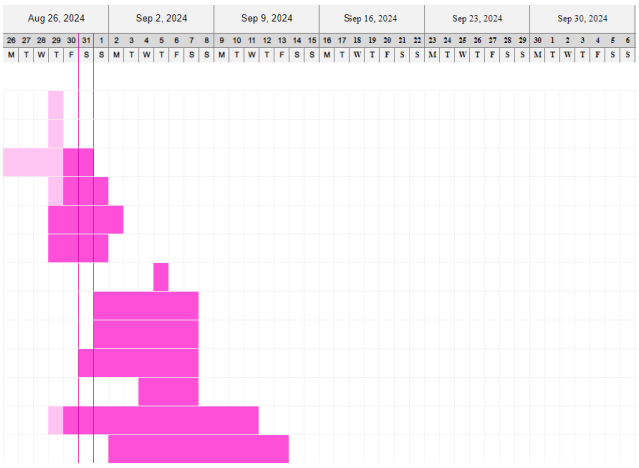
These are the remaining design efforts needed to be completed. The majority are high fidelity but need refinement once manufacturing has begun and testing is complete.

- High-fidelity top-level assembly CAD
- Separation system testing and revisions
- Motor mount/ fin bracketry
- Avionics bays
- Wiring diagrams
- Recovery systems

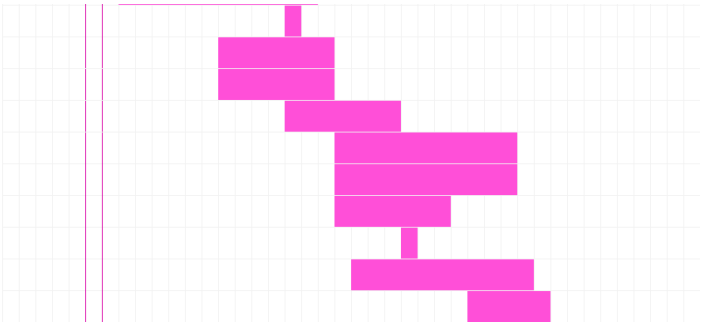
Gantt Chart:

Below is an updated Gantt chart for ME 486C Fall 2024. Every task that takes place before the 33% hardware status due September 26th.is considered stage one of this semester. This is a major milestone as we should have structural parts coming in for the separation system and/or the fin canister assembly. Everything that will be carbon fiber should also be built by the 33% build milestone. Due to the size of the rocket, all carbon fiber parts already account for about 33-40% of the entire rocket. If most carbon fiber parts are manufactured by this milestone, the project will be on track.

TASK	ASSIGNED TO	PROGRESS	START	END
Stage 1	Team		8/26/24	
Kickoff Meetings (team/staff) 1	Team	100%	8/29/24	8/29/24
HW 00	Individual	100%	8/29/24	8/29/24
Project Management Assignment	Team	75%	8/26/24	8/31/24
Sep. Sys. Rev 5 update		30%	8/29/24	9/1/24
Body Tube Rev 2 update		0%	8/29/24	9/2/24
Fin Canster Rev 2 update		0%	8/29/24	9/1/24
Team/Staff Meeting 2	Team	0%	9/5/24	9/5/24
Sep. Sys. Rev 5 Drawing update		0%	9/1/24	9/7/24
Fin Canster Rev 2 Drawing update		0%	9/1/24	9/7/24
Coupler Design Rev 2 update		0%	8/31/24	9/7/24
Engineering Calculations	Team	0%	9/4/24	9/7/24
ANSYS Fluid Flow Model - Full Rocket	Koi	10%	8/29/24	9/11/24
Self Learning or Individual Analysis	Individual	0%	9/2/24	9/13/24



Team/Staff Meeting 3	Team	0%	9/12/24	9/12/24
Mandrel Construction		0%	9/8/24	9/14/24
Nose Cone Mold Construciton		0%	9/8/24	9/14/24
Fin Construction		0%	9/12/24	9/18/24
Body Tube Construction		0%	9/15/24	9/25/24
Nose Cone Construction		0%	9/15/24	9/25/24
Coupler carbon construction		0%	9/15/24	9/21/24
Team/Staff Meeting 4	Team	0%	9/19/24	9/19/24
Hardware Status Update - 33% Build	Team	0%	9/16/24	9/26/24
Peer Eval 1	Team	0%	9/23/24	9/27/24



Stage 2 is shown in the green section of our Gantt chart. Stage two includes all the tasks that need to be completed by the 66% build milestone. The vehicle should have all couplers and fin canister built and ready for assembly at this point. The Motors casings should be sent off by this point to be filled with propellent.

The manufacturing sections of stages 1 and 2 are subject to change. That potentially could be switched depending on the procurement of tooling and hardware for the manufacture of carbon fiber. Along with design of tooling do be manufactured for carbon fiber. The separation system can be moved up depending on prototyping and confirmation of final design.

Stage 2				
Team/Staff Meeting 5	Team	0%	9/26/24	9/26/24
Flight computer aquirement		0%	9/23/24	10/4/24
Coupler hardware aquirement		0%	9/27/24	10/5/24
Sep Sys material aquirement		0%	9/27/24	10/5/24
Motor assembly material aquirement		0%	10/2/24	10/11/24
Fin Canster material aquirement		0%	10/2/24	10/11/24
Team Staff Meeting 6	Team	0%	10/3/24	10/3/24
Sep Sys manufacture		0%	10/7/24	10/17/24
Full Coupler Construction		0%	10/7/24	10/17/24
Motor assembly manufacture		0%	10/7/24	10/17/24
Fin canster manufacture		0%	10/7/24	10/17/24
Website Check 1	Team	0%	10/7/24	10/11/24
Hardware Status Update - 67% Build	Team	0%	10/14/24	10/17/24
Testing Plan	Team	0%		

Stage 3, in the yellow, of the project this semester will be the 100% build milestone. The vehicle will be fully built by the end of this milestone ready to be launched in November. This includes tasks like parachute procurement and assembly of all other assemblies built before this stage. Tasks in this stage are not negotiable to change due to the full assembly being due.

Stage 3				
Team Staff Meeting 7	Team	0%	10/10/24	10/10/24
Assembly hardware material aquirement		0%	9/30/24	10/11/24
Motor 1 Fill		0%	10/7/24	10/25/24
Motor 2 Fill		0%	10/7/24	10/25/24
Parachute 1 and 2 aquirement		0%	10/7/24	10/25/24
Parachute 1 and 2 charge aquirement		0%	10/7/24	10/25/24
Early Launch Date		0%	10/19/24	10/20/24
UGRADS Registration	Team	0%	10/18/24	10/24/24
Peer Eval 2	Individual	0%	10/21/24	10/25/24
Team Staff Meeting 8	Team	0%	10/17/24	10/17/24
Booster Assembly		0%	10/14/24	10/30/24
Main Rocket Assembly		0%	10/14/24	10/30/24
Draft of Poster	Team	0%	10/18/24	10/31/24
Finalized Testing Plan	Team	0%	10/21/24	11/1/24
Hardware Status Update - 100% Build	Team	0%	11/1/24	11/7/24

Stage 4, in the blue, includes all final tasks that need to be completed. Tasks such as final launch, final report, final CAD package. Presentation of the overall project is to be completed during this stage.

Stage 4				
Team Staff Meeting 9	Team	0%	10/24/24	10/24/24
Final Poster and PPT	Team	0%	11/11/24	11/14/24
Peer Eval 3	Individual	0%	11/11/24	11/15/24
Primary Launch Date	Team	0%	11/16/24	11/17/24
Initial Testing Results Video	Team	0%	11/11/24	11/21/24
Final CAD Packet	Team	0%	11/4/24	11/22/24
Product Demo and Testing Results in class	Team	0%	9/27/24	11/27/24
Final Report	Team	0%	11/18/24	12/3/24
Final Website Check	Team	0%	11/18/24	12/4/24
Final Product Demo	Team	0%	11/18/24	12/5/24
Operation/Assembly Manual	Team	0%	11/25/24	12/5/24
Expo PPT and Poster Presentation Delivery F	Team	0%	12/6/24	12/6/24
Practice Presentations	Team	0%	12/2/24	12/5/24
Peer Eval 4	Individual	0%	12/9/24	12/12/24
Client handoff	Team	0%	12/9/24	12/11/24

Top Level Finances:

The team's financial summary is presented in the table below. The total project budget is $7,000, with the team responsible for fundraising 10% of this amount. With an ongoing GoFundMe campaign and material donations from various local vendors, the team has successfully met its fundraising goals.

In the Expense table, the initial prototype focused on the separation system's functionality and reliability. Over the summer, the team collaborated with the client to advance testing of the entire Separation System. In the coming months, approximately $3,500 is expected to be allocated for the complete vehicle Bill of Materials (BoM). Many of the composite materials for the vehicle's exterior will be sourced through donations. Although the budget currently shows half of the funds remaining, these will likely be reserved for any unforeseen challenges.

NG Supersonic Budget	
Expenses	
Categories	**Totals**
Total expenses	$4,028.59
Prototype/First Semester	$131.93
Summer Purchases	$175.66
Final Vehicle BoM	$3,571.00
Travel Expenses	$150.00
Cash Difference (short/extra)	$3,586.41
Income	
Category	**Totals**
Client	$7,000.00
Donations	$160.00
GoFundMe	$455.00
Total	$7,615.00

Purchasing Plan:

Below is a rough draft of our vehicle's BoM. In the coming weeks the team expects to create a more detailed BoM with hardware and sizing.

Purchasing Plan							
Part Number	Part Description	Make/Buy	Vendor	Part Number(Vendor)	Cost	Part Status	Manufacturer
Nose Cone	Carbon Fiber	Manufactured	Sponsored			To be Made	Team
Upper Body	Carbon Fiber	Manufactured	Sponsored			To be Made	Team
Lower Body	Carbon Fiber	Manufactured	Sponsored			To be Made	Team
Upper Motor	N/A	Purchased	Aerotech	N1000W	$1258	Not ordered	N/A
Lower Motor	N/A	Purchased	Aerotech	N3300R	$1154	Not ordered	N/A
Avionics Bulkheads	Aluminum	Manufactured	Metals Depot	R36	$30	Not ordered	N/A
Recovery	TBD	TBD	TBD	TBD	TBD	Not ordered	N/A
Fins x 4	Carbon Fiber	Manufactured	Sponsored			To be Made	Team
Separation System	Aluminum	Buy	Metalsdepot	R36	$425	Not ordered	Outsource
Flight Computers x4	N/A	Purchased	Featherweight	Blue_Raven	$175 ea	On Hand	
Item 1	3D Printed	Manufactured	N/A	N/A	$2	On Hand	Team
Item 2	3D Printed	Manufactured	N/A	N/A	$2	On Hand	Team
Item 3	Stainless Steel	Purchased	McMaster-Carr	N/A	$9.12	On Hand	
Item 4	Stainless Steel	Purchased	APW Company	N/A	$67.19	On Hand	

Manufacturing Plan:

The current manufacturing plan is to start with the carbon fiber parts of the rocket. The reason is due to past projects that had difficulty doing carbon fiber layups. So for this project the team would like to start off early with the carbon fiber parts, giving the needed time for the layups and extra time in the case of emergency.

The next step will be to manufacture the separation system, the fin canisters, and the motor holders. In terms of difficulty these are the next assemblies that will have the most difficulty manufacturing. Depending on the time needed to complete the carbon fiber parts of the vehicle, the separation system will start manufacturing simultaneously. In this case, the team will split up into two teams, one working on the carbon fiber layups. The other team is working on machining the main components of the separation system.

As it is still the early part of the semester, the team has not been assigned specific manufacturing roles yet. Every member has agreed to getting the machine shop certifications and training on campus if another member needs to take over certain manufacturing tasks. All hardware specific to the smaller assemblies will be acquired as that specific assembly is being manufactured.

After all minor assemblies have been manufactured and assembled, the final step will be to combine all assemblies together to finish the booster and main body of the vehicle. All final hardware will be ordered and acquired by this point. All final pieces such as the parachute and charges for parachute deployment will be ordered and acquired. The assembly of the main vehicle body and the booster of the vehicle will also include the incorporation of the computers and altimeters.

The team will most likely be split into teams of two to speed up the manufacturing process. At the same time, check each other's work to make sure there are no flaws in the designs. If there is a fall, that specific team will redesign and rework, requesting help from the other team if needed.