Rocket Engineering Design Process

Week 6

GMPR Tasks

- Open rocket - **AEROTECH 29MM G80T-10**
- CAD entire rocket in an Assembly (nose cone, body tube, bulkheads, boattail, fins, payload housing)
- Laser cut your fins and bulkheads
- 3D-Print Nosecone
- Make your body tube via fiberglass layup
- Make your switch box!
- Integrate your components
- Decorate!
- Present a PDR

Design Process

01

DEFINE YOUR GOALS

Project and internal

02

DESIGN, ANALYSIS, CAD

Use Openrocket, Solidworks, Analysis Software

03

REVIEW AND IMPROVE

Utilize design reviews and perform iterative design

04

MANUFACTURE

Use a variety of techniques and be safe

05

INTEGRATE

Assemble the rocket

06

LAUNCH

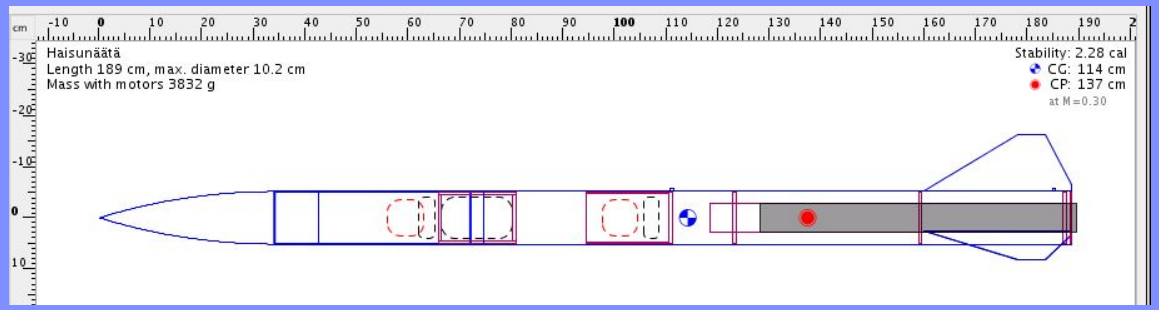
Prepare procedures in advance and have fun

Starting Point

- Define your **high level goals**
  - This can include target apogee, diameter, features, stability etc...
- Define **specific technical goals**
  - Wireless electronics, custom motor, full diameter oxidizer tank, etc.
- Have a vision for your team so you know what your end product should include

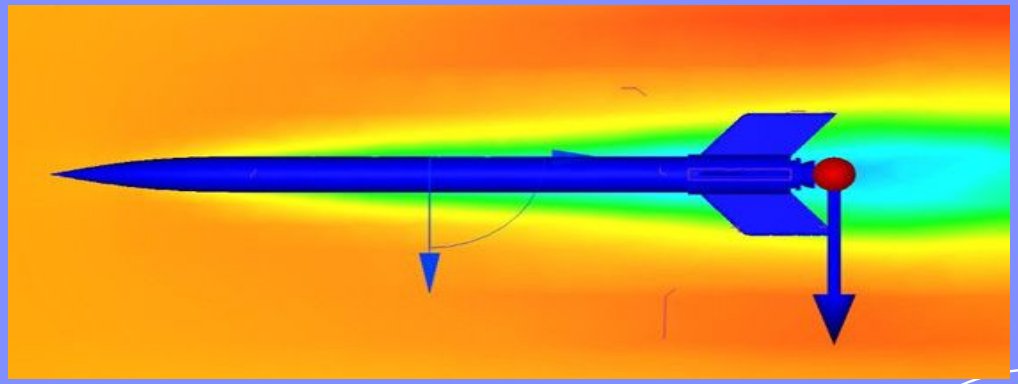
Design, CAD, Analysis

- Always start with a basic open rocket
  - Start with the basic structural elements such as body tubes and work up to higher complexity
- Make sure to keep your openrocket updated as you improve your design
- Make CAD's (computer aided design) of your part
- Assemble them and see how feasible integration is



Analysis

- Perform analysis using techniques such as computational fluid dynamics (CFD), Finite element analysis (FEA), and trajectory simulations on softwares such as matlab
  - Is your design following your goals?
  - Is your design valid under a variety of conditions?
  - Is your design safe?
- Iterative design: continuously develop and improve your design



Design Reviews

- **Internal Design Review**
  - In Rocket Project, each subteam (Vehicle Engineering, Propulsion, and Electronics) has internal design reviews
  - Technical review of your designs, CAD, and basic analysis
  - Reviewers identify major issues that may result in failure
- **Preliminary Design Review**
  - Display your final designs
  - Explain the rationale behind your design choices
  - Before you start manufacturing so you can refine your designs and begin purchasing/building

Preliminary Design Review

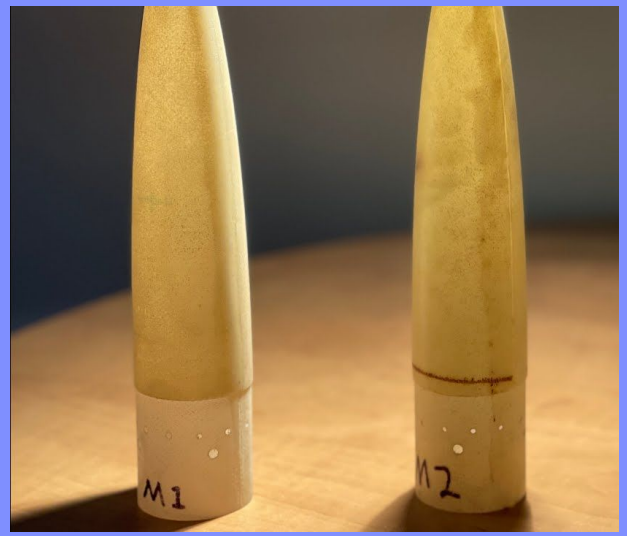
- **Team Overview and Roles**
- **Project requirements and internal requirements** (timeline, feasibility, etc.)
- **Design overview**: CAD assembly, explain major design decisions
  - Apogee and Openrocket Trajectory
  - Flight characteristics: stability, off the rail speed, thrust, mass, diameter, length, max velocity, impulse...
  - Review material selection
  - How is payload incorporated?
  - Avionics overview
  - recovery system: descent time and velocity, drift distance, ejection method, parachute choice
- **Risk assessment**: how is your design addressing potential failures?

Design Reviews

- **Critical Design Review**
  - Are your manufactured parts ready to integrate?
  - Are you on a path towards launch?
- **Test Readiness Review**
  - Are you approaching this test safely?
  - What is the criteria for success of this test?
  - Are you prepared enough to justify going out to do this test?
- **Flight Readiness Review**
  - Are you ready to launch?
  - Is your rocket safe to launch?
  - Have all major components been validated to point you feel safe flying?
  -

Manufacturing

- Explore different techniques to achieve your final part
  - Try not to copy exactly what was done in the past because there is always room for improvement
- Plan out what you are going to do far in advance
  - Give yourself much longer than you think you'll need
- Practice safety
  - Wear appropriate PPE, don't use items you don't know how to use



Integration

- Plan integration even when designing
- Things to consider
  - How will you secure everything in?
  - Are all points of attachment easily accessible?
  - Can the rocket be disassembled and reassembled without over complication?
  - What order should parts be put together?
  - Can most elements be pre-assembled prior to putting in propulsion system?

Launch

- Have launch day procedures
- Define roles for each team member
- Practice safety
- Have fun!!

Thank you!

Questions?

Homework (due **next week**)

- Finished GMPR OpenRocket Design and CAD
- WorkSafe Module: Field Safety
- PDR Slides
- Manufacturing plan/timeline