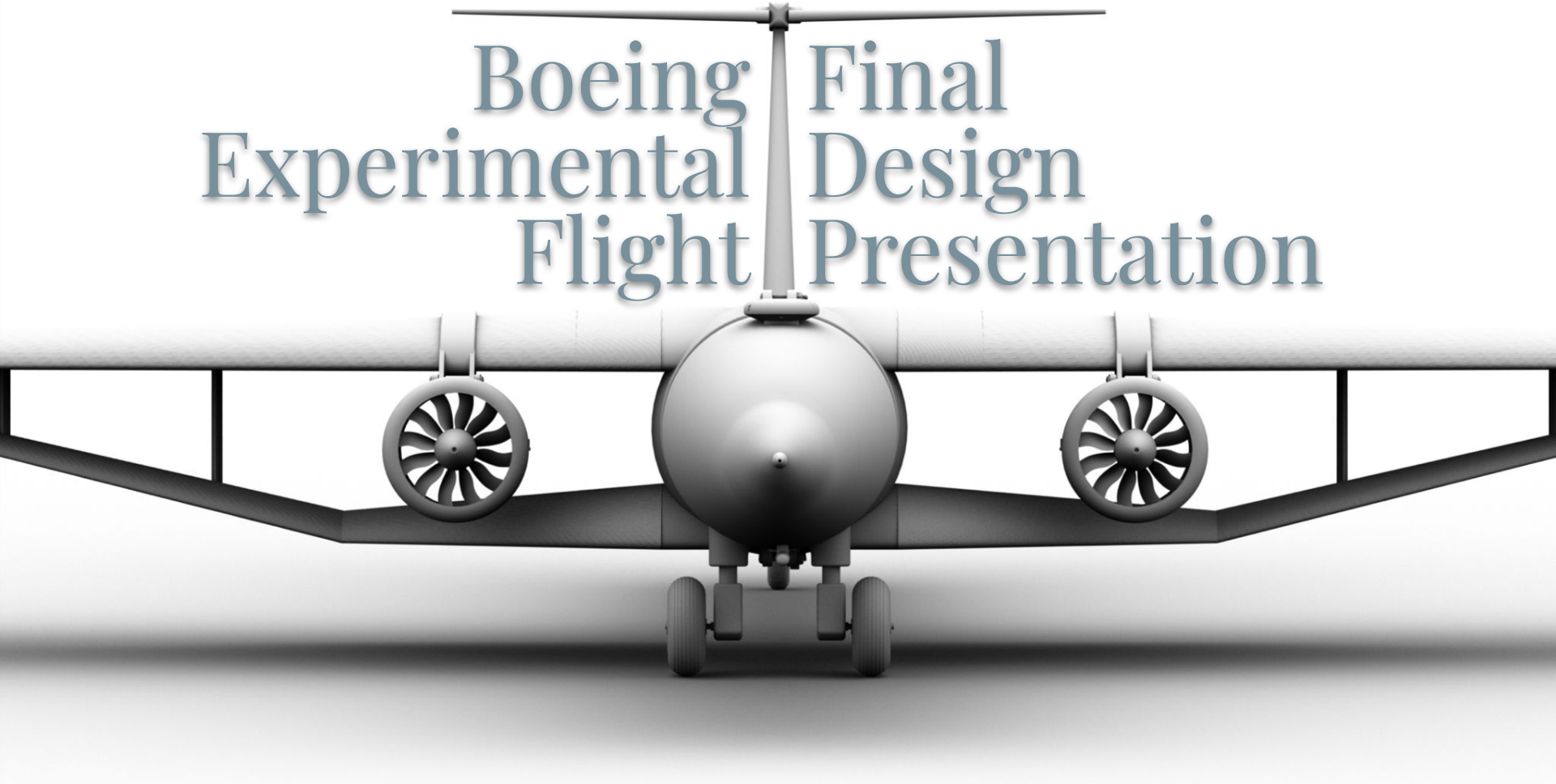
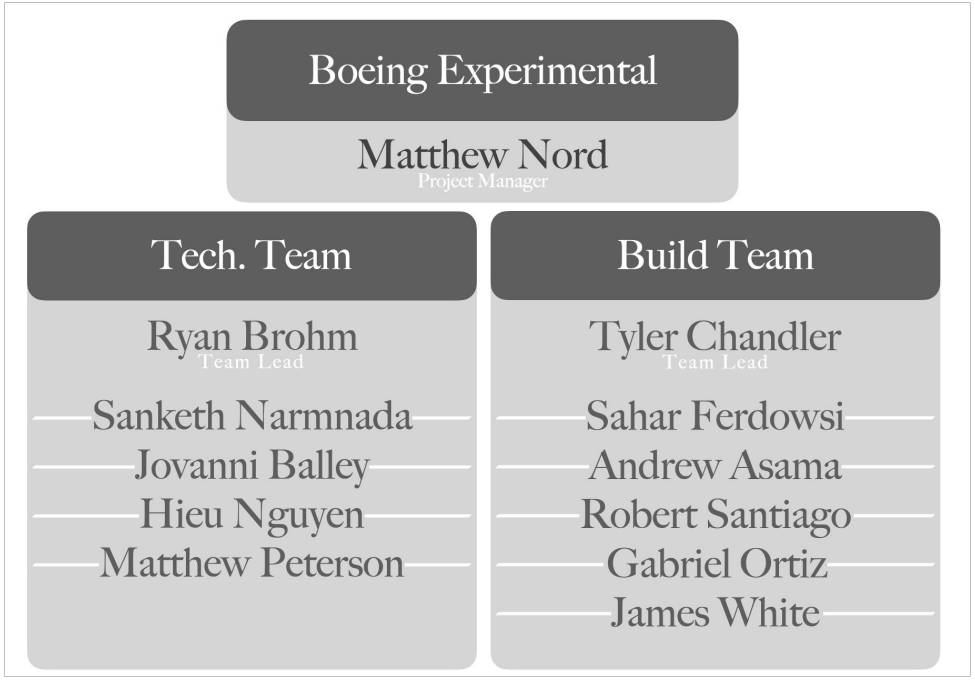
Boeing Experimental Flight

Final Design Presentation



The Team


Boeing Experimental
Matthew Nord
Project Manager
Tech. Team
Ryan Brohm
Team Lead
Sanketh Narmnada
Jovanni Balley
Hieu Nguyen
Matthew Peterson
Build Team
Tyler Chandler
Team Lead
Sahar Ferdowsi
Andrew Asama
Robert Santiago
Gabriel Ortiz
James White

Last Semester's Goals

—Project Goals —

The goal of this semester was to conceptualize, design, & engineer a testbed aircraft from the ground up.

The Flight

—Project Goals —

The goal of this semester was to build and test a craft capable of data collection and semi-autonomous flight.

The Flight

What went right?

Build Team

- Manufactured parts and assembled the entire aircraft
- Control surfaces move in their intended directions
- Aircraft able to handle forces that it will be exposed to
- Landing Gear Handled Forces
- Members Introduced to ANSYS Workbench
  - Static Structural & Fluent

Tech Team

- Battery system finished
  - Parallel Y-harness
- Full electronics configuration operational
- Aileron and empennage controlled effectively
- Servos, motors operate as intended
- Pixhawk Struggles Overcome
  - Reliable connection

The Flight

- All electronic systems functioned well once configured
- Trimming was fast & Painless in the field
- Acceleration was impressive
- Motors worked As intended
- Durability was incredible
  - Despite Crashing, only one aileron & Landing gear was damaged.
  - Nose & Tail Handled Force very well.
- The plane was traveling quickly
- Plane easily repairable in the field
- Modularity Proved itself
  - Made Transportation Possible in Normal Cars
- Learned A Lot!

What went wrong

Effect of Covid

Covid exacerbated many common problems:

- Less in-person time
  - Hard to foster feeling of team ownership
  - Difficult to foster team sense of place
  - Difficult to teach new tech without extended in-person time
- Lab time restrictions
  - Hard to find time to work
  - Constantly Limited
  - Hard to space time
    - Can’t do extra work when members have time to do so

Effect of Covid

Soley-COVID reliant Issues:

- Masks made personal contact difficult
  - Hurt team building
- Many People Struggle with Isolation
- Vigilance & Covid Stress was piled upon existing stress

Build Team

- Minor issues with fitting wing over sleeve
- Accidental damage done to parts
- Delays on Some parts
- Onboarding for Solidworks was difficult with covid
    - Especially difficult for Build.

Tech Team

- Time for shipping of parts delayed progress
- Pixhawk 4 issues
- Y-harness soldering issues
- Electric Ducted Fan vibrations
- Spontaneous issues with electronics

What We Accomplished

Accomplished : Full Team

- We built the plane
  - Lay-up of the wings
  - Assembled Parts
  - Got electronics Working
- We attempted our first flight
- We figured out the autonomous flight system
- Designed the wing for next semester
- Began the parametric project
- Acquired Data from Attempt
- Expanded Team knowledge of ANSYS & Solidworks

Accomplished : Tech Team

- Configured controls
  - Ailerons
  - Rudder
  - Elevator
  - Tail Gear
- Configured autopilot
- Set up the telemetry
- Completed the Wiring
- Synchronized and ran electric ducted fans

Accomplished : Build Team

- Laid up Truss-Braced Wings with carbon fiber
- Designed and manufactured modular landing gear
- Assembled aircraft
- Began parametric design
- Prepared Cantilever Control Wing for manufacturing
- Began researching Wing Configuration III


Build Team Work

Scope of Work

- Design, manufacture, assemble parts of the aircraft
  - Designing landing gear system that can be removed or adjusted within minutes
  - Cutting, putting together, and laying up wings, trusses with carbon fiber
  - Post-processing components for proper assembly and results
  - Attaching components to the 3D-Printed sleeve and carbon fiber fuselage
  - Logistics for Flight- Transportation, Field, FAA Regulations
- Future Wing Configurations
  - Revisiting Cantilever Wing
  - Other designs with Parametric Design implementation

Tyler Chandler

- Worked in Composites Lab to lay up wings and trusses
  - Post-process components
- Helped assemble Empennage, Trusses, Wings, EDF Mounts
  - Adjust sleeve and components to ensure proper connection
- Reconfiguring Sleeve for Control Wing
- Prepare Control Wing for CNC
- Led Build team though a successful Semester

Andrew Asama

- Composites
  - Laid up composites in the Howe Lab
- Sensors
  - Found compatible Lidar for pixhawk system
- Travel
  - Found travel restrictions and required forms for transportation

Sahar Ferdowsi

- Design front landing gear
  - Research forces that will be acting on PLA sleeve during takeoff and landing
  - Create SolidWorks model of landing gear
  - Perform ANSYS Static Structural on landing gear to ensure failure will not occur
  - Assemble landing gear to fuselage
- Create Pre-Flight Checklist
  - Create checklist to ensure everything is working properly before takeoff
  - Includes range of temperature that dictates the plane fit to fly in terms of melting point of PLA
- Create Flight Plan
  - Fill out the required FAA form that needs to be submitted for a typical flight

Gabriel Ortiz

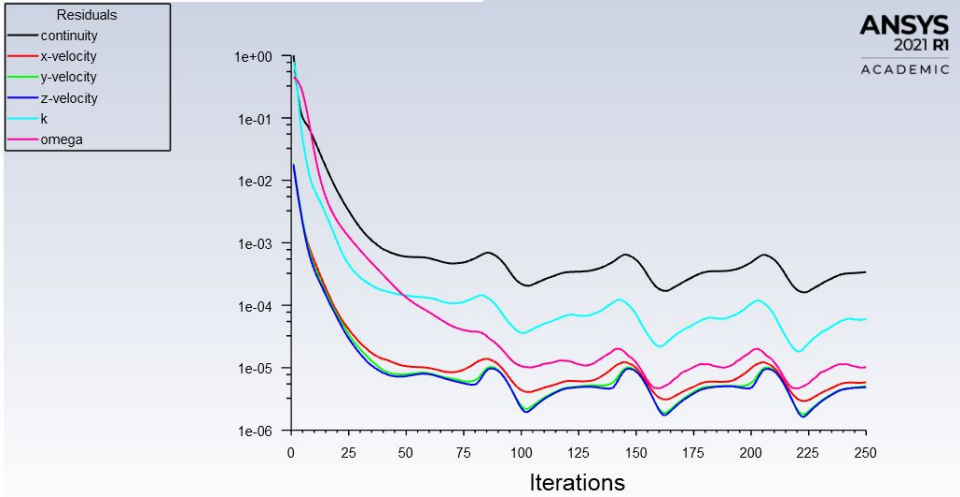
- SolidWorks
  - Designed the control horns
- Build/Composites
  - Wrapped foam wings and trusses in carbon fiber
    - Post processing
      - Filed off unnecessary pieces of carbon fibre and epoxy
      - Removed some interior foam so they could fit nicely on the sleeve
- Communication
  - Found an airfield to fly
    - Central Iowa Aeromodelers: Cambridge, IA
      - Coordinated flight date and time with president - Mark Taylor

Robert Louis Santiago

- Landing Gear Sleeve
  - Designed the Sleeve that attaches front wheels to the wing thru Solidworks
- Control/Cantilever Wing
  - Parameters based on past research from last semester
    - Taper Ratio
    - Airfoil
  - Designed a better and optimal B-737 like airplane in Solidworks
  - Use Ansys Fluent to analyse fluid flow
- Parametric Design
  - Started Parametric Design on the Horizontal Stabilizer thru Matlab
    - Projected Horizontal Tail Moment Arm

James White

- Build
  - Helped glue wing pieces before they went into composites
  - Helped to fit wings and trusses on the sleeve
- Ansys
  - Put the cantilever wing through ansys fluent to analyze fluid flow
- Research
  - Conducted research on possible wing designs that can be used in the future



Tech. Team Work

Scope of Work

- Autonomous Flight
  - Configuring Pixhawk 4
  - Running Ground Control Software
- Configuring electronics
  - Obtaining all relevant electronics
  - Testing servos and motors
  - Creating a system that efficiently utilizes batteries
- Assisting with build assembly
  - Wing, truss attachment
  - Empennage

Ryan Brohm

- Led static testing of motors
- Participated in assembly of wings, trusses
- Design and assembly of control surface actuation
  - Elevator, rudder, steering
  - Ailerons

Mathew Peterson

Pixhawks 4

- QGroundcontrol
  - Worked on setting up the all the configuration for Pizhawks in QGroundcontrol though it was taking to long and much of the software was a little hard to figure out.
- Mission Planner
  - Successfully got the Pixhawks to recognize our commands and get it properly set up in a few weeks.
- Static Tests of Motors
  - Helped with the Set up Static Motor tests and took videos of them.
- Soldering Help
  - I helped with soldering the wire for the battery connection.

Jovanni Balley

- Research
  - Determining which servos were needed for the control surfaces based off of the forces they would be experiencing
  - The requirements and guidelines set by the FAA so that we could follow them accordingly
- Testing
  - Testing servos after determining which would be perfect for the task
  - Running motor tests to make sure that they would be ready for flight
  - Ground testing on the craft to further readiness for flight
- Assembly
  - Help assemble the empennage, trusses, and wings

Sanketh Narmnada

- Two electronics configurations
  - Decided to create a y-harness to optimize battery life
- Spent a decent amount of time soldering two y-harnesses together
  - Required learning how to solder
  - Ran into issues with maintaining connections
- Helped assemble Craft
  - Composites lab
  - Control Surface & Empennage Construction
  - General Assembly

Hieu Nguyen

- Helping Sanketh develop Y- Harness.
- Help soldering Y - Harness
- Research on pixhawk.
- Helping in lab on building power supplied.
- Testing project on ground.

What We Accomplished

Reflecting on the Semester

Reflecting on the Semester

Lessons Learned

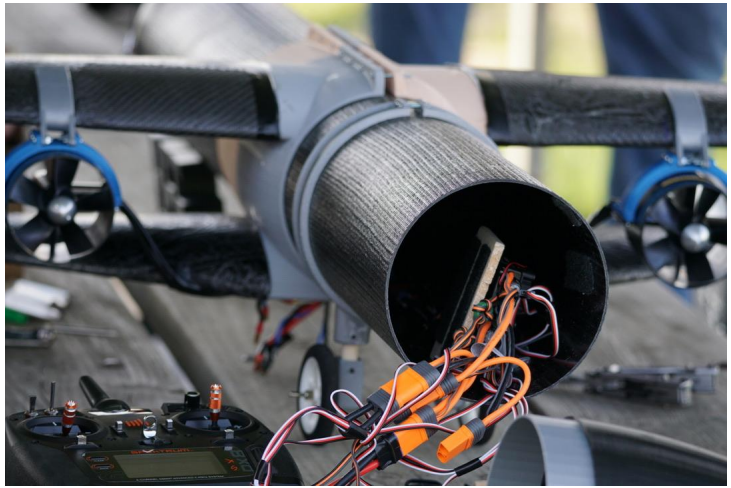
- Order parts as early as possible to leave less buffer time
- Leave more time for dealing with issues in software
- Leave Greater Margins
  - Increased Tail Sizes
  - Increase Wing Size
- Cable Management is vital
- Must Improve ground steering
- Increase Cross Training for new members
- We must improve flight planning
  - Checklists & Procedure Documentation are needed

Looking into the Future

Lesson Implementation

Wiring

- Do away with stringing together servo connectors
  - Wire all pixhawk connectors as a single line
    - Crimp or Solder connections
    - Tape All Wires From Tail to Nose to Tube
    - Reduce excess Wiring near nose.
- Increase Fuselage Hole Size or Add Another
  - Remove need for internal connectors
    - Make servo connections from the ailerons similar to the motor connectors.
- Continue to Improve Wiring Quality



Lesson Implementation

Pixhawk

- 3D Printed Pixhawk Mount that goes in nose
- Increase plug and play ease of use
  - 3d print module to control placement & ordering easily though the whole process
- Cross Train more members on pixhawk & mission planner
- Spend time to configure Automatic Flight

Implementation of Lessons :

Componentry

- Show up to flight site with extras for high impact pieces
  - Extra Landing Gear Sleeve & Wheels
  - Improve Ground Steering system
- Must Improve landing gear general concept.
  - Move to be under wing
    - Ensure it is still moveable
- Add Trailing Edge on Wing.
- Buy New Servos
  - Invest in smaller, higher quality servos
    - Reduce weight & profile
    - Improve consistency & safety
    - Can be ‘optimized’ to fill rolls in particular locations.
- Must Increase the initial angle of attack
- Increase horizontal stabilizer size.

Future Of BEF

- More design based off of parametric design
- Reorganization of internal electronics
- Prop-powered flight as a comparison
- Cantilever wing design
- Future Wing Configurations
- Get members with a part 107
- Do away with dichotomous Design & Build Semester system
  - Quickly build and test designs
- Retry Flight Early in Semester

Major Milestones

Major Milestones of Next Semester

- Redoing test flight
- Creating internal structure for electronics
- Improving knowledge of parametric based design
- Introducing prop-powered flight and comparing performance with EDFs
- Cantilever Wing Design

Acknowledgements

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All Photos & Renders (including backgrounds) in this document are taken by Matthew Nord

1. The Team
2. Original Goals For Semester
    a. Pixhawk
    b. Fly
    c. Build
3. What We Accomplished
    a. Tech Team
        i. Scope of Work
        ii. Member Slides
    b. Build Team
        i. Scope of Work
        ii. Member Slides
4. Looking Back
        i. What went right
            1. General Full Team
            2. Tech.
            3. Build
        ii. What went wrong
            1. General Full Team
            2. Tech
            3. Build
        iii. Effect of Covid
        iv.
5. Lessons Learned
    a. How We Use these Lessons
6. Future of the Team
    a. General Plans For Next Semester
    b. Aspirations
7. Deliverables
    a. Full Team
    b. Unable to Accomplish
    c.