MAE 189 Capstone Design
UCI DBF Payload Team

Final Presentation Fall 2021

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Overview

AIAA Design Build Fly, known as the ***"DBF Team"***

Our entire team is split into two parts:

- Aircraft
- Payload
  - Drop Mechanism
  - Fuselage

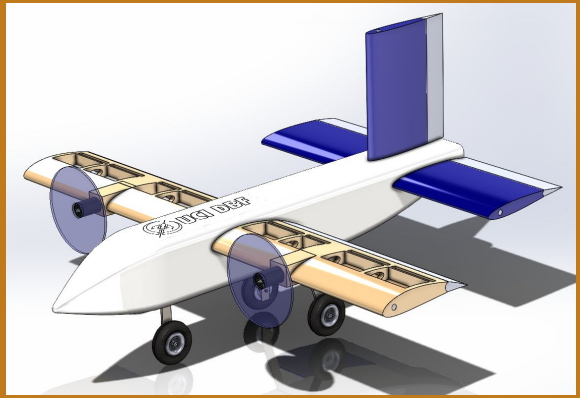

Figure 1: Preliminary Design of UCI ICU

Problem Definition:

The AIAA Design, Build, Fly competition is a nationwide competition which will take place between April 21-24, 2022 in Wichita Kansas. We have faculty advisors including Professor Jacqueline Huynh, Colin Sledge and Nathan Yeung to provide insight and direction for the different components of the project. Our UCI ICU DBF team qualified for the competition, where our proposal placed 15th of the 110 colleges accepted, and 127 of the colleges that applied.

Team Breakdown

Aircraft Team

- Aircraft Performance
- Structural Analysis
- Propulsion and Electric
- Weight and Balance
- Wing and Tail Design

Payload Team

- Drop Mechanism
- Fuselage Design
- Deployment of vaccine packages
- Structural Integrity of Fuselage to carry Payload

Competition

- **First Mission**: timed laps, no payload
- **Second Mission**: the same as the first with the vaccine syringes on board
- **Third Mission**: aircraft will fly one lap, land, deliver one vaccine vial package to the drop zone, and repeat until all are delivered.
    - **Ground Mission**: loading the entire payload into the aircraft and safely deliver it

Our team plays a pivotal role in both **Mission 2 and Mission 3** as we are responsible for both the drop mechanism and the fuselage

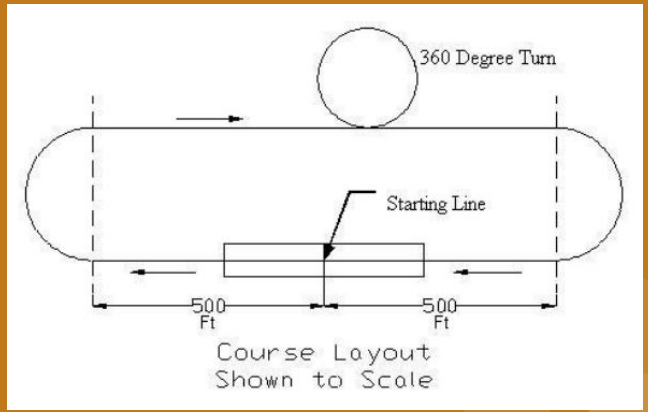

Figure 2: Competition Course

Scoring Analysis

Mission 2 - Syringes

- Goal: Carry as many syringes, attentive to weight
  - Complete 3 laps within 5 minute window
  - Must complete a successful landing to get a score

Scoring:

M2 = 1 + [N_(#syringes/time) / Max_(#syringes/time)] , where Max_(#syringes/time) is the highest #syringes/time score of all teams.

Mission 3 - Vaccine Vial Packages

- Goal: Successfully deliver packages
  - Maximum packages is based on the 10% of maximum number of syringes successfully achieved in Mission 2
  - Takeoff field length is 25 feet

Scoring:

M3 = 2 + [# of successful deployments in our team / maximum # of successful deployments among all teams]

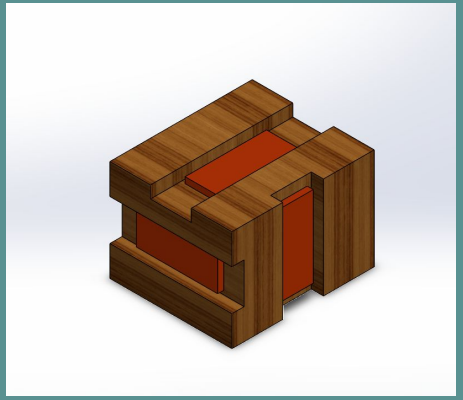

Figure 3: CAD image of Vial Package

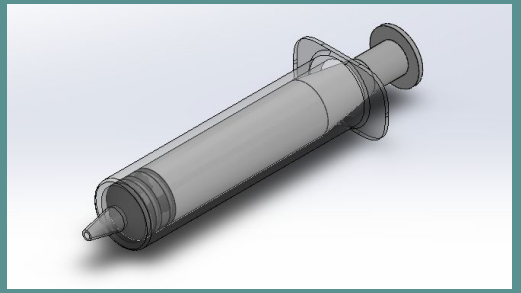

Figure 4: CAD image of Syringe

Requirements

- Design and build a fuselage to carry the drop mechanism and at least 10 syringes
  - Goal: around 250 syringes
  - Limiting factor: weight and size of syringes
- Design and build a drop mechanism capable of deploying 1 vaccine vial packages without triggering the shock sensors.
  - Initially 5G, recently changed to 25G
  - Goal: 6 Packages
  - Limiting factor: time to unload

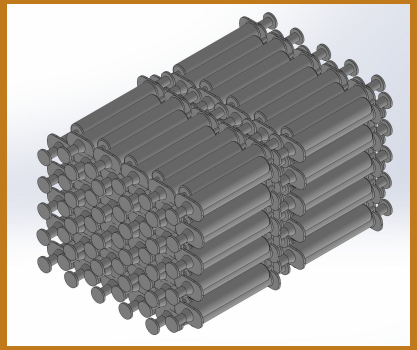

Figure 5: CAD Image of Syringe Packing

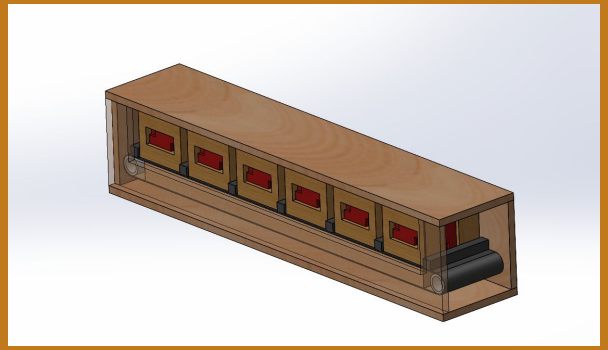

Figure 6: CAD image of Drop Mechanism

Fuselage Design

- 4.2’ long
- Mixture of materials
  - Balsa wood bulkheads
  - Balsa wood floor
  - Kevlar doors for loading
  - Tail boom
- Design is not final
  - Suggestions and advice from Professor Huynh
  - Adjusting as we start to build

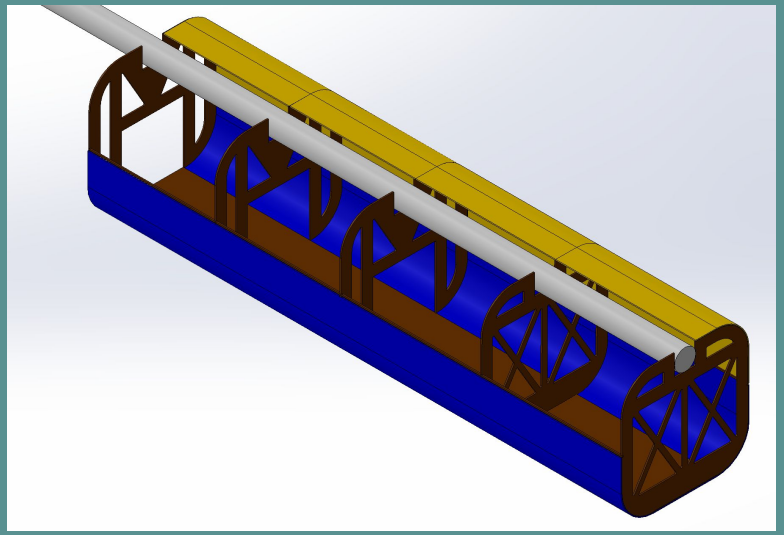

Figure 7: Cutaway Image of Fuselage Structure

Fuselage Analysis

- Balsa to reduce weight & Kevlar for extra strength
- Kevlar or hinge tape - attach boom and doors in place
- Currently 4.2’ long
  - Leaving room for nose, tail, & fairing
  - Maximum length of 8ft long per competition rules
- Brainstorming other designs to try to reduce extra space

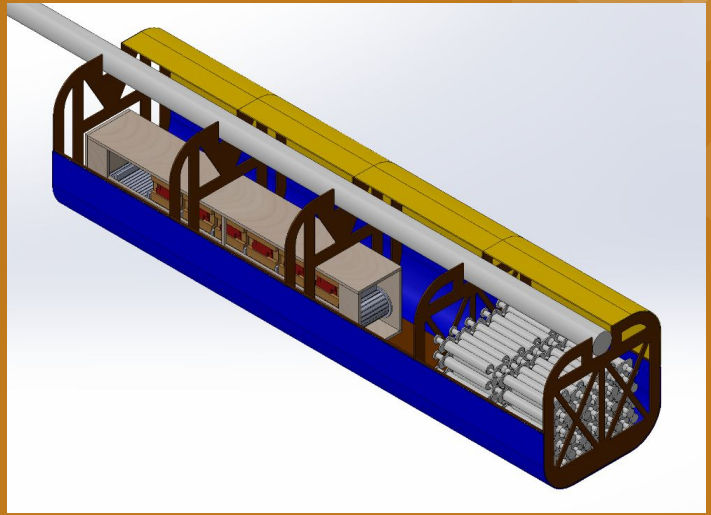

Figure 8: CAD Image of Fuselage Design

Syringe Packing

- 5x5 packs, 10x10x2 in first section
- 250-300 syringes can be carried volumetrically
- Adjusted the bulkheads

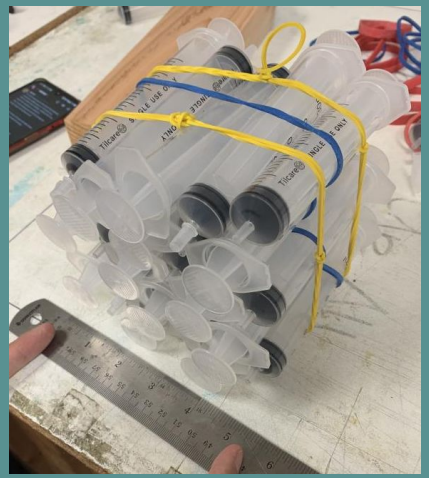

Figure 9: Syringe Packaging

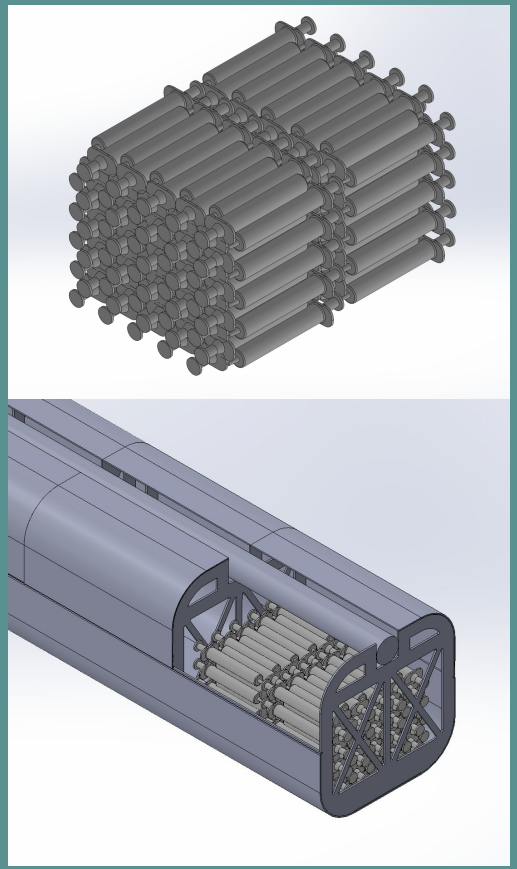

Figure 10: CAD Syringe Packaging with and without Fuselage

Drop Mechanism Analysis

- Initially the sensors were 5G, but this changed about 2 weeks ago
  - From testing the initial 5G sensors of different height drops (in.) found that a drop ≥ 2in would trigger the sensors
  - Tested at max 12in
- Designed a system that can deploy one package at a time safely and smoothly
  - Leading to the conveyor belt system with a ramp of rollers

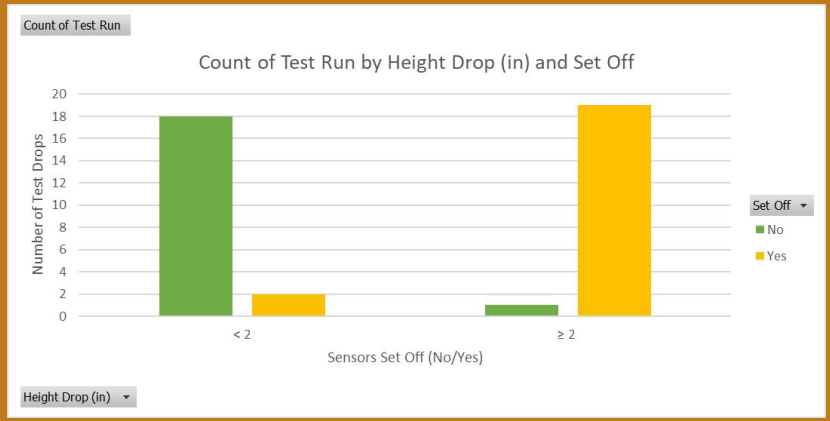

Figure 11: 5G Sensor Testing Results

Current Drop Mechanism

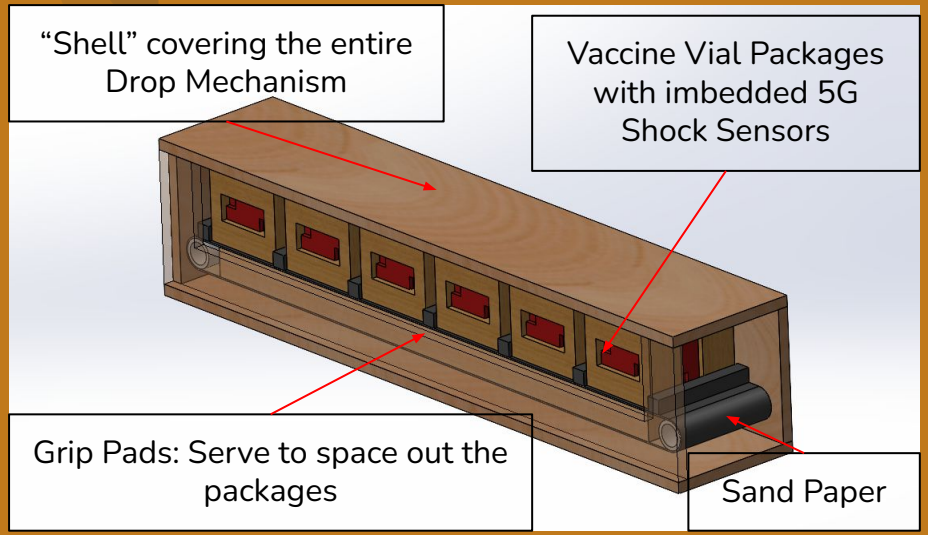

Figure 12: Current Drop Mechanism

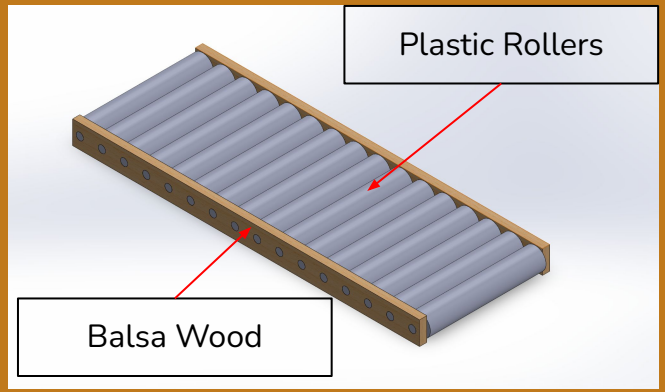

Figure 13: Ramp

- Designed to hold up to 6 Packages
- Want a faster drop without setting off the shock sensors
  - Take off constraint during course
  - Keeping in mind time

- Ramp will be used to smoothly drop off each package
- Made of plastic rollers and Balsa Wood
- This belt is designed to be retractable

Drop Mechanism Analysis

- Currently researching for a potential continuous Servo Motor
  - In hand:
    - 2000 series 25-4 (Servocity)
    - Parallax Feedback 360° High Speed Servo
  - Contender available: HSR-2648CR Servo (Servocity)
- Based off current design
  - 3.5in of distance to move entire distance of Grip Pad + Package
  - Total Weight on Belt: 54oz = 3.375lbs
    - 6 packages = 48oz
  - Belt Length ~21 in
- Want to meet all our requirements keeping in mind Speed, Efficiency, and Weight

Figure 14: 2000 series 25-4
Figure 15: Parallax Feedback Servo

Drop Mechanism Final Design

- The conveyor belt is subject to change
  - Using rubber bands for the belt
  - A servo with gears or a pulley
  - Potentially use a helicopter belt or a tail drive belt
  - String to pull onto the packages
  - Flooring consisted of rollers
- After 25G testing, will finalize if a ramp is necessary
- Looking to decrease size of rollers, and adding multiple
  - Spaced out
- Ultimately looking to find the best way to meet our requirements

Figure 17: Pulley Belt

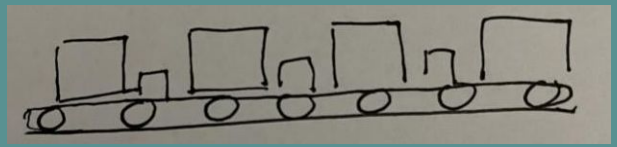

Figure 16: Sketched Idea of Belt with multiple rollers integrated to the floor of the fuselage

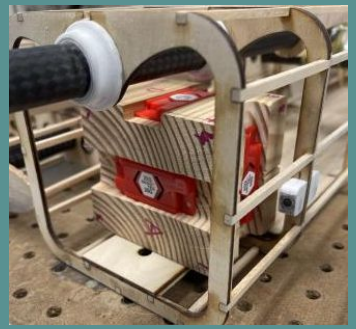

Figure 18: Reference image of Package in a Fuselage

Drop Mechanism Analysis

- 25G Shock Sensors have just arrived
- Testing will be done this week on how sensitive these new sensors are
- Labeled each Face and Corner of the Cube
  - Will be dropping the block at different heights, aiming at different sides, edges, and corners

	Side "x" Drop at Height "y"			Edge "x" Drop at Height "y"			Corner "x" Drop at Height "y"		
Trial	Sensor 1	Sensor 2	Sensor 3	Sensor 1	Sensor 2	Sensor 3	Sensor 1	Sensor 2	Sensor 3
1									
2									
3									
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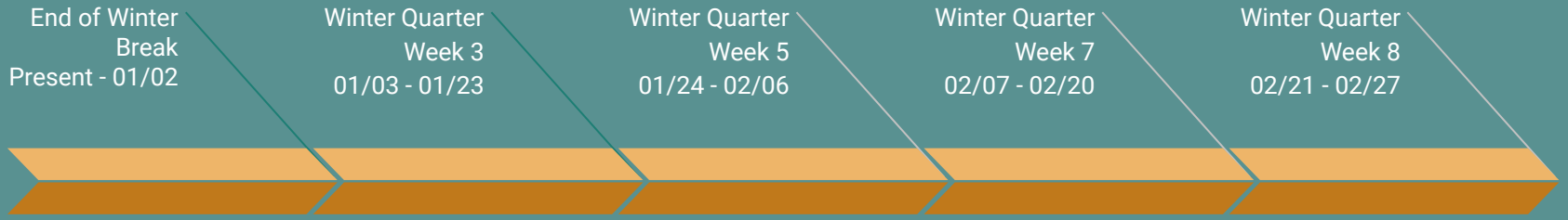
Figure 19: Testing Plan

Figure 20 & 21:
Updated Testing Block

Timeline



Finalize Design

- Finalize all CAD models and designs
- 25G Shock Sensors Limitation Testing

Manufacture Prototype

- Begin the manufacturing process
- Complete a successful prototype

Begin Prototype Testing

- Test first prototype
- Note all errors encountered during testing

Troubleshoot

- Reassess design based on prototype testing

AIAA Design Report Due

- Submit Design Report for AIAA DBF Competition
- Due 02/25/22 3 PM PST

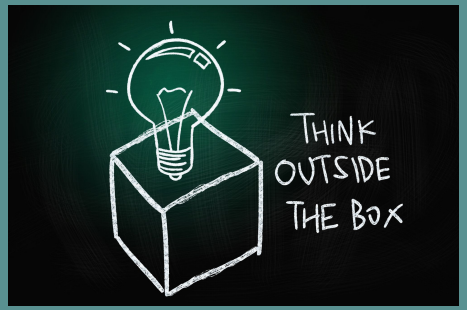
Questions and Concerns

- Concerns:
  - Updated sensors for the packages from 5G to 25G
  - Optimization for best material for the fuselage
  - Ability to construct the fuselage with the material
  - Strength of the fuselage structure
- New possibilities and alterations to a conveyor belt
  - Weight
  - Is sandpaper the best material for the belt?
  - How many rollers will be needed?
  - What other materials can be used?

Figure 22: 25G Sensors

Recommendations for the future

- Recommendation
  - Have all members dedicate and commit to the project and work together efficiently
- Improvements
  - Learning from prototypes once manufacturing begins
- Lessons Learned
  - Think outside the box



Thank you

If you have any questions or concerns, please contact the 189 DBF team for more information!