# Milestone Review Flysheet 2019-2020

| Institution | University of Illinois at Urbana-Champaign |
|---|---|

| Milestone | CDR |
|---|---|

## Vehicle Properties

| | |
|---|---|
| Total Length (in) | 110 in |
| Diameter (in) | 4 in (body) / 6 in (fairing) |
| Gross Lift Off Weight (lb) | 27.1 lbm |
| Airframe Material(s) | Blue Tube (body tube), Fiberglass (nose cone), PLA (streamlining interstage) |
| Fin Material and Thickness (in) | 1/8 in Fiberglass |
| Coupler Length(s)/Shoulder Length(s) (in) | 10"/4" (coupler); /3" (nose cone) |

## Motor Properties

| | |
|---|---|
| Motor Brand/Designation | AeroTech K1050W |
| Max/Average Thrust (lb) | 488.3/254.7 |
| Total Impulse (lbf-s) | 533 |
| Mass Before/After Burn (lb) | 4.857/2.068 |
| Liftoff Thrust (lb) | 220.3 |
| Motor Retention Method | 54mm Aero Pack motor retainer |

## Stability Analysis

| | |
|---|---|
| Center of Pressure (in. from nose) | 81.6 in |
| Center of Gravity (in. from nose) | 59.6 in |
| Static Stability Margin (on pad) | 3.67 cal |
| Static Stability Margin (at rail exit) | 2.65 cal |
| Thrust-to-Weight Ratio | 8.1 |
| Rail Size/Type and Length (in) | 144 in, 1515 rail |
| Rail Exit Velocity (ft/s) | 87.6 |

## Ascent Analysis

| | |
|---|---|
| Maximum Velocity (ft/s) | 601 |
| Maximum Mach Number | 0.54 |
| Maximum Acceleration (ft/s^2) | 351 |
| Target Apogee (ft) | 4450 |
| Predicted Apogee (From Sim.) (ft) | 4481 |

## Recovery System Properties - Overall

| | |
|---|---|
| Total Descent Time (s) | 87.2 |
| Total Drift in 20 mph winds (ft) | 2300 |

## Recovery System Properties - Energetics

| | | |
|---|---|---|
| Ejection System Energetics (ex. Black Powder) | | Black Powder |
| Energetics Mass - Drogue Chute (grams) | Primary | 2.8 grams |
| | Backup | 3.3 grams |
| Energetics Mass - Main Chute (grams) | Primary | 5.4 grams |
| | Backup | 5.9 grams |
| Energetics Mass - Other | Primary | (CO2 Ejection) |

## Payload Deployment

| | |
|---|---|
| Location: Air or Ground (if applicable) | Air |
| Altitude of Deployment (if applicable) | 400 ft |

## Recovery System Properties - Recovery Electronics

| | |
|---|---|
| Primary Altimeter Make/Model | Perfectflite StratologgerCF |
| Secondary Altimeter Make/Model | Altus Metrum Telemetrum |
| Other Altimeters (if applicable) | |
| Rocket Locator (Make/Model) | Altus Metrum Telemetrum |
| Additional Locators (if applicable) | |
| Transmitting Frequencies (all - vehicle and payload) | Telemetrum: 433 MHz; Xbee Pro S3B 900 MHz |
| Pad Stay Time (Launch Configuration) | 2 Hours |
| Describe Redundancy Plan (batteries, switches, etc.) | Redundant altimeters with separately connected batteries for each unit |

## Recovery System Properties - Drogue Parachute

| | | | | |
|---|---|---|---|---|
| Manufacturer/Model | | | Fruity Chutes Elliptical | |
| Size or Diameter (in or ft) | | | 28 in | |
| Main Altimeter Deployment Setting | | | Apogee | |
| Backup Altimeter Deployment Setting | | | 1 second after Apogee | |
| Velocity at Deployment (ft/s) | | | <5 | |
| Terminal Velocity (ft/s) | | | 70 | |
| Recovery Harness Material, Size, and Type (examples - 1/2 in. tubular Nylon or 1 in. flat Kevlar strap) | | | 0.25 in tubular Kevlar shock cord | |
| Recovery Harness Length (ft) | | | 20 ft | |
| Harness/Airframe Interfaces | | U-bolt on coupler and eye bolt on motor | | |
| Kinetic Energy (Ft-lbs) | Section 1 | Section 2 | Section 3 | Section 4 |
| | 142 | 530 | 211 | 1017 |

## Recovery System Properties - Main Parachute

| | |
|---|---|
| Manufacturer/Model | Fruity Chutes Elliptical |
| Size or Diameter (in or ft) | 60 in |
| Main Altimeter Deployment Setting (ft) | 800 ft |
| Backup Altimeter Deployment Setting (ft) | 700 ft |
| Velocity at Deployment (ft/s) | 70 |
| Terminal Velocity (ft/s) | 20.7 |
| Recovery Harness Material, Size, and Type (examples - 1/2 in. tubular Nylon or 1 in. flat Kevlar strap) | 0.25 in tubular Kevlar shock cord |
| Recovery Harness Length (ft) | 20 ft |
| Harness/Airframe Interfaces | U-bolt on coupler and eye bolt on upper section |

| (grams) - If Applicable | Backup | |
|---|---|---|

| Kinetic Energy (Ft-lbs) | Section 1 | Section 2 | Section 3 | Section 4 |
|---|---|---|---|---|
| | 9.2 | 34.2 | 13.6 | 65.7 |

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## Payload

| | Overview |
|---|---|
| Payload 1 (official payload) | The official payload will be an unmanned aerial vehicle (UAV), deployed aerially at 400 ft through vertical lowering through the fairing after recovery of the nose cone. The nominal operational period is 12 minutes, wit the UAV descending and navigating to the nearest recovery area by means of GPS and computer vision. Then, the UAV will lower onto the recovery area, retrieving ice samples by way of an actuatable arm. Having retrieved the sample, the UAV will distance itself from the recovery area. The payload will be operated autonomously, with manual control being possible by way of a remote control link operated by a human operator. Telemetry is also provided for, so that ground control may ascertain vehicle health and proper operations throughout the mission. |

| | Overview |
|---|---|
| Payload 2 (non-scored payload) | |

## Test Plans, Status, and Results

| | |
|---|---|
| Ejection Charge Tests | The required black powder charges will be determined through calculations and then real-world ejection charge tests. Here, the shear bolt will be tested under volumetric constraints. |
| Sub-scale Test Flights | The half-size subscale vehicle was launched on January 6, 2020. The expected altitude with conditions was 1486 feet, and the measured altitude was 1529 feet. The stability margin, mass distribution, and thrust profile were, in general, similar to the full scale. Primary ejection charges for the drogue and main were activated by a StratologgerCF. Secondary charges were set to fire later via a TeleMetrum. All charges were activated succesfully at the expected times. The main parachute did not deploy; investigations revealed that it was packed too tightly and did not slide out as planned. It was instead pushed further into the body by the charges. The appropriate considerations have been made to prevent this in the future. |
| Vehicle Demon-stration Flights | Demonstation of full system capabilities, including but not limited to staging, parachute deployment and payload deployment testing. After payload deployment is achieved, the payload will be tested for flight time and reliability when controlled both autonomously and remotely. A mockup of the actual flight environment will be constructed so as to validate the reliability and efficacy of the computer vision and guidance algorithms. Finally, sample retrieval will be demonstrated. |
| Payload Demon-stration Flights | In addition to the abovementioned vehicle demonstration flight, the payload will undergo additional testing to validate its flight time, maneuverability, failure tolerance and mission performance. |

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| Transmitter #1 | | | |
|---|---|---|---|
| Location of transmitter: | Avionics Coupler | | |
| Purpose of transmitter: | Recovery Transmitter | | |
| Brand | Altus Metrum | RF Output Power (mW) | 40 |
| Model | TeleMetrum | Specific Frequency used by team (MHz) | 433 |
| Handshake or frequency hopping? (explain) | Fixed frequency | | |
| Distance to closest e-match or altimeter (in) | 0 | | |
| Description of shielding plan: | Avionics will be shielded by copper mesh lining | | |

| Transmitter #2 | | | |
|---|---|---|---|
| Location of transmitter: | Nose Cone | | |
| Purpose of transmitter: | Recovery Transmitter | | |
| Brand | Altus Metrum | RF Output Power (mW) | 40 |
| Model | TeleMetrum | Specific Frequency used by team (MHz) | 433 |
| Handshake or frequency hopping? (explain) | Fixed frequency | | |
| Distance to closest e-match or altimeter (in) | 0 | | |
| Description of shielding plan: | Avionics will be shielded by copper mesh lining | | |

| Transmitter #3 | | | |
|---|---|---|---|
| Location of transmitter: | Nose Cone | | |
| Purpose of transmitter: | UAV Deployment System | | |
| Brand | Digi | RF Output Power (mW) | 250 |
| Model | Xbee Pro XSC S3B | Specific Frequency used by team (MHz) | 900 |
| Handshake or frequency hopping? (explain) | Multiple channels are available | | |
| Distance to closest e-match or altimeter (in) | 1 | | |
| Description of shielding plan: | Avionics will be shielded by copper mesh lining | | |

| Transmitter #4 | | | |
|---|---|---|---|
| Location of transmitter: | | | |
| Purpose of transmitter: | | | |
| Brand | | RF Output Power (mW) | |
| Model | | Specific Frequency used by team (MHz) | |
| Handshake or frequency hopping? (explain) | | | |
| Distance to closest e-match or altimeter (in) | | | |
| Description of shielding plan: | | | |

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## Transmitter #5

| | | | |
|---|---|---|---|
| Location of transmitter: | | | |
| Purpose of transmitter: | | | |
| Brand | | RF Output Power (mW) | |
| Model | | Specific Frequency used by team (MHz) | |
| Handshake or frequency hopping? (explain) | | | |
| Distance to closest e-match or altimeter (in) | | | |
| Description of shielding plan: | | | |

## Transmitter #6

| | | | |
|---|---|---|---|
| Location of transmitter: | | | |
| Purpose of transmitter: | | | |
| Brand | | RF Output Power (mW) | |
| Model | | Specific Frequency used by team (MHz) | |
| Handshake or frequency hopping? (explain) | | | |
| Distance to closest e-match or altimeter (in) | | | |
| Description of shielding plan: | | | |

## Additional Comments