Aircraft design
1. VTOL design
2. Payloads

5B: VTOL aircraft design

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In this lecture you will learn:

- How aircraft are designed
- What considerations impact the design of an aircraft?

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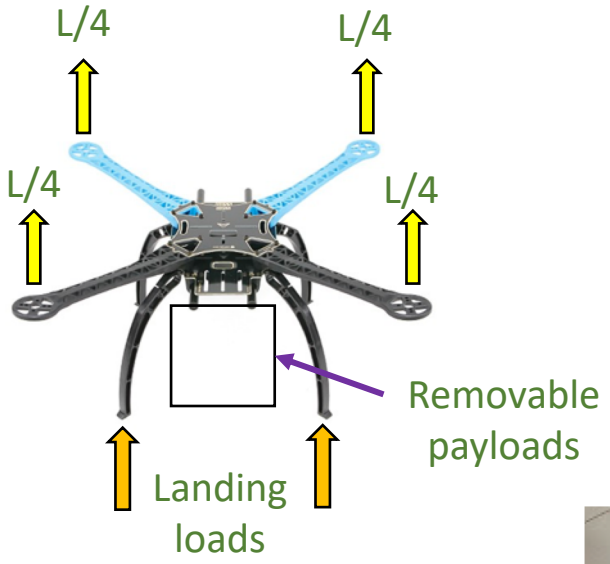
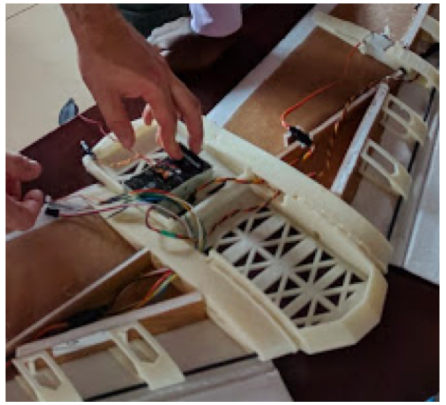
VTOL Fuselage design considerations

- The fuselage / central structure of the aircraft is designed around three purposes:
  - It transmits the loads from the wings/propellers (for VTOL) to the equipment and electronics bay
  - It accommodates removable payloads
  - It supports the landing gear which should be designed to handle hard landings





EcoSoar fuselage

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VTOL Fuselage design considerations

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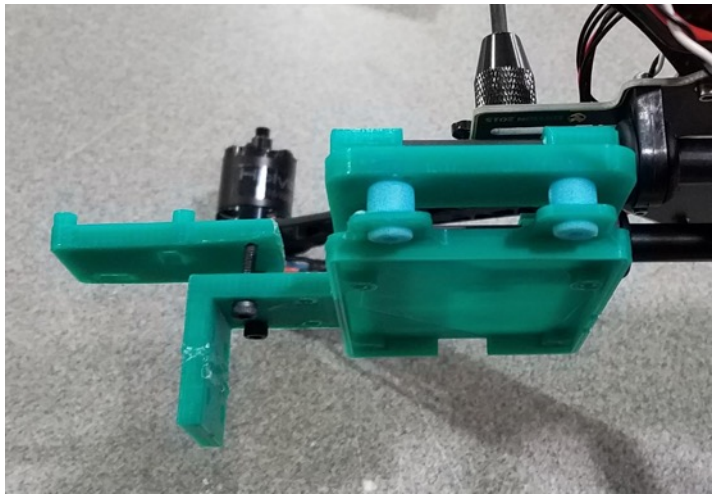
- For VTOL aircraft, payload attachment is important
  - Vibration isolation may be incorporated into a mounting system to prevent vibration of an imaging payload
  - Standard mounting rails are typically used so that payloads can be interchangeable from one aircraft to another

The **same aircraft** carries a radiation detector (left) and a SBC + stereovision system (right)



3D printed camera mount that is isolated. It mounts to carbon rails on the aircraft

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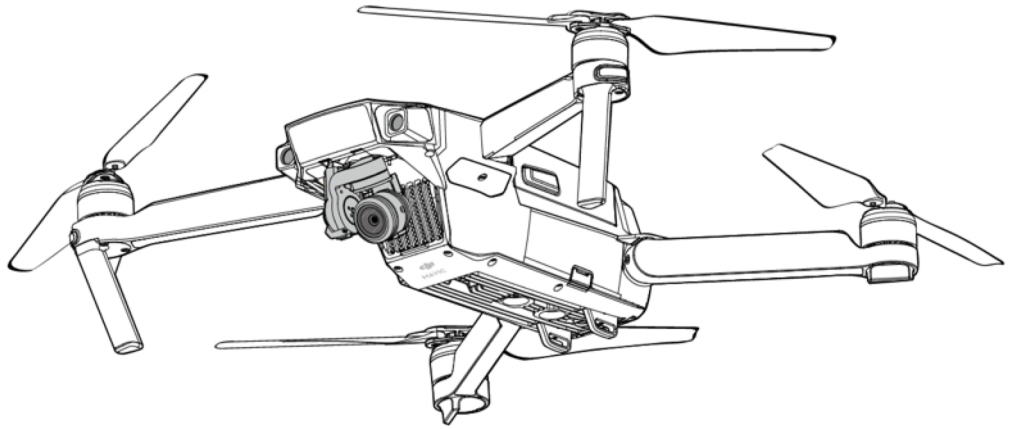
VTOL design

- Vertical takeoff and landing (VTOL) aircraft are capable of hovering but also flying very fast forward
- They have become a very popular option among drone operators
- They make ideal camera platforms
- They are limited in endurance - it is not easy to find a VTOL drone that will fly more than 30 minutes



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Aircraft design
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VTOL design

- VTOL aircraft are simple platforms for carrying a variety of payloads
  - Imaging systems
  - Spray systems
  - Winched payloads
  - Stereovision imaging
  - Servo-actuated drop mechanisms
  - Spotlight platform
  - Speaker platform
  - Radiation detection
  - Gas sampling

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VTOL aircraft can be analyzed as a system of three components: **structure, propulsion, control**

Aircraft design
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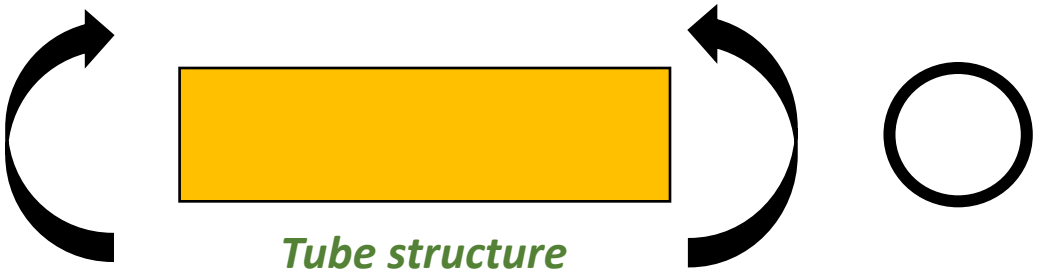
- **Structure - monocoque design**
  - The loads are carried through the outer shell of the aircraft
  - This makes a very lightweight, strong structure
  - Aerodynamically it works well for fixed wing aircraft
    - **The DJI Phantom series aircraft are made in this fashion**



Tube structure

Loads are carried in the outer shell efficiently

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VTOL aircraft can be analyzed as a system of three components: **structure, propulsion, control**

Aircraft design
1. **VTOL design**
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- **Structure - central body and arm design**
  - The loads are carried through joints in the central body, through the arms to the motors
  - The construction is simple and modular, making it easy to repair if damaged
    - It may be slightly heavier than a monocoque design, but its simplicity is appealing
    - The arms can be designed to fold for easy transport

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VTOL aircraft can be analyzed as a system of three components: **structure, propulsion, control**

Aircraft design
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- VTOL configurations
  - Quadcopters are a popular configuration due to cost and performance
    - Minimal motor and prop configuration reduces cost
  - Hexacopters are an optimal design for efficiency if load carrying capacity is a priority
    - ***Hexacopters are also redundant systems and if one motor fails, they will become a heavily loaded quadcopter and descend under control***
  - Motors can be located above and below the arms to create contra-rotating propulsion systems that greatly increase the load carrying capacity

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VTOL aircraft can be analyzed as a system of three components: **structure, propulsion, control**

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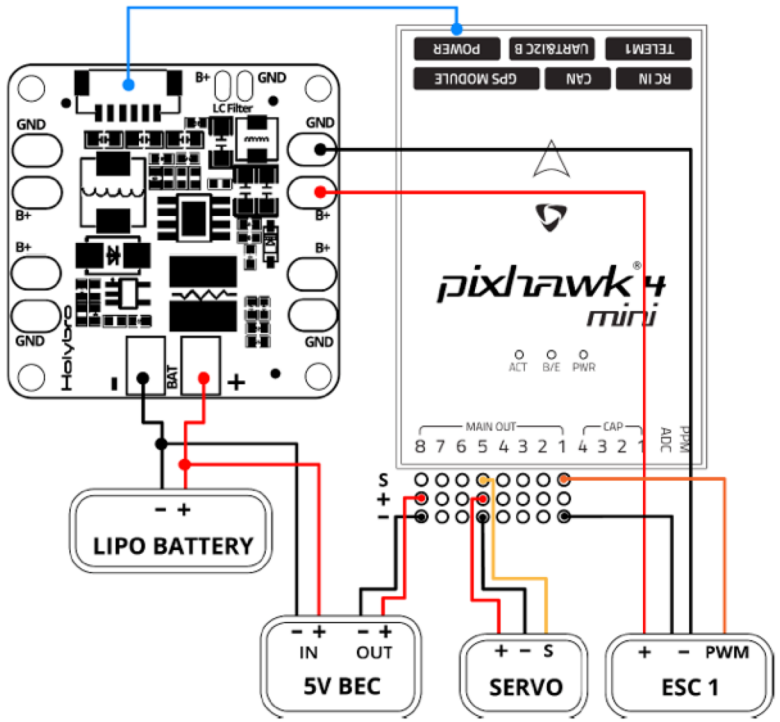
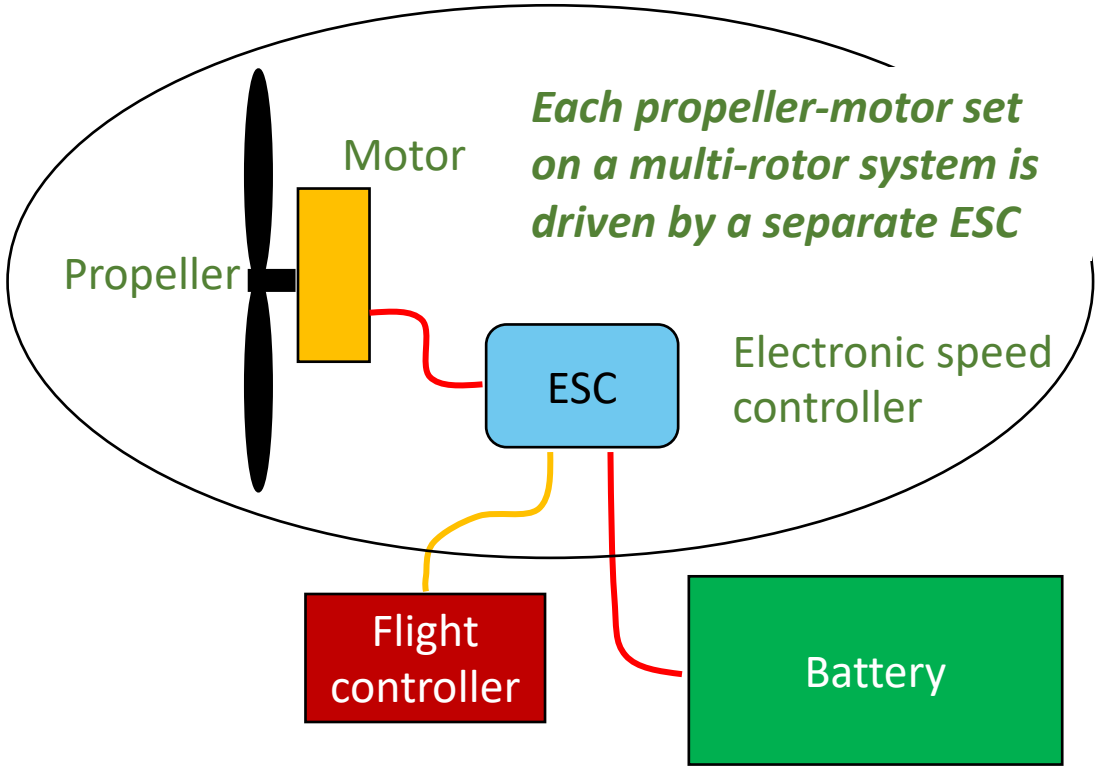
- The propulsion systems on VTOL aircraft require a flight controller that accepts a variety of thrust configurations





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The carriage of payloads is the primary reason that drone use has grown among non-recreational users

Aircraft design
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2. **Payloads**

- Payloads can be integrated directly into an aircraft structure or be modular to allow quick sensor swapping
  - Usually, integrated payloads are found in more aerodynamically efficient aircraft while modular payloads represent a compromise of efficiency
  - Modular payloads expand the capability of the aircraft by allowing multiple missions to be flown by a single aircraft

Boeing ScanEagle

RMAX with winch system

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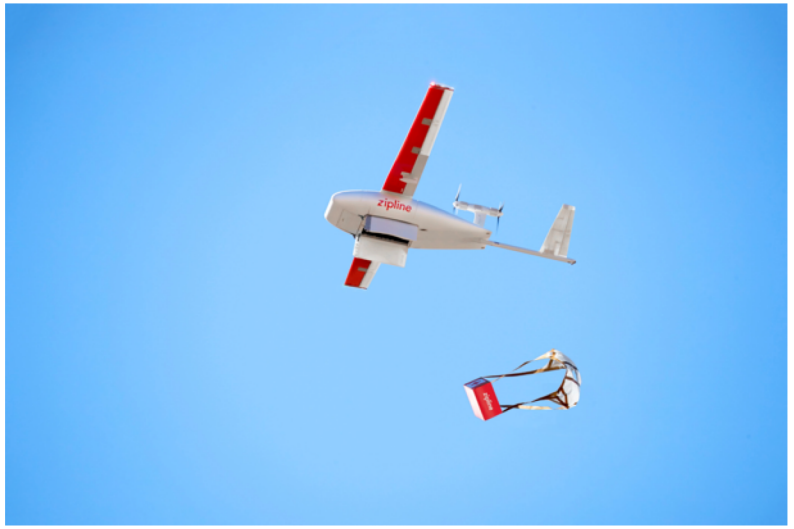
The Zipline system

- Zipline has a fully enclosed payload bay that contains a parachute-delivered cargo
  - The aircraft does not land at its destination but drops off the payload in flight



Flyzipline.com

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Aircraft that carry modular payloads have a great benefit to serve a broader audience

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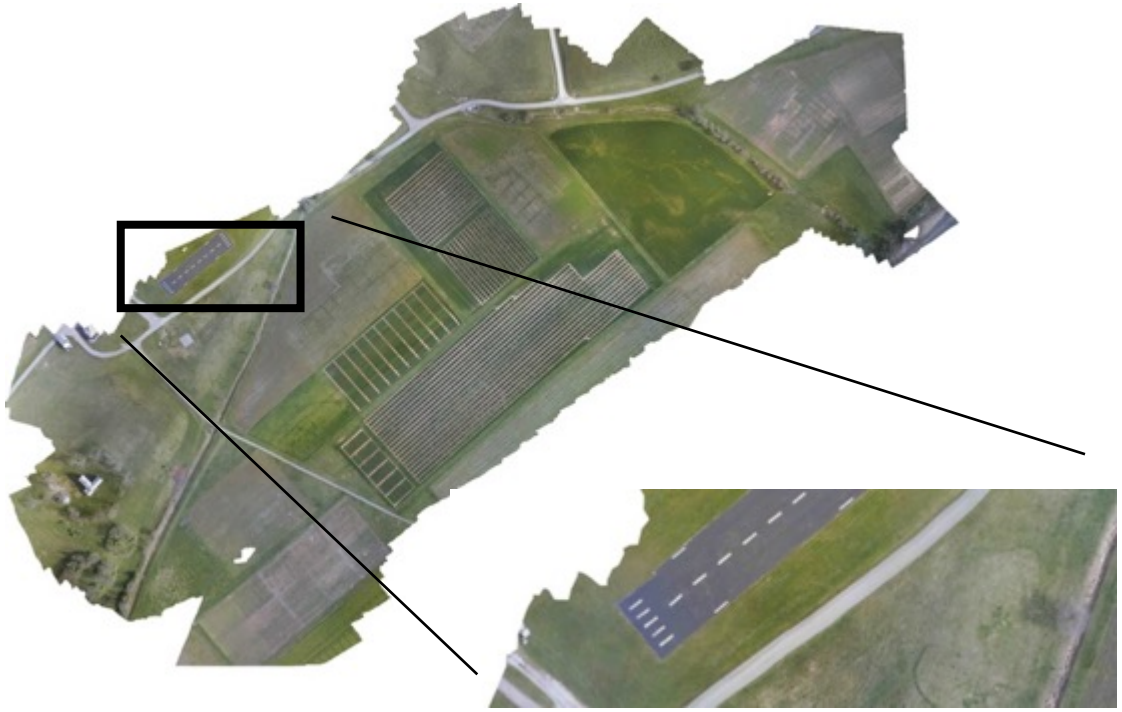
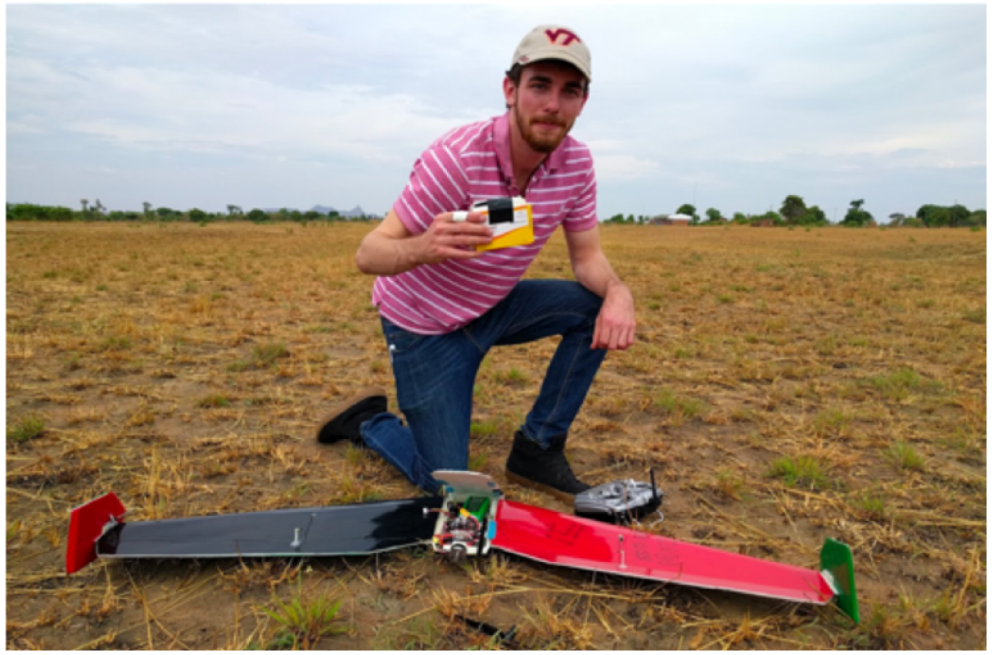
- Public health users are served by drones that carry dried blood spot samples, vaccines, units of blood **but also** collect imagery for building ortho-mosaic composites of the flight area





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