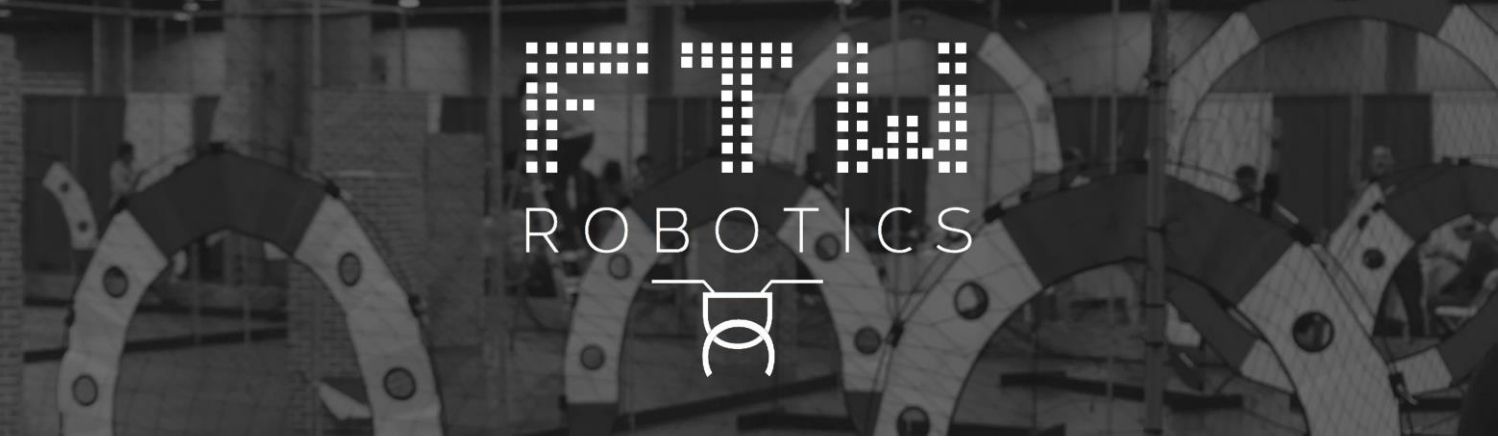
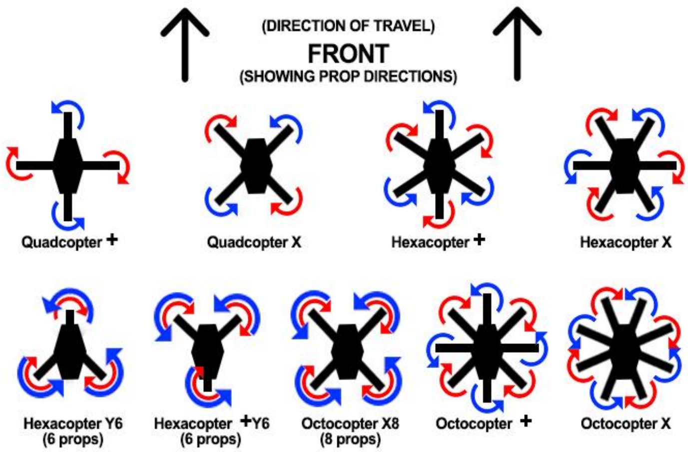


Curriculum/Units

- 1: Design & Documentation
- 2: Safety Considerations
- 3: Introduction to Drones
- 4: Fundamentals of Flight
- 5: Airframes
- 6: Electric Motors
- 7: Propellers
- 8: Electronic Speed Controllers (ESCs)
- 9: Flight Controllers
- 10: Batteries, Charges & Connectors
- 11: Transmitters & Receivers
- 12: Cameras, Gimbals & Other Payloads
- 13: Ground Control Stations & FPV
- 14: Regulations & The FAA
- 15: Drone Maintenance & Battery Care
- 16: Efficiency vs. Performance



FTW Curriculum	FTW-007
30 Seats	$999.99

Each Unit Includes:

Lesson Plan – Teacher Prep

Activity – Student Activity

Student Reading – Take home reading

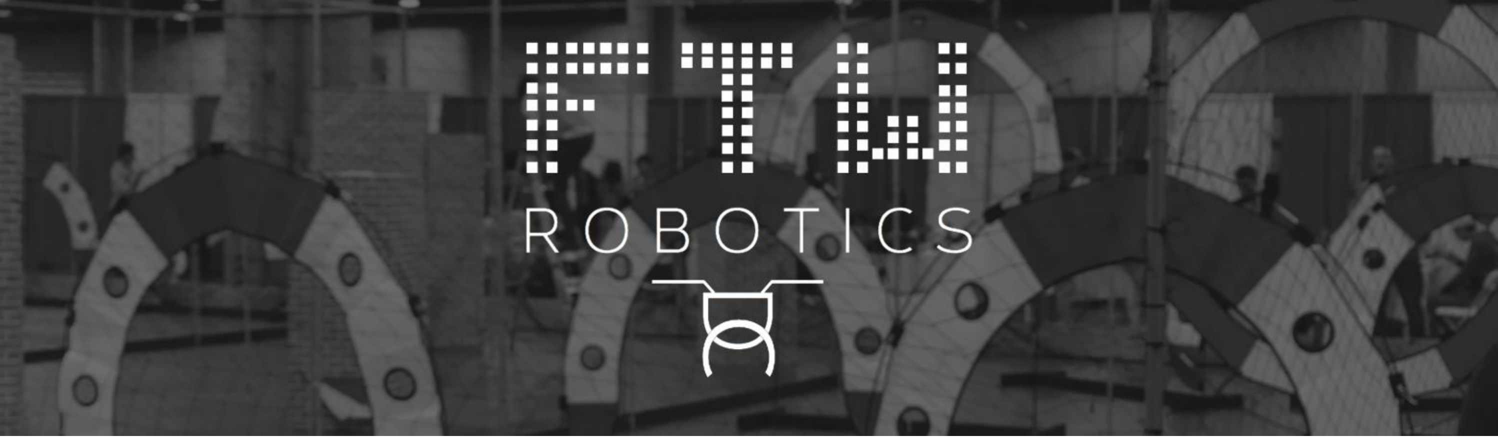
PowerPoint Presentation – In Class Presentation

Unit Quiz

Vocab

Vocab Quizzes

	Description	Minimum # days (if some activities are skipped)	Maximum # days (if all activities completed)
Unit 1: Design & Documentation	Introduces the engineering design process and stresses the importance of cooperation, teamwork, and documentation to solve problems.	3	7
Unit 2: Safety Considerations	Stresses the importance of adopting a "safety attitude" when building and flying a drone. Covers workshop safety and outdoor flying.	3	7
Unit 3: Introduction to Drones	Covers nomenclature, history of aerial drones, reputation, airframe, configurations, basic components, and current/future uses of drones.	4	7
Unit 4: Fundamentals of Flight	Introduces aerodynamics, history of flight, Newton's Laws of Motion, Bernoulli's Principle, four forces of flight, three axes of flight, how they apply to drone flight. Reveals issues aircraft pilots encounter including airspace, traffic patterns, and safe altitudes.	4	7
Unit 5: Airframes	Covers history of helicopter design, early multirotor design, various configurations, airframe sizes, and construction materials.	3	5
Unit 6: Propellers	Covers history of propeller design, fixed-pitch and constant speed blades, airfoil design, size, pitch, and blade-count. Includes balancing tips and construction materials	3	5
Unit 7: Ground Control Stations & FPV	Introduces telemetry, data tracking, mission planning, and 3D mapping and modeling. Covers first-person-view flying safety and drone racing options.	3	5
Unit 8: Common Sense Flying	Discusses responsibility of flying and being "neighborly." Discusses building or buying a drone.	3	5
Unit 9: Regulations & The FAA	Covers role of the FAA and NTSB. Stresses importance of regulation, and lists registration and recreational use of drones. Section 333 Exemptions and Part 107 Rules are explained.	2	3
	TOTAL	28	51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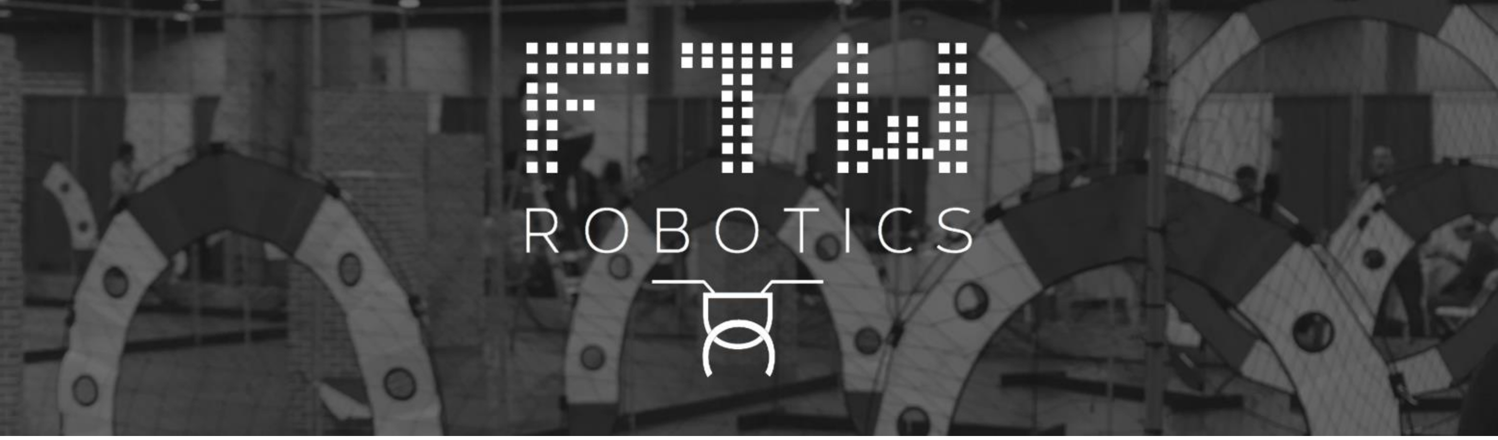
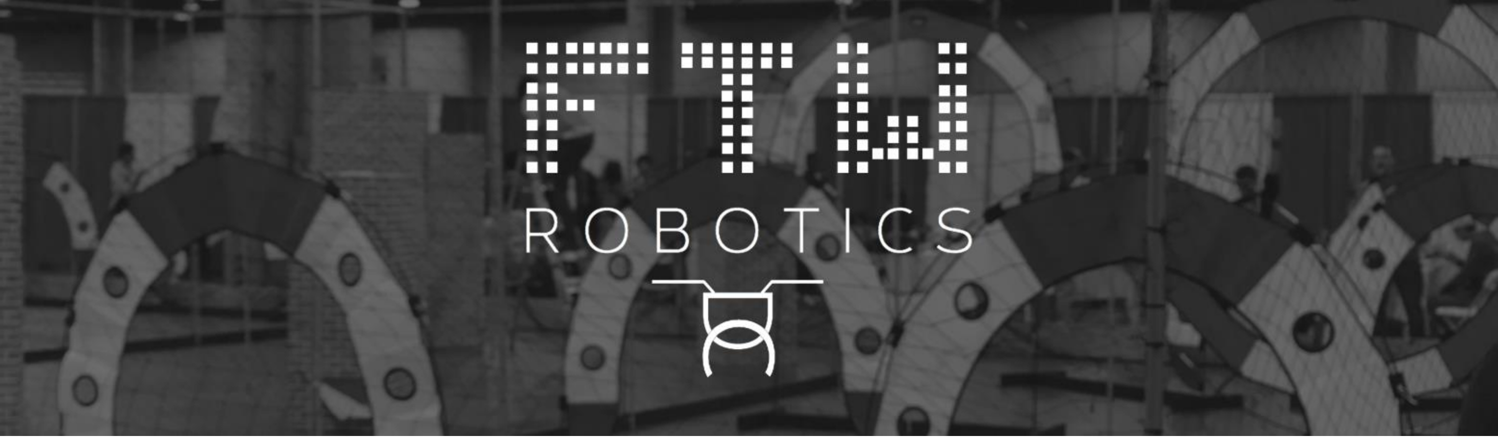
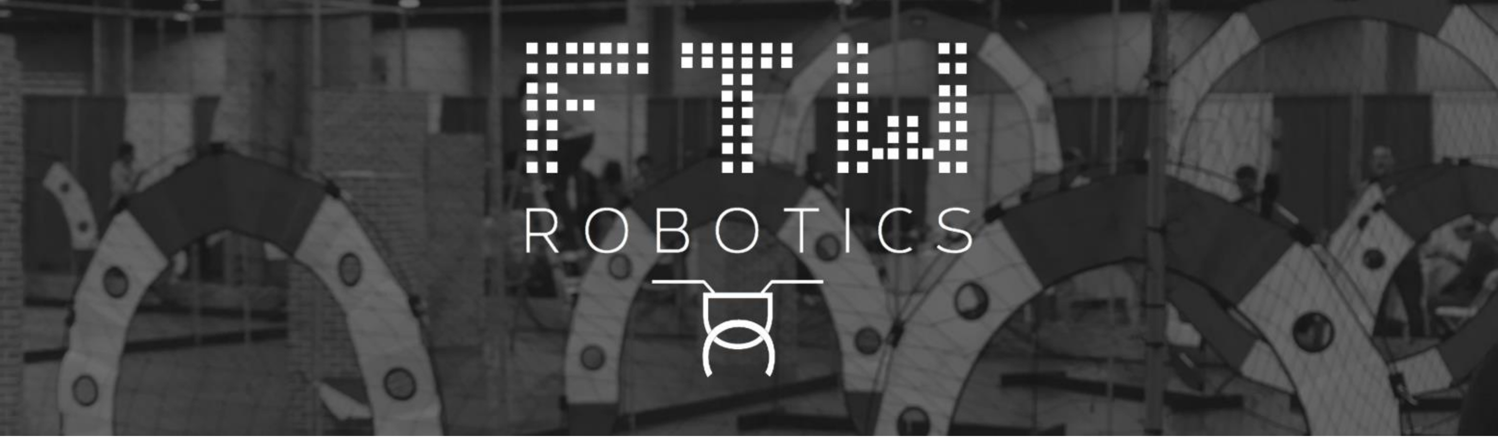
ROBOTICS







Unit 3: Introduction to Drones – Lesson Plan

NOTE: Activity 3.4 is in the form of a Design Challenge. It does NOT require supplies. Students should have an engineering notebook or paper to document all activities.

1. You have the option to copy and distribute the **Unit 3 Handout** for student binders or use it solely as a teacher reference.

2. Copy and distribute the **Unit 3 Vocabulary Definitions**. There are 68 vocabulary terms. Review the first 34 terms and definitions at this time ("**2.4 GHz**" thru "**Kettering Bug**").

3. Teach the lesson using the **Unit 3 PowerPoint** up through and including **Section 3.8**.

4. Students complete **Activities 3.1** & **3.2**.

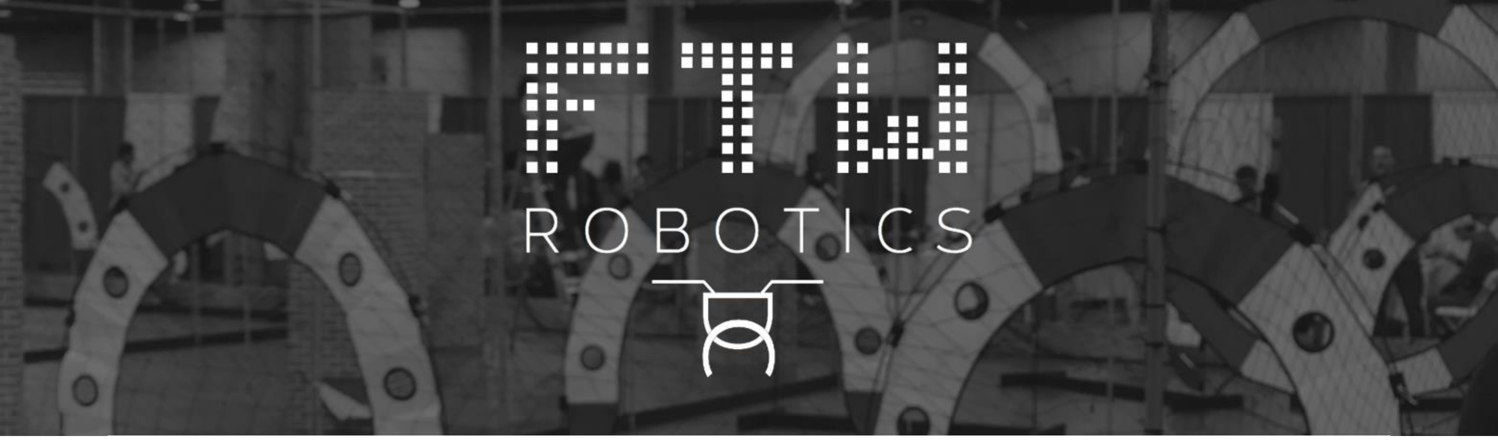
   Activity 3.1: Unit Comprehension (3.1-3.8)
   No supplies needed. The students write subjective responses to questions dealing with the first half of the Unit presentation (3.1 – 3.8). They will need to use their engineering notebooks or paper for the responses. Following the written portion, lead the class in a discussion encouraging every student to participate and share their responses. You have the option of collecting their responses when finished.

   Activity 3.2: Configuration Suggestions
   No supplies needed. The students write subjective responses to a scenario dealing with drone configurations. They will need to use their engineering notebooks or paper for the responses. Following the written portion, lead the class in a discussion encouraging every student to participate and share their responses. You have the option of collecting their responses when finished.

5. Review the first 34 vocabulary terms again. Students should take the **Vocabulary Quiz – Part 1 (matching)**. (Note: You can have the students grade their own quiz or exchange papers and grade each other's – unless you prefer grading them yourself).

6. Review the next 34 vocabulary terms/definitions from **Unit 3 Vocabulary Definitions** ("**Kv rating**" thru "**yaw**").

7. Return to the lesson using the **Unit 3 PowerPoint** beginning at **Section 3.9: "Drone Components."**



3.1 Activity

Unit Comprehension (3.1-3.8)

Using your engineering notebook or regular paper, respond to the following questions. Each response should be a minimum of three paragraphs (a paragraph is defined as at least three sentences):

Question #1
Describe the brief history of drones and major developments that led to the development of small UAVs.

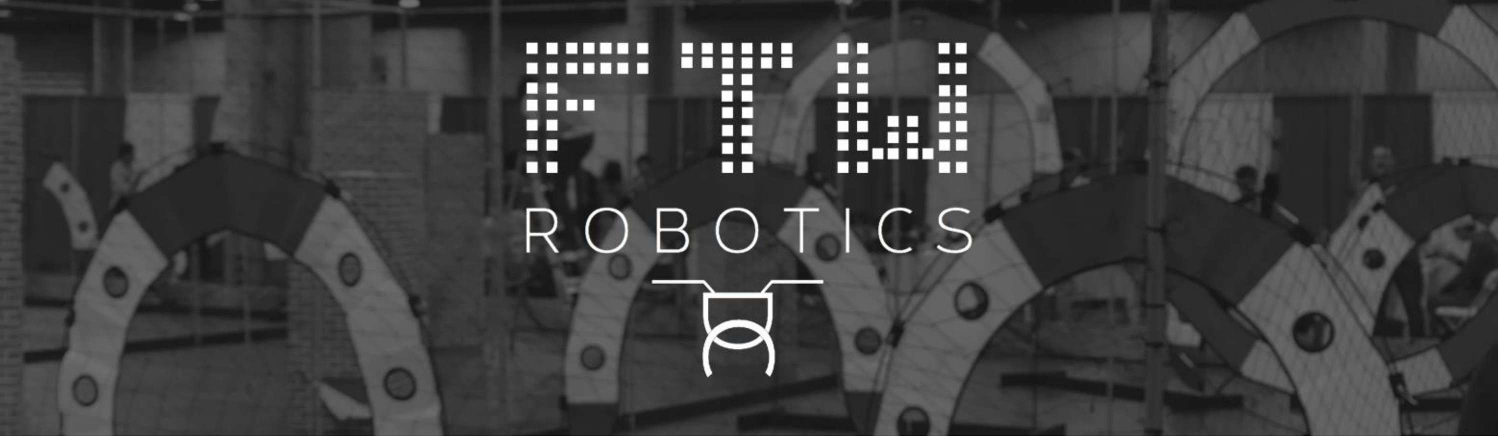
Question #2
Explain why drones were greeted with resistance and disapproval when first introduced to the consumer and commercial markets.

Question #3
Describe the various configurations of multicopters including quadcopters, hexacopters, and octocopters.

Question #4
Explain why a bicoter, tricopter, and V-Tail configuration is less desirable.

Question #5
Describe some factors to consider when choosing a multicopter configuration.

Following the activity, you will participate in a class discussion of the responses. Be sure to share your responses and be involved in the group. Turn in your responses to your teacher if required.



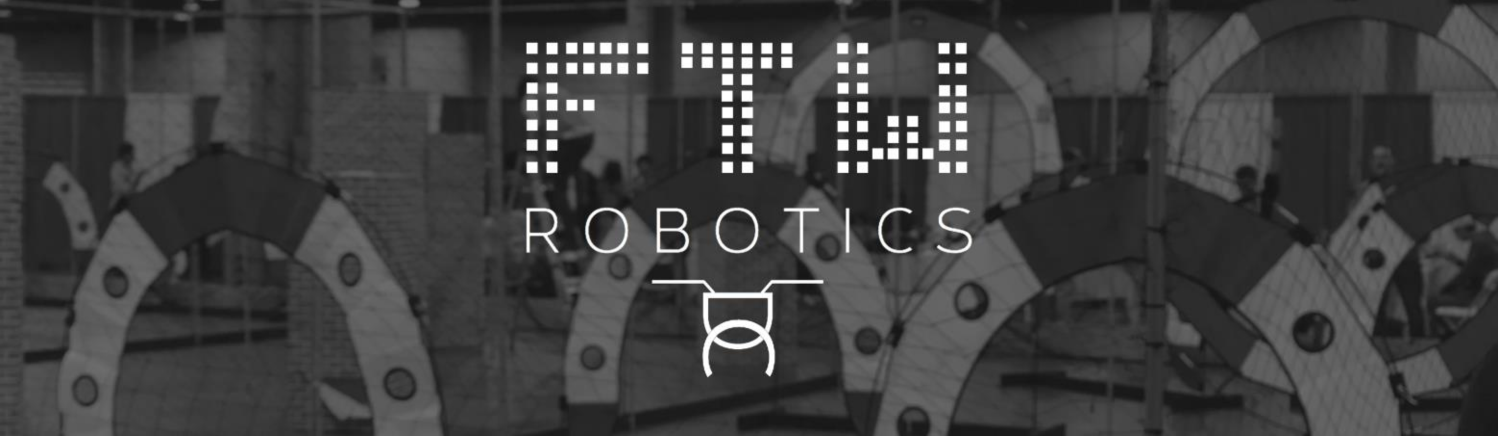
Unit 3: Introduction to Drones

Unit 3 Vocabulary

2.4 GHz
accelerometer
airfoil
airframe
algorithm
autonomously
autopilot
barometric sensor
bicopter
bind
brushed DC motor
brushless DC motor
carbon fiber
chassis
CW (clockwise)
CCW (counter-clockwise)
channel
compass
constant
current
datalogger
DIY (do-it-yourself)
ESC (electronic speed controller)
flight controller
FPV (first-person view)
frequency
gimbal
GCS (ground control station)
GPS (Global Positioning System)
hexacopter
IR (infrared) camera
receiver
jumper
Kettering Bug
Kv rating
LED (light-emitting diode)
LiPo (lithium polymer)
mAh
magnetometer
microcontroller
micro SD
Mode 2/Mode 1
modem
multicopter
multirotor
nano drones
octocopter
payload
pitch
quadcopter
racing drones
R/C (radio control)
ROV (remote operated vehicle)
sensor
servo
stator
submersible
sUAV
telemetry
terrestrial
torque
tricopter
UAS (unmanned aerial system)
UAV (unmanned aerial vehicle)
UGV (unmanned ground vehicle)
V-tail
VLOS (visual line-of-sight)
waypoint
yaw

Unit 3 Concepts

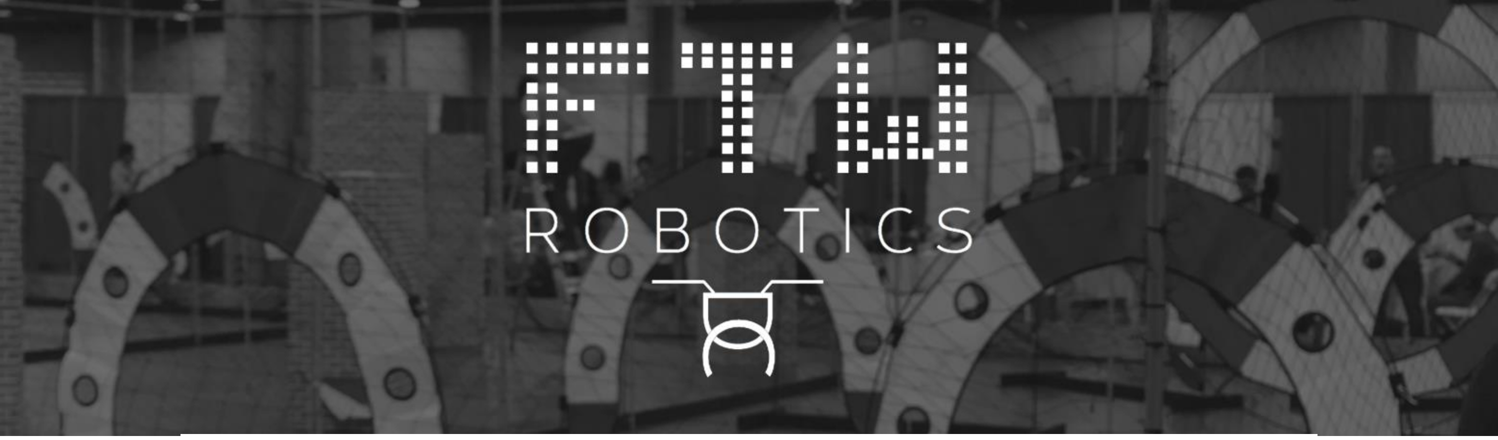
1. A **drone** or **UAV (unmanned aerial vehicle)** is the label given to an unmanned aircraft that navigates by either human remote control (R/C) or autonomously by its own onboard microcontroller.
2. As drones were introduced to the public for consumer use, they were first greeted with resistance and disapproval largely due to controversy surrounding their **military use** abroad, **privacy concerns**, and nuisance flying by "**irresponsible hobbyists**."
3. Fueled by continuing advancements in **miniaturization** and the availability of the **Global Positioning System (GPS)**, consumer and commercial drone production has grown drastically in the past few years.
4. **Multicopter** and **multirotor** are interchangeable terms, and both are used as the generic name for a drone with multiple propellers.
5. A **quadcopter** has 4 rotors positioned on a horizontal plane like a helicopter, a **hexacopter** is a multirotor aircraft that has six rotors, and an **octocopter** is a small UAV that has eight rotors.
6. Multirotors with a **high number of rotors** are typically larger and designed to carry a heavier payload.



Unit 3: Introduction to Drones

Unit 3 Vocabulary

2.4 GHz	2.4 GHz, a frequency designated by the FCC as the industrial, scientific, and medical radio bands, is utilized by many sUAV operators for their transmission control.
accelerometer	An accelerometer is an instrument for measuring acceleration, typically that of an automobile, ship, aircraft, or spacecraft, or that involved in the vibration of a machine, building, or other structure.
airfoil	An airfoil is the shape of a wing or blade of a propeller as seen in cross-section. An airfoil-shaped body moving through a fluid produces lift, an aerodynamic force that is perpendicular to the direction of motion.
airframe	An airframe of an aircraft is its mechanical structure.
algorithm	An algorithm is a process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer.
autonomously	Autonomously refers to being navigated and maneuvered by a computer, without a need for human control or intervention under normal conditions.
autopilot	An autopilot is a system used to control the trajectory of a vehicle without constant 'hands-on' control by a human operator being required.
barometric sensor	A barometric sensor is a device that is responsible for measuring the atmospheric pressure of the environment.
bicopter	A bicopter is an unmanned multicopter having two rotors.
bind	Binding is the simple process by which you program the receiver in an aircraft to respond to a specific aircraft transmitter.
brushed DC motor	A brushed DC motor is an internally commutated electric motor designed to be run from a direct current power source.
brushless DC motor	A brushless DC (BLDC) motor is powered by direct current and has electronic commutation systems instead of the mechanical brushes and commutators used in brushed dc motors.
carbon fiber	Carbon fiber is a material which is created using carbon fibers bonded by a resin. The binding polymer is often a resin such as epoxy, and the bonding alignment gives the fiber high strength-to-volume ratio.
chassis	A chassis is the base frame of a vehicle or aircraft.
CW (clockwise)	A clockwise (CW) motion is one that proceeds in the same direction as a clock's hands, from the top to the right, then down and then to the left, and back up to the top.
CCW (counter-clockwise)	A counter-clockwise (CCW) motion is one that proceeds in the opposite direction as a clock's hands, from the top to the left, then down and then to the right, and back up to the top.
channel	A channel refers to the number of actions that the R/C transmitter controls such as for the throttle and for steering.
compass	A compass is an instrument containing a magnetized pointer that shows the direction of magnetic north and bearings from it.
constant	In mathematics, the term constant refers to a fixed and well-defined number or another mathematical object.
current	An electric current is a flow of electric charge. In electric circuits this charge is often carried by moving electrons in a wire. It can also be carried by ions in an electrolyte, or by both ions and electrons such as in a plasma.



3.5 – Development of Small UAVs

Fueled by continuing advancements in **miniaturization** and the availability of the **Global Positioning System (GPS)**, consumer and commercial drone production has grown drastically in the past few years. Numerous companies are developing hundreds of commercial drone systems and products. Companies like Amazon, Wal-Mart, and Google are developing drone delivery systems, and the hobby market has exploded with models of all sizes and capabilities. It's estimated that over 100,000 drone-related jobs will be created in the next 10 years, and sales of drones will reach over 125,000 by the year 2020.

3.6 – What's in a Name?

What's the difference between a **drone**, a **UAV** and a **UAS**? These terms are often used interchangeably to describe unmanned aircraft however there are some distinctions to be made. The most common term being used to describe an unmanned aircraft is a **drone**. However, because of its associated reputation from controversial military applications, those in the "drone industry" prefer the more descriptive reference of **Unmanned Aerial Vehicle (UAV)**. The terms **UAV** and **drone** are now essentially used interchangeably. According to the FAA, a UAV or drone is an aircraft without an onboard human pilot, controlled either autonomously or by remote control. Another term, **sUAV** is used to identify "*small*" UAVs ("*s*" meaning *small*) that weigh less than 55 pounds.

Unmanned Aerial Systems (UAS), on the other hand is a reference term that by definition is clearly distinguished from a drone or UAV. The term refers to the unmanned aircraft **AND all of its components** including, but not limited to:

- Ground control stations and software
- Radio-frequency linkage
- Remote controls
- Payloads
- Launch and recovery equipment.

3.7 – Types of Small UAVs (sUAV)

Multicopter and **multirotor** are also interchangeable. Both are used as the generic name for a drone with multiple propellers. There are a variety of multicopters classified as drones. Here are the most common configurations:

- **Quadcopter:** As the most popular configuration for small UAVs, a quadcopter has **4 rotors** positioned on a horizontal plane like a helicopter.
- **Hexacopter:** A hexacopter is a multirotor aircraft that has **six rotors** which gives it the advantage that it can lose any single engine and still maintain control to land.
- **Octocopter**: An octocopter is a small UAV that has **eight rotors**.

M**ultirotors** with a high number of rotors are typically larger and designed to carry a heavier payload. For example, because of their increased flight range, stability, and ability to carry moderate amounts of weight, octocopters are preferred by many of the businesses developing UAVs to deliver packages.