DRONES@STEAM

Fostering digital Transformation in VET schools and creating new job prospects in the labour market

Project Result No: 2

Activity 3: EDUCATIONAL PACK: TEACHING MATERIAL AND ASSESSMENT

UNIT 2, Chapter 2.4, Worksheet 2.4.1

Lead partner(s): Politeknika Txorierri

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CONTEXT

Grant agreement	2021-1-EL01-KA220-VET-000034686
Programme	Erasmus+
Key action	Cooperation for innovation and the exchange of good practices
Action	Strategic Partnerships
Project acronym	DRONES@STEAM
Project title	DRONES@STEAM: Fostering digital Transformation in VET schools and creating new job prospects in the labour market
Project starting date	28/02/2022
Project duration	28 months
Project end date	27/06/2024

WEBSITE:

https://dronesteam.eu/

CONSORTIUM: PARTNER LIST

- University of Crete (UoC) - Greece
- ECAM-EPMI (ECAM) - France
- Cyprus Computer Society (CCS) - Cyprus
- Politeknika Ikastegia Txorierri S. Coop (PIT) – Spain
- National Center for Scientific Research "Demokritos" (NCSRD) - Greece
- A & A Emphasys Interactive Solutions Ltd (EMP) – Cyprus
- Regional Directorate of Primary and Secondary Education of Attica (RDPSEA) – Greece

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Contents

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UNIT 2: Lesson Plan 2.4.1

UNIT 2	
Chapter 2.4	**Drone flying and remote control programming**
Equipment, Software, Consumables (if needed)	PC with access to the internet
Duration	1 teaching hour
Short description	In this worksheet the students will **identify and understand the basic parameters and conditions of flying and remote controlling a drone**
Learning Outcomes	Identification of issues related to remote drone flying: equipment, weather conditions or communication issues
	Awareness of ethical and privacy issues
	Collaboration, Teamwork, Critical Thinking, Creativity, Communication, Decision Skills
Activities	
Activity 1	Presentation 2.4.1.1: The MEUH Concepts
Aim of the activity	The aim of this activity is to introduce students to the "MEUH concept" as a guide to ease the identification of parameters related to the remote piloting of drones
Duration	5 min
Type of Activity	Presentation
Teaching Objectives	By the end of this exercise, students will understand how each of these categories affects drone operations and learn about the specific factors that fall under each group.
Resources	Worksheet 2.4.1 / Presentation 2.4.1.1
Activity 2	Exercise 2.4.1.2: Mind Map for the four MEUH categories
Aim of the activity	This activity is designed to deepen the knowledge of the parameters related to remote drone flight. The aim is to identify as many parameters as possible through collaborative work
Duration	20 min
Type of Activity	Collaborative Mind Map
Teaching Objectives	By the end of this exercise, students will learn to identify the key concepts and sub-concepts related to each category and develop a deeper understanding of how they impact drone operations
Resources	Worksheet 2.4.1 / Mind Map 2.4.1.2
Activity 3	Exercise 2.3.1.3: Questionnaire on the MEUH concepts
Aim of the activity	This activity is focused on students explaining the concepts they already know and learning the unfamiliar ones autonomously
Duration	35 min
Type of Activity	Questionnaire
Teaching Objectives	By the end of this exercise, students will reinforce their understanding of the main parameters and conditions of remote piloting of drones
Resources	Worksheet 2.4.1 / Questionnaire 2.4.1.3
Further Reading	
Resources/Links	https://www.easa.europa.eu/en/domains/civil-drones

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Activity worksheet 2.4.1 (teacher version)

Chapter 2.4: Drone flying and remote-control programming

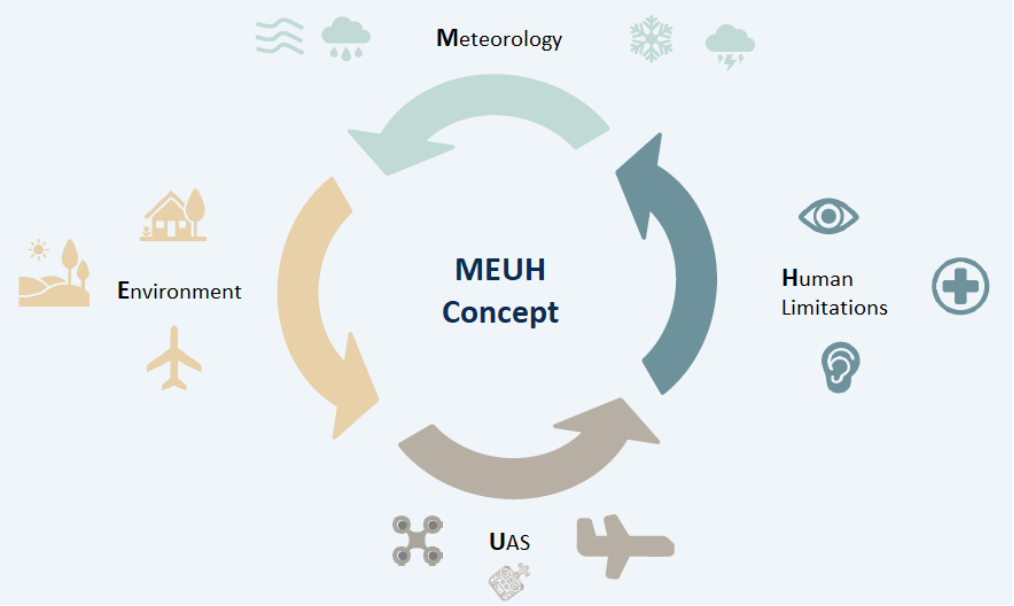
Level: Intermediate

In this worksheet we will learn about the main parameters and conditions to consider when flying a drone by remote control:

- The MEUH concept (**M**eteorology, **E**nvironment, **U**AS, **H**uman Limitations) will serve as a basis for classifying the parameters into 4 main categories
- The main parameters of each category will be identified through the development of a collaborative mind map
- A final questionnaire will help to understand the main parameters involved in the remote flying of a drone

Presentation 2.4.1.1: The MEUH Concepts

Flying a drone can be a fun and rewarding experience, but it is important to know the parameters involved in the remote operation of drones before flying them because drones are sophisticated and powerful machines that can cause harm to people, property and other aircraft if not operated correctly.



MEUH Concept Categories

Drone pilot training emphasises the importance of assessing several parameters before and during the flight of a drone. The MEUH concept establishes four factors to be taken into account by every pilot:

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1. METEOROLOGY

Meteorology plays a critical role in aviation as weather conditions can significantly impact the safety and efficiency of flight operations. Changes in temperature, humidity, wind speed and cloud cover can affect visibility, air pressure and aerodynamic performance, leading to turbulence, icing, reduced visibility and other hazards. Accurate weather forecasting is essential for flight planning and decision-making, as it helps pilots and air traffic controllers to identify and avoid adverse weather conditions, plan alternative routes and adjust flight parameters accordingly. In addition, aviation weather services provide timely and relevant weather information to support safe and efficient flight operations, making meteorology a vital component of aviation safety and performance.

2. ENVIRONMENT

Environmental conditions can have a significant impact on drone flying, affecting the safety, stability and performance of the drone. Factors such as temperature, wind, precipitation, obstacles and environmental factors like electromagnetic interference and air pollution can all disrupt the drone's sensors and communication systems.

The flight must also be checked for compliance with regulations and possible limitations and restrictions imposed in the area of operation.

3. UAS

UAS stands for Unmanned Aircraft System, which is also commonly referred to as a drone or UAV (Unmanned Aerial Vehicle). A UAS consists of several key components, including an unmanned aircraft or drone, a ground control station and a communication link between the two.

Before any flight, the remote pilot must check that the UAS is in proper condition and that maintenance has been carried out.

4. HUMAN LIMITATIONS

The role of the pilot in drone flight is critical, as they are responsible for the safe and efficient operation of the drone. Pilots must have a thorough understanding of drone technology, regulations and safety procedures and must be able to assess environmental conditions and adjust flight parameters accordingly. It is therefore also important to assess the factors that may affect his/her capacities.

Exercise 2.4.1.2: Mind Map for the four MEUH categories

In this activity, we will create a collaborative mind map to expand in more detail on the four MEUH categories related to remote drone flying. The starting point is four categories: meteorology, environment, UAS and Human Limitations.

Research as a group to identify as many concepts as possible from each category. You can use applications such as Bubbl.us, mindmomo, Lucidchart or Canva to design your maps.

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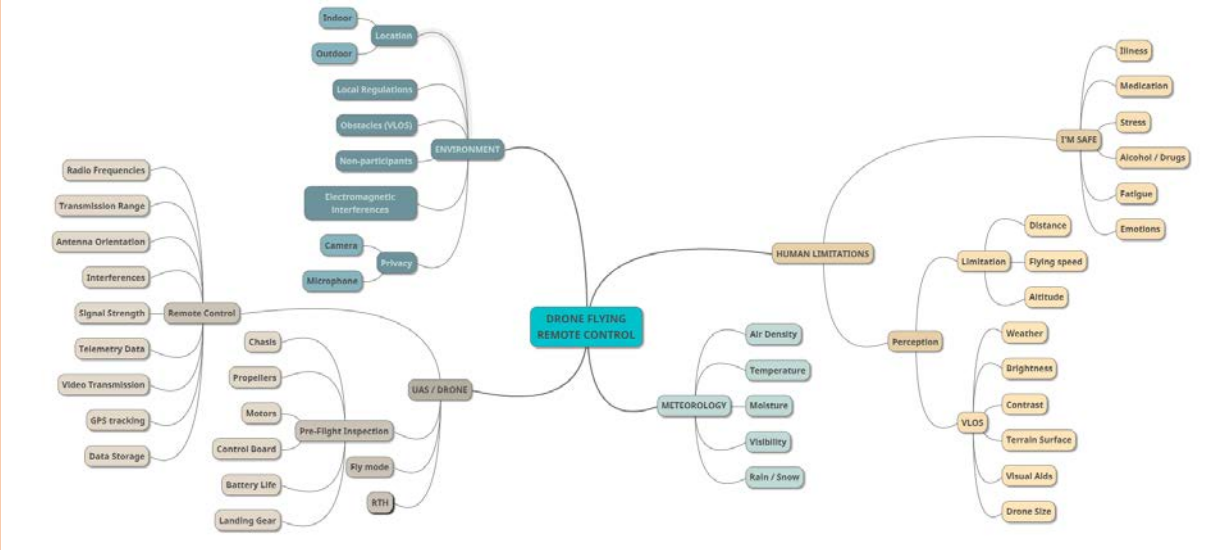
NOTE: The activity can be approached by organising the students in different ways:

- 4 groups. Each group prepares the mindmap of one of the 4 categories and then they are all put together in a single map, making a final review.

- Classroom group. A student is appointed to be responsible for making the map while the group brainstorms ideas.

NOTE: A possible solution is proposed below



Exercise 2.4.1.3: Questionnaire on the MEUH concepts

It may be that unfamiliar concepts have arisen during the elaboration of the mind map. To clarify these doubts and reinforce learning about the parameters related to the remote piloting of drones, in this activity we are going to answer a questionnaire as a final review.

1. **What are VLOS and BVLOS in the context of drone operation? Why do you think it is obligatory in many countries?**

VLOS stands for "Visual Line of Sight" And BVLOS for "Beyond Visual Line of Sight". VLOS refers to the requirement that a remote pilot must always maintain a clear and unobstructed view of the drone with their naked eye, without the use of visual aids such as binoculars or video screens.

In many countries, it is a regulatory requirement because it is critical for ensuring the safe operation of drones. VLOS helps to ensure that the pilot can maintain situational awareness and avoid collisions with other aircraft, obstacles, or people on the ground. It

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also helps to ensure that the drone is operating within the pilot's immediate vicinity and can be quickly and easily retrieved or landed in case of emergency.

2. **Which are the main fly modes of a drone?**
   - Manual Mode: the pilot has complete control over the drone's movements and is responsible for maintaining its stability and position.
   - Altitude Hold Mode: the drone maintains a steady altitude while the pilot controls its movement. Used for aerial photography and videography.
   - GPS Mode: the drone uses GPS signals to maintain its position and altitude.
   - Waypoint Mode: the pilot uses pre-programmed flying instructions. The drone will fly along the path automatically.
   - RTH: "Return to Home." It is a safety feature that allows the drone to return to its takeoff point automatically. RTH is useful in case of low battery, lost connection, or any other emergency situations where the pilot is unable to control the drone.

3. **How can weather factors like moisture, air density, wind, temperature, visibility, rain or snow affect the flight of the drone?**
   - Moisture: The atmosphere always contains some portion of water molecules in vapour form. Due to the lower density of water vapour compared to dry air, a given volume of moist air weighs less (is less dense) than the same volume of dry air. Therefore, when the humidity of the air decreases, it causes the lift of the UAS to also decrease.
   - Air density: It influences lift, drag, engine performance and propeller efficiency.
   - Wind: Can affect aircraft range and manoeuvrability.
   - Temperature: This can affect range and battery performance.
   - Visibility: Light level or fog affects the remote pilot's ability to maintain the aircraft in VLOS mode.
   - Rain or snow: It can decrease visibility, interfere with sensors and communication systems and add weight to the drone. The moisture can cause damage to the drone's motors and electronic components, reducing the drone's performance and stability. The precipitations can cause wind gusts and turbulence, making it more challenging to control the drone's flight path. Therefore, it is generally recommended to avoid flying drones in rainy or snowy conditions or to take extra precautions and use weatherproof equipment and accessories when flying in such environments.

4. **Which environmental elements should be checked before flying a drone?**
   - Location: choose a safe and open location to fly your drone. Avoid flying near airports, buildings, people, or other obstacles that may pose a risk to the drone or others.
   - Restrictions: familiarize yourself with any local or national restrictions regarding drone operation. Some areas may have specific regulations or requirements.
   - Possible obstacles (buildings, vehicles, public roads, mountains, trees, antennas, power lines, aerials, etc.) that may prevent at some point in the flight keeping the

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aircraft in VLOS mode and therefore affect the safety of the operation or interfere with the planned route.
- People not participating in the operation or concentrations of persons. If non-participants are detected, they should be instructed to move away from the controlled area on the ground.
- Electromagnetic interferences produced by radio waves, television, mobile phones, and wireless connections (Wi-Fi, Bluetooth, etc.) that may cause signal degradation or loss. This effect will be even greater in urban environments, so the remote pilot should check, before the flight, that the signal status is adequate.
- Privacy: In Europe, privacy is recognised as a human right, which means that everyone has a basic right to privacy. Any intrusion into privacy is illegal. cameras and microphones are the elements to take into account not to capture personal information.

5. What tool can be useful to check the condition of the drone before flying it?

A pre-flight checklist is a perfect tool to perform a detailed test of the drone's condition. It must take into account the technical considerations of the manufacturer and it can include the following items:

- Battery level
- Propellers
- Remote control
- GPS signal
- Flight area
- Flight conditions
- Legal restrictions
- Emergency procedures

6. Which items are related to data transmission in remote piloting?

- Radio Frequencies: most drones use radio frequencies to communicate with their remote control. It's important to understand the frequencies being used and any regulations or restrictions in your area.
- Transmission Range: it refers to the maximum distance that the drone and remote control can be from each other and still maintain a stable connection. It's important to stay within this range to prevent loss of control or signal.
- Signal Strength: it can be affected by distance, obstacles and interferences. Take appropriate measures to maintain a stable connection
- Antenna Orientation: it can affect the quality and strength of the signal. The antennas should be pointed in the direction of the drone for optimal performance.
- Interferences: Other devices that use radio frequencies can interfere with the drone's signal.
- Telemetry Data: some drones have sensors that provide telemetry data such as altitude, speed and battery level. This data is transmitted to the remote control for monitoring, as a help to ensure safe operation.
- Video Transmission: many drones have cameras that can transmit live video footage to the remote control. Be aware of any delay or lag in the video transmission and adjust your flight accordingly.

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- GPS tracking: drones can use GPS to track their location and transmit that data back to the controller.
- Data storage: Drones can also store data on an onboard memory card or transmit it wirelessly to a remote storage location. This data can include photos, videos and other sensor data collected during the flight.

7. What is the I'M SAFE methodology?

It is a checklist used by pilots before flying to assess their physical and mental fitness. It is an acronym for Illness, Medication, Stress, Alcohol, Fatigue and Emotion. Pilots are encouraged to evaluate each factor and determine whether they are in good condition to fly safely.

8. What is human perception?

Human perception is the ability of human beings to interpret the input they receive through their senses and to form a physical impression of their environment. Human perception is limited and can be erroneous.

9. Do you think a pilot on the ground can correctly perceive the drone he is flying? Why?

Since during the flight the remote pilot is on the ground and at a considerable distance from the UAS he/she has to be aware that he/she does not have a correct perception of the:

- The distance between the drone and an obstacle, or the distance between obstacles.
- The speed at which the UAS is flying.
- The exact height at which the UAS is located.

10. Give examples of factors that may affect the visual range of the unmanned aircraft (VLOS mode)

- Weather conditions: In situations where weather conditions are adverse or unfavourable, the pilot's cognitive perception at a distance may be affected Examples: fog, rain, snow, etc
  - Brightness: In situations where a lack of brightness or too much light may affect the pilot's vision. Examples: Flights with the sun facing the pilot, flights at dusk or dawn in which there is little light, etc.
  - Contrast: Cases in which the colour of the drone is similar to the colour of the environment where the flight takes place may make it difficult to see during the flight. Example: A drone with a blue colour similar to the colour of the sky is more difficult to see when flying as it could be confused with the colour of the sky, etc.
  - Terrain surface: when the surface of the terrain where the flight is going to take place has unevenness, this must be taken into account as the UAS can be lost from view behind the terrain. Example: When flying on the side of a mountain and wanting to obtain images of the other side of the mountain.

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- Visual aids: systems such as lights or reflective materials that make it easier for pilots at a distance to see the drone.
- Drone size: Bulky or larger drones are more readily visible to the remote pilot than smaller ones.

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