UAS 1010-51

Operations

Lesson 5d: Aeronautical Decision-Making

Operations: Objectives

- To determine that the applicant is knowledgeable in radio communication procedures.
- To determine that the applicant is knowledgeable in airport operations.
- To determine that the applicant is knowledgeable in sUAS emergency procedures.
- To determine that the applicant is knowledgeable in aeronautical decision-making.
- To determine that the applicant is knowledgeable in the physiological factors affecting remote pilot performance.
- To determine that the applicant is knowledgeable in sUAS maintenance and inspection procedures.

Operations - Aeronautical Decision-Making (ADM)

1. Aeronautical Decision-Making (ADM):
   a. Effective team communication
   b. Task management
2. Crew Resource Management (CRM).
3. Situational awareness.
4. Hazardous attitudes.
5. Hazard identification and risk assessment.

Good Aeronautical Judgment

- Estimates suggest that about 80% of all aviation accidents are related to human factors.
- "Error Chain" Describes a series of judgmental errors leading to a human factors-related accident.
- Your job as the RPIC is to do everything possible to prevent Error Chain accidents.

5.1 Aeronautical Decision-Making

- A systematic mental approach to consistently determine the best course of action in a given situation.
- As the RPIC you will use a number of resources to safely operate your UAS: e.g. human resources (visual observers or other the person manipulating the controls), hardware, flight software, and other information.
- RPIC uses ADM to mitigate risk factors associated with flight operations.

ADM Reduces Risk

- ADM provides a framework with the purpose of:

1. Identifying Hazards
2. Classifying the potential threat from those hazards.

What does AMD Involve and what are ADM Best Practices?

1. Conducting an attitude assessment before flight to identify where/when a hazardous attitudes might be present.
2. Learning to recognize and cope with stress.
   - Situations likely to increase stress include:
   - inexperienced crewmember(s)
   - interacting with the public officials
   - understanding new regulatory requirements
3. Using visual observers (VO), who are trained crewmembers in visual line-of-sight of the UAS and who assists the remote PIC with collision avoidance and complying with the rules of flight.
4. Completing a thorough preflight inspection,
5. Planning for weather
6. Familiarity with the airspace & project area
7. Proper aircraft loading,
8. Performance planning to mitigate identified risks.

Examples of ADM Best Practices

- Schedule flights to avoid possible conflict/overflights of people on the ground. e.g. around school schedules or other activities that take place on a regular schedule.
- Restrict people from area where the flight is to take place. e.g. Cordon off the project area and/or post VOs or other crew members at likely access points.
- Identify alternative landing sites in the event of an emergency or airspace conflict with other aircraft. There are times when it might be necessary to sacrifice your UAV to avoid endangering others. You need to be aware of this possibility and plan accordingly.

Assessing Risk

Risk mitigation involves:

1. Considering the hazards of a given operation
2. Determining the risk severity, and
3. Developing a plan to lessen (or to mitigate) the risk to an acceptable level.

Risk Assessment involves considering **both**

1. The likelihood of an event happening

   and

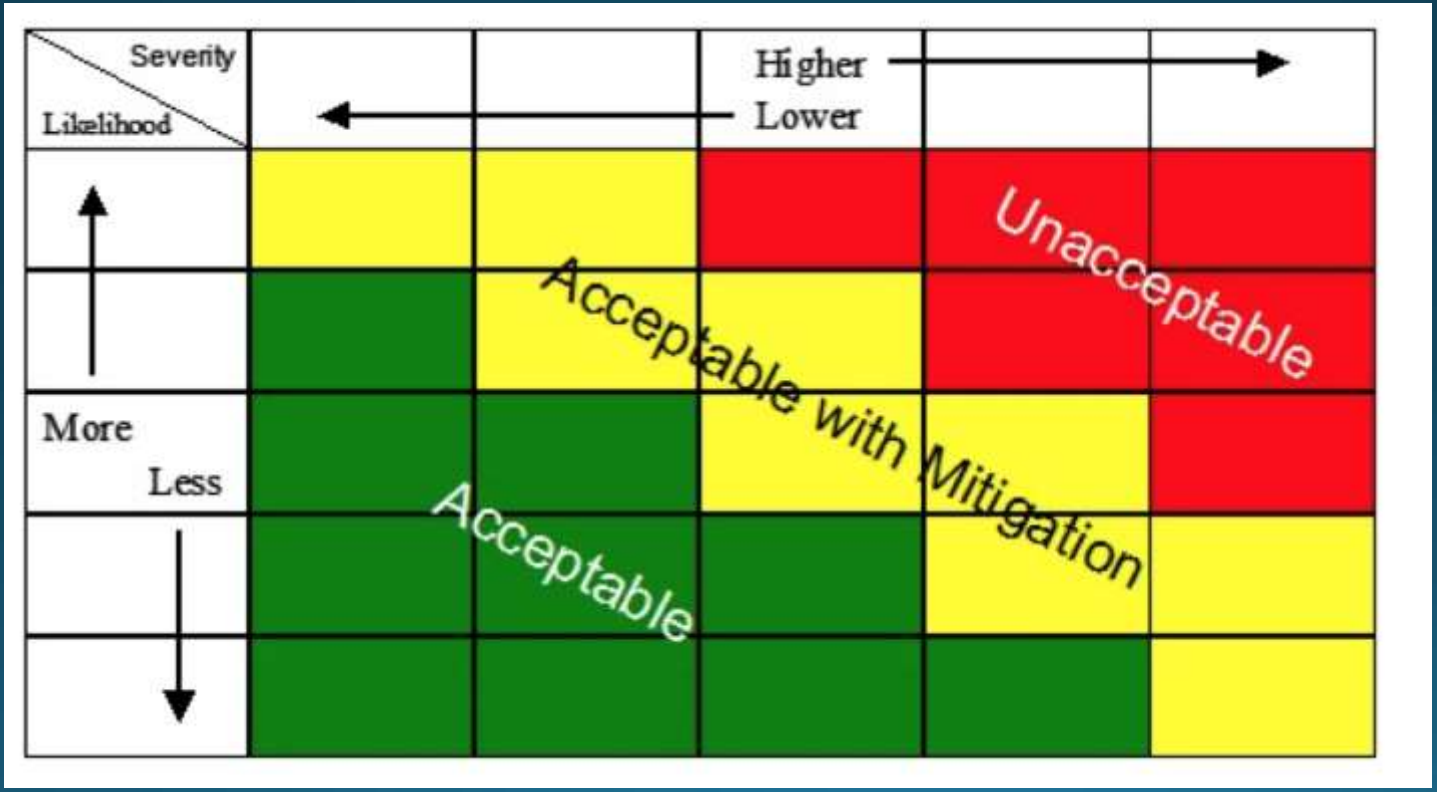
2. The severity of the situation

It may not be possible to eliminate all risk so it is necessary to assess what is "Acceptable Risk?"

Risk Assessment Workflow

Acceptability of Risk

- The acceptability of risk can be evaluated using a risk matrix, that shows three levels of risk acceptability.



Source: FAA AC 107-2 (Table A-2)

Sample Severity & Likelihood Criteria

You may want to revise this table to better suit your operations.

Severity of Consequences			Likelihood of Occurrence		
Severity Level	Definition	Value	Likelihood Level	Definition	Value
Catastrophic	Equipment destroyed, multiple deaths.	5	Frequent	Likely to occur many times	5
Hazardous	Large reduction in safety margins, physical distress, or a workload such that crewmembers cannot be relied upon to perform their tasks accurately or completely. Serious injury or death. Major equipment damage.	4	Occasional	Likely to occur sometimes	4
Major	Significant reduction in safety margins, reduction in the ability of crewmembers to cope with adverse operating conditions as a result of an increase in workload, or as result of conditions impairing their efficiency. Serious incident. Injury to persons.	3	Remote	Unlikely, but possible to occur	3
Minor	Nuisance. Operating limitations. Use of emergency procedures. Minor incident.	2	Improbable	Very unlikely to occur	2
Negligible	Little consequence.	1	Extremely Improbable	Almost inconceivable that the event will occur	1

Source: FAA AC 107-2

Risk Acceptance

Risk Acceptance. In the development of risk assessment criteria, sUAS remote PICs are expected to:

- Develop risk acceptance procedures, including acceptance criteria and designation of authority and responsibility for risk management decision making.

Example Risk Matrix

Risk Likelihood		Risk Severity				
		Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent	5	5A	5B	5C	5D	5E
Occasional	4	4A	4B	4C	4D	4E
Remote	3	3A	3B	3C	3D	3E
Improbable	2	2A	2B	2C	2D	2E
Extremely Improbable	1	1A	1B	1C	1D	1E

RED – Unacceptable Risk
YELLOW – Acceptable Risk with Appropriate Mitigation
GREEN – Acceptable Risk

Source: FAA AC 107-2 (Table A-2 - Example)

Mitigating Levels of Risk – Unacceptable Risk

- **Unacceptable (Red)** When the severity and the likelihood are both high, you fall into the red area.
- The risk should be assessed as **unacceptable**.
- In this situation, you should design an intervention to eliminate that associated hazard or to control the factors that lead to higher risk likelihood or severity.

Mitigating Levels of Risk – Acceptable Risk with Mitigation

- **Acceptable with Mitigation (Yellow)** Where the risk assessment falls into the yellow area, the risk may be accepted if you identify ways to mitigate, or lower, the risk.
- Example of this situation - Operations near school.
  - Scheduling the operation to take place when school is not in session to mitigate the likelihood of students being in the area of the project.
  - Another mitigation could be restricting people from the area of operations by placing cones or security personnel to prevent unauthorized access during the flight operation.

Mitigating Levels of Risk – Acceptable Risk

- **Acceptable (Green).** When the severity **and** the likelihood are both low, you fall into the green area.
- The objective in risk management should always be to reduce risk to as low as practicable regardless of whether or not the assessment indicates that it is already an acceptable level of risk.
- Anytime the RPIC becomes apprehensive for the safety of the operations, for any reason, they should request immediate assistance.

Reducing Risk - *root cause analysis*

- Risk analyses should concentrate not only on assigning levels of severity and likelihood, but on determining why these particular levels were selected.
- The first step in developing effective controls is to reduce risk to lower levels.
  - In many cases, simple brainstorming sessions among crewmembers is the most effective and affordable method of finding ways to reduce risk. This also has the advantage of involving people who will ultimately be required to implement the controls developed.

Procedure for Hazard ID and Risk Assessment

- Consider the hazards presented during the operation.
- Determine the risk severity.
- Develop a plan to lessen (or mitigate) the risk to an acceptable level.

Responsibility

It is the responsibility of the RPIC, **and** all participating Crew Members to identify all potential hazards and risks **and** that you take all appropriate actions to reduce the risk to people and property.

Risk Management

- As noted above, it is not realistically possible to identify every possible risk.
- Therefore the Risk Assessment should focus on the hazards that pose the greatest risks.
- Once appropriate risk controls are developed and implemented, the operation can begin.

Crew Resource Management (CRM)

CRM – is the process of managing all the resources that are available to the remote pilot-in-command (PIC) prior to, and during, flight. That includes resources both on board the aircraft and from outside sources.

Components of CRM - 1

- **Communication Procedures**. One way to accomplish this is to have the VO maintain visual contact with the small UA and maintain awareness of the surrounding airspace, and then communicate flight status and any hazards to the remote PIC and the person manipulating the controls so that appropriate action can be taken. Then, as conditions change, the remote PIC should brief the crew on the changes and any needed adjustments to ensure a safe outcome of the operation.

- **Communication Methods**. The remote PIC, person manipulating the controls, and VO must work out a method of communication, such as hand-held radio, that would not create a distraction and allows them to understand each other. The remote PIC should evaluate which method is most appropriate for the operation and decide on it prior to flight.

Components of CRM - 2

- **Task Management.** Task management is the process pilots use to manage the many concurrent tasks involved in safely flying an aircraft. Tasks vary depending on the complexity of the operation. Depending upon the area of the operations, additional crewmembers may be needed to safely operate. Enough crewmembers should be utilized to ensure no one on the team becomes overloaded. Once a member of the team becomes over-worked, there's a greater possibility of an incident/accident.
- **Other Resources.** Take advantage of information from a weather briefing, air traffic control (ATC), the FAA, local pilots, and landowners. Technology can aid in decision-making and improve situational awareness. Being able to collect the information from these resources and manage the information is key to situational awareness and could have a positive effect on your decision-making.

Situational Awareness

- Situational awareness describes the accurate perception and understanding of all the factors and conditions that affect safety before, during, and after flight.
- An extreme case of a pilot being over taxed, or "getting behind the aircraft" can lead to the operational pitfall of loss of situational awareness.

Risk Management & Situational Awareness

- Effective Risk management relies on situational awareness, problem recognition and good judgment to risk.
- Checklists and Situational Awareness
- Don't rely on short and long term memory for repetitive tasks. Use a checklist, it will make you a safer pilot!
- Checklists help you avoid missing important steps, always use the appropriate checklists.
- Consistent adherence to approved checklists is a sign of a disciplined and competent pilot.

Situational Awareness Checklists

PAVE, IMSAFE & DECIDE MODELS

- Three model checklists are commonly used in aviation.
- Use of these models can reduce your risk of an incident. (Aviation does not use the term "accident.")

Personal Minimums (PAVE) Checklist

Components of PAVE for Hazard Identification

- **P**ilot-in-Command
- **A**ircraft
- En**V**ironment
- **E**xternal Pressures

Hazard Identification. Using the Personal Minimums (PAVE) Checklist for Risk Management, I will set personal minimums based upon my specific flight experience, health habits, and tolerance for stress, just to name a few. After identifying hazards, I will then input them into the Hazard Identification and Risk Management Process Chart.

Source: FAA AC 107-2

PAVE/IMSAFE Checklist - PIC

- **Pilot-in-Command:** Am I healthy for flight and what are my personal limitations based upon my experience operating this sUAS? During this step, you can use the IMSAFE checklist in order to perform a more in-depth evaluation:
  - **Illness** – Am I suffering from any illness or symptom of an illness which might affect me in flight?
  - **Medication** – Am I currently taking any drugs (prescription or over-the-counter)?
  - **Stress** – Am I experiencing any psychological or emotional factors which might affect my performance?
  - **Alcohol** – Have I consumed alcohol within the last 8 to 24 hours?
  - **Fatigue** – Have I received sufficient sleep and rest in the recent past?
  - **Emotion or Eating** – Have I fully recovered from any recent upsetting events? Am I sufficiently nourished?

PAVE Checklist - Aircraft

- **Aircraft:** Have I conducted a preflight check of my sUAS (aircraft, control station (CS), takeoff and landing equipment, etc.) and determined it to be in a condition for safe operation? Is the filming equipment properly secured to the aircraft prior to flight?

PAVE Checklist - Environment

- **Environment:** What is the weather like? Am I comfortable and experienced enough to fly in the forecast weather conditions? Have I considered all of my options and left myself an "out?" Have I determined alternative landing spots in case of an emergency?

PAVE Checklist – External Pressures

- **External Pressures:** Am I stressed or anxious? Is this a flight that will cause me to be stressed or anxious? Is there pressure to complete the flight operation quickly? Am I dealing with an unhealthy safety culture, meaning that there are not strong policies and procedures in place? Either the organization with which I am associated or myself should develop Standard Operating Procedures (SOP) that relate to an acceptable level of safety. Am I being honest with myself and others about my personal operational abilities and limitations?

DECIDE model – Hazards Assessment and Risk Analysis

- **D**etect – the fact that a change has occurred
- **E**stimate – the need to react to or counter the change
- **C**hoose – a desirable outcome for the flight or situation
- **I**dentify – actions to control the change successfully
- **D**o – take the necessary actions
- **E**valuate – the effects of the action to react to or counter the initial change

Improving Situational Awareness

- To improve situational awareness, we do everything we can to consider our environment and all of its parts **before, during, and after flight**.
- **Example 1:** You may want is to monitor the Common Traffic Advisory Frequency (CTAF) at 122.8 MHz for what traffic conditions to expect before entering Class B airspace.
- **Example 2:** Meet with your client / landowner for mission and location requirements.
- **Example 3:** Scout out the flight location and intended mission operations prior to flight. Preferably during a pre-mission site visit before going to the field to fly the mission.

Hazardous Attitudes

- Poor Attitudes are no less a hazard than Severe weather or in-flight equipment failure.
- They can lead to catastrophic results.
- Be aware of your attitude Before & During your flight.
- One or more of the five defined Hazardous Attitudes will likely appear on the Part 107 Exam.

Five Hazardous Attitudes

1. Anti-Authority
2. Impulsivity
3. Invulnerability
4. Machismo (or Macho)
5. Resignation

There are well established antidotes for each of these attitudes. Learn them and apply them whenever you become aware you are experiencing any of these attitudes.

1 - Anti-Authority

- **Don't tell me.** This attitude is found in people who do not like anyone telling them what to do. In a sense, they are saying, "No one can tell me what to do." They may be resentful of having someone tell them what to do, or may regard rules, regulations, and procedures as silly or unnecessary. Of course, it's always your prerogative to question authority if you feel it is in error. But don't be anti-authority.
- **Antidote:** Follow the rules -- they are usually right. Do not bend the rules to get your way, as it will backfire.

2 - Impulsivity

- **Do it quickly.** This is the attitude of people who frequently feel the need to do something, anything, immediately. They do not stop to think about what they are about to do; they do not select the best alternative, and they do the first thing that comes to mind.
- **Antidote**: Not so fast -- think first. Most situations do not require one-second snap decisions. You have time to evaluate and choose an action.

3 - Invulnerability

- **It won't happen to me.** Many people feel that accidents happen to others but never to them. They know accidents can happen, and they know that anyone can be affected. They never really feel or believe that they will be personally involved. Remote pilots who think this way are more likely to take chances and increase risk.
- **Antidote:** Just because you've never had a motor fail or weather turn bad, that does not mean it will never happen to you.

4 - Machismo (or Macho)

- I can do it. Remote pilots who are always trying to prove that they are better than everyone else are thinking, "I can do it – I'll show them." Pilots with this type of attitude will try to prove themselves by taking risks in order to impress others. This is not just a male characteristic! Women are equally susceptible to macho attitudes. Many times, the basic drive for a pilot to demonstrate the "right stuff" can have an adverse effect on safety, by generating tendencies that lead to practices that are dangerous, often illegal, and may lead to a mishap.
- Antidote: Taking chances is foolish. Although a certain amount of confidence is required for flying and you are feeling more capable when your skills improve, it's important to keep a realistic view.

5 - Resignation

- **What's the use?** Remote pilots who think, "What's the use?" do not see themselves as being able to make a great deal of difference in what happens to them. When things go well, the pilot is apt to think that it is good luck. When things go badly, the pilot may feel that someone is out to get them or attribute it to bad luck. The pilot will leave the action to others, for better or worse. Sometimes, such pilots will even go along with unreasonable requests just to be a "nice guy."
- **Antidote:** I'm not helpless -- I can make a difference. Keep to a safety mindset and decide for yourself if a flight is safe, instead of letting outside pressures push you to the final go / no-go decision.

Hazardous Attitudes - Summary

The Five Hazardous Attitudes	Antidote
Anti-authority: "Don't tell me." This attitude is found in people who do not like anyone telling them what to do. In a sense, they are saying, "No one can tell me what to do." They may be resentful of having someone tell them what to do or may regard rules, regulations, and procedures as silly or unnecessary. However, it is always your prerogative to question authority if you feel it is in error.	**Follow the rules. They are usually right.**
Impulsivity: "Do it quickly." This is the attitude of people who frequently feel the need to do something, anything, immediately. They do not stop to think about what they are about to do, they do not select the best alternative, and they do the first thing that comes to mind.	**Not so fast. Think first.**
Invulnerability: "It won't happen to me." Many people falsely believe that accidents happen to others, but never to them. They know accidents can happen, and they know that anyone can be affected. However, they never really feel or believe that they will be personally involved. Pilots who think this way are more likely to take chances and increase risk.	**It could happen to me.**
Macho: "I can do it." Pilots who are always trying to prove that they are better than anyone else think, "I can do it—I'll show them." Pilots with this type of attitude will try to prove themselves by taking risks in order to impress others. While this pattern is thought to be a male characteristic, women are equally susceptible.	**Taking chances is foolish.**
Resignation: "What's the use?" Pilots who think, "What's the use?" do not see themselves as being able to make a great deal of difference in what happens to them. When things go well, the pilot is apt to think that it is good luck. When things go badly, the pilot may feel that someone is out to get them or attribute it to bad luck. The pilot will leave the action to others, for better or worse. Sometimes, such pilots will even go along with unreasonable requests just to be a "nice guy."	**I'm not helpless. I can make a difference.**

Figure 10-2. *The five hazardous attitudes identified through past and contemporary study.*

Source: Remote Pilots Study Guide, P. 54

Sources for Hazards Identification, Risk Assessment & Hazardous Attitudes

- Additional Information is available from these documents.
- AC-107-2 small Unmanned Aircraft Systems (sUAS) Circular
- Pilot's Handbook of Aeronautical Knowledge

Both of these documents are available for download on the course website.