# Crew Resource Management (CRM) on Flight Testing of Unmanned Aerial Systems (UAS)

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# Outline

- Introduction
- Human Factors in Aircraft Accidents
- CRM In Aviation
- Crew Concept in UAS
- CRM Skills in Terms of UAS Test Flights
- Conclusion

# INTRODUCTION

*First Flight*

1900’s

- Throughout history, mankind has always kept the idea of flying alive in his dreams and has made many attempts to solve its mystery.
- For centuries, many people, from scientists to magicians, from soldiers to adventurers, have sought ways to reach the sky.
- The Wright brothers' first airplane flight, lasting only 12 seconds, on December 17, 1903, in the Devil Hills of North Carolina, reshaped the history of aviation.

# INTRODUCTION

1940’s

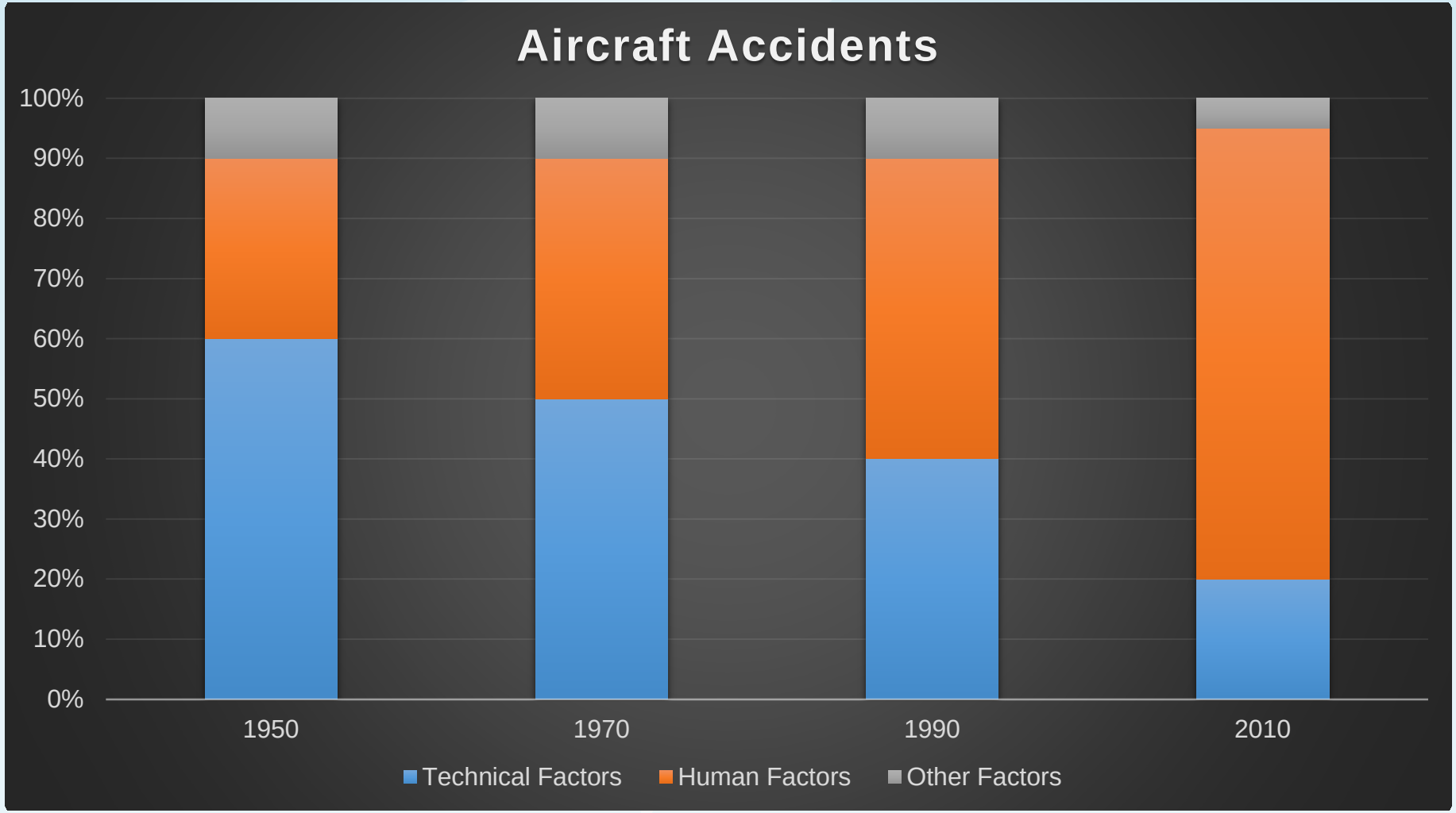
1970’s

2010’s

- With the realization of an unattainable dream, airplanes and aviation technology have continued to develop at a dizzying pace in the last 100 years.

- After reaching the sky, human beings continued to dream of making faster, higher and more comfortable flights and continued their search from the simple planes of the Wright brothers to the modern planes equipped with today's high-tech devices.

# HUMAN FACTORS IN AIRCRAFT ACCIDENTS



# HUMAN FACTORS IN AIRCRAFT ACCIDENTS

## *Why Do We Care? What is the Role of Flight Test?*

- Often the first time human factors issues are evaluated in the flight environment using production represantative systems.
    - Liveware
    - Hardware
    - Software
- Validate human factors design goals
- Human factors are integral to other flight testing

# CRM IN AVIATION


- Task Analysis
- Adaptability and Flexibility
- Leadership
- Decision Making
- Self Confidence
- Situational Awareness
- Communication

# CRM IN AVIATION

- CRM includes everyone who contributed to its successful flight into the concept of crew.
- Therefore, every individual who supports the flight with the crew tasked with flying an airplane is a member of the crew formed in order to perform a flight duty in aviation.
- Flight planners, air traffic controllers, tower personnel, radar controllers, maintenance crew, who assist pilots in all phases including pre-flight, during and post-flight, and indirectly or directly affect the success of the flight mission, with the crew other than the pilots on the plane, flight safety officers and medical teams are all members of the aviation crew.
- In summary, a crew is a group of two or more people who work in constant interaction and cooperation to achieve a common goal.

# CREW CONCEPT IN UAS

**UAS flight test requires teamwork.**


- UAS flight tests are carried out by integrated test crew consisting;
  - Flight Test Engineers,
  - Test Pilots,
  - Flight test instrumentation engineers,
  - Technicians,
  - Related design, system, analysis engineers.

# CREW CONCEPT IN UAS

- In order for unmanned aircraft to perform the test flight task, it is necessary to divide the work and share the responsibilities.
- Crew harmony should be like a kind of seed-Earth relationship.
- In order to obtain a good product, it is necessary to plant the seed in good and suitable soil and to maintain it regularly as well as its quality.
- Therefore, working in harmony with high crew performance depends on individual quality, crew quality and management quality.

# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS


# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

## *Task Analysis*

- There are three stage of task analyses: preflight planning, inflight monitoring/updating current situation and post-task review.

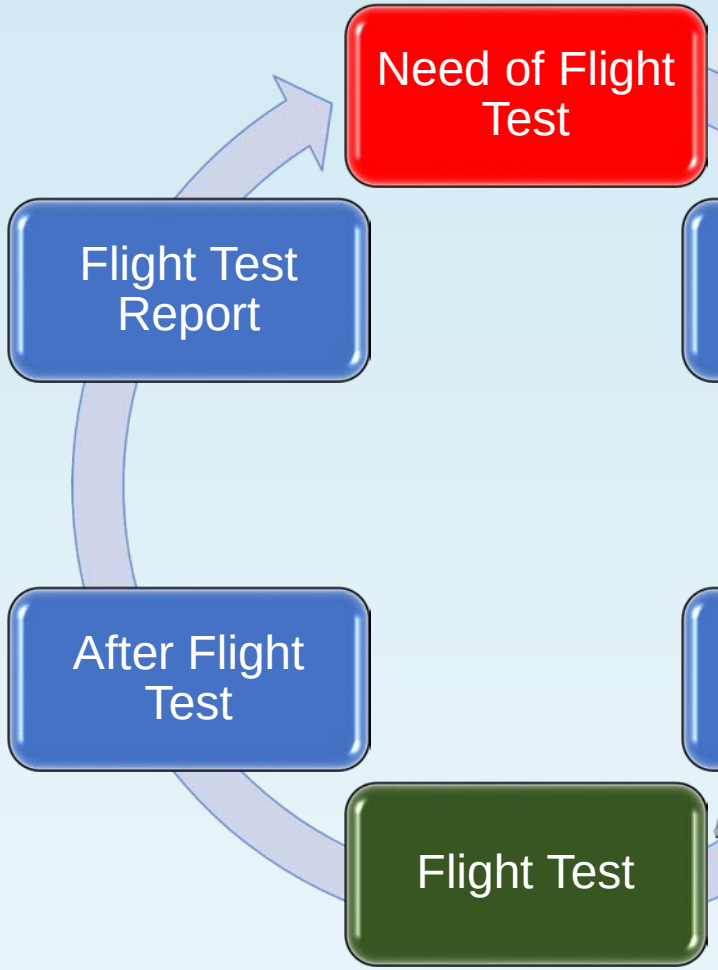
- Before each test flight and campaign, flight test requirements should be shared with the flight test engineers by the relevant design engineers and flight tests should be performed according to the prepared test cards.


**"TEST FLYING IS FUNDAMENTALLY BORING...**

**IF IT ISN'T, YOU'VE DONE SOMETHING WRONG!"**

# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

## *Task Analysis*




- Purpose of tests
- Flight test instrumentation
- Test Points Optimization
- Test Safety

- Test A/C,
- Flight Program,
- NOTAM etc…
- Test Cards,
- Flight Information and Documentation,
- Sortie Briefing

- Download Data,
- Sortie Debrifing,
- Process Data,
- Evaulate the sortie

**“PLAN THE TEST, FLY THE PLAN”**

# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

## *Adaptability and Flexibility*

- It is the ability to make behavioural changes in accordance with the changing conditions in the performance of the flight test and to solve the problems.

- When it is necessary to go out of the plan, each crew member has to understand the task assigned to him well and adapt to the new situation.

# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

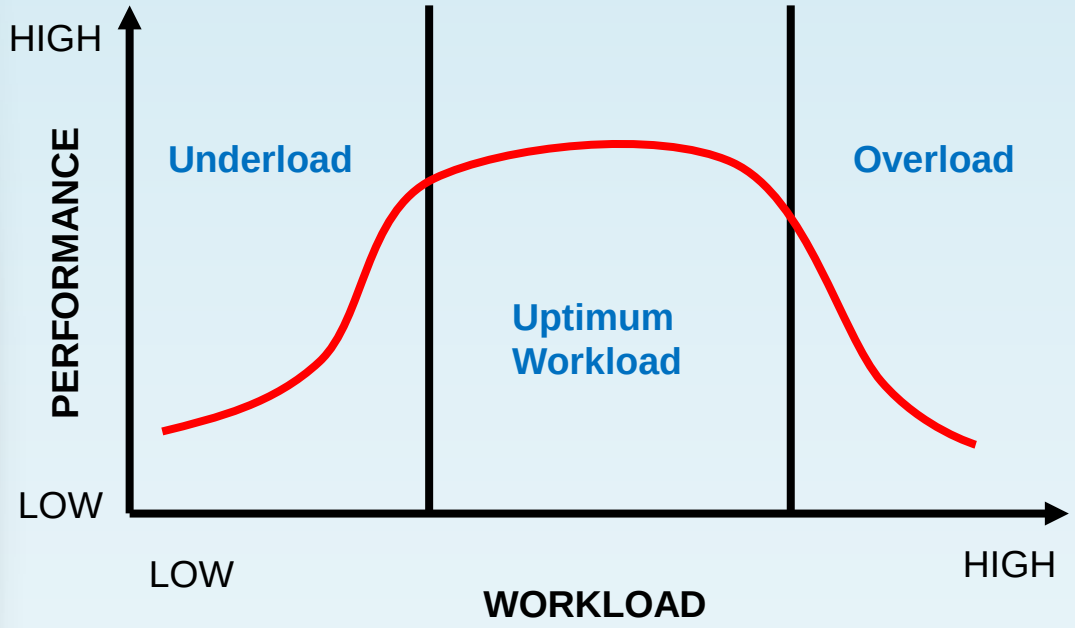
## *Adaptability and Flexibility*

# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

## *Adaptability and Flexibility*

**WORKLOAD**

- Human – most reliable under moderate workload
  - Constant and steady workload - important
- Excessive workload = unable to cope
  - Cockpit complexity and regulations
- Low workload = boredom and low attention
  - Automation



# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

## *Leadership*

- Leadership in aviation is the ability to define, direct activities and encourage personnel to work as a crew.
- A leader directs and coordinates the crew's activities, makes assignments, ensures that staff understand what is expected of them and is responsible for the performance of his crew.

# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

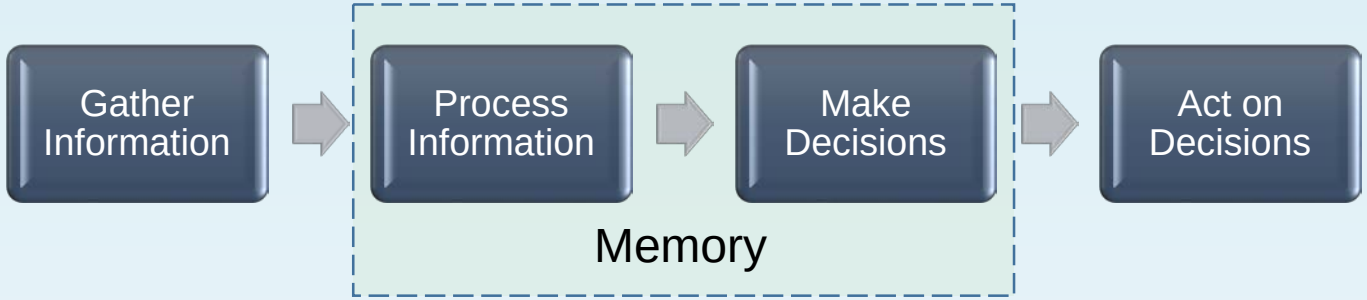
## *Leadership*

- In UAS test flight crew, the person who will undertake this task will be the lead flight test engineer.
- The lead flight test engineer should;
  - Have a grasp of the critical points of the flights,
  - Equip the crew with test flight information,
  - Request the necessary information from the crew about the test flight,
  - Provide feedback on the performance of the personnel,
  - Should be able to establish and maintain a professional environment.

# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

## *Decision Making*

- Decision making is the ability of understanding the situation, considering all the information at hand, reviewing the results they will bring with alternative forms of action, and choosing and implementing the appropriate action.




# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

## *Decision Making*

To improve Decision making skills;

- **D**etect: Changes in events that require attention,
- **E**stimate: Possible changes,
- **C**hoose: The one related to flight safety from the alternatives,
  **I**dentify: The correct controllers to control the flight,
- **D**o: The chosen decision,
- **E**valuate: The changes applied later in the flight.

# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

## *Self Confidence*

- Defending the truth is difficult but necessary.

- If it is believed that a job done, an instruction from the air traffic controller, a procedure applied by the maintenance team, or information received is false and unsafe, it is imperative to talk, ask, and defend the truth. This does not mean an infringement on the authority of the leader. The aim is to clarify the situation.

- Every crew member should be assertive or persistent if the directive, methods or procedures are violated due to the fact that safety is at stake. Participation and self-confidence are essential at every stage of flight.

# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

## *Self Confidence*

Situations where self-confidence is needed include:

- *At the pre-flight briefing*: The leader should speak in a manner that supports the personnel to express their motivational ideas openly without hesitation, in terms of both their expressions, questions and behaviors.

- *During the test flight*: Situations where inputs cannot be made when necessary due to overly aggressive attitudes or close friendships should be avoided.

- *At the debriefing*: It is very important to express the problems encountered and unresolved in flight and ideas on how to do the flight test better.

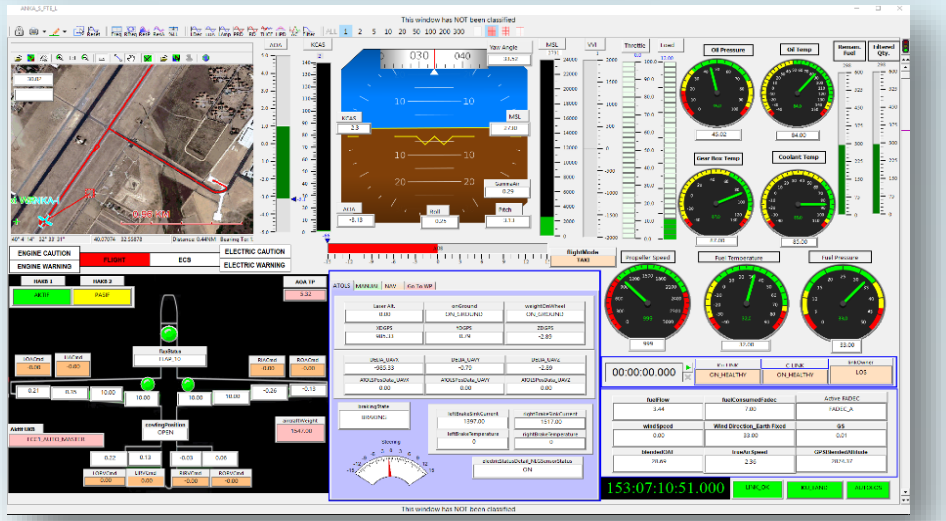
# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

## *Situational Awareness*

- Situational awareness in aviation refers to the ability to accurately grasp what is happening inside and outside the aircraft.
- It is the correct perception of the events that may occur both now and in the near future regarding the aircraft and the environment.
- In unmanned aircraft, the pilot who steers the remotely controlled aircraft without being inside the aircraft should be more careful about the situational awareness.
- Developing situational awareness ensures that the crew is prepared for contingencies.

# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

## *Situational Awareness*

# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

## *Situational Awareness*

- Controls should be easily identifiable to be operated quickly and instinctively by crew member under stress
  - Shape
    - According to purpose
  - Texture
    - Smooth, fluted, knurled
  - Size
    - Practical limit
  - Location
    - Group functional switches together
  - Color
    - Red guarded = emergency only

| Arrangement Philosopy | |
|---|---|
| Functional | Group elements together according to function |
| Importance | Most important elements grouped together in best location |
| Optimum | Each element located in its own optimum location |
| Sequence | Elements arranged to take advantage of sequence of use |
| Frequency | Most frequently used elements located in best position |

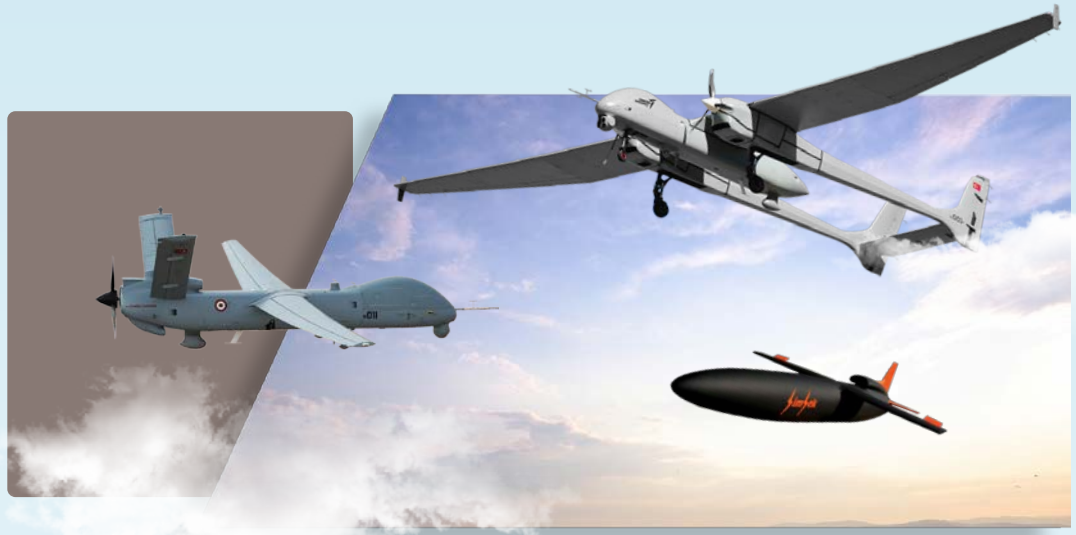
# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

## *Communication*

- The ability to clearly and accurately send and receive information, instructions or commands.
- Communication is vital to the success of the test flight. It enables situational awareness to continue and lays the foundation for other abilities.
- It can be defined as methods of reducing and eliminating communication barriers; active listening, choosing the appropriate tone and level of voice, using known terms, professional attitude or behavior, dividing into understandable sections, solving problems on the spot, avoiding inappropriate crew matches.

# CRM SKILLS IN TERMS OF UAS TEST FLIGHTS

## *Communication*



# CONCLUSION

- The most important factor in A/C accidents – Human
- To minimize this factor - CRM
- How the 7 basic skills of CRM should be used in UAS test flights.

# QUESTIONS ?

# Thank You