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HUMAN PERFORMANCE AND LIMITATIONS

CHAPTER 1 – INTRODUCTION

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INTRODUCTION

More than 80% of accidents in aviation are attributed to human factors. It is the **physiological** limitations, actions, reactions, and decisions of pilots that cause most accidents, and not the failure of aircraft systems.

Physiological means that which concerns physiology, which is the science of the functions of living organisms and their parts.

The pilot in a modern aircraft is exposed to a multitude of forces and conditions rarely experienced in his or her natural "ground" environment. The aviation environment is hostile, unnatural, and particularly unforgiving.

Any impairment of our ability to handle all these factors, even to the extent that would be considered totally insignificant in normal day-to-day activities, could have disastrous effects on the flight crew member, claiming perhaps not only his or her life, but possibly that of many passengers, and even innocent people on the ground.

It is with these matters in mind that "Human Factors" need to be studied.

COMPETENCE AND LIMITATIONS

Flight crew have to function at an exceptional level if a high degree of aviation safety is to be maintained.

Apart from the stressors of **hypoxia**, **hypothermia**, noise, vibration, fatigue, disturbed sleep cycles, and boredom (often interspersed with periods of intense concentration and/or sensory overload), pilots sometimes have to contend with disorientating low-visibility conditions, combined with complex multi-axis movements (for which the human body was not actually designed).

Hypoxia is a deficiency of oxygen reaching the tissues.

Hypothermia is the condition of having an abnormally low body temperature.

In aviation, even a completely healthy and normal individual could easily find him/herself operating in conditions where the human body simply cannot function adequately.

An individual who is not healthy, or who has physical restrictions, is even less likely to be able to function adequately in physiologically demanding situations.

The discipline of Human Factors concentrates on the aviator and his or her fitness to enter the aviation environment, how to function optimally within the physiological constraints of the human body, and how to minimise the physical effects of the aviation environment on the human body.

The physical factors governing the human body in the aviation environment are fairly well defined, and most people are immediately able to appreciate their importance. The other facet to human factors, aviation **psychology** is just as important, but has largely been overlooked.

Psychology is the scientific study of the human mind and its functions, especially those functions affecting behaviour in a given context.

One possible reason is that the term "psychology" often elicits a very negative response in pilots ("I'm not crazy, I don't want anything to do with shrinks!"). The truth of the matter is that the "psychology" part of human factors does not focus on psychological flaws in pilots (very few people with significant psychological flaws ever actually qualify as pilots), but rather concentrates on how humans react to certain situations, and how a person's response to these situations can be optimised.

Examples of this include, how our perceptions can create potential problems, situational awareness and

information processing, management of workload/stress/fatigue, leadership, effective communication skills, and cockpit resource management.

The purpose of the study of human factors therefore is, to improve aviation safety by ensuring that flight crew members are:

- Physiologically fit ("fit" meaning suitable, not physical fitness).
- Familiar with physiological limitations, so that they can operate within them.
- Familiar with human behaviour, so that correct actions can be taken.
- Competent (mentally prepared with correct attitudes).

> **Note: Physical competence (i.e. stick and throttle skills) is not part of human factors per se - it is the responsibility of the instructor/testing officer to ensure this.**

PILOT COMPETENCY

There are two aspects we have to look at when deciding whether a pilot is competent to safely carry out his or her duties. These are **proficiency** and **professionalism**.

PROFICIENCY

Traditionally, when deciding whether to grant an applicant a pilot's license, the licensing authority has tested **proficiency**, i.e. the candidate has to pass some written examinations and a flight test.

> **Proficiency** is the state or quality of being proficient, which means performing in a given art, skill or branch of learning with expert correctness and facility.

This is actually no guarantee that the successful candidate is competent. Reasons for saying this are:

- The format (and even to a large extent the contents) of the exams is well known. Candidates may pass an exam by merely memorising the portions, which are likely to appear in the exams.
- Candidates who memorise "typical exam questions and answers" may pass the exam even if they do not understand the work, or have any idea on how to apply it.
- The average person will soon forget most of the facts memorised leaving a person with a valid license, but extremely little knowledge - a sure recipe for disaster!
- Similarly, a candidate may pass a flight test by demonstrating adequate "stick and throttle" skills and procedures, which have been practised by **rote**, but could be completely overwhelmed when confronted by a situation, which was not taught or tested.

Rote means mechanical or habitual repetition (with reference to acquiring knowledge).

PROFESSIONALISM

The human factors approach to competence emphasises **professionalism** (whether flying is your profession or not!).

Professionalism is the qualities or typical features of a profession or of professionals, especially competence, skills, attitudes and attributes.

Here the pilot does not simply memorise enough to pass the exams, but ensures that he or she knows and understands as much as possible about aviation.

It also implies that he or she are constantly seeking to deepen and broaden their knowledge, and in doing so prepares themselves to face even the most unusual occurrences.

The professional pilot realises that their life and the lives of others could depend on them having knowledge and insight beyond the exam curriculum.

AIRCRAFT ACCIDENTS

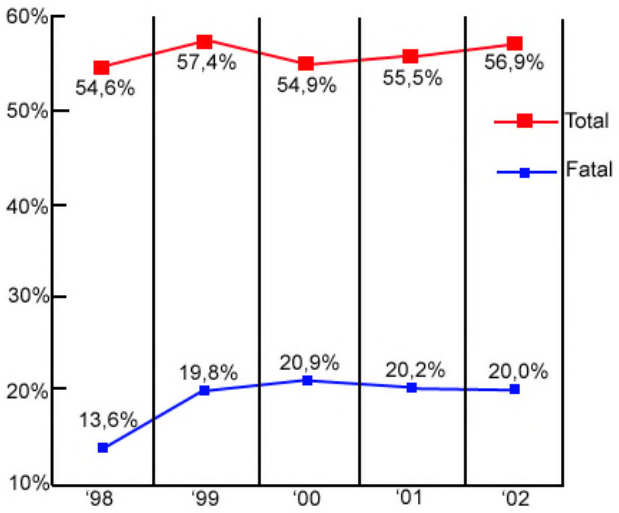
STATISTICS

Studies done during World War I brought some startling results to light. Of all the aircraft losses that occurred during WWI:

- 2 % were due to enemy fire.
- 8 % were due to aircraft failures.
- 90 % were due to physical/ psychological problems (Human factors).

The 2003 Nall Report "Accident Trends and Factors for 2002" (based on the USA National Transportation and Safety Board aircraft accident and incident reports) indicates that while the accident rate has declined from 46 per 100 000 hours flown in 1950 to 6.69 (1.33 fatal) per 100 000 hours in 2002, there were once again no surprises regarding the leading factor for general aviation accidents. About 75% of aviation accidents were pilot-related, a statistic that changes little from year to year.

In every form of human activity involving machinery, such as automobiles, boats, and aircraft, the hardware is invariably more reliable than the human operator. Humans cannot be re-engineered to improve piloting or decision-making skills, while machinery is improved to make it more reliable. This does not mean that accidents are inevitable, nor does it mean that just by trying harder, or by adding multiple layers of regulation, the safety record will improve significantly. It does mean that a thoughtful approach to every flight by every pilot with a realistic assessment of risk and appropriate training is essential.



Take-off and Landing Accident Trends

Statistics indicate that just three phases of flight account for about two-thirds of all accidents, and almost half of all fatal accidents. Of these three, manoeuvring flight accidents are far more likely to result in fatalities. In 2002, over half (57.3 %) of all manoeuvring flight accidents were fatal. For take-off, the fatality percentage was 18 %; for landing, just 2.5 %.

A study of accidents from 1991 - 2000, indicated that pilot failure to maintain control of the aircraft was the leading factor for both take-off and landing accidents, accounting for 30.2 and 32.8 % of all such accidents, respectively.

Accident investigators ascribe a variety of factors to such accidents, including failure to establish a positive rate of climb, inability to maintain climb speed, stalling, premature rotation, or spatial disorientation. Other factors often cited are wind conditions, power loss, surface conditions, aircraft configuration, and landing gear malfunction.

But almost without exception, loss of control of the aircraft on take-off or landing is an issue of either inadequate training or lack of pilot proficiency. In take-off and landing accidents, insufficient or incorrect rudder and aileron use is often the culprit, and can be corrected only by competent initial instruction and ongoing practice after earning a pilot licence.

Examples

Here are just some interesting examples of accidents as a result of human factors:

Possibly the first flying fatality ever mentioned, is in the legend of Daedalus and Icarus.

The legend tells the story of the father and son who had wings made of feathers and wax. One day Icarus disobeyed his father and flew too close to the sun. The sun melted the wax and Icarus plunged to the ground. Although this may be mythical, the incident still happened due to disregard of instructions that were laid down.

In 1783 a Frenchman, named Pilatre de Rozier, decided that if a hot air balloon worked well, and a hydrogen balloon worked even better, then a heated hydrogen balloon would really perform.

Scientists warned him that this might be dangerous, but thinking he knew better and seeking the publicity, he pressed on. The balloon exploded on ascent and de Rozier was killed.

This was the first (non-mythical) recorded human death attributed to an aviation accident.

There is a school in France named after Pilatre de Rozier that trains balloonist.

Also in France during April 1875, Messers Croce-Spinelli and Sivel died from hypoxia in a balloon ascent to 29 000 ft. Professor Paul Bert, who earlier pioneered the use of oxygen to prevent hypoxia, had advised Spinelli and Sivel on the use of oxygen. They failed to heed his advice and ran out of oxygen at 29 000 ft, lost consciousness and died.

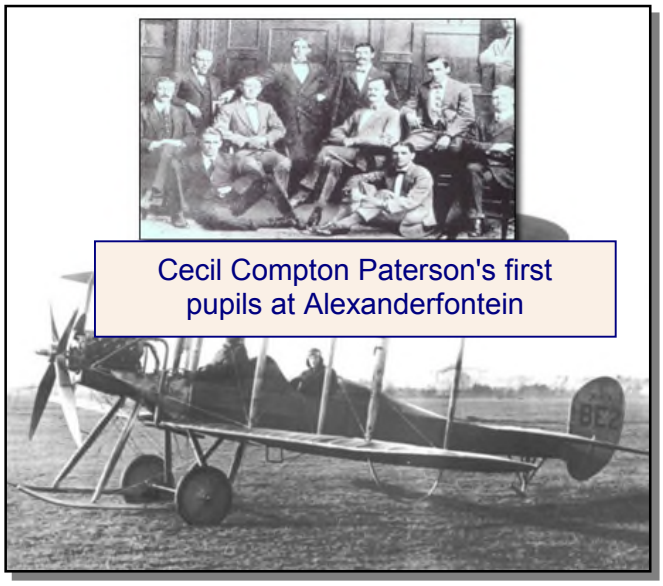
This graphic depicts one of the balloons used in an around-the-world attempt. Incidentally the make or type of balloon is listed as a "de Rozier".

On 17 September 1908, Lt. Thomas Selfridge became the first aircraft passenger fatality when an aircraft piloted by Orville Wright crashed near College Park, Maryland, U.S.A.

Although the cause of the crash was failure of an experimental propeller, which caused structural damage to the aircraft, the main attributing factor was inexperience.

The first death in South Africa was an instructor, E.W. Cheeseman, at the first fully equipped military airfield at Alexanderfontein, outside Kimberly.

On 15 October 1913, Cheeseman died - official cause of death - "Fracture and internal haemorrhage; accident followed weakening of physical resistance by malaria".



Cecil Compton Paterson's first pupils at Alexanderfontein

CONCLUSION

To constantly improve aircrew performance, the study of Human Factors and aircrew psychology is becoming increasingly important. When human error, weakness or illness causes an accident, aviation medicine specialists are involved in the accident investigations to ensure that they do not re-occur.

Aviation in itself is not inherently dangerous, but to an even greater degree than the sea, it is terribly unforgiving of carelessness, incapacity or neglect.

The HARDEST thing about flying is the GROUND!

We owe it to ourselves, and those who fly with us, to be as well prepared as possible - physically and mentally - for every flight we undertake.