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HUMAN FACTORS IN AVIATION: CREW MANAGEMENT

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Abstract: Human error is a major cause of aviation accidents, representing about 80% of them, while only 20% are attributed to technical problems. While flight safety has improved considerably over time and the number of aviation accidents has decreased, our desire to have a 100% safe flight is still far from being achieved. If technologically progress has been enormous, the human factor remains the weak link in air transportation. Although in the phases of selection, training and monitoring crew activity there have been taken measures in order to improve this negative performance, the human factor is still the main cause of the aviation events. The explanation for this is not the inefficiency of the selection or of the training programs, but the considerable increasing in the amount of information to be processed and the shrinking of the response times, mainly due to airspace congestion and aircraft speed performance. To safely fly an aircraft, knowledge and skills are not enough. A pilot, especially if flying a multicrew aircraft, has to work on attitude, communication, team spirit, discipline, workload and stress management.

Keywords: human factors, flight safety, crew management

1. INTRODUCTION

Since the beginning of the aviation, flight safety was a major concern of the public opinion. Although these days air transport is the safest way to travel, any accident or incident involving an aircraft will keep the front page of the newspapers. Despite the technological progress, accidents are still happening in aviation. The main cause: the most sophisticated and sensitive factor involved – the human one. Statistics showed that around 80 percent of aviation accidents are caused by a human error. Figure 1 shows the top five causes of accidents as it resulted from a study conducted by the Flight Safety Foundation.

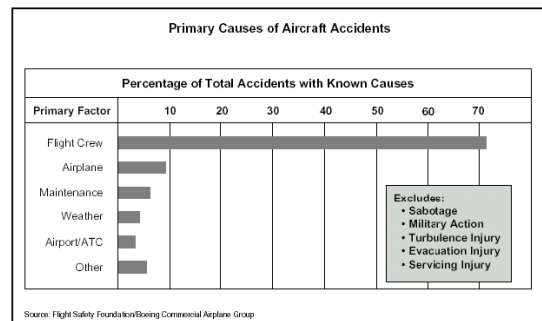


Fig. 1: Primary causes of aircraft accidents.
Source: Flight Safety Foundation – Flight Safety Digest, vol. 15, no. 1

Then why are we still using human pilots? Well, this is an endless discussion, but we do this mainly because a machine has the bad habit of doing what you are telling to do, not what you want to do, and it has no adaptability, meaning that you have to program it for an infinite number of situations. Given that, let's get back to human pilots and see why they are making mistakes and how can we train them not to make them.

Despite the fact that accidents rarely resemble each other, investigations showed that we can talk about a set of “typical aircrew error”. The top of this “standard mistakes” consists of the following:

- Loss of situational awareness;
- Violation of the flying rules and regulations;
- Failure to follow the commonly known safe procedures;
- Poor judgment or decision making;
- Preoccupation with minor mechanical problems;
- Inadequate leadership.

As you can see, in this top there are no knowledge related errors. This is because all flight crews are tested periodically in terms of knowledge, motor skills and medical fitness. The only thing that was missing until recent years was the training in complementary fields like attitude, stress management, communication, team work, etc.

It was a time in aviation when everybody believed that to fly safely all you need are motor skills and solid knowledge. Unfortunately, practice showed that it wasn't enough. For many years, the quest for training “the perfect pilot” was focused only on technical skills, ignoring completely non-technical competences. This deficiency in pilots training was revealed when accidents investigators discovered that highly trained crew members made judgment errors or had an inappropriate response to a situation.

When we talk about technical skills, we refer to three main categories: knowledge, motor activity skills and procedural activity skills. For a pilot, knowledge is the information base containing all policies, rules, laws and regulations regarding airspace, weather and equipment, along with the aircraft performance and limitation. Motor skills represent the sum of abilities involved in aircraft and system control, as well as visual acquisition and interpretation of the information and hazards. Procedural skills refer to competences regarding standard communications and normal / emergency operating procedures.

Non-technical skills, also called “soft skills”, were initially neglected and not included in crew members training programs. Accidents history showed that those skills are equally important, even though are not so aviation related. Non-technical skills are also split into three categories. The first category is represented by cognitive skills. This includes all skills related to planning, preparation, decision making process and situational awareness. The interpersonal skills form the second category. The interpersonal skills category includes all abilities regarding communication, teamwork, group climate, leadership and conflict resolution. The last category regards emotional climate and stress. As you can see even from the first glance, non-technical skills are important. So important that there were studied for a long time, and improvement techniques were applied in different economical sectors based on team work, except aviation. This happened, like I said, because aviation was considered a very technical sector, requiring more motor skills and knowledge and less or not at all “soft skills”.

2. COGNITIVE SKILLS

Situational awareness can be defined as the accurate perception of all the factors affecting the aircraft and the crew, including knowing what has happened in the past, what's going on now, and how these affect what might happen in the future. In order to achieve and maintain a good situational awareness, a crew must work on some critical success factors. The first one is knowledge, doubled by experience and training. This is not referring only to aircraft handling and operating procedures, but also to be familiar with crew performance and limitations at any given moment. The second one is attitude – an open attitude, which allows the pilot to deal with personal weakness. There are some typical hazardous attitudes that can lead to loss of situational awareness or to critical errors:

- **ANTI-AUTHORITY:** “Don't tell me!” Some people just don't like to be told what to do. They think that rules, regulations and procedures are silly or unnecessary.



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(Antidote: Follow rules, because there are usually right!);

- **IMPULSIVITY:** "Let's do something now!" This "act now, think later" attitude is quite dangerous, because an impulsive action can do more damage than the initial problem. (Antidote: Not so fast. Think first!);
- **INVULNERABILITY:** "That could never happen to me!" This kind of attitude leads to superficiality in mission preparation. (Antidote: "It could happen to me!");
- **MACHO:** "I can do it!" Trying to prove self. It is a sign of insecurity. (Antidote: Taking chances is foolish.);
- **RESIGNATION:** "What can I do about it?" (Antidote: "I'm not helpless. I can make a difference!").

Those dangerous attitudes are the target of psychological exams for aeronautical personal, but there are some cases when it is impossible to detect them from the beginning of the selection process. That is why all crew members must be able to detect and correct this kind of hazardous attitudes.

The personal health is another factor that influences the situational awareness. It is a well known fact that a good health condition sharpens the senses, while a bad one leads to a diminution in capacity. Any minor health problem can lead to a serious threat to flight safety in some circumstance. Nowadays is famous a personal health check-list, called "I'M SAFE". Its name comes from the initials of health status items to be checked: Illness, Medication, Stress, Alcohol, Fatigue and Eating. Those are the primary factors that should prevent an airman to fly. The first auditor of a pilot health status is not the medic, but the pilot himself.

Another factor that leads to an increased situational awareness is crew coordination. It may seem obvious, but it is important to state that crew coordination can make the difference

especially in an abnormal or emergency on board situation. To obtain a good crew, you have to train those men to work as a team in order to get benefits from their joint efforts. Like I said, it may seem obvious, but it is incredible how many air operators ignore this factor. Even though there are good crew training courses, some mandatory (depending on license type), companies are sometimes mixing the crew members depending on their needs, and more or less, the crew homogeneity is losing. The last three factors that can influence the situational awareness are closely related to each other: inquiry, assertiveness and analysis. Inquiry is the active questioning, investigation and use of aggressive scepticism. Analysis consists in continuous evaluation of all mission parameters in order to keep the plan updated. Assertiveness is used in the sense of obligation to speak-up. Given the specific of aviation job, every crew member is not just entitled, but also obliged to speak-up his concerns. However, there are some situations which can make an aviator hesitant to speak up when faced with a potential safety problem. The excessive professional courtesy is one of these cases. It manifests by hesitancy to say anything for fear of insulting the other pilot's skills, especially if that pilot is a friend or superior. For example, the statement: "we might be a little slow", when a stall is imminent represents a dangerous case of excessive professional courtesy. Another barrier could be the "hallo effect". This appears when the pilot committing error is an expert or has a lot of experience. Instead of thinking "he knows better", the crew member should state his concern. There is also the reversed situation, called "the co-pilot syndrome", when the more experienced crew member choose to ignore the warning coming from a younger colleague. This is another case when assertiveness is mandatory in order to regain situational awareness. To overcome this

mind traps, there are five steps: opening, state concern, state the problem, offer a solution and obtain agreement. In case that this approach doesn't work, the proven method is the "This is stupid!" statement. Using this line, a crew member will get immediate attention by using the shock effect and will get others to listen to his perception regarding a potentially unsafe situation.

Loss of situational awareness can occur from many causes. The most frequent ones are: fixation, ambiguity, unresolved disagreement, complacency, euphoria, and distractions. Among these, the most interesting is fixation. Many aircraft accidents had as a main cause fixation. It usually starts with a minor malfunction which is getting the whole attention of the entire crew, while nobody is paying attention to the operational procedure and aircraft flying. It looks so stupid that you think that it is impossible to happen, but experienced crews manage to cause accidents in this way. One of the most famous incidents of an aircraft disaster attributed to fixation was the crash of Eastern Air Lines Flight 401 near Miami, Florida on 29th of December 1972. The pilot, co-pilot, and flight engineer had become fixated on a faulty landing gear light and had failed to realize that the autopilot buttons had been bumped by one of the crew altering the settings from level flight to a slow descent. The distracted flight crew did not notice the plane losing height and the aircraft eventually struck the ground, killing 101 out of 176 passengers and crew.

Planning and decision making process is an important part of an aviator's job. Unlike other jobs, in aviation decision making process is a group duty, meaning that all crew should participate to this process, and any changing in the initial plan should be communicated and acknowledge to / by the whole team. This is particularly important during abnormal operations or in an emergency situation, where conditions affecting the progress of the flight and the safety of the aircraft are likely to change rapidly. In these circumstances, regular updates on the status of the flight allow each individual crew member to be sufficiently aware of the situation and needs of the moment to contribute in the most effective

way to the decision-making process. The degree of intervention of each crew member into the decision-making process may vary depending on the mission, on-board function, and, of course, social norms and organizational culture. Anyway, regardless of all this, assertiveness is the main privilege and also obligation of all crew members. This is because the decision-making process can be affected by many factors, like a sudden loss of judgment. Here are some examples:

- HELICOPTER MIND TRAP: "This thing can be set down anywhere, so if it gets too bad I'll just land...";
- AIRSHOW SYNDROME: "I've got to put on a really good show! Can't let'em down...";
- PERCEIVED PRESSURE: The illusion that either peers or superiors are pushing you to go ahead with a flight;
- HALO EFFECT: Maybe this pilot used to be really great, but is he still? This is expired experience!

3. INTERPERSONAL SKILLS

Interpersonal skills refer to all abilities related to interaction between crew members, and I sustain that the most important process related to human interaction is communication. A good level of communication is important anywhere, but in aviation is almost vital. Communication is also social and culturally related, although in aviation industry is instructed on importance of good communication. There are three levels of communication: poor, good and effective. We consider a communication as poor when the message sent is not even received, resulting in confusion. A good level of communication is when the message is received, but the receiver has not responded with the desired action. When the message is not only received, but also had resulted in the action desired, we call the communication effective. The communication process consists in the following: the sender is encoding the message (words, signals, etc.), then is transmitting the encoded message and receiver is decoding the message. The encoding and decoding



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processes are subjective ones. All encoding and decoding is passed through the filters of each person personalities: the sum total of his / her past experiences. If vast differences exist in personality, then this encode/decode will result in loss of communications and frustration. There are several hazards which reduce the quality of communications:

- transmission failures (the sending of unclear or ambiguous messages, language problems);
- transmission environment difficulties (background noises or distortion of the information);
- receiving failures (the expectation of another message, wrong interpretation of the arriving message or even its disregard);
- physical problems (impaired hearing or wearing of the oxygen mask).

In order to reduce communication failure, a standard phraseology is mandatory in all aviation communication, and feed-back is assured by read-back of all important messages and simple acknowledge for the rest.

The others interpersonal skills are team-related. The goal of teamwork is achieving synergy, meaning that the output of the team is greater than the sum of outputs of each individual. This is the main role of crew coordination trainings, not the fact that every member will know what to do and when. An air crew is basically the same like any other group, some will say with closer ties because of the special nature of the job. Usually, the formal authority in air crew is the same with the informal leader, because there are no shortcuts, and the captain is the most experienced (and, hopefully, respected) crew member. Anyway, discipline on board of an aircraft is not like in the military and every crew member can participate to the decision-making process (as far as the veto right in some cases regarding flight safety). This is why I will not insist on leadership and get

straight to conflict resolution. Like in any team, in an air crew may be conflicts. Of course, there is nothing worse than a conflict on flight deck. But when occurs, it is better to know what to do and what not to do. First of all, apologizing prematurely is wrong. This will break down communication before solving the problem. I was mentioning before the social and cultural barriers. Well, in the cockpit, they should not exist. It is up to company policy to establish rules that allows airman to lose their cultural inhibition. Other destructive patterns in cockpit conflict resolution are the use of: non-related issues, intimate knowledge, belittling humour, indirect attack or hollow promises. The proper way of solving conflicts consist in taking time to discuss issues. In this discussion, peoples have to define issues clearly, identify points of agreement and points of vulnerability and deal with them in a positive way. Every part has to admit its own mistakes and to be open to the other's reconciliation attempt. If the parts do not agree on the future course of action, the decision factor (captain) should apply the "conservative response rule". This consists in choosing the safest course of action, presuming that both ways could be wrong.

4. EMOTIONAL CLIMATE AND STRESS

The emotional climate represents the way that crew members think and feel about each other during flight. This climate may enhance or reduce performance of the cognitive and interpersonal processes. There are many factors that influence the emotional working climate, like clarity of tasks, other members' degree of participation, recognition of merits, effectiveness of communication, expectations, perception of safety, etc. The emotional climate depends on company policies regarding command authority, job description, freedom of speech, etc. (those could be as well

social and cultural norms) and, ultimately, depends on each team member's attitude.

A big influence on performance has the stress, not only by the emotional climate point of view, but also from human physical and cognitive limitation. Stress is the reaction of the human body when it adapts to stressors. A stressor could be eventually everything that forces us to cope. Stressors could be environmental, personal or organizational. Examples of environmental stressors are: light, dark, cold, heat, humidity, living or travel conditions. Personal stressors could be intrapersonal (hereditary traits) or interpersonal, like conflicts, mistrust, lack of support or poor communication. An important chapter of personal stressors is represented by the private life. Family problems, financial concerns, health care, lack of time for personal use are just a few examples of private life stressors. A significant amount of stress is experienced at workplace. Organizational structure, people management, workload, job ambiguity, salary, work satisfaction, time pressure are all organizational stressors. Practically everything we experience in life can be a source of stress. Each of us is affected differently by these things. Stress has a major impact on human body which transmits signals. The most noticeable signs of stress are headaches, heartburns, cramps and fatigue. Human body response to stress is basically preparation of the primitive response "fight or run". This preparation consist in increasing heart rate and adrenaline flow, pituitary gland secreting ACTH (a stress hormone), liver secreting cholesterol, kidneys increasing their activity, blood vessels constriction and brain increasing alert. In order to avoid extreme stress, people should know some basic stress management techniques. Organizing work is the first to do when dealing with stress. This allows taking control of time and energy used in work process. Communication is also important. Declaring the state of overload and asking for help is the right thing to do. And, eventually, saying "no" or "not now" is a solution. In aviation is a well known dictum saying that you have to "take time to make time". A rush and under pressure decision could lead to catastrophic consequences.

Other ways of decreasing stress level are: making brakes, using relaxation techniques, building a good psychological condition by surrounding with positive and enjoyable people, and taking care of physical condition (which helps body to resist better to stressors).

An important amount of organizational stress is caused by work overload. Regarding work performance, we can distinguish three types of workload: underload, optimum load and overload. We might not always have full control over total workload, but we can recognize its effects and take some action. When the workload is optimum, everything is good: people are creative, rational and satisfied. When the workload is too low, boring, fatigue and frustration appear. The trouble begins when the workload is too high. It may appear dangerous disorders like sudden loss of judgment, irrational response to problems, exhaustion, illness and low self esteem. The workload levels are different for each individual, each having a different optimum. This optimum level of workload is also variable depending on task: a simple task can be performed under high workload, while complex task are less compatible with overload situations. So, how air crew perform under overload situation? First, they try to work faster, do more in the same time frame. This is a circumstance that potentially leads to slips and mistakes. The overall view of the flight is lost, and so it is the scope of the mission. The flight manner becomes responsive instead of anticipative. Attention becomes tunnelled and the fixations may appear. And the most dangerous thing that appears is reversing to old habits (good or bad). The role of intense training is to wipe off old bad habits and establish new and better ones. High workload is not easy to be recognized, especially because the subject is usually too deeply immersed in the situation to fully perceive it. Signs of overloading are:

- difficulty in sticking to normal performance standards (heading, altitude, hearing radio calls, etc.);
- errors or erratic (unpredictable or inconsistent) performance;



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- uncertainty, indecision, discomfort, loss of good instrument scan, tunnel vision and fixation;
- time distortion (a few seconds seem like eternity, half an hour goes by in a flash and feels like five minutes);
- hesitant or confused speech (often apparent on ATC tapes just before an accident...).

To be protected against work overload, you have to enhance personal workload limit (by constantly improve knowledge, attitudes and skills) and perform a good pre-flight preparation (because knowing what to do means buying you time in an overload situation).

5. CONCLUSIONS

Aviation can be compared with a team sport. It doesn't matter just how good you are, but how can you play in your team. If we put trained crews in cockpit instead of talented

people, chances to have a safe flight are considerable increased.

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