Pilot fatigue as one of the factors causing air accidents

ZUZANA ZGODAVOVÁ[1] – RÓBERT ROZENBERG[2] – STANISLAV SZABO[3] - VLADIMÍR SOCHA[4] - VLADIMÍR NĚMEC[5]
[1,2,3,4,5] *Technical University of Košice, Faculty of Aeronautics*
Slovak Republic

Abstract

The aim of the article is to highlight the issue of human factor and topicality of risks arising from the analysis of aviation accidents and recently conducted surveys. Despite the fact that human being is the most important, most adaptable and most effective element of the system, contributes to a high proportion of air accident. The average significantly exceeds the pilot's profession, as the most error-prone component. Fatigue that occurs in crews has recently become major factor endangering the safety of flight operation. Effects of fatigue not only disturb the functions of the human body, but they greatly influence pilot's performance during the flight, as confirmed by measurement results.

Keywords: Human factor, Fatigue, Performance, Pilot error, Safety

JEL Classification: L93

1 Introduction

The causes of air accidents and incidents in the history of civil aviation were mostly serious structural and system errors, or underestimation of the impact of meteorological conditions. Established technology and overall reliability of the aircraft systems haven't always been sufficient at this time. However, the 70's of the 20th century brought significant changes. During this period there is a huge expansion of the commercial air transport by jet airplanes. At the same, the newly implemented technology has reached such a level of reliability that the causes of air accident due to technological failures have been gradually declining. Nevertheless, the number of air special events has risen constantly. Therefore, it was necessary to ask a question, what a role plays human factor in flight operation or flight safety.

Air accident analyzes in 1970 - 2010 showed, that 70-80 % of air accident were caused due to human error. Although the human factor is considered to be crucial, the most adaptable and the

[1] Ing. Zuzana Zgodavová; Technical University of Košice, Faculty of Aeronautics, Flight Preparation Department,, Rampová 7, 041 21, Košice, Slovak Republic, zuzana.zgodavova@tuke.sk
[2] Ing. Róbert Rozenberg, PhD.; Technical University of Košice, Faculty of Aeronautics, Department of Flight training, Rampová 7, 040 21, Košice, Slovak Republic, robert.rozenberg@tuke.sk
[3] doc. Ing. Stanislav Szabo, PhD., MBA, LL.M.; Technical University of Košice, Faculty of Aeronautics, Rampová 7, 040 21, Košice, Slovak Republic, Stanislav.Szabo @tuke.sk
[4] Ing. Vladimír Socha, PhD.; Czech Technical University in Prague, Horska 3, 128 03, Prague, Czech Republic, vladimir.socha@fbmi.cvut.cz
[5] doc. Ing. Vladimír Němec, PhD., prof.h.c.; Faculty of Aeronautics, Department of Flight training, Rampová 7, 040 21, Košice, Slovak Republic, vladimir.nemec@tuke.sk

most flexible component of the aviation system, it is also the most vulnerable to impact adversely affecting its performance. Pilot failure due to a disruption in harmonization of its activities with other components of the system (man – machine – environment), when its psychological and physical reserves are not sufficient to compensate the fail of one of its components, is referred to as a human factor failure. Pilot error is considered to be one of the most common causes of air accident with a significant proportion of up to 60 %. Errors can occur at all stages of activity such as perception, assessment of the situation, choice of reaction, performance of task, evaluation of result. The main purpose of applying the findings of human factor in aeronautical practice is to know predictable human capabilities and limitation and to use this knowledge in flight operation subsequently.

The table below shows range and causes of air accidents in percentage in the decade format from 1950 to 2010. It was completed from the Plane Crash Info database and represents 1015 fatal accidents of commercial aircraft. Statistic data doesn't include planes with less than 18 passengers on board, military aircraft and private aircraft and helicopters.

Table 1 Accidents by cause

Cause	1950 - 59	1960 - 69	1970 - 79	1980 - 89	1990 - 00	2000 - 10	Average
Pilot error	42	36	25	29	29	34	32
Pilot error (related to weather)	10	18	14	16	21	18	16
Pilot error (mechanical fault)	6	9	5	2	5	5	5
Total pilot error	**58**	**63**	**44**	**57**	**55**	**57**	**53**
Other human errors (caused by other person)	3	8	9	5	8	6	6
Weather	16	9	14	14	8	6	12
Mechanical fault	21	19	20	21	18	22	20
Sabotage	3	5	11	12	10	9	8
Other	0	2	2	1	1	0	1

Source: http://www.planecrashinfo.com

The results of an air accident investigation confirm the existence of several casual factors. Failure may be caused by any element in the system or by their interaction. Most often, air accidents are result of a series of faulty tasks, while separate errors don't cause a high level of risk. The European Aviation Safety Agency provides each year a statistical overview of air safety in the EASA Member States, as well as identifying the most common safety risks that lead to air accident in different aviation operational areas. Based on the analysis of the investigations in recent years, EASA has established pilot fatigue as one of the five contributory factors, which is significantly contributes to the occurrence of air accidents.

2 Current state

Experts estimate that pilot fatigue contributes to 15-20 % of all fatal air accidents associated with human factor failure. Between 1990 and 2013, Aviation Safety Network recorded 22 air accidents that were caused by crew due to insufficient rest or fatigue. These accidents resulted in 595 fatalities and several tens serious injuries. Recent events constantly emphasize the importance of fatigue that occurs among flight crew. It is understandable that in the case of longer duty period, a relatively higher risk of accidents appears than in comparison to short ones. The longer the pilot's wakefulness is, the more they tend to make mistakes, especially cognitive, such as decision making. These "minor errors" also confirm many of air accident. We can mention some from more serious accident such as:

- **Korean Air** (1997),
- **Colgan Air** (2009),
- **Air India Express** (2010).

For better understanding of fatigue and its most likely causes and consequences, were realized by members of the European Cockpit Association several studies related to pilot fatigue. Surveys were carried out between 2010 and 2012 in Austria, Denmark, France, Germany, the Netherlands, Norway, Sweden and the United Kingdom of Great Britain and Northern Ireland. Pilots involved in the survey should assess the level of fatigue they experience during the flights. Surveys have revealed remarkable, alarming results. Pilot fatigue has become a reality in European cockpits. It is currently common than expected and significantly under-reported by pilots.

In the following graph (Figure 1) we can see percentage of pilot fatigue that pilot are experiencing during their flight duty in different European countries. Grey scale represents percentage of pilot fatigue and red scale shows percentage of pilots who state that they have been fallen asleep or experienced moments of micro-sleep in the cockpit.

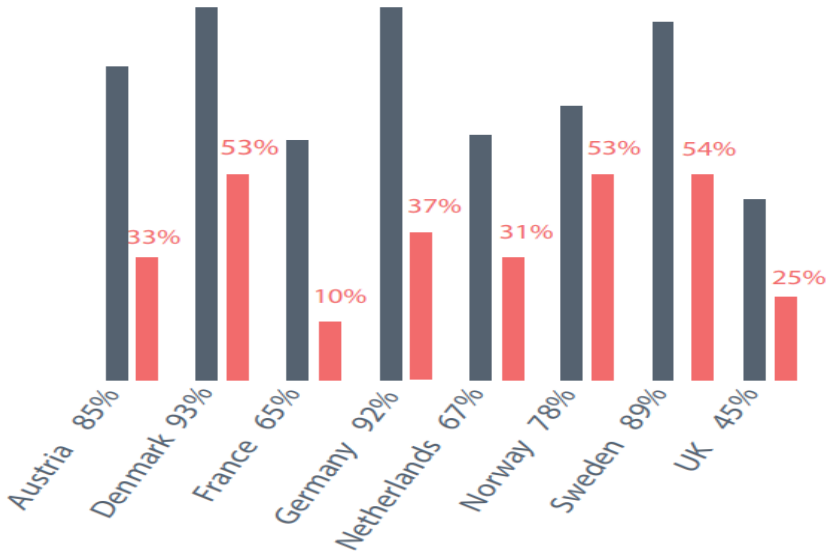

Figure 1 Percentage of pilot fatigue and dozing off or micro-sleep episodes
Source: https://www.eurocockpit.be/sites/default/files/eca_barometer_on_pilot_fatigue_12_1107_f.pdf

More than 50 % of surveyed pilots experience fatigue as a weakening of their ability to perform duties during flight duty. 92 % of German pilots admitted that they feel too tired or not capable for

duty on board at least once in the last 3 years. Similar results in other European countries show that is not an isolated case. In Austria, 85 % of pilots reported that they were too tired during their flight duty, while two thirds of them having this experience more than once. Similarly, 89 % in Sweden, and 93 % of Danish pilots admitted their claim. The lowest percentage of serious fatigue in flight crews was recorded in the Netherlands "only" 67 %. It follows that two of the three pilots suffer from fatigue to extreme exhaustion. More than a third of the surveyed people said that they have slept or took naps during the flight without agreeing of their colleague.

The results of the survey point to the key aspects of the operation (long duty, standby hours, night flights and often changing flight schedule), for which the pilots are insufficiently rested. This study largely confirms what scientific and medical research has identified as particularly tiring factors of air operation that require particular attention and risk management.

3 Experimental measurement for assessment of fatigue effects

Fatigue reduces the physical and mental ability to safely perform a flight. A tired person can lose 80% of his attention and 70 % of his ability to respond. Pilot fatigue leads to increased reaction time, short term memory loss, impaired judgment, incorrect decision making and reduced visual perception and so on. It is true that pilots often aren't aware of these effects. The main cause of fatigue is lack of sleep and disturbance of biological rhythms in the body.

Since fatigue can be considered as one of the aspect causing changes in pilot performance and increased vulnerability to errors, which significantly affects the safety of air operation, an experiment was conducted at the Faculty of Aeronautics to observe these changes. The basic assumption was to find adequate novices, create a flight task (flight track), determine the parameters of measurements, use the appropriate type of flight simulator and adequately generate the effects of fatigue. In the study two 24-hour flying intervals were completed during which two pilots were shifted. The number of flights depends on the staying power of the research sample of pilots, while with individual pilots repeating the task 11 or 12 times. The main aim of the experimental measurement was to observe errors made by pilots as a result of fatigue, deflections in the flight track and intervals or track points in which mistakes occurred. The purpose of the experiment was also assessing of the pilot performance and determination impacts on safety of air operation. For the purposes of this contribution we will take a closer look at the measurement results for one of the sample pilots. The following graph shows the deflections from the reference values set for altitude, as one of the parameters used to assess crew performance and correct piloting of the aircraft.

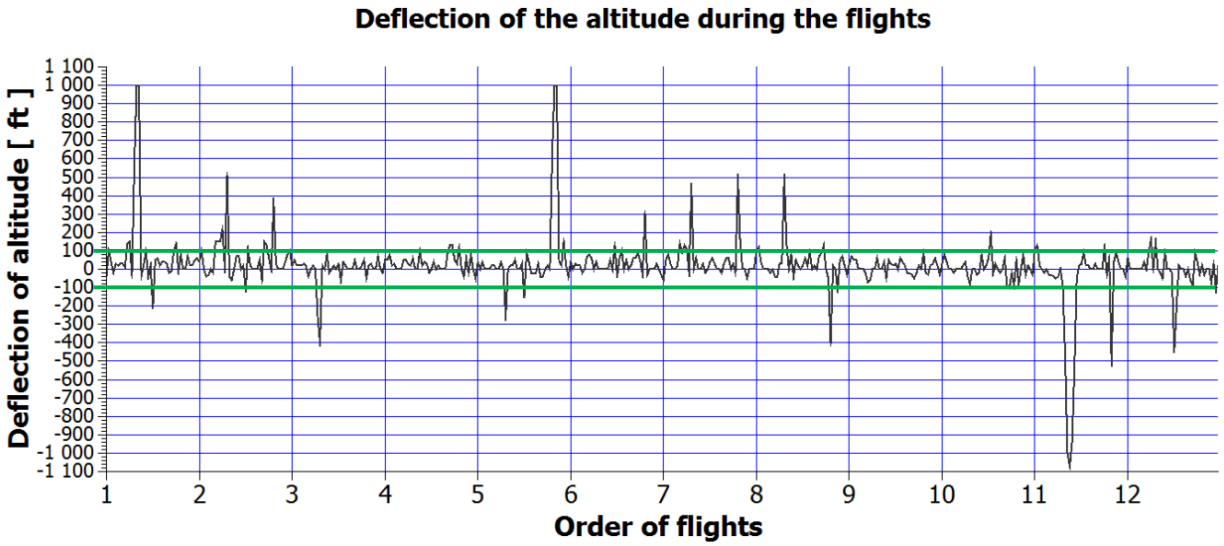

Figure 2 Deflection of the altitude during the flights
Source: Own elaboration

In the graph you can see 3 significant deflections of altitude that were recorded during 24 hours at the first flight (time 09:25), 5th flight (time 18:30) and 11thflight (time 07:00). Maximum deflection from the reference value was identified at 7 o'clock in the morning with value -1070 ft at point P. Pilot began to descend before turn left on heading 053 ° at the point N and O when he should fly in altitude 3500 ft, he flew about 1000 ft below. Pilot continued in the descent also at approach (at the points P, Q, and R) when he reached altitude 1430 ft (instead 2500 ft). This led to exceeding safety range that represents +/- 100 ft (highlighted on the graph with the green lines). A mistake has been probably caused by fatigue and limited alertness. Pilot stopped to monitor all instruments comprehensively and he concentrated only on localizer and glideslope of ILS. Preoccupation with one task at the neglect of other tasks leads to loss of situational awareness. At the first and 5th flight the same maximum deflections were found out at the points N and O, that value was +1000 ft. It wasn't so high safety risk as during the 11thflight.

From the measurement results of the selected pilots, considerable variability was found out in the performance. Several deflections of altitude in both positive and negative values were observed for all pilots. Exceeding the permitted safety limit in negative values was a greater safety risk for a pilot than in positive values. In comparison to other tested pilots, deflection of the mentioned above pilot significantly exceeded the maximum permitted values, especially at the phase of final approach of landing. Despite exceeding maximum permitted deflection, the pilot didn't make maneuver "go around" in one case, but continued to approach. Although for all pilots, greater negative deflections were recorded (-700 ft, -250 ft, -300 ft, -310 ft, -350 ft,-360 ft), these mistakes didn't make in the final approach, when is required to pilot the aircraft as accurately as possible.

The error observed with each of the pilots, was found out at the M and N points, when the pilots forgot to descend to the required altitude 3500 ft on the heading 204° during several flights. Severe errors in the form of more marked negative deflections from the specified values mostly began to appear in last flights at dawn. As a result of fatigue, the safety limits have been exceeded what was most likely caused by decreasing in performance, what also meant safety risk.

4 Conclusion

Fatigue represents a potential risk to flight crew and air operation. The severity of this phenomenon is constantly increased in last years. This fact is confirmed not only by database of air accident the Aviation Safety Network and surveys of the European Cockpit Association, but even the European Aviation Safety Agency considers fatigue to be one of the factors leading to the occurrence of air accidents and incidents. Effects of fatigue cause reduced alertness, increased reaction time, influenced judgement, logical reasoning, short term memory loss, or increased occurrence of errors.

For observing the effects of fatigue and possible changes in pilot performance caused by fatigue, an experiment was realized. Its aim was to observe errors and their intensity during 24-hour flying intervals. Serious errors were found out by measuring, which occurred mostly in last flights, when effects of fatigue on the human body were more marked. The results cannot be ignored, because even a small mistake can lead to catastrophe and loss of human life.

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