Chosen Aspects of Pilots Situational Awareness

Odabrani aspekti situacijske svijesti pilota

Jarosław Kozuba
Polish Air Force Academy
Faculty of Aeronautics
Poland
e-mail: aabuzok@wp.pl

Ján Piľa
Technical University of Košice
Faculty of Aeronautics
Slovakia
e-mail: jan.pila@tuke.sk

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Summary

This paper tries to find the answers to the following questions: What does Situational Airworthiness (SA) truly mean from the viewpoint of the pilot ability to keep acceptable safety level on each phase of the aircraft mission execution? Which element of the aviation model has the highest influence on that pilot ability? Which sub-factors have the highest influence on the probability of achieving and maintaining an acceptable level of sub-areas of SA by the pilot during the preparation and execution of air missions? Moreover, the paper discusses sub-subjects as the definition of SA, relations between processes and the status of SA. The conclusions of the paper are partially based on the Authors' research of the years 2012-2013.

KEY WORDS

aviation safety
situational awareness
aviation model

Sažetak

U ovom radu pokušalo se pronaći odgovore na sljedeća pitanja: što situacijska svijest u zrakoplovstvu (SA) zaista znači sa stanovišta sposobnosti pilota da održi zadovoljavajuću razinu sigurnosti u svakoj fazi izvedbe zrakoplova? Koji element avijacijskog modela ima najveći učinak na takvu sposobnost pilota? Koji pod-čimbenici imaju najveći učinak na mogućnost postizanja i održavanja prihvatljive razine pod-područja SA pilota tijekom pripreme i izvedbe zračnih misija? Osim toga, u radu se raspravlja o pod-temama kao definiciji SA, odnosima među procesima i statusu SA. Zaključci rada djelomično se temelje na istraživanju koje su autori proveli 2012-2013.

KLJUČNE RIJEČI

sigurnost u avijaciji
situacijska svijest
avijacijski model

INTRODUCTION

Aviation safety is neither the objective nor the task of aviation. Aviation safety is a condition in which all planned objectives are realized, while at the same time potential hazards that could affect the course of their realization are kept under control. The role of the "human factor" in the aviation safety system has been known for a long time. The artticle discuss one of the most important factor which has fundamnetal influence on the level of avaition safety – Situational Awareness. Authors try to fined the main reason of weaknesses presented by pilots in the area of SA by taking into consideration results of their own research.

SITUATIONAL AWARENESS DEFINITION

In the most publications Situational Awareness (SA) is treated as a state, a process or a basis of a decision-making process for an operator – an aircraft pilot. A more thorough analysis of the SA definitions and descriptions of SA suggests that some researchers concentrate on SA viewed as a state whereas others differentiate between SA understood as a state and as a process.[1] The absolute majority of those definitions refer, more or less directly, to SA in the aspect of pilot – aircraft – mission – environment interactions. Interrelations between the elements of this system exert a decisive influence on the decisions made by a pilot, who in the process of SA plays the roles of a recorder, an analyst, and a decision maker. In most of SA definitions no answer can be found as to the way in which information contributing to the state of situational awareness was obtained. This remains in compliance with the opinion of Andre, who claims that "those who analyze the states tend to avoid the questions relating to how the information has been obtained" [2]. Thus, they avoid the reconstruction of the way the workload affects the pilot in the process of obtaining and utilizing information in order to create a mental picture of the aircraft's status in a certain stage of air mission execution and determining the changes of that picture in a specified future time period – the state of situational awareness.

Taking into consideration the definitions can be found in the literature and Situational Awareness (SA) may be defined as the aircraft operator's ability to obtain information relevant to creating a clear mental picture of the aircraft's status at a certain moment from the dynamic mission environment and to anticipate its future changes in a certain time frame – the process of SA. The objective of these actions is to attain a desired state of knowledge - SA state being a basis for decision - making and allowing the operator (pilot) to maintain the required safety level during air mission execution.

SITUATIONAL AWARENESS PROCES VERSUS STATE

From the theoretical point of view a "process" is defined as "a series of events which occur sequentially and result from one another, or a series of changes which constitute subsequent phases of something" [3] as a result of which a certain state of an individual or a system is attained. The term "state", on the other hand, is used in its general meaning to describe a condition or a level of quality characterizing an individual or a system. An analysis of both these definitions point out to the fact that, in any area of activity, attaining a certain state of e.g. awareness, mission accomplishment, professional development, etc. is dependent on performing a certain mental, research or technological process, manual work, etc., a process which is regarded to be homogenous or combined of several processes.[4] The complex SA process is therefore nothing else than a "tool" used to attain the state of Situational Awareness.[5] Taking the above into consideration, rejecting one of these concepts or categorizing the importance of the state or the process with regard to SA ought to be viewed as inappropriate. The process and the state of SA should be perceived through interactions between them, i.e. one should not speak of SA without first defining the phases of the process and the relevant requirements, whose fulfillment will allow attaining the desired level of their "quality". They should be perceived through interactions between them, i.e. one should not speak of SA without first defining the phases of the process and their "quality". The concept of SA is applied both to the results of particular processes of SA, which are executed at given stages of air mission accomplishment, and to the final state of SA – e.g. one may say that when executing an air mission, the pilot presented the desired state of SA. Consequently, when speaking of a SA state which results from the execution of a given process, we mean an instantaneous state, which a pilot attains in a particular stage of air mission accomplishment. This state may undergo changes, as a result of changes being introduced into the mental picture of his aircraft which the pilot has created, when subsequent processes of SA are performed in subsequent stages of air mission accomplishment. Therefore, the reports of air accident investigation boards frequently refer to pilots suffering from momentary degradation of SA in a certain respect, which resulted in certain consequences related to air mission execution safety.

To develop Endsley's definition (1988), the process of SA should be viewed from the perspective of its three significant phases: perception, creating a mental picture of an aircraft and determining changes of the aircraft status in a specified future time period (Fig.1).

Attaining the desired level of SA by the operator is possible only when the desired qualitative level being the

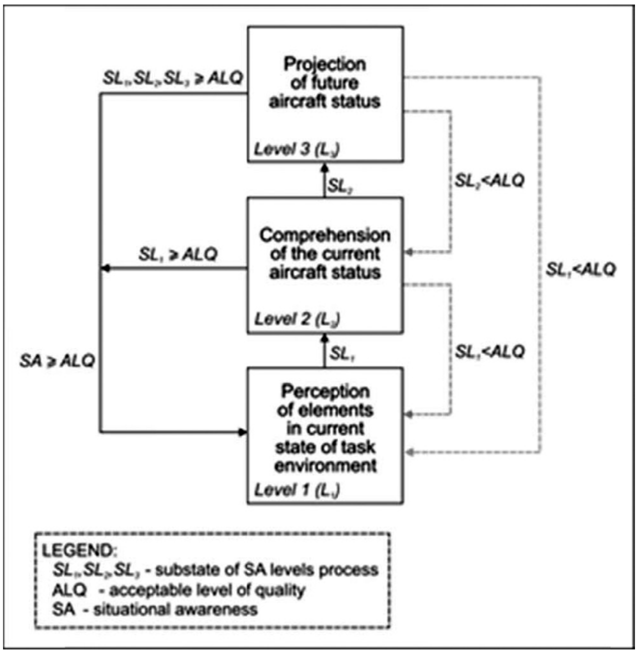


Figure 1 Sub-states of pilot's SA in particular stages of the process and the course of that process

Source: Author' own work

condition of the proper execution of the subsequent process stages is attained by the operator in all stages of the process. If the desired qualitative level is not attained at any stage of the process, in the following stages of the process the pilot has to search for the error that has been committed. Then, the duration of the process will be much longer than expected, which may cause momentary or permanent loss of SA. Such a state should be considered as a threat to safety in aviation. A much worse situation occurs when the pilot assesses the status of the aircraft by using data which are insufficient in the current situation, or if he does not realize that those data differ considerably from valid data. It is in such a situation that the improper mental picture, created by the pilot, of the aircraft may cause erroneous decisions leading directly or indirectly – by the accumulation of errors – to undesirable flight-related events. An Authors´ analyse of undesirable flight-related events, which occurred in the training units of the Polish Air Force Academy (PAFA) in 1974 –1984 [6] unequivocally shows that 82% of the incidents caused by the human factor resulted from errors committed at Level 1 of the Situational Awareness process, i.e. the operators were unable to collect sufficient information for making the right decision onboard the aircraft. 11% of the errors were committed at Level 2. The pilots were unable to properly interpret the information they had collected and, what it involves, to create the mental picture of the aircraft which would adequately reflect the reality. The fewest errors (7%) committed by the pilots belonged to Level 3, i.e. were related to projecting the future status of the aircraft in the predictable future time period. This seems, therefore, to confirm the thesis that most undesirable flight-related events resulting from pilot's errors do not result from errors occurring directly at the decision-making level. The cause of an undesirable flight-related event is, in fact, taking into consideration solutions that are inadequate for the real situation, which results in gradual deepening of the crisis relative to the desired level of air mission execution. In the final phase of such a crisis, the situation may evolve into an undesirable flight-related event.

SUBAREAS OF SITUATIONAL AWARENESS

As a rule, this term is used in connection with the influence that SA exerts on the quality of executing missions carried out by the pilot. It is also used in order to define a broad spectrum of factors affecting the pilot's loss of SA in the event of an undesirable flight-related event. When a flight ends successfully, this term is used in the context of the pilot having the desired level of SA. It should be stressed that no matter whether we refer to the entire flight or to its phase, we use the expression "state of SA ". Because of the complexity of the SA state, when discussing flight related events, the assessment of SA is usually limited to the claim that one of the causes of the discussed undesirable flight-related event was the crew's poor level of SA, or that the level of the crew's SA had been correct until the undesirable flight-related event occurred. According to the views presented by the representatives of ESSAI (Enhanced Safety through Situational Awareness Integration in Training) consortium, SA is treated as a higher level of support for the crew, the aim of which is to avoid threats and to reduce the risk associated with them present during the mission execution.[7]

Therefore, when discussing the SA state one ought to realize that the state is made up of a number of subareas**.** Without identifying those subareas it would be difficult to find answers to the questions why the pilot's state of situational awareness was so poor, or what caused the loss of SA**.** In other words, in which subareas did the state of SA support the avoidance of threats and the reduction of associated risks and in which subareas did the insufficient state of situational awareness lead to the mission accomplishment failure or to an undesirable flight-related event?

In reference publications, the state of SA is usually divided into subareas defined by M. Endsley: geographical SA, spatial/temporal SA, system SA (involves the management of aircraft systems) and environmental SA.[8] E. Klich, on the other hand, distinguished geographical SA, environmental SA, aircraft status SA, SA concerning the crew's physical and psychological disposition and SA concerning the crew's health condition.[9] In available reference publications, both authors have referred to the contents of each of the above-mentioned SA subcategories rather than to pilot's abilities which are necessary to attain the desired state in each of them. It should also be stressed that both authors give different descriptions of subcategories (subareas) with the same names. For the purpose of the present work, the author has decided to introduce his own division of SA into eight subareas and to determine the factors which affect attaining the desired state of SA by the crew in relation to all subareas (Fig. 2).

They should be regarded as supplementary. The fact that some of them repeat points out to their particular importance in attaining the desired state of situational awareness with respect to a given subarea. SA is formally defined as a person's perception of the elements in the environment within a volume of passing time and space, the comprehension of their meaning and the projection of their status in the near future. Viewing SA from the perspective of its state, one should realize that SA consists of a number of subareas whose importance is crucial in maintaining the desired qualitative level of SA, allowing a safe mission execution.

What factors do affect attaining the desired state of the subareas of SA by the pilot? To give the answer for so formulated question Authors conducted research by using an anonymous survey technique. Field studies were conducted in the years 2011-2012. The survey comprised a sample of 100 active duty service members – the pilots serving in the training, transport and helicopter aviation units of the Polish

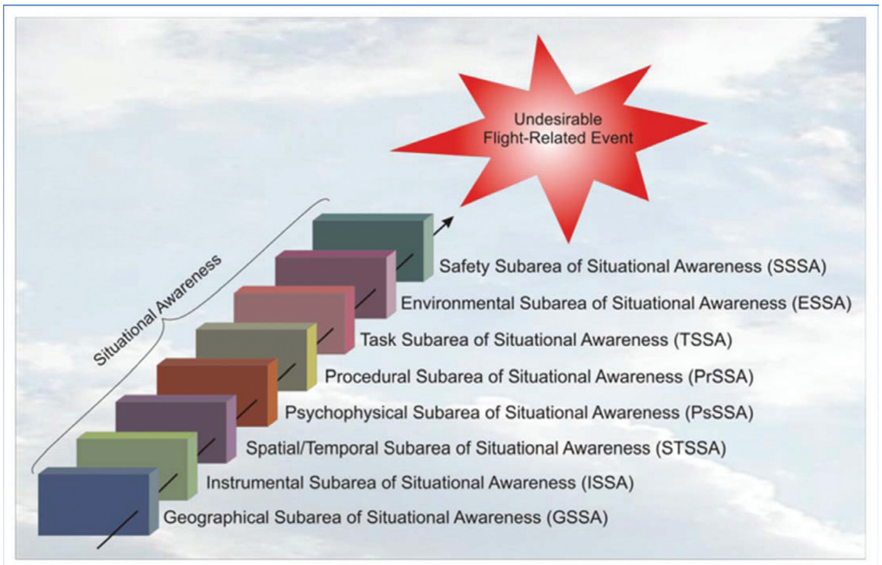
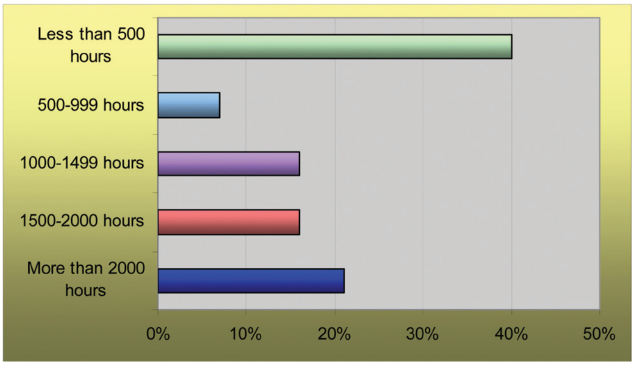
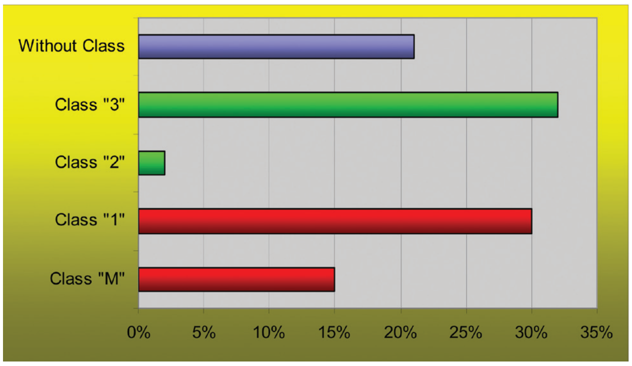


Figure 2 Subareas of SA and undesirable flight-related event from the perspective of the domino effect model
Source: author's own work.





a b

Figure 3 The aviation experience presented by respondents: flying time (a), professional training (b).

Source: Author´s own work

Armed Forces. Those service members represented 20 per cent of the total population of pilots serving in the aviation units of the Polish Armed Forces. It includes 25% of aircraft training pilots-instructor, 22% of helicopter training pilots-instructors, 27% of cargo aircraft pilots and 25% cargo and/or combat helicopter pilots. The respondents presented the following levels of professional training (Fig. 3b), flying time (Fig. 3.b.).

Taking in to consideration the forth crucial factors – human factor, technical factor, environmental factor and organizational factor, respondents unequivocally points out to human factor as a the most important factor from the point view of pilot situational awareness level. It is worth to underline that the human factor received the highest level of influence in each subareas of SA. High score was given to the machine, environment and aviation organization , which are treated by respondents as factors from the point of view of influence on the SA level presented by pilot (Fig. 4.).

Respondents stated that such factors as level of specialist skills, level of specialist knowledge, professional experience, training continuity and psychophysical state of a pilot have a very high influence on the his/her ability to reach and maintain the acceptable level of SA subarea states during the mission execution (Table 1.).

Almost the same score we can be observed when we search factors which had the highest influence on aviation accidents according to statistics. Taking into consideration the statistics, does not matter what kind of aviation, aircraft or period of time will be taken into consideration the human factor is the main cause of approximately 70% – pilots (50%), mechanics (14%) and air traffic controllers (6%) of aviation accidents, machine 12%, others – 18% - environment (8%), organization (6%), unknown (4%) (Fig. 5.).

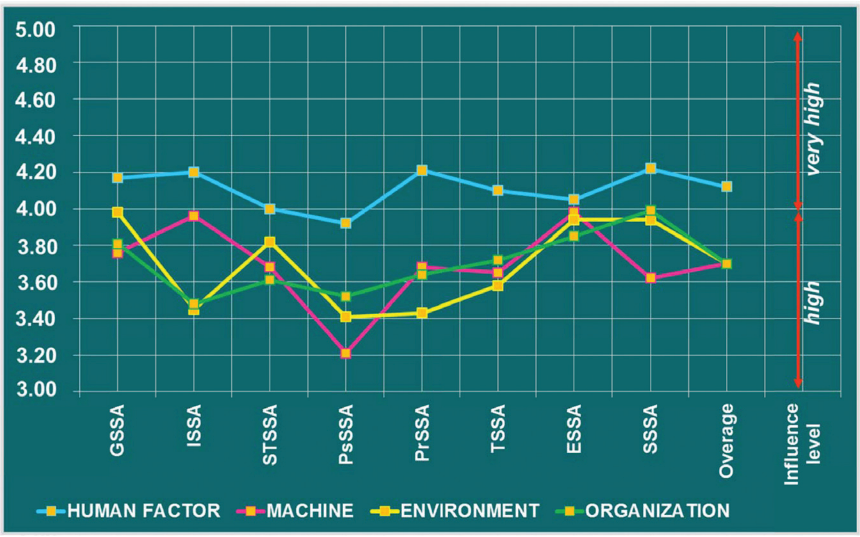


Figure 4 The impact of individual components of the aviation system – Man – Machine – Environment – Aviation Organization – on the probability of achieving and maintaining an acceptable level of situational awareness by the pilot during the preparation and execution of air missions. The following scale of rating was given to anonymous survey attendance: 1 – very low level of influence; 2 – low level of influence; 3 – average level of influence; 4 – high level of influence; 5 – very high level of influence

Source: Author´s own work

Table 1 The impact of factors which have important influence on the probability of achieving and maintaining an acceptable level of SA subareas by the pilot during the preparation and execution of air missions

	SA subareas / Factors of SA subareas	GS SA	IS SA	STS SA	PsS SA	PrS SA	TS SA	ES SA	SS SA	Overage result	Level of influence
HF[1]	Level of specialist knowledge	4.00	4.34	3.56	3.73	4.50	4.07	4.07	4.21	4.06	very high
	Level of specialist skills	4.17	4.22	3.78	3.55	4.35	4.15	4.03	4.21	4.05	very high
	Professional experience	4.28	4.34	4.43	3.98	4.32	4.22	4.26	4.50	4.29	very high
	Training continuity	4.40	4.19	4.19	4.01	4.18	4.10	3.96	4.32	4.16	very high
	Psychophysical state	4.05	3.98	4.09	4.36	3.77	3.96	3.93	3.90	4.00	very high
M	Aircraft automation level	3.80	3.98	3.69	3.22	3.84	3.71	4.05	3.67	3.74	high
	Aircraft ergonomics	3.75	3.94	3.69	3.22	3.53	3.59	3.92	3.57	3.65	high
E	Weather condition	4.06	3.50	4.02	3.32	3.38	3.52	3.84	3.90	3.69	high
	Dynamics of changes in the mission environment	3.86	3.40	3.67	3.50	3.51	3.64	3.96	3.96	3.68	high
O	Complexity level of the air mission executed	3.72	3.57	3.59	3.53	3.77	3.80	3.75	4.02	3.71	high

Source: Author´s own work

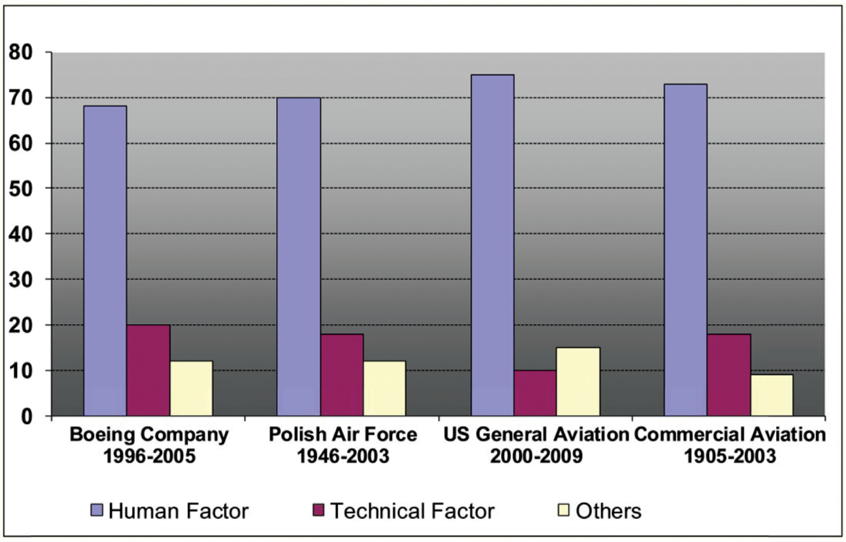


Figure 5 Aviation accidents/incidents factors.

Source: Author´s own work.

Rules and regulations are important for a number of reasons. Without them there would be a total collapse of organized societies today. [10] Taking into consideration above mentioned results of research pilots and another aviation personnel have the highest influence on the aviation safety. Does not matter, if we take them into consideration as an element of the structure of the organization with their area responsibility or single element of the organization e.g. pilot, engineer, air traffic controller, their influence on aviation safety is equally important. The key to their proper activity is continuous readiness to reach and keeping an acceptable level of situational awareness

[1] HF- Human Factor, M – Machine, E – Environment, O – Organization.

CONCLUSION

Pilot SA is one of the most influencing element of the air mission safety level. Because of that, it should be put a special attention on the pilots readiness to keep SA on an acceptable level during the mission execution. To reach such results both aviation organization and pilots should treats SA as a process, state and finally as the base for decision process. The results of above showed research results proven that pilots are aware of their role in the areas connected with SA, especially elements which are crucial for SA evaluation. Moreover, pilots are fully aware of their role in the aviation systems and their influence on the level safety during the mission execution. On the other hand, we can conclude that organization should be a leading actor in the process of pilots continuous training with a special attention paid on SA. The training should give pilots opportunity to create and to develop their knowledge, skills and ability to be resistance on difficulty connected with the air mission execution. That is one of the most important conditions of proper pilots preparation to keeping the acceptable level of SA.

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