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HUMAN FACTORS CONTRIBUTION TO AVIATION SAFETY

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Abstract: *In approximately 75-80% cases of aviation mishaps the main cause were human performance deficiencies. Human error is rather the starting point than the end in the investigation and prevention of aviation mishaps. One of the most popular models for analyzing the human factor and its role in aeronautical activity is the SHELL model. The components of this model are: software, hardware, environment, liveware. The system need for human factors is determined by their impact in two major areas: system efficiency and the health of operational staff. The most important applications of human factors are in the field of preventing and managing human errors through education in the human factors.*

Keywords: *aviation safety, human factors, human error*

1. INTRODUCTION: WHAT ARE HUMAN FACTORS?

The human element is the most flexible, adaptable and valuable part of the aeronautical environment, while being the most vulnerable. Because most aviation incidents and accidents are the result of decreased human performance, there is a tendency to attribute the causes of these mishaps to human error. However the term "human error" does not help in the prevention and investigation of aviation events; although it shows us where the system failed it does not tell us anything about the causes that led to the failure. Also the term "human error" hides the latent factors that should be revealed in order to prevent aviation accidents. For example, errors attributed to individuals may actually be caused by design flaws, poor training, incorrect procedures or operating manuals. In the modern approach to aviation safety, human error is not the end but rather the starting point in investigating and preventing aviation events.

Early concerns in the field of human factors were centered on flight crews and demonstrated the danger of ignoring the human element as a part of the socio-technical system (the aircraft). System-induced errors such as those related to misreading the flight instruments or the wrong selection of cabin contacts were reduced through a better design of the pilot-cabin interface. Understanding the predictable dimensions of human capabilities and limitations and applying this knowledge in operational environments is the main concerns of human factors. Other early concerns in human factors were related to the effects on the human body of factors such as noise, cold, heat, vibrations and accelerations [1, 4, 5].

In time, the study of the human factor has expanded and developed to include aviation maintenance activities. In approximately 75-80% of aviation mishaps the main cause was a decrease in human performance. Aviation engineers and mechanics are subject to the influence of a unique set of human factors that can lead to errors in aircraft maintenance working at heights, in difficult weather conditions, in an environment where the noise level is very high or under time pressure. A scientific paper presented at a conference of the Royal Aeronautical Society shows the growing trend of maintenance occurence of errors per million flights. The number of errors has almost doubled in a period of 10 years (see Figure 1) [3].

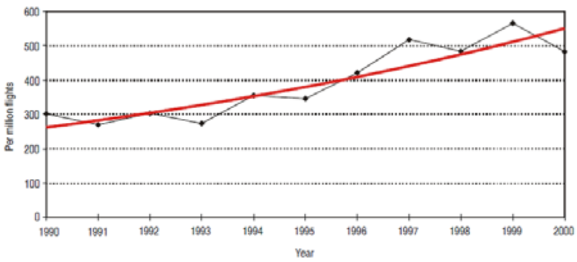

Fig 1. Maintenance occurence of errors per million flights

Research has shown that training in human factors can save money and can reduce the number of incidents and accidents, thus minimizing human casualties and property damage. A civil aviation company reported that following a two-day training program on human factors had a 68% reduction in incidents on the ground, a 12% reduction in work related injuries and a 10% reduction of working overtime. Also, the same company reported savings of about $ 60,000 for that year.

2. SHELL MODEL

For a better understanding of human factors, a gradual approach needs to be taken with the help of the "SHELL" theoretical model. The figure below illustrates this model using squares representing different elements of human factors. The model name comes from the initials of the components: Software (procedures, symbols), Hardware (machines, aircraft), Environment (environment, the context in which L-H-S system works) and Liveware (the human). This model has only a didactic value and aims to facilitate a better understanding of human factors.

Fig 2. Hawkins model

A. Liveware. The center of this model is the human, the most sensitive and flexible system component. People, however, are subject to considerable variation in performance and its limitations, most of which are predictable in general terms. Liveware is the core component of the model; all the other components should be adapted to "fit" with it [3].

B. Liveware-Hardware. This interface is most often considered when talking about man - machine system: designing seats depending on human body characteristics, designing displays depending on the characteristics of sensory information processing, or the cockpit controls with proper control.

C. Liveware-software. This interface is about man and procedures, manuals and checklists, symbology and computer software.

D. Liveware-environment. This interface was among the first addressed. Initially, the first steps were to adapt human to the environment (helmets, flight suits, oxygen masks). After that the trend reversed to adapt the environment to humans by introducing pressurization and air conditioning, soundproofing. This includes also perceptual illusions generated by environment, but also aspects of political and economic constraints.

E. Liveware-Liveware. This interface is about interpersonal relationships. Traditionally, education, training and performance evaluation was done individually for each person. In this interface we are concerned with leadership, cooperation between team members, teamwork and interpersonal interactions. Also the scope of this interface is staff/ management relationships, work climate, organizational climate and the pressures of the organization that may affect human performance.

3. THE IMPORTANCE OF HUMAN FACTORS

About three in four accidents result from human error made by individuals apparently healthy and with the necessary qualifications. The source of these errors can result from improper design of equipment / procedures, from inadequate operating instructions or deficient training. The human and financial costs of low performance have become so big that an unprofessional approach to human factors is no longer possible [3, 4].

The system need for human factors is determined by their impact in two major areas which interact so closely together that factors influencing one implicitly affect the other area. These areas are:

- System efficiency;
- The health of operational personnel.

System efficiency

Safety. To demonstrate the impact of human factors on aviation safety we will present some examples of aviation accidents in which they played a decisive role:

1. In 1974, a B-707 crashed during approach at Pago-Pago in Samoa, with a loss of 96 lives. A visual illusion related to the black-hole phenomenon was a cause factor (NTSB/AAR 74-15);
2. In 1974, a B-727 approaching Dulles Airport in Washington crashed into Mount Weather, with a loss of 92 lives. Lack of clarity and inadequacies in air traffic control procedures and regulations led to the accident. The absence of timely action of the regulatory body to resolve a known problem in air traffic terminology was also listed as a factor (NTSB/AAR 75-16);
3. In 1977, two B-747s collided while on the runway at Tenerife, with a loss of 583 lives. A breakdown in normal communication procedures and misinterpretation of verbal messages were considered factors (ICAO Circular 153-AN/98).;
4. In 1982, a B-737 crashed after take-off in icing conditions in Washington. Erroneous engine thrust readings (higher than actual), and the co-pilot's lack of assertiveness in communicating his concern and comments about aircraft performance during the take-off run were among the factors cited (NTSB/AAR 82- 08) [1].

Efficiency. The need for human factors is not reduced only to aviation safety. Work efficiency is also affected by not applying or lack of knowledge about human factors. Proper placement of displays and controls in the cabin also improves performance. If crew members are well trained and evaluated they will have better performance.

The health of opperational personnel

Among the factors that affect the health of operational personnel we encounter fatigue, circadian rhythm disturbation and sleep deprivation. Other factors affecting the physical or mental health are: temperature, noise, humidity, light, vibration, workplace design and space.

Fatigue. It is considered a condition resulting from insufficient rest, but also a range of symptoms associated with circadian rhythm alterations. Acute, chronic or emotional fatigue can lead to dangerous situations and loss of efficiency. Hypoxia and noise are also contributing factors [1, 2].

Health and performance. Certain pathological medical conditions -

gastrointestinal, heart attacks, etc. - led to pilot incapacitation, and sometimes they result in an aviation mishap.

Stress. Stress is associated with life events, but can occur in situations where mental workload is high, such as taking off, landing or in-flight emergencies.

4. HUMAN FACTORS APPLICATIONS

Human error management. To limit and control human error, we must first understand how it occurs. Error causes are different, as are the consequences of the same type of errors in different situations. Some errors may occur due to lack of attention, negligence, others occur due to faulty design of equipment or may be the result of normal reactions of a person in a given situation. The latter can be repeated, but its occurrence can be anticipated.

Erros at the models interfaces. Each of the components of the SHELL model can be a source of error. Liveware-Hardware interface is responsible for errors due to improper placement of displays and control devices. Liveware-Software interface can generate delays and confusion due to inadequate maps and documents. Errors associated with the Liveware-Environment interface are caused by environmental factors (noise, temperature, vibration, etc.). In the Liveware-Liveware interface the main concern is the interaction between people, since it directly affects crew performance.

Information processing. Perceptual process is a fertile ground for the error. Expectations, personal experience, attitudes, motivation and the level of excitation of the sense organs have a direct influence on perception and can be sources of errors.

Control of human error. Control of human error is performed in two directions. First there is a need to reduce the frequency of errors. This is achieved by ensuring a high level of competence for the operational personnel, designing controls to meet the required anthropometric characteristics, checklists, manuals, adequate maps, noise reduction, vibration and other stress generating conditions.

The second direction in controlling error is to reduce the consequences of persistent human error using cross-monitoring through cooperation between crew members and designing equipment to allow reversibility.

Training and evaluation. Education and training are seen here as two separate elements of the training process. Education encompasses a broad set of knowledge, values, attitudes and skills required to build a psychological skill foundation on which later the professional skills will be acquired. Training is a process focused on the development of skills, knowledge and attitudes specific to a particular job or to the execution of a particular task. Adequate and effective training can not be achieved if through education was not created an appropriate foundation of knowledge, attitudes and skills [1].

5. CONCLUSIONS & ACKNOWLEDGMENT

Knowing how people function is very important in aircraft accident and incident investigation. The main goal of human factors application is to understand why people and organizations involved in design, manufacture maintenance and management of aircraft operations make errors that may have the potential to lead to aircraft accidents.

The purpose of understanding why people make errors is to produce safety reports and recommendations that will help prevent aircraft accidents.

The study of human-machine interaction transposed in theoretical models, like SHELL, helps us to achieve a systematic and thorough understanding of why humans make errors.

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