AN INTERCONTINENTAL REVISE OF EMPLOYEE AND EMPLOYER HUMAN FACTOR ISSUE PUT UP AT AEROSPACE AND AVIATION INDUSTRY

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Abstract

The most crucial aspect of Aviation Industry is Human Factor. Lot of research has been done with considerable amount of effort invested to improve the physical motor skill-centric design considerations. With advancements in AI, human factors such as Hardware/Software, System Performance, Efficiency, Reliability has to be assessed with Employee Working Conditions and Time Constraints to reduce human error. Error is not only caused by the Employees, but also Management, Customers, Passengers, Crew e.t.c. have their share of contribution in it. That's why, prevention and management of Human Errors through awareness and proper training is needed. In this paper, we have analysed real-life accidents based on human errors, explore the different aspects and fields where human factor is relevant in the industry, to minimise human errors.

Key words : human factors, aviation employee issue , aviation passenger

Aviation and HealthCare Post-CoVID Scenario

The practices followed in aviation for improvement in healthcare are discussed here. The human factor (HF) training achievement of airline industry is fillip for the healthcare services. In UK, **PPL** was re-introduced on 13th of May 2020 with strict social distancing terms, following the prohibition of non-essential flying activities. **CAA** and **GASC** issued documents with tools and recommendations to help the pilots with longest period without flying. Personal Currency Checklist,Currency Barometers and Task-O-Meter are some examples. Latest tool advancements through research are also improving to minimise error and improve safety.

Human Factors in Manouvres and Accidents

History

Human factors, as a whole, is a relatively new discipline, arguably with its nascency in the 1940s in the aviation domain. However, it is also a fragmented discipline, drawing upon basic science from psychology, sociology, physiology/medicine, engineering and management science, to name but a few. From an overall system perspective, three generic, antagonistic parameters can be applied to evaluate system functioning: safety, performance and cost. Airworthiness authorities are concerned solely with safety aspects of aircraft design, pilot training and airline operations.

A history of human factors

The The roots of human factors in the aviation domain lie within the work undertaken in the UK and North America during and shortly after World War II. Nevertheless, from the mid-1960s human factors began to make increasingly large contributions, particularly in the three areas of selection, training, and the design of flight decks. From the mid-1940s to the mid-1960s the discipline was essentially building its applied science base, drawing heavily from experimental and social psychology, and aerospace medicine. With increasing knowledge and specialisation, the discipline of human factors began to fragment, with sub-disciplines in human-centred design, training and simulation, selection, management aspects (organisationalbehaviour), health and safety, and so on.

Selection

Even until relatively recently it was reported that, in the USA, 75% of new-hire airline pilots were recruited after commencing their flying career in military aviation. Appropriate and effective selection procedures (especially for ab initio trainees), although expensive, can ultimately save airlines a great deal of money.The The processes and methods for the selection of flight crew particularly began to develop in their degree of sophistication throughout the 1970s. In the 1950s and 1960s airlines tended to rely quite heavily on the military for producing trained pilots. This coincided with a change in the nature of work of the airline pilot. Selection techniques tended to rely on techniques that assume candidates are already trained and competent

Training

Indeed, there is now a mandated requirement for crew training as part of the Airline Transport Pilot Licence (ATPL) syllabus. A great deal of the emphasis was placed upon technical training (e.g.This resulted in a series of intra-cockpit flight crew management programmes being instigated. The failure of the flight deck crew to act in a well-coordinated manner further contributed to this end on many occasions. The advent of CRM training was partly contingent upon a change in training philosophy towards line-oriented flight training (LOFT). This placed emphasis on training to facilitate the flight deck (later whole aircraft) crew acting as a coordinated team. The main cause of these accidents was a failure to utilise the human resources available on the flight deck in the best way possible. how to handle the aircraft's systems or how to fly the aircraft manually) and training for emergencies resulting from a technical failure (e.g.Until Until relatively recently, pilot training and licensing concentrated on flight and technical skills (manoeuvring the aircraft, navigation, system management and fault diagnosis, etc.).

Human factors future trends:

Human factors alone cannot improve the operational efficiency of an aeroplane (Harris, 2006). A wider, 'system perspective' is required. Human factors integration (HFI), which is a sub-discipline of systems engineering, began to emerge as a concept during the 1990s. HFI provides an integrative framework for the application of human factors. HFI originally encompassed six domains that were regarded as essential for the optimum integration of the human element into a system (UK Ministry of Defence, 2001). These were:

• Staffing (how many people are required to operate and maintain the system?)

• Personnel (what are the aptitudes, experience and other human characteristics required to operate the system?)

• Training (how can the requisite knowledge, skills and abilities to operate and maintain the system be developed and maintained?)

• Human factors engineering (how can human characteristics be integrated into system design to optimise performance within the human/machine system – essentially human-centred design?)

• Health hazards (what are the short or long-term hazards to health resulting from normal operation of the system?) and

• System safety (how can the safety risks which humans might cause when operating or maintaining the system be identified and eliminated, trapped or managed?)

• Recently a seventh domain has been added, the organisational and social domain, which encompasses issues such as information sharing and interoperability.

Nevertheless, the opportunity now exists to capitalise on the developments made by this relatively new discipline, which was originally born in the aviation domain just half a century ago. The discipline must also coalesce once again in order that the maximum benefit from an integrated, through-life approach can be realised.Human Human factors as a discipline has come of age. It must, however, avoid its natural inclination to rush to claim the moral high ground by marking its territory solely within the realm of aviation safety. To a large degree, while increasing levels of specialisation have served to develop the science, this has also simultaneously militated against its coherent application in commercial aviation

Human error is the most significant factor involved in CFIT accidents (IATA, 2014). Pilot error has been attributed as the cause of many aviation accidents in the past says the study.An An analysis of human factors in fifty controlled flight into terrain aviation accidents" is an article published in the Journal of Safety Research in the march of 2019. Further in the article, authors discuss about Controlled flight into terrain (CFIT) human error factors, the second most common category of fatal accidents after Loss of Control Inflight (LOCI). The authors used the Human Factor Analysis and Classification System (HFACS) for determining the factors involved in the fifty Controlled Flight into Terrain (CFIT) accidents from twenty-four countries over a period of 10 years (2007-2017). And they re as follows :

• Non-compliance with established Standard Operating Procedures (SOPs).

• Inadequate flight path management.

• Lack of vertical and/or horizontal position awareness in relation to terrain.

• Un-stabilized approaches.

• Failure to initiate a go-around when required.

• Conducting operations in poor weather conditions.

• Incorrect action/response by flight crew.

• Failure in Crew Resource Management (CRM) such as cross-checking, communications, coordination, leadership, etc.

The characteristics of analysed accidents is mentioned in the article (table 2). In the conclusion paper identified the human factors involved with aviation accidents that resulted in CFIT. This research determined that human factors represent a major component of CFIT accidents and human factors were broad in nature ranging from loss of situational awareness to intentional violation of procedures. The model HFACS model is also mentioned in the article by the authors (Table 3) and characterised into four levels.In In the article the authors also discuss about the system of method used in the study of the topic, the study was complete recorded and is provided in the article (Table 1), which included Flight cat, A/C reg, A/C make, A/C model, Type of operation, A/C damage, Fatalities, Phase of flight Impact, VMC/IMC, Light, Pilot in control.

Human factors evaluations of Free Flight Issues solved and issues remaining

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Moreover, the intent-based system is not effective at solving multi-aircraft conflicts. The main focus of these results is on human factors issues and particularly workload, measured both subjectively and objectively. An extensive discussion is included on many human factors issues resolved during the experiments, but also open issues are identified. Expected traffic loads and conflict rates for the year 2020 appear to be no major problem for professional airline crews participating in flight simulation experiments. Detailed results from three projects and six human-in-the-loop experiments in NLR's Research Flight Simulator are reported. Flight efficiency is significantly improved by user-preferred routings, including cruise climbs, while pilot workload is only slightly increased compared to today's reference.Eight Eight years of research, in co-operation with partners in the United States and Europe, has shown that Free Flight has the potential to increase airspace capacity by at least a factor of 3. An intent-based Conflict Detection and Resolution system provides ''benefits'' in terms of reduced pilot workload, but also ''costs'' in terms of complexity, need for priority rules, potential compatibility problems between different brands of Flight Management Systems and large bandwidth.

A A state-based CD&R system also provides ''benefits'' and ''costs''. Studying this CD&R system is still an open issue. This combination of state-based CD&R with a limited amount of intent provides ''the best of both worlds''. Benefits compared to the full intent-based system are simplicity, low bandwidth requirements, easy to retrofit and the ability to solve multi-aircraft conflicts in parallel. The optimal CD&R system has been suggested to be state-based CD&R with the addition of intended or target flight level. Modern navigation no longer relies on flying to and from ground-based navigation beacons, while new technologies are being developed which allow pilots to ''see'' other aircraft electronically. Air Traffic Control became responsible for separation, while navigation beacons allowed navigation without ground visibility. The goal of Free Flight is to provide more flexibility for aircraft operators, while at the same time improving safety and airspace capacity. The definition of Free Flight was from 1999 onwards included in the European operational concept for the future of the ATM system. In those days, visual contact with the ground and other aircraft was required.

Free Flight has been studied at NLR since 1996. The RFS was a generic flight simulator and represented a modern large airliner. The primary focus of the research was to explore human factors issues of the Free Flight concept. The RFS has since the beginning of 2005 been replaced by an even more flexible and versatile Generic Research Aircraft Cockpit Environment flight simulator. GRACE has full interchangeable cockpits , an advanced visual system and an electrical 6 degrees-of-freedom motion system, see Fig. This was done in the Research Flight Simulator by selecting a button on the Control and Display Unit of the Flight Management System on which a ''Workload'' page would pop-up every 2min .

NLR's Generic Research Aircraft Cockpit Environment .

CD&R CD&R functionality of the ASAS system was based on aircraft state information only. This means CD&R uses position plus three-dimensional speed vector information from its own position and other traffic to detect and resolve conflicts. Non-nominal conditions consisted of own and other aircraft system failures and increased delay times in CD&R. PASAS calculates which headings and vertical speeds will result in a conflict with another aircraft within the look-ahead time . Moreover, in case of multiple conflicts within the look-ahead time, the resolution vectors are summed, thereby creating a CD&R system capable of solving multiple conflicts. In the 1997 human-in-the-loop experiment, the traffic density, the level of automation and nominal/non-nominal conditions were varied as independent variables. The result is that intrusions due to sudden aircraft manoeuvres nearby, like an aircraft reaching a top-of- descent, are prevented. Conflicts are detected up to 6min ahead of the aircraft. This results in a so-called ‘‘protected zone’’ around each aircraft of 5 nm and 7950 ft. The implementation defined by the conceptual design and the safety analysis was tested in a human-in-the-loop simulation experiment in 1997 .

NLR/NASA Free Flight experiments. This implies that there are in fact two types of conflicts, a state-based conflict and an intent-based conflict. 14 shows a conflict situation in which the ownship has detected a conflict using the intent-based conflict detection method. The previous human-in-the-loop experiments had one ‘‘human’’ crew involved, while the other traffic was controlled automatically. In the INTENT simulation set-up, conflict prevention indications were provided for both the state-based and the intent-based concept. Based on the conflict geometry and the aircraft flight plans, the resolution module can now determine a route change that will resolve the conflict. Another option to resolve this conflict would be an altitude change in the flight plan of the ownship, as shown in Fig. It is clear from the highlighted loss of separation that the method has taken into account the intent of both aircraft. In 2000, a follow-on experiment was conducted to find the answer to a remaining research question of ‘‘human interaction’’.

Intent-based conflict prevention consisted of an additional function to the FMS, which checked all route changes, either suggested by the pilot manually or by the CD&R system to solve a conflict. When the route change generated conflicts within the look-ahead time of the intent-based CD&R system, the pilots were not allowed to activate this route. The conflict prevention strategy, which was also applied for the conflict resolution manoeuvres, resulted sometimes in the inability of the intent-based CD&R algorithms to find a resolution manoeuvre within the look-ahead time of the CD&R system. This was due to a combination of traffic density and large look-ahead times.

When the intent-based CD&R system was unable to find a solution for the conflict, the pilots had the option to fall back on the state- based CD&R system. When using the state-based CD&R system, the pilots would have to give way to intent-based CD&R aircraft. Within the INTENT project, two human-in-the-loop experiments were conducted in the RFS. The aim of the first INTENT human-in-the-loop experiment was to derive a human operator model for fast-time simulations based on measurements during the simulations and to get feedback on the use of an ASAS incorporating aircraft intent information, used in the en-route phase of flight.

The aim of the second airborne experiment was to validate the outcome from the fast-time simulations and the part-task simulations, extending the scope of the flight to departure and arrival phases of flight.

The experiment consisted of a flight from London Heathrow to Munich . The flight started at cruise altitude just before the Belgian coast, with a planned route to Munich already implemented in the FMS. The route was guidelined and determined by ‘‘the airline’’, but since the flight was performed in FFAS, this route could be freely altered by the crew. Traffic samples were created for traffic density 1, 2 and 3.

In these traffic samples, all traffic avoided the active military areas. The first INTENT simulations clearly indicated the effect of the traffic intent information level .

The second INTENT experiment was a 2 ☐ 2 ☐ 3 within- subjects design varying the following factors

The first flight was from Frankfurt to New York . It started in the climb phase at FL120, with a flight plan to New York already implemented in the FMS. The flight included the climb-out to cruise level and part of the cruise flight. The second experiment flight was from New York to Frankfurt .

Moreover, it is confirmed that workload significantly rises with respect to cruise flight.This This flight started in the cruise phase at FL390 about 10 min before top-of-descent, with a flight plan to Frankfurt already implemented in the FMS. The second INTENT experiment, with focus on climb and descent phases of flight, revealed that the traffic load has a significant effect on the pilot workload and acceptability.

Summary

It has been seen that human errors are mostly responsible for accidents. There were professionally trained and well experienced 4 pilots and the aircraft used was Embraer Phenom 300. Basically human factor errors are based on Reason's model of human error. It analysethe pilot faults, air traffic control errors and investigate maintenance errors in aircraft. Regarding simulation environment, SIVOR flight simulator, a high-tech motion based simulator, built by Aeronautics Institute of Technology and Embraer. Hence, it is mandatory to study critical safety systems to accustom with complex automation systems on board. The 1st one is proposed to study the variable behaviour of the pilot and the 2nd is used to analyse the means and aims to compare the pilots. There was also time limitation of 23secs, as the aircraft would take to reach 1000feet during experiment. The experiment design was based on Design of Experiments theory, stated by Mnotgomery. For statistical approach basically two metrics are used to distinguish pilotsinformation. There are some specific parameters to be noted like, pilot commands, altitude, roll, pitch, true airspeed, heading, linear velocities and angular velocities. Apart from this, some researchers proposed different fuzzy logic, neutral network and clustering techniques to justify the human errors, which later on include FDI to analyse the failure and human factors through clustering and statistical data. FDI and Human Factor analysis The main part of analysis is the system of data processing.In In modern world, flight safety is the top priority for the aviation industry.

Algorithm 1 for standard deviation metric

```
Input: Dataset with all parameters for all flights.
Output: One value for each combination of pilot and maneuvre condition
(12 values).
for each pilot do for each maneuver condition do
 for each parameter do for each time step do Compute the standard devia-
tion.
end for
 Compute the mean of the standard deviation for all time steps.
end for
Compute the mean of the standard deviation for all parameters.
end for
end for
Algorithm 2 for difference of mean metric
Input: Dataset with all parameters for all flights.
Output: One value for each combination of pair of pilots and maneuvre
condition (18 values).
for each pilot do for each maneuvre condition do
for each parameter do
for each time step do Compute the mean.
end for
end for
end for
end for
for each pair of pilots do
 for each maneuver condition do
 for each parameter do
for each time step do Compute the absolute difference of means.
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end for
 Compute the mean of the absolute difference of means for all time
steps.
end for
 Compute the mean of the absolute difference of means for all parame-
ters.
end for
 end for
```

Dimension reduction is done by the principal component analysis, which transforms data in a orthogonal co-ordinate based on data variance.

K means clustering algorithm

An iterative algorithm that assigns n observations to 1 clusters defined by centroids. It requires 3 parameters; number of clusters K, cluster initialization and distance metric. For this experiment, number of clusters that justify is 3, for each different conditions.

Algorithm 3 for K means clustering

Input: Dataset for all flights (after performing PCA) and number of clusters K.

Output: Cluster assignment for each flight.

1) Choose K initial cluster centers (centroids) using the kmeans ++ algorithm;

2) Compute the distance from each observation point (each flight) to each cluster centroid;

3) Assign each observation to the cluster with the closest centroid;

4) Compute the average of the observations in each cluster to obtain K new centroid locations;

5) Repeat steps 2 through 4 until cluster assignments do not change.

Results and Conclusion

For standard deviation metric results, for normal and engine failure condition, pilot 3 has the highest value of deviation (0.49 normal, 0.44 engine failure) and pilot 4 has the maximum value of deviation for flap failure (0.34). Researchers have made an assumption that as the pilot 3 is from commercial airline, he may have hhigh values for deviation than other pilots as they belong from military background and are more accurate and precise. For difference of mean and metric results, high values of this metric condition indicates that there is dissimilarity between the behavior of pair of pilots in performing maneuver. For k means clustering algorithm, out of 72 flights, 65 gains an overall accuracy of 90.28%. From this paper, it is clear that human factors and errors are major cause for accidents in context of failure detection and investigation. From different process of data processing and statistical analysis, we can evaluate and distinguish between human behavior and factors affecting on board and also about their reaction. It suggests importance of human factors regarding flight safety and failure detection

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