Aeromedical Evaluation of Aircraft Accidents Human Engineering Aspects

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Introduction

STATISTICS continue to show an increased incidence of serious aircraft accidents where the cause has been attributed to human factors. Human Engineering aspects responsible for making the factors operative have not always been specifically determined in subsequent accident investigation. This becomes a relevant consideration particularly when the modern aircraft has been manufactured with the guidance of accepted concepts of human engineering design. Various facets of man-machine dynamics, layout of cockpit area, design of control and instruments, environmental control vis-a-vis human capacities, abilities, reaction, time lag, anthropometric variabilities are appropriately considered. General acceptance of these principles is evidenced by the uniformity in grouping of basic flying instruments in various aircraft. However, existence of problem areas due to certain specified constraints and working compromises can not be denied.

What factors cause a pilot to react improperly in a given situation, why he makes an error to set in motion a chain of events leading to an accident or how each error can be eliminated is a complex question defying an easy answer. One constant factor is ever present—the human factor. We can always trust the man for his limitless ingenuity for fantastic discoveries not only to solve problems but also to create new situations.

Inherent and apparently innocuous design deficiencies get magnified by errors of operation, errors of servicing and maintenance, unsafe practices and lead to accidents. Identification and aeromedical evaluation of various aspects with a degree of finality is a challenge to be faced by the investigator.

A few cases have been selected to highlight various human engineering aspects probably operative in aircraft accident and injury causation. An attempt has been made to recommend suitable measures.

Design deficiencies

The deficiencies get revealed only with operational experience on the aircraft. In one of the trainer aircraft in an incident, the heel of pilots flying boot was jammed between the rudder pedal and floor during flight. This was due to uneven floor surface, non-abrasive coating of the floor as well as design of the pedal.

In the same aircraft, the canopy was reported to open in flight. This was due to inadequate operation of the canopy locking lever which has to be pushed forward fully and horizontally. The position of the lever is instrumental in causing inadequacy in operation which continues to be a cause of accidents.

Modifications are easily suggested and accepted by the technical experts after feasibility studies. But in its wake they bring more problems during their gestation period for implementation.

Modification and nonstandard aircraft

Modifications once accepted have to be implemented in a phased manner. The process is time consuming and modifications can not be incorporated in all aircraft at the same time without suspending flying activity. This has resulted in a situation where aircraft with different mod status were being flown in a training squadron. An environment conducive to accidents due to habit interference is obvious and avoidable. It is not difficult to appreciate that no yard-stick could be used to determine habit interference as a causative factor in aircraft accident. Implementation of modifications with speed and uniformity is very desirable.

Maintenance lapse

Couple of years back there were two fatal accidents in a squadron where the pilots failed to eject for apparently inexplicable reason. From the same

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squadron after some time a report emanated that a pilot experienced difficulty in operating ejection seat firing hand grips during practice trial on an unarmed seat mounted on servicing stand. The difficulty in operating was due to the locking wire which was not easily breakable. An investigation followed and the facts revealed were :—

(a) As a design feature it is laid down that effort applied should not exceed 20 Kg force. The specified locking wire to be used gives way at 15–17 Kg force. This is well within the squeeze force likely to be exerted even by a short or thin pilot.

(b) A different type of locking wire which breaks at 28–30Kg force (meant for locking other components) was being used with lack of proper tension.

(c) The supply agency was issuing the higher grade of locking wire as an in-lieu item because of apparent similarity in nomenclature.

(d) The use of correctly specified locking wire did not create any problem in the operation of firing hand grips.

Could it be possible that failure to eject was due to a maintenance lapse during servicing by using wrong locking wire? The practice of using in-lieu items, inherently hazardous even under strict supervision, was prohibited with good result.

Error of operation (Inadvertent operation of switch by wrong selection)

In a fighter squadron there were series of accidents wherein the pilots happened to jettison drop tanks on the runway soon after landing. It was contended that because of emergency tank jettisoning button and tail chute jettisoning button being closely located, inadvertenily wrong button was being operated. Evaluation showed that both these buttons or switches were on different panels, one below the other but with a vertical separation of 10.0 cms, a distinct colour coding and different direction of opening of guard. This much separation is considered too adequate. The remedy lay in blind operation drill which was meticulously implemented and till todate similar accident on that aircraft has not recurred. Another associated problem was that at some places the colours had faded and made the letters unreadable due to lack of contrast. This was also recommended for rectification. In fact the squadron had thought of painting the lower panel red. But timely human engineering evaluation prevented this, which would have nullified the colour coding followed as a design feature.

Inadequacy in personal safety equipment

In a helicopter squadron flying in high altitudes, the pilot is provided with a head set with lip mike. But when supplemental oxygen is to be used he uses an oxygen mask which does not match hence the pilot either compromises with the RT or oxygen inhalation. Local modifications have been done but neither evaluated nor approved. This is an unsafe practice. What is more important is that it may not be possible in the event of an accident to find out whether insidious hypoxia was really a causative factor.

Aircrew–aircraft incompatibility : Anthropometric limitations

Accident investigation is not complete unless both accident causation and injury causation factors for aircraft are laid down consistent with ease of operation of controls, visibility of instruments, outside visibility and ejection safety. Some body dimensions can be altered at will by the individual e.g. abdominal girth, sitting hight and knee separation. Though such changes help in accommodation into a restricted space but these expedients are temporary and undesirable.

Of particular concern is maximum sitting height limitation. Besides causing discomfort in routine flying where the pilot has to adjust to read the instruments or do with partial cut off of some instruments, maximum sitting height has an important bearing on vertebral injuries during ejection when overhead firing handle is used. If the sitting height exceeds the maximum specified, there will be induced neck flexion. This is an aspect meriting serious thought and proper investigation.

Conclusion

A few cases have been presented to highlight some human engineering aspects in aircraft accidents and their evaluation. It will be appreciated that certain factors which are known to exist but how much role can be ascribed to these in the causation of an accident or injury has to be a conjecture. We have yet to quantify stress, reaction time or habit interference in such terms which can be utilised for prevention of an accident. However, recognition of the factors and implementation of remedial measures will help us progress towards the aim of improved flight safety.