Human Aspects in Air Safety

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As a person connected with the regulatory authority of civil aviation in India, my paper takes a bird's-eye-view of safety in scheduled air transportation in India during the past two decades or so, on a systems concept, touching on some of the relevant factors that affect safety particularly the human aspect. With rapid advance in aeronautical science and related fields, accident investigation has to cover the entire field with specialists from various subjects, including aviation medicine. We need the assistance of specialists like you at all stages *i.e.* from initial stage of recruitment to operations, research, training, safety measures and investigation of accidents, so as to reduce accidents and improve safety.

Safety in transport, particularly air transport, depends to a very large extent on human ability in achieving acceptable degree of safety levels. It has been repeated often that if any one wants 100% safe aeroplane, it should remain on ground. But this does not serve the purpose for which it is intended *viz.*, carrying men and material from one place to another. By acceptable degree of safety levels, I mean we should be very clear in our minds, how much a society is prepared to spend so that the main important aspect viz., travel is not over burdened as to defeat the very purpose of its functions. I am emphasising this because people tend to ask for air safety at all costs and this is not practicable. It must be borne in mind, that major air disasters bring in glaring publicity and at such emotional moments there is a very strong urge to succumb to public pressures immediately. However, after rational thinking, in the context of the nation's economy, a balanced reasoning enables the authorities concerned to take a dispassionate view of the whole question. I am not trying to say that in India we have already achieved the highest level of safety in civil scheduled air transportation. There are a number of ways of looking at the problem of safety in air transporation such as fatality per million aircraft hours flown/number of landings/ passenger kilometres flown. I would prefer to present the data in terms of fatalities per million passenger kilometres, since the number of fatalities is a measure of the damage inflicted and the passenger kilometres is a measure of utility of air tracasportation as a system. Figure 1 shows the trend of safety level for the last twentyfive years based on moving average of passenger fatalities for 100 million passenger kilometres. I have resorted to this form of presentation, as in a number of years we had no accidents whatsoever and suddenly we had a few fatal accidents distorting the entire picture, so that it would be rather difficult to arrive at a trend. From this figure, there is a clear indication that safety levels are improving in India.

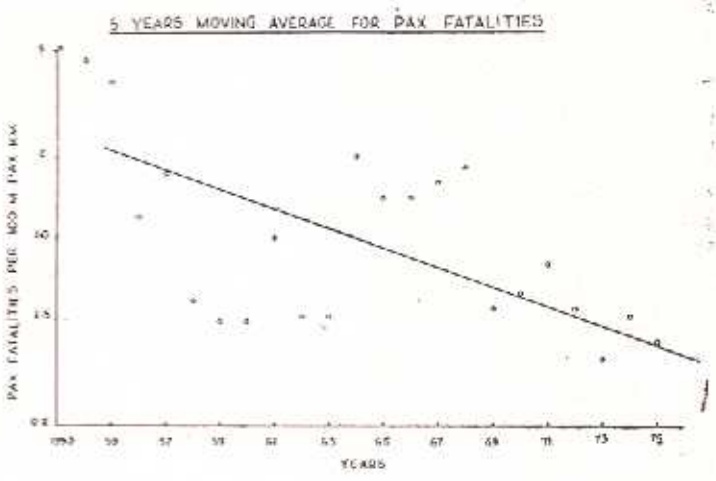

Fig. 1

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Continuing improvement in safety has been noticed even in the world air transport, the number of aircraft accidents as such has come down substantially, but the fatalities tend to increase in view of the larger capacity aircraft. However, the passenger kilometres travelled also increased substantially thereby reducing the fatalities per 100 million passenger kilometres.

It must be borne in mind that after independence and in the early fifties mainly Dakotas were in operation in India. Even though this was a very highly reliable aircraft compared to many other aircraft during that period, the basic design concept *i.e.*, the ability to continue the flight after the failure of an engine in any phase of flight was not provided. In the current aircraft modern navigational aids, concepts of maintenance and other aspects have produced overall improvement in flight safety.

In air transport operations there are many agencies and sub systems that go together to provide air safety as a whole. The airline management, civil aviation department, aircraft design, meteorological services, A.T.C., navigational aids, training methods, inspection and maintenance methods, aviation medicine, etc., have all their interplay so as to provide finally what we regard as air safety in air transportation. Since over 50% of the accidents have been attributed to flight crew error, there is generally a tendency to jump to the conclusion that pilot error is the cause of most of the accidents. I would rather prefer to say that the cause of the majority of the accidents is due to human error as human error could well occur from the initial drawing board stage of aircraft or aero-engine or any system or any of the agencies referred to earlier.

In this connection it would be interesting to refer to the data presented to the Istanbul Conference of IATA based on the analysis of air transportation accidents during 1962 to 1971.

A.T.C., aircraft design	...	15%
Crew	...	62%
Material, system	...	8.5 %
Sabotage	...	6.5 %
Weather	...	4.5 %
Maintenance	...	3.5 %

Looking at the above statistics, human element seems to be responsible in 80% of the cases and thus the contribution of human factors other than crew is quite substantial.

I would like to cite a few examples where accidents were caused by human error other than pilot error. The DC-10 crash in Paris in 1974 is an example of human failure in design, manufacturing and certification processes. Failure of designers to design a sound cargo door latching system, failure of manufacturer to act on the complaints received from operators and failure of FAA to issue Airworthiness Directives after a cargo door failure, combined together and lead to the serious catastrophe in Paris. Similar human failures were also noticed in major incidents caused by turbine blade failure in Boeing 747, fatigue failure of wing support in Beechcraft F18S and many others. Many of us, I am sure, would remember the fate of the Comet aircraft which faced serious problems of fatigue failure leading to major mishaps. Rapid advancement in the field of air traffic control has placed enormous responsibility on the air traffic controller. Human failures in this area too, have led to major accidents and fresh in our memories is the collision of two Boeing 747's in Tenerife, Canary Islands on March 27th, 1977.

There have been instances in this country of aircraft accidents caused by human error, other than Pilot error. I am quoting these instances as I had close association with the investigation as an Officer of the R & D Directorate of Civil Aviation. One such, is the accident to Hiper-DC-3 aircraft in early sixties. Investigation by the R & D Directorate of the Civil Aviation Department disclosed that one of the causes of the accident was improper/incorrect rigging of the rudder bungee system. Because of the incorrect rigging the rudder got into a rudder lock condition which led to the accident. This accident was, therefore, partly caused by human error in maintenance. Another set of examples are the accidents to two Pushpak aircraft in the sixties. Detailed investigations by the R & D Directorate showed that the accidents were caused by fatigue failure of the lug to which wing rear strut is attached. It was established that the fatigue failure was due to an undercut in the lug at the place where it is welded to the front strut. This could be diagnosed as a human error in design/produc-

tion. Yet another instance is the spate of inflight failures of fuel pumps on Caravelle aircraft and other aircraft in 1965. Investigation by the R & D Directorate showed that this was due to sulphiding of the silver plating on the plunger face in the fuel pumps. The investigations by the Directorate also proved that the sulphiding was due to the contamination of fuel on the one hand and on the other, due to omission by the engine manufacturers to specify suitable test for the turbine fuel to be used on these engines. Therefore these accidents are an instance of human failure in the system.

Adequate attention has not been paid in going deeper into the causes of pilot error in order to establish whether any particular trend could be discerned from analysis of these accidents attributed to pilot error. In this connection, I would like to refer to the analysis of the National Transportation Safety Board which have given the following causes for pilot error in USA.

Unprofessional attitude and behaviour	47%
Visual Perception Misjudgement	19%
Pilot technique	21%
Inflight judgement or decision	5%
Improper operation of equipment	6%
Unknown	4%

An interesting study had been undertaken by a team of scientists of NASA to dwell deeper into pilot error related accidents from the data already available in the accident investigation reports of NTSB. They have enumerated as many as 48 parametres and made a detailed computer analysis and have been able to obtain certain trends in some of the cases. Thus, in my opinion, a scientific approach is essential for a systems safety study for the system as a whole. This also includes aero medical aspects.

We have periodic medical tests for pilots and the Airlines have their own preflight check. I am not sure of the extent of examination that can be carried out, as it would be rather impracticable to go into detailed investigations within the time frame available. I wonder whether medical field would be able to provide a satisfactory answer, either for pilots or for managerial personnel or ATC or maintenance crew, as to why a particular decision is taken at a critical phase of operation which could ultimately result in an accident, though they are medically fit. I understand, various tests are available in order to find out the condition of a person at moments of stress or after physical exercise. Would these give a clue as to the reasons for a wrong decision taken by any of the personnel during the critical phase of operation? I leave this open to the medical specialists here to ponder over and suggest a solution, if possible, to this problem.