Original Article

Human factors in helicopter and transport aircraft accidents in IAF

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ABSTRACT

Between 1990 and 2000, IAF has lost 23 aircraft due to human error accidents involving helicopters and fixed wing transport aircraft these have occurred despite there being multi-crew on board, redundancy of resources and existence of detailed SOPs. This study identifies various human factors, which led to these accidents and suggests few measures to minimize such accidents.

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KEY WORDS: Aircraft accidents, Human factors, Human error accidents

Human error took its first toll when Icarus tried to fly with wings fixed to his body. In his enthusiasm to fly he did not consider the effect of high solar temperature on his wings. Ages **Met**, Piiatre de Rozier and Ramain disregarded the advice of Prof Charles; besides being overconfident, Iiey erred in not carrying out proper preflight checks, inadequate pre-flight planning, flying beyond their capability, false assumptions and desire to show off. .After the invention of aero plane, aviation technology has advanced enormously. Over the years the aviation accidents have reduced in number as a result of technical advances and operations related improvements. However, the 'human' flying the aircraft continues to remain a limiting factor. Over die years accidents have been occurring with regularity. Repeated studies into the human factors in these accidents have revealed similar human errors. **h** suggests the need to understand why an individual behaves in certain manner under the given circumstances. Such an understanding can be then utilized for effective prevention of accidents...

This study was undertaken to determine the incidence and analyze the contribution of 'Human Factors' in causation of aircraft accidents in non-fighter aircraft i.e. helicopter and transport aircraft in IAF. The period under consideration was 1990 - 2000.

Methods

The data pertaining to the period May 1990 - May 2000 was retrieved from the computerized database at 'Directorate of Flight Safety', Air HQ. In addition, the documentary records of the COI proceedings were perused to know the details of the accidents. The human factors were identified on the basis of these proceedings

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Results

During the 10 years' period from May 1990 to May 2000, there were a total of 23 accidents involving transport / helicopter aircraft (Table 1). This means, on an average, 2.3 aircraft were lost per year. Out of these, 07 involved fixed wing transport aircraft and 16 involved helicopters. Table 2 shows the relative incidence of accidents of various types of aircraft. Table 3 shows the incidence of accidents vis-a-vis nature of the mission. Table 4 shows incidence of accidents with respect to the phase of a sortie. Table 5 shows the rank of the captain of the aircraft. Table 6 shows the experience of the captain in terms of hours flown on all types, total solo and solo on type. Tables 7 and 8 enumerate the human factors / errors identified in this study.

Discussion

According to International Civil Aviation Organization, "Human factors are about people in their working and living environment, about their relationship with their equipment, procedures and the environment. Just as importantly, it is about their relationship with other people. Its two objectives can be seen as safety and efficiency"[l]. 'Human Error' has been defined in the following manner [2]: "An inappropriate / undesirable human decision or behavior that reduces / has the potential for reducing the safety, effectiveness or system performance." Several schemes for classifying errors have been proposed by different authors, e.g., Rouse and Rouse, Rasmussen, Ramsey, Sanders and Shaw. They differ in their degree of specificity and generality across different domains. Irrespective of the classifications, it is essential to understand how an accident takes place, and where do these human factors fit into the sequence. *J Reason* gave a theory of accident causation, which identifies psychological precursors and unsafe acts in the chain of an accident [3].

Accident Causation Theory

Psychological precursors or preconditions are potential sources of a wide variety of unsafe acts. Whether certain precursors will lead to an accident

Will depend upon the complex interactions between the tasks to be performed, the particular dynamic environment and the dangers and handicaps present at that particular time. Any psychological precursor can lead to a large number of unsafe acts. Few examples of these precursors are: inattention, undue haste, stress, high workload situation, insufficient demands and over zealousness. Unsafe acts are the acts performed by the frontline operators and are the obvious cause of accidents and incidents. Some of these are: attention failures like intrusion, omissions, reversals, disordering and mistiming; memory failures like omitting planned items, losing and forgetting intentions; judgment failures like misdiagnosis, misperception of hazards, corner cutting, etc. It can be inferred that starting with fallible decision; we proceed through the line management deficiencies and the psychological precursors to the unsafe acts committed by the front line operator. An unsafe act is always the last element in a chain that starts with latent failures. Further, all complex systems have defenses, normally built up during the life of the organization as it learns from previous accidents and incidents. But time and again there always turns out to be a hole in these defenses called a 'limited window of accident opportunity'. A complex combination of latent and active failures is necessary for the trajectory of accident opportunity to find a hole in each and every plane in the entire defense layer. As per Reason's model, it is obvious that the chances of a particular active error or a particular broken down defense leading to disaster are very small, but unfortunately, very unpredictable.

The present study revealed the following facts:

(a) Type of aircraft (Tables 1, 2). 16 out of 23 accidents involved helicopters of various types. Amongst all these aircraft, Chetak / Cheetah together were involved in the maximum 110) accidents. This incidence is directly related to the high frequency of operations, operations in difficult (hills, desert) terrain and unpredictable circumstances. Avro / AN-32 were involved in 06 accidents which is only second to the Chetak / Cheetah. This is also directly related to the high frequency of operations of these aircraft in the fixed wing variety.

(b) Nature of sortie at the time of accident (Table 3). 08 out of 23 accidents occurred during training sorties. It is in consonance with the fact that a trainee is an inexperienced person on board. In the present data, these accidents happened due to lack of skill and inadvertent acts of commission or omission. 07 of the 23 accidents occurred during routine sorties and 04 occurred during recce. 02 AN-32 aircraft were lost during a dark night paradrop sortie. In this freak accident, one aircraft failed to remain with the formation and later tried to correct his position without communicating with the other aircraft of the formation. The second aircraft perceived that he had failed in formation keeping and tried to 'correct' himself in the new situation. He failed in corroborating his position with respect to the aircraft ahead of him. In other words, one erred in formation keeping and the other perceived it as his own error. Both tried to correct their positions within their own frames of reference. This occurred in dark night formation flying, which demanded high degree of vigilance on part of all aircrew in monitoring their position. In terms of Reason's model, errors at multiple levels aligned to provide a window to the accident trajectory. 02 accidents occurred during SAR missions. One of them was due to poor visibility. The other was due to over zealousness in taking off shortly after a prolonged sortie, overlooking the implications. This overstressed the machine and caused the crash.

(c) Phase of flying at the time of accident (Table 4). 08 of the 23 accidents occurred during landing or while approaching for landing. It is well known that the take off and landings are the most crucial phases of flying. But an equal number of accidents during level flying or cruise highlight the fact that a high degree of pre-flight planning and situational awareness is required even in level flying of transport / helicopter aircraft. This is required especially in helicopter flying, in view of the 'not-so-well-defined' and labile environment. 02 accidents (helicopter) occurred during hover phase. One accident each occurred at transition after takeoff, ultra low level flying and formation flying.

Human errors (Tables 7, ***8).*** All these accidents were just a repetition of the history of human errors (HE). The present study also revealed that the experience of the pilot, existence of SOPs, redundancy of resources and support services could not prevent all the accidents. Table 7 shows the list of errors identified in these accidents. These errors as named by the courts of inquiry are shown in Table 8. Inattention contributed to 06 accidents. Inattention as a causative factor was glaring in two accidents. In one AN-32, all aircrew were engrossed in maintaining the direction while ignoring their vertical position and repeated warnings by the GPWS. This was a case where 'unsafe acts' of each aircrew provided a 'window of opportunity' for the accident to happen. The trajectory of accident could have been interrupted, if even one of the aircrew could have paid attention to this warning. Similarly, in one Mi-8, the multiple unsafe acts completed the chain to cause an accident. In this mission, the aircraft was on border recce, with BSF staff on board. An unexpected sighting of suspicious boats captured the attention of all the aircrew because it was different from the routine task of flying. All of them forgot their primary job i.e. to maintain good look out and fly the aircraft safely. Further, to fulfill the requests of BSF staff, aircraft was flown at ultra-low height against SOPs. The last straw was the lack of proper communication between pilot and co-pilot at the time of handing over of controls.

Poor flying technique contributed to 06 accidents in the form of poor observation of system. For example, two AN-32 aircraft collided when one of them did not monitor his position visa-vis the others in the 3-aircraft formation and tried to realign itself on the basis of unreliable external visual cues in dark night flying. Poor flying skill has also manifested in this study as failure to execute a procedure correctly in the face of flying emergencies in the critical phase's viz. hover or landing, leading to inadvertent operation of certain controls.

Judgment failure of pilot has been noticed in 05 accidents i.e. the pilot had to choose between more than one options, but his choice turned out to be hazardous. For example, one helicopter was flown despite low fuel warnings, hoping that they would be 'able to make it' to the base, but flamed out on approach. Two helicopter accidents occurred due to steep approach at a high rate of descent at a helipad. One IL-76 aircraft scraped trees during missed approach procedure. One helicopter accident occurred due to late realization of sink of the aircraft due to excessive AUW.

Poor pre-flight planning was the contributory factor in 05 accidents in the form of hasty pre-flight checks, wrong calculation of AUW and last minute changes of sortie profile.

Spatial Disorientation (SD) precipitated the situation in 04 of the HE (A) accidents. The SD was due to poor visibility in three cases and due to unrecognized drift from the course in one case. In two of these 04 cases, SD remained unrecognized till impact and in the other two, the recognition of SD was too late to recover from the situation.

Indiscipline caused 04 accidents. This was in the form of disregard for SOPs, pre-flight briefings and adventurism. All the 04 accidents were of helicopters. The flexibility available in helicopter flying probably proved 'tempting' for the aircrew to try the unscheduled actions e.g. one helicopter was flown below prescribed height in order to take a photograph of the landscape from a particular perspective, causing fouling of aircraft with electric cables! These accidents reaffirm the need of sticking to flight plans and SOPs.

Loss of situational awareness (LSA) could be identified in 03 of the accidents. This was in the form of failure to monitor the parameters necessary for safe flying.

In 03 accidents, supervisory failures started the process of latent failure as described by Reason. The unsafe acts of the pilots completed the chain that culminated in these accidents.

In one accident, despite recognition of SD due to poor visibility, pilot hesitated in abandoning the mission and entered an irretrievable situation.

In one Mi-8 accident, non-standard communication between the pilot and co-pilot during handing over of controls at ultra low altitude, proved to be the last unsafe act. As a result, there was loss of control of aircraft at a critically low altitude.

Recommendations

Although technological advances can compensate for various human errors, yet the human component of the man-machine loop remains the weakest link. For example, a GPWS

Alerts the aircrew, but aircrew may fail to take corrective action; detailed SOPs exist but the aircrew decides to flout them. The question is how to prevent the recurrence of similar type of errors and accidents, which have been replicated over the years. In terms of Reason's theory on accident causation, both psychological precursors and unsafe acts need to be minimized. The psychological precursors can be reduced by selecting 'more suitable' personality for the pilot's task. Secondly, these can be minimized by better supervision and training to prevent psychological precursors like undue haste, over zealousness etc. It may be proposed that the first step should be to select right type of candidates for the job of piloting. Presently, the selection process utilizes personality inventories as a means of screening individuals, but these are more directed towards screening out psychopathology' rather than selecting for the characteristics associated with effective group function. This implies the need for better techniques of selection based on thorough job analysis. Any limitations of the psychological screening can be overcome by better training. The 'unsafe acts' can be prevented by altering behavior and by reinforcing desirable behavior. This is possible through 'real feed back' about in-flight behavior of a pilot. Presently, the aircrews are expected to learn from others' experiences that are shared through discussions, journals, seminars, workshops, etc. But these are unlikely to bring a long term change in one's behavior. It is highly probable that a pilot would have manifested similar errors in the sorties before the last accident happened. But those errors went unnoticed because accident did not happen due to in-built defenses of the system. In a multicrew aircraft, captain is involved with the primary task of flying. It is not possible for him to monitor / supervise the other aircrew. /. would be worthwhile to use the method of 'audio-visual feedback' from some of the sorties flown by the aircrew. These may reveal the crew behavior and their 'weak areas'. This would be akin to LOFT (Line Oriented Flying Training) used for training in commercial aviation. This is likely to be more beneficial than a feedback provided by others, because it is not easy to discount it if one sees oneself. Such feedback can be used to train the transport aircrew on better utilization of cockpit resources. It needs no emphasis that such feedback would have to be confidential and non - punitive.

Conclusion

This study revealed that in last 10 years, IAF has lost 23 aircraft of non-fighter category due to human factors. Aviation accidents due to human factors like judgment failure and spatial disorientation cannot be eradicated. But the human factors like inattention, poor flying technique, indiscipline, supervisory failures and communication errors can be reduced by a more scientific approach to the selection of aircrew and behavioral modification (individual and group behavior) through continued and effective feedback and training. The latter is applicable to everybody involved in planning, operation and supervision on ground as well as in air. In the modern age of technology, it is desirable to use innovative methods for such feed back and training. Any investment towards this will yield rich dividends in the long run.

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Table 1 Type of aircraft and incidence of human error (HE) accidents

Category of ac	Type of ac	Incidence
Fixed wing ac (N=7)	AN-32	5
	AVRO	1
	IL-76	1
	Chetak	6
	Cheetah	4
Rotary wing ac (N=16)	Mi-17	3
	Mi-8	2
	Mi-35	1

Table 2
Relative frequency of HE accidents between different types of aircraft

Type of aircraft	No of accidents (HE)
Chetak	6
AN-32	5
Cheetah	4
M-17	3
Mi-8	2
Mi-35	1 ,
AVRO	1
IL-76	1

Table 3
Nature of sortie and incidence of HE accidents

Nature of sortie	Incidence
Training	08 (34.8 %)
Routine sortie	07 (30.4 %)
Recce	04 (21.7 %)
Dark night formation flying	02 (08.7 %)
SAR	02 (04.3 %)

Table 4
Phase of sortie at the time of accident

Phase of sortie	Incidence (N=23)
Landing / Approaching for landing	08 (34.8 %)
Cruise / Level flying	08 (34.8 %)
Take-off	02 (08.7 %)
Hover	02 (08.7 %)
Formation flying	01 (04.35 %)
Ultra-low level flying	01 (04.35 %)
Transition to turn after take-off	01 (04.35 %)

Table 5 Rank of the captain

Rank	**Incidence**
Fit Lt and below	10 09 03
Sqn Ldr **Wg** Cdr	01
Gp Capt	

Table 6 Experience of the captain

	Solo on type (far)	**Total Solo (hr)**	**Total Hrs**
Range	230-2410	280-5248	540-8051
Median	1522	1547	2767

Table 7 List of human errors

SI. No.	**Human errors**
1.	Inattention
2	Disregard to briefings / SOPs
3.	Judgment failure
4	Crew monitoring failures
5.	Spatial disorientation
6.	Wrong calculation of or excessive 'all up weight'
7.	Hurried pre-flight checks causing inadvertent control operation
	Inappropriate response to in-flight emergency
9.	Poor judgment about fuel causing flame out
Id	Supervisory failure
11.	Overstressed the machine
12	Coning of attention of all crew to an event at the cost of primary task
13.	Communication errors
14	Diffusion of responsibility / Poor crew-coordination
15.	Lack of response to the warning system
16.	Hesitation to abandon the warning system
17.	Inadvertent operation of a control (fouling)
18.	Failure to cross check position in formation

Table 8 Incidence of human errors (as identified by courts of inquiry)

SI.	pe of *human* error	Incidence
	ıttention	6
	or flying technique	6
	dgment failure	5
	or pre-flight planning	5
	atial disorientation	4
	liscipline	4
	ck of situational awareness	3
	pervisory failure	3
	sitation to abandon the mission	1
	mmunication error	1