# The New Generation Cockpit : A Boon or A Dilemma

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***Modern cockpits offer tremendous change in terms of automation,system protection and cockpit displays. Yet recent accidents show that more automation does not automatically improve safety. Automation leads to new problems like reduced workload and boredom, reluctance to change to manual mode in case of malfunction, inadvertant incorrect selection of switches and controls and many other problems/dilemmas. There is a need to ponder more critically on operational significance of changes in design concepts and training curriculum for pilots.***

**Keywords :** ***Primary Flight Displays (PFD), International Air Transport Association (IATA), Wind Shear, Cathode-ray tube (CRT), Glass Cockpit.***

In the Aviation industry, during the last few years, there has been a tremendous change in automation, system protection, cockpit displays etc. Innumerable types of computers perform various tasks. Crew complement has been reduced from 5 to 2 in the past 30 years. The human pilot is in this environment and is expected to be the master of the situation at all times and operate the aircraft safely and efficiently under all conditions of failure and environment.

Modern transport aircraft are extremely expensive. To meet the demand and overcome airspace congestion, larger aircraft with enormous passenger capacity are on the cards and are expected to fly in the near future. These are the future full passenger deck aircraft from various manufacturers. Technology improvement with redundencies has brought in improved safety of operations and economy. Inspite of all this, accidents continue to occur. For example, among the modern glass cockpit technology aircraft, the casualties have been three A320 aircraft (Air France, Indian Airlines & Air Inter), a Lauda B767 and the recent Thai A310 near Kathmandu.

According to IATA statistics, nearly 80% of the accidents occur during the phases of take off, approach and landing. A large number have been attributed to human error. With so many accidents to modern aircraft, a time has come to assess if we are giving adequate opportunities for the human pilot in the centre of these modern cockpit to operate the aircraft safely keeping in view the limitations of human performance.

A pilot uses his various sensory perceptions and movements to analyse the situation and reacts using his hands and feet. Curiosity and attention are basic human traits. A flight is always a dynamic situation. The cues that are available to the pilot to handle any situation are most important for immediate action thereby improving safety.

In the modern cockpits instead of the earlier maze of instruments, we have a few CRTs. Instead of the earlier large number of toggle switches and relay switches with their own special sounds during operation, we now have push button switches with light indications. Instead of the earlier dual control wheels, we now have a neat, generally wrist operated, side stick controls in some aircraft. Instead of the earlier sounds of engines that could be made out clearly, the sound-proofing has reduced sound levels to a very great extent. Instead of earlier moving auto throttles, we have now static fixed detent thrust levers in modern aircraft. There are many more changes and new design concepts. Modern cockpits look beautiful. Are they pilot friendly?

Improved automation and modern cockpits have a lot of advantages and are a boom in many ways.

The flight Management System which automatically controls flight path and speed using auto pilot and auto throttles and the associated detailed navigation display have reduced crew workload during cruise considerably.

Displays of system status and performance with auto changeover to alternate systems in case of failures followed by checklist actions being displayed on the CRTs are excellent in terms of improving safety and reducing crew workload.

A lot of information on the CRT called primary flight display gives the pilot almost all information to fly the plane. Eye movements are reduced compared to the movements needed in earlier aircraft.

Improved autoflight, auto throttle and auto land systems with good flight and navigation displays reduce workload and improve monitoring capabilities during very low visibility category II & III operations. Diversions can be minimised improving economy.

Engine computers controlling the thrust output to be within maximum acceptable limits for the existing environment at all times, improve engine health and life.

Computers limiting the flight envelope in terms of bank limits, pitch limits, speed limits etc, improve safety tremendously.

There is considerable reduction of workload during all normal flight situations.

Most of the flights in a pilot's career are normal with minor or a few problems such as an engine failure, a system failure etc. These are routine and the pilot is trained to handle these.

A computer can be programmed. It will follow commands in a dumb fashion. A pilot is not a robot and cannot be programmed. A pilot can only be trained. Environment is always different. Does the modern cockpit pose a dilemma to the pilot under certain circumstances? Few of these problems will be discussed briefly.

With the present degree of automation and reliability, problems can develop. With long comparatively idle periods with reduced workload, boredom can reduce alertness, quality of observation and reaction time. How does a pilot react to an unusual situation at a critical time if this arises after a long uneventful flight?

Due to good reliability of auto systems, a reluctance to change immediately to manual mode in case of malfunction is a definite possibility.

Multifunction switches, controls & displays reduce clutter, but inadvertant incorrect selection leading to unsafe situations can not be ruled out. Location of controls is also very important.

Pitch Angle Protection : In some of the new aircraft, computers limit the angle of attack to prevent a stall. In an adverse situation, if a pilot pulls the stick back to get a higher angle of attack, but below the stall, the computer may prevent such angles and if aircraft has a tendency to go beyond programmed limits, the computer may even pitch the plane downwards. How would a pilot react if aircraft response is against pilot's thinking and actions?

**Table : Flight Information on Primary Flight Displays**

| | AWY<br>TRM | SHT<br>EDA | WAY<br>PT | INS | POSITION/FREQ<br>COORDS | (TRT) | DIS | EET<br>ETA | RETA<br>ATA | FL<br>GS | WIND<br>AT | ACWT<br>CBO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | GBW<br>336 | 074<br>208 | PG<br>N26 | 57.0 | /114.30<br>E064 08.0 | (336) | 098<br>... | 0.11<br>.... | ...<br>... | 310<br>504 | 04020<br>30 | 3301<br>0309 |
| (2) | VA4<br>261 | 150<br>310 | SIV<br>N39 | 47.4 | /114.2<br>E036 53.6 | (267) | 200<br>.... | 0.25<br>... | ...<br>... | 350<br>473 | 30024<br>47 | 2861<br>0749 |
| (3) | B33<br>308 | 104<br>332 | CAG<br>N45 | 08.4 | /338.0<br>E024 41.0 | (311) | 058<br>... | 0.07<br>.... | ...<br>... | 350<br>494 | 19005<br>50 | 2692<br>0918 |
| (4) | UB6<br>328 | 033<br>350 | BATTY<br>N50 | 39.0 | /<br>E005 51.0 | (325) | 002<br>... | 0.00<br>.... | ...<br>... | 350<br>503 | 22056<br>50 | 2506<br>1104 |

Engine thrust limit protection: Earlier aircraft had part throttle engines. Pilot had to set required thrust limit when needed. If throttles are moved forward to the gate, thrust limit would be exceeded. Now, computers limit thrust even if levers are moved to the gate. In case of severe wind shear close to ground or during a microburst encounter, if the pilot needs more power for survival, there is no way for the thrust to be increased beyond computer ordered limits. There are earlier examples of aircraft surviving by using power beyond normal limits. .

On the primary flight displays, there is a lot of flight information and written information. To read this and understand it fully, eyes must move from left to right and line to line. Many crew were asked to look at the bracketed figures in the centre of top lines of few pages of a flight plan (Table). Everyone remembered the figures and their order. But none could say what lies either to the left or right of the figure even on the same line. With so much of writing on the PFD, unless one reads everything written, it cannot be seen and understood. Mode changes are indicated on PFD. If an inadvertant subtle change occurs, it can be noticed only when pilot reads that mode and this may not be immediate.

Static thrust levers : One manufacturer having static fixed detent thrust levers has already generated a discussion. Some other manufacturers have retained moving auto throttles, as they feel it is too important a cue to be removed from a pilot.

Designers are extremely intelligent people. They do take care and spend a lot of time and effort and money to develop systems, which they think are best in the interests of safety and economy. But differences in design concepts of various manufacturers clearly show that concept of safety is different from manufacturer to manufacturer.

Designing and test flying with thorough knowledge of system design and line flying with only "need to know" knowledge of systems cannot be compared in any manner whatsoever. In addition to various other tests, even though nearly 1500 to 2000 hours of flying are carried out before certification, the large number of modifications that are carried out by manufacturers after certification based on operational experience in airlines, indicate that it may not be possible to test everything prior to certification. Airline operators could be the major research base for manufacturers.

Training curriculum even for new technology is developed after a lot of careful thought and anticipated possible emergencies. Everything that can occur during a flight can not be simulated or practiced. Pilot reaction to an untrained situation at a critical time cannot be forecast. Experience to a great extent helps towards improved safety.

Because of similarity in design of cockpit and operational procedures, there could be a future thought for common ratings to fly 2 & 4 engined aircraft of the same manufacturer. No. 2 engine is on the right in one and on the left in the other aircraft. The consequences in case of incorrect handling on a change over after a long time on one type can be imagined.

Majority of flight crew and senior operations personnel in civil aviation would be aware of some of these following accidents & incidents :

1 An L 1011 accident in Everglades (USA) on approach: A gear unsafe light drew the attention of all the flight crew when gear was selected down during an approach to land. All of them were busy attending to the malfunction, trying to get landing gear into a safe configuration for landing. During this period, the aircraft continued its descent unmonitored and crashed well short of the runway into marshy land.

2 A Boeing 747 SP went into a spiral dive from 41000'. An engine failure which occurred drew the attention of all the crew. When that was being attended to, the aircraft went into a spiral dive. During the pull out, excessive loads imposed on the structure caused serious damage to the structure of the aircraft.

3 A Boeing 737 on a non precision approach in very poor visibility crashed killing all occupants. The minimums were 320' above aerodrome elevation. There were trees in the approach path reducing this clearance. After reaching the minimums, the aircraft continued descent and crashed into the trees.

Was diverted attention cause of all the above?

4 A Boeing 737 400 crashed on approach short of runway. When certain engine problems were experienced during climb, the wrong engine had been shut down. Diversion to the nearby home base was selected. Descent to that airfield was with low power on the live engines. When engine thrust was increased on that engine on short final to sustain flight path, the engine failed as that was defective engine. Indication improvements on CRT displays were recommended after this accident.

These incidents have been briefly indicated to bring out the importance of the human characteristics of curiosity and attention. Cockpit display systems also play a major role towards safety of operations. Their design should be such that no confusion can arise at any time.

In the modern cockpits, there are only two pilots. Normally, the pilot flying monitors the flight progress and the pilot not flying handles the emergency in coordination with the pilot flying. This poses no problem when exigency occurs at a good height and with good speed of flight.

Consider Hong Kong airfield. A take off from Runway 31 would need an immediate turn to the left to keep clear of hilly terrain. If a major problem such as an engine fire or failure occurs immediately after take off, it is very essential that the proper departure flight path is maintained for safe operations. Hong Kong does get quite a lot of bad weather during many seasons. Under those conditions, the visual cue of the hills would not be available. In some of the aircraft, present procedures call for action to be carried out by pilot not flying, which has to be monitored by the pilot flying. If for a short period, attention is diverted away from the flight progress of the aircraft, disaster is possible. There are other airfields of similar nature, wherein any diversion of attention during critical stages of flight could be dangerous.

Crew workload, crew actions and procedures in these modern aircraft have to be examined very carefully. Under adverse weather situations , can we accept unmonitored actions of the pilot not flying? Such pilot not flying could be new on that aircraft and also with low total flight time.

It is for psychologists to evaluate if new design technologies cater to the sensory and reaction limitations of the human pilot and give that pilot more than adequate opportunity to fly safely. For this, psychologists would need to know all types of adverse situations that can occur with every new innovation being brought into the cockpit. It may not be possible to visualise all during certification. Efforts are needed to achieve best possible solution.

Airlines are facing severe competition and economic constraints. Training is also reduced to bare minimum and completed in the shortest possible time. Due to present costs, earlier type of long detailed training on simulator and aircraft is no longer available.

The final link between an accident and survival is the human link in the form of the pilot. If at critical moment, a failure of this human link occurs, the result could be catastrophic in one instance. Under a different set of circumstances, the same failure could just be an incident. Time available to this human link to understand and react, plays a very prominent part between survival and disaster. Design characteristics in the new generation cockpits are very important for this reason.

More automation in the cockpit does not automatically improve safety. Being carried away by designer's ideas, economic pressures, time constraints in development due to competition etc, can bring new technology in to the cockpit with possible untested, unimagined problem areas. This can, some day surface as a trap to result in the failure of the final human link namely, the pilot. Investigators can blame this human link and contribute to statistics. It is very essential that all new technology in the cockpit is pilot friendly and problems are easy to detect, understand & correct. The efforts towards that end should be continuous and possibly expensive. Any shortcuts could be disastrous.

The new generation cockpits are a great boon. But, they can pose a dilemma to the pilots under certain circumstances.