Diminishing Skills?

An examination of basic instrument flying by airline pilots reveals performance below ATP standards.

BY MICHAEL W. GILLEN

With the advent of advanced, highly automated cockpits in current transport category jet aircraft, pilots no longer fly solely by reference to raw data from airplane instruments, and as a result, their basic instrument flying skills may have diminished.

In a study designed to assess their instrument flying skills, 30 airline pilots were asked to perform five basic instrument maneuvers without using automation. In addition, the pilots were questioned about their perceptions of their own instrument skill levels. Analysis of the findings revealed that, although the pilots believed that they retained a high degree of skill, all of the flight maneuvers were performed at levels below those required for U.S. airline transport pilot (ATP) certification.

Previous studies have found that opportunities for pilots to practice and maintain their skills decrease significantly over time, in part because of airline policies, advanced automation and increased long haul flying. In addition, a 1998 report from the Australian Bureau of Air Safety Investigation (now the Australian Transport Safety Bureau) found that 43 percent of pilots surveyed said that their manual flying skills had declined after they started flying advanced technology aircraft.[1]

Most pilots hand fly their aircraft at some stages of each flight. Anecdotal evidence indicates that the main reasons for this are the pilot's personal satisfaction in performing manual flying tasks, the requirement to perform manual flying exercises during simulator sessions (including recurrent training and license renewal) and the need to be able to manually fly the aircraft should the automated systems fail.

Nevertheless, it appears that both the pilots who were tested and their airlines have failed to maintain their perceived level of manual flight skills. In response, some airlines have implemented supplementary simulator programs to bolster these skills.[2]

A 1996 report by the U.S. Federal Aviation Administration (FAA) Human Factors Team — established after the April 26, 1994, crash of a China Airlines Airbus A300 in Nagoya, Japan, that killed 264 people and seriously injured seven — found that pilots often misunderstood the operation of automation equipment, as well as when it should be used.[3]

For example, accident investigators found that the China Airlines first officer had been hand flying the A300, with the autothrottles engaged, on an instrument landing system (ILS) approach when he inadvertently selected the takeoff/go-around mode, causing an increase in thrust. The crew disengaged the autothrottles and manually reduced thrust but then engaged the autopilot and failed to recognize that it was trimming the horizontal stabilizer nose-up.

The Human Factors Team said that its members were concerned that incidents and accidents such as this one appeared to highlight difficulties in flight crew interactions with increasing flight deck automation.

A follow-up report by the FAA Performance-Based Operations Aviation Rulemaking Committee and the Commercial Aviation Safety Team (CAST) is expected to be released later this year.

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Other studies in the 1990s found that highly automated cockpits tend to change the ways pilots perform tasks and make decisions. The studies identified problems in the use of advanced automated systems, including mode misunderstanding, failures to understand automated system behavior, confusion or lack of awareness concerning what automated systems are doing and why, and difficulty tracing the functioning or reasoning process of automated agents.[4,5]

Focus on Instrument Flight

The study that is the subject of this article gathered data from airline pilots employed by U.S. carriers during a recurrent training cycle. The average experience level of the 30 participating pilots was 7.1 years (in both aircraft and seat) with a range from two to 16 years. Seventeen of the pilots were captains and 13 were first officers; 18 flew narrowbody airplanes, and 12 flew widebody airplanes.

The study focused on two aspects of basic instrument flying. First, a qualitative survey was given to pilots to gauge their perception of their own instrument skills. The second part of the study required the use of "first look" data — data derived from a pilot flying a maneuver without a pre-briefing — from participating airlines. The first look data were obtained from a maneuver set comprising a takeoff, an ILS approach, holding, a missed approach and an engine failure at V_1.[6] These maneuvers were flown without the use of autothrottles, a flight director or a flight management computer/map and solely by reference to raw data obtained from the heading, airspeed, attitude and vertical speed instruments. The data subsequently were de-identified.

Simulator Performance

The pilots performed the five basic instrument maneuvers in an FAA-certified Level D simulator — the most advanced type of simulator, with a 180-degree wrap-around visual display and a daylight visual system. The maneuvers were rated by an FAA-certified check pilot and were graded on a scale of 1 through 5, based on the standards of both a major airline and the FAA.

The rating scale was as follows:

- 5 — Well within airline standards. Performance was exemplary.
- 4 — Within airline standards. Pilot flew to ATP standards.
- 3 — Minor deviations from airline standards that were promptly corrected. Pilot flew at the basic instrument level.
- 2 — Major deviations (e.g., full-scale localizer/glideslope deflection) for more than 10 seconds.
- 1 — Major deviations from airline standards that were not promptly corrected and/or were unsafe; or the pilot was unable to perform the maneuver/task without assistance. Crash or loss of control.

Comparisons

The type of aircraft the pilots typically flew was a factor in comparing both the survey responses and the performance of maneuvers. The pilots were divided into two categories determined by the aircraft that they were flying at the time: widebody (A340, Boeing 747, 767) or narrowbody (A320, 737, 717). This distinction was required because these two pilot groups fly a similar number of hours per month but have vastly different numbers of takeoffs and landings. During a typical 20-hour assigned flight sequence, a narrowbody pilot may conduct as many as 12 or 15 takeoffs and landings, whereas a widebody pilot typically would conduct two. Because of the higher number of cycles, narrowbody pilots might be expected to perform better on the maneuvers than widebody pilots.

'Glass' vs. Non-'Glass'

The study compared self-reported experience in "glass" airplanes — those with highly automated flight management systems and electronic flight instrument systems — and non-glass airplanes, along with the amount of time that had passed since the pilot last flew a non-glass aircraft, a majority of which are being retired. These results were further analyzed to take into account specific survey responses relating to pilot experience.

In answer to these questions, more than 56 percent of the pilots said that they had either never flown a non-glass aircraft or that the last flight had been more than 10 years earlier.

Forty-six percent said that they had spent two years or less flying non-glass aircraft, compared to 20 percent who had flown non-glass aircraft for more than 10 years.

In contrast, 73 percent said that they had been flying glass aircraft for at least 10 years. None of the surveyed pilots indicated that he or she had two years or less in glass aircraft.

Self-Assessments

In assessing their own basic instrument flying skills, 80 percent of the pilots said that they "strongly agree" with the survey statement "I usually hand fly the aircraft below 10,000 ft." A pilot retains maximum skill by routinely hand flying below this altitude in the most maneuver-intensive phases of flight. The positive responses, however, did not indicate if the pilots had been using all of the aircraft's advanced capabilities or flying by "raw data" while hand flying.

Sixty percent of the pilots agreed with the statement that they feel comfortable flying by reference to raw data only.

In response to the statement "I could fly a takeoff, V_1 cut, ILS and a missed approach using only raw data," 53 percent of pilots strongly agreed and 47 percent somewhat agreed. No pilots disagreed with the statement. Although their responses indicate that the pilots believed that they could fly these maneuvers, the "somewhat agree" responses indicate that some believed that their performance might not be perfect.

Asked if they believed that their basic instrument skills had declined over time, 26 percent of pilots strongly agreed, and 53 percent said that they "somewhat agree." Only one pilot strongly disagreed with the statement; however, 16 percent said they "somewhat disagreed."

More than three-quarters of pilots said that they practice basic instrument skills often, with 33 percent strongly agreeing and 46 percent somewhat in agreement with that statement. Twenty percent of the pilots somewhat disagreed with the statement.

Simulator Performance

Analysis showed that the average grades given the pilots for their performance of the five maneuvers were significantly below the FAA's standards for acceptable ATP performance and closer to the basic instrument level (Table 1).

The lowest rating — less than 2.4 — was for the holding maneuver, which rarely, if ever, is performed by reference to raw data instrumentation. The highest — 3.2 — was for takeoffs, which typically involve reference to such instrumentation.

Further analysis of the data revealed no significant differences between the pilots of widebody and narrowbody airplanes in their performance on the individual maneuvers or on a composite measure.

Misplaced Confidence?

Technical failures in advanced glass aircraft can significantly degrade cockpit instrumentation. Poor basic instrument flying skills make these

Maneuver Ratings

	Number of Pilots	Mean[1]
Takeoff maneuver	30	3.2000
V_1 cut maneuver	30	3.0333
Holding maneuver	30	2.3667
ILS maneuver	30	2.9667
Missed approach	30	3.0667

ILS = instrument landing system

Note

1. The mean is the average of maneuver ratings received by all 30 participants. Each maneuver was rated on a scale from 1 to 5. A grade of 4 represented the standards established by the U.S. Federal Aviation Administration for an airline transport pilot.

Source: Michael W. Gillen

Table 1

failures more difficult to detect because cross-checking raw data from the basic instruments is the key factor in quickly identifying failures.

In addition, when these failures occur, pilots must use basic instrument skills to safely fly the airplane. Pilots who are competent in basic instrument flying enhance their overall flying skills; because they can devote less attention and cognitive function to physically flying the airplane, they can spend more time managing their environment.

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Although most pilots in the study agreed that their instrument skills have declined over time, their survey responses indicated that they felt they could still fly basic instrument maneuvers. However, their survey responses do not correlate with their actual maneuver grades, leading to the conclusion that the pilots had a false sense of confidence.

The maneuver grades generally conform to what the literature review revealed in related studies that found that skills, when not used, decline over time. This was observed throughout the study in the average maneuver grades.

The suggestion in earlier studies was that if a skill set was learned and practiced over a long period of time, it would be retained longer than if it was practiced over a shorter period of time. This was not seen in the widebody–narrowbody comparison. Although pilots of widebody aircraft had more experience flying older-generation aircraft, their maneuver grades were similar to those of narrowbody pilots, and there was no statistical difference between maneuver grades for the two groups. This is most likely because, as mentioned earlier, although both groups of pilots fly a similar number of monthly hours, narrowbody pilots fly many more cycles than widebody pilots and spend more time maneuvering the aircraft; one result is improved flying skills.

The results of the maneuvers performed as part of this study show that airline pilots' basic instrument skills may decline over time. This is associated with the decreased use of these skills in routine line flying. In addition, newer-generation aircraft generally do not lend themselves to basic instrument flying, and most companies do not train or promote this type of flying. Although rare, some failures in advanced glass aircraft can degrade aircraft instrumentation to the extent that pilots must fly the aircraft using raw data. During the past 10 years, two such failures have occurred at an airline that participated in the study. In both cases, the flight crews landed the airplanes safely.

Airline safety can be improved by ensuring that pilots are competent not only when all advanced instrumentation is functioning but also when that instrumentation fails. Pilots possessed these basic instrument skills at one time in their careers, and their skill levels can be increased through training and practice.

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Notes

1. Australian Bureau of Air Safety Investigation. *Advanced Aircraft Technology Safety Survey Report*. June 1998.
2. Ibid.
3. Abbott, Kathy et al. *The Interfaces Between Flightcrews and Modern Flight Deck Systems*, FAA Human Factors Team Report. June 18, 1996.
4. Billings, Charles E. *Human-Centered Aviation Automation: Principles and Guidelines*. U.S. National Aeronautics and Space Administration (NASA), Ames Research Center. 1996.
5. Sarter, Nadine R.; Woods, David D. *Cognitive Engineering in Aerospace Application: Pilot Interaction with Cockpit Automation*. NASA Ames Research Center. 1993.
6. U.S. Federal Aviation Regulations Part 1.2 defines V_1 as "the maximum speed in the takeoff at which the pilot must take the first action (e.g., apply brakes, reduce thrust, deploy speed brakes) to stop the airplane within the accelerate-stop distance. V_1 also means the minimum speed in the takeoff, following a failure of the critical engine at V_{EF}, at which the pilot can continue the takeoff and achieve the required height above the takeoff surface within the takeoff distance." (V_{EF} is "the speed at which the critical engine is assumed to fail during takeoff.")