56 Seconds to Live:
Evaluating Pilot Response to Degrading Visual Conditions

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When you think about it, 56 seconds seems like a long time. Imagine driving down an interstate highway and closing your eyes for that long. Time would certainly drag by. In times of high task saturation, however, the time would literally fly by. Studies reveal that 56 seconds in a helicopter experiencing an unexpected and unintentional loss of visual conditions represents the median time before a fatal mishap.[1] Conventional wisdom in the helicopter community continues to support the notion that the inherent instability of helicopters, lack of pilot proficiency flying in degraded visual conditions and external pressures to complete flight tasks are the leading factors contributing to fatal accidents where loss of visual references was a contributing cause. The lack of IFR certificated helicopters, cost and accessibility of high fidelity approved training devices and the lack of opportunity/need for regular use of instrument flying skills adds to the problem. Any aviator, however, recognizes that the concept of proficiency involves several factors such as training, currency, and experience.

The purpose of this study was to determine risk factors related to pilot performance in a degraded visual environment in order to improve safety and reduce the likelihood of a fatal accident. We examined how different combinations of proficiency factors affect pilots' ability to respond to unexpected, degrading visual conditions in flight. Our most significant finding is that experience can minimize the negative effects associated with a lack of currency and/or training.

Due to the limited nature of this study, we suggest additional research to explore how recent and repetitive training opportunities involving instrument meteorological conditions (IMC) might prevent future mishaps. Moreover, we encourage researchers to evaluate how synthetic experiences, such as simulator or virtual-reality training, in such conditions can reduce the likelihood of IMC-related mishaps. To be clear, this study provides the evidence necessary to support the idea that recent and repetitive, synthetic training opportunities *could* make a real difference in making sure that the aircrew survives what could have been a perilous 56 seconds!

Study Design and Methodology

The study was conducted at Heli-Expo 2022. With over 20,000 attendees annually, this event provided an excellent cross-section of the helicopter pilot community in one location. Any event attendee was welcome to participate in the study. Prior to the experiment, we surveyed 77 pilots to determine their proficiency (raw data is available through the U.S. Helicopter Safety Team). We compiled that information and used it to analyze each pilot's performance in the simulation. For the purpose of this study, we divided the concept of *proficiency* into three different factors: training, currency, and experience. For training, we

[1] U.S. Helicopter Safety Team, "56 Seconds to Live: Unintended Flight in Instrument Meteorological Conditions (UIMC) Safety Initiative" (15 June 2021).

considered formal courses such as an FAA Instrument Rating (IR), Certificated Flight Instructor with Instrument (CFI/I) or an Airline Transport Pilot (ATP) rating. For currency, we used FAA standards for instrument currency as outlined in 14 CFR 61.57. Experience was measured in terms of total time in helicopters.

Following the survey, participants were given a short briefing which included safety items as well as the scenario of the flight to be flown. In terms of the experiment, there were two scenarios available, one was an air ambulance mission to transport a patient and the other was a post-maintenance test flight. In both cases, the conditions stemmed from an actual fatal helicopter mishap caused by flight into unintentional IMC (UIMC). Both scenarios included weather conditions, the purpose of the flight, and specific location information including type of airspace. Pilots were randomly assigned a scenario except for air ambulance pilots—those pilots were intentionally assigned to the post-maintenance test flight to inject some lack of familiarity in the type of operation.

Pilots were instructed to treat the scenario as they would any actual flight and to utilize the researcher as air traffic control and company operations personnel as applicable. Once the briefing was complete, volunteers were seated in a virtual reality simulator supplied by Ryan Aerospace and Precision Flight Controls. The simulator had 3-axis movement and a complete set of Bell 206 helicopter flight controls with a virtual reality (VR) headset which created a fully immersive experience.

The immersive nature of the simulator was key in the research design. After a short familiarization flight, pilots were instructed to return to the runway and depart when ready on the scenario previously briefed. By this time, the novelty of the VR environment had passed and pilots were mentally engaged in the flight tasks assigned. As the scenario evolved, the visual environment was continually degraded until, eventually, the pilot lost all visual ground references. If the pilot requested to exit the conditions or made the decision to not depart at all, researchers acknowledged that and gave the pilot a reason to depart anyway to complete the evaluation. Researchers scored the pilot's actions on a grade sheet which included scores for pilot decisions, pilot actions to recover from UIMC and the amount of time required to stabilize the aircraft. Total points for the scenario ranged from 21 to -2. The higher the score, the better the pilot performed.

One point we noticed during the initial intake and data collection was that many pilots revealed that their specific jobs in industry could (and likely did) have an impact on their ability to safely respond to unexpected periods of degraded visibility. For example, several pilots remarked that the reported weather conditions were outside their organization's allowable minimums causing them to decline the flight. We considered each of these a positive outcome.

Findings

Based on our experience and initial research, we expected pilots that were current, trained, and experienced to recognize the hazardous conditions faster, respond to degraded visual conditions sooner, and to establish aircraft control in a shorter amount of time. For pilots with less proficiency in terms of currency, training, and experience, we expected slower times for recognition and response and longer times to regain/maintain aircraft control.

Of the 69 valid results, there were 36 pilots, 52%, with instrument training (IR, CFI/I or ATP). Of those 36 pilots, 24 pilots, 67%, that reported they were instrument current.[2] Nineteen pilots crashed. Of the 50 pilots with a successful outcome, the average time to recover the aircraft to a stable attitude after entering IMC was 15.8 seconds. To make the data more visible, we break down the data associated with the 36 pilots into their respective experience groups based on total helicopter hours and distinguish the pilots that were trained and current from those that were trained but not current.

Experience (Total Helicopter Time)	Successful Outcome: Trained and Current	Successful Outcome: Trained, Not Current	Successful Outcome: Not Trained	Unsuccessful Outcome: Crashes* Trained	Unsuccessful Outcome: Crashes* Untrained	Average Response Time Trained and Current	Average Response Time Trained, Not Current	Average Recovery Time (stable)
1-100	0	0	7	n/a	4	n/a	n/a	20 sec
101-250	3	1	0	2	3	22.5	15	20 sec
251-500	1	1	3	2	0	35	30	18 sec
501-1000	1	1	5	1	0	20	10	18.6 sec
1001-1500	3	2	0	0	1	10	10	10 sec
1501-2000	1	1	0	0	1	10	10	10 sec
2001+	11	4	5	2	3	18.3	22	14 sec

* Crashes include pilots who did not establish a stable flight profile within 50 seconds. The likelihood is that, after over 50 seconds of unstable flight, the aircraft was would have been the victim of controlled flight in to terrain (CFIT) or Loss of Control Inflight (LOC-I) based on the 56-Seconds data.

As we expected, the average recovery time decreased with increased experience in helicopters, including a slight uptick in time for pilots reporting greater than 2000 helicopter flight hours. Experienced pilots were also more likely to have a successful outcome than inexperienced pilots for *both* trained and untrained pilots, leading us to believe that pilot experience influences decision making and aircraft control, even in an unfamiliar environment. Interestingly, currency did not seem to have as significant of a role in a successful outcome as expected. Instrument current pilots crashed more often than the pilots who were not instrument current.[3] It is worth noting that 19 pilots crashed the helicopter or were unsuccessful at establishing a stable flight profile within 50 seconds, but seven of those pilots only had an unsuccessful outcome after taking a precautionary action in response to the conditions. This included one of the following actions: declined/evaluated the flight, attempted to turn around and return to base, or attempted a precautionary landing in visual conditions. Of the pilots who took action, 57% were trained (held IR, CFI/I, ATP). In our view, it is noteworthy

[2] There were 77 participants however, 8 participants reported no previous helicopter experience. Their results were not computed in any of the findings as their data was neither valid nor reliable.
[3] Of the pilots who crashed, 58% were instrument current, as opposed to only 42% of the pilots that were not instrument current.

that pilots were able to recognize a situation that they were unprepared for or untrained to address. Lastly, an anomaly that took us by surprise was the success of the pilots who reported 1-100 total helicopter hours. 100% of those pilots also reported no instrument training (IR, CFI/I, ATP) however, 58% reported over 1000 hours of airplane time and the remaining 42% reporting 1-100 hours of airplane time. We interpreted this as significant, applicable experience that likely led to the surprising success rate of "untrained" pilots.[4]

Recommendations

Prior to our recommendation, we want to re-emphasize that this was an initial test into the plausibility of how a synthetic experience like virtual reality can be used to assess a pilot's proficiency in dangerous situations like UIMC. This type of study should be used as a basis for future testing in a more controlled environment that will preclude participants from having any idea about the purpose of the experiment.

Unexpectedly, we found it might be possible to use a synthetic experience with VR simulation to provide the needed experience to pilots so they may recognize and respond to UIMC situations sooner and reduce the amount of time needed to gain/maintain aircraft control. We think exploring the connection between the type of training and the experience gained from that training could be a key to providing low-cost opportunities to helicopter operations that cannot afford conventional instrument training.

[4] We use the term "untrained" here because we do not know the status of their airplane certificates or ratings.