# 2. HELICOPTER SIMULATION: AN AIRCREW TRAINING AND QUALIFICATION PERSPECTIVE

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FAA goals for the training and qualification of commercial aviation rotary-wing airmen are no different from those in the fixed-wing categories—to improve safety through effective training and checking. Flight simulators have been successfully employed for this purpose in the air carrier community for a number of years, and the FAA has developed an explicit set of regulatory compliance requirements in that regard. The recently established Advanced Qualification Program (AQP) expands the regulatory boundaries for device-based fixed-wing training and aircrew qualification, by allowing for families of devices lower on the equipment complexity continuum than the traditional categories of flight simulators. Although our understanding of the issues involved in qualifying synthetic devices for such applications is becoming increasingly mature, this circumstance is decidedly not yet the case for rotary-wing application. We wish to review some of the unique considerations which (1) distinguish the commercial rotary-wing domain from its fixed-wing counterpart, and (2) motivate the FAA to proceed cautiously in extrapolating from our fixed-wing experience in establishing qualification requirements for helicopter simulators. It is proposed that the issue of device qualification should be considered in the context of an overall training and qualification system. Rather than focusing solely on the isomorphism between the engineering characteristics of the synthetic device versus the aircraft, such an approach would integrate engineering and behavioral criteria. Ideally, a decision strategy on helicopter simulator fidelity requirements would include consideration of the proficiency objectives on which airmen would be trained and qualified using the device.

Good afternoon ladies and gentlemen. I'm honored to have an opportunity to share my views, and more importantly the views of the Federal Aviation Administration, of our regulatory goals for the use of helicopter flight simulators and helicopter flight-training devices.

Although I may spend a lot of time and energy highlighting the differences in helicopter and airplane requirements later in this presentation, I am going to start by saying that the FAA's regulatory goals for flight simulation are exactly the same for helicopters as they are for airplanes. These goals are to increase safety in flight operations, to ensure attainment of reasonable aircrew proficiency standards, and, through better trained crews, to foster the safe and efficient growth of the aviation industry. The FAA recognizes that flight simulation is a proven and effective means of attaining these goals.

The FAA considers its experience in flight simulation to be a positive example of how the industry and government can cooperate to achieve their sometimes diverse goals. Through foresightedness, dedication, and plain hard work, we, both government and industry, have made the use of airplane simulators one of the most successful programs ever undertaken to increase safety and efficiency. Our simulation programs have been an unqualified success.

Aircrews recognize and appreciate the use of flight simulators because of their proven ability to enhance the crew's performance. The FAA, airlines, and the traveling public benefit immeasurably from the safety improvements simulator training has brought to day-to-day operations. Before simulation came into widespread use, required airline training activities contributed substantially to airport congestion, delays, and noise problems, as well as to other environmental issues. In today's airline training environment, air-traffic control doesn't have to accommodate the training that is done in simulators, and aircraft and fuel resources are conserved. We anticipate even greater progress in these areas with the advent of increasingly sophisticated but low-cost flight-training devices. At the FAA, we see no reason for any lesser degree of success in the use of helicopter flight simulators and flight-training devices. Interestingly, this has not yet occurred.

Let's take a quick look at where we are in the FAA with respect to helicopter flight simulation. The helicopter simulator has no detailed regulatory basis, such as the airplane simulator has in Appendix H of Part 121. The operating and airman certification regulations do not have provisions for use of helicopter simulators that parallel those of airplane simulators. However, we do have a draft helicopter simulator qualification advisory circular which has been used as an interim standard in approving two civil helicopter simulators. I participated in the evaluation of these simulators and would like to share my thoughts and observations about them with you. I believe we should be cautious in extrapolating from our airplane flight-simulator and flight-training device experience. I also feel that the overall training and qualifications systems for helicopters are not directly equivalent to airplane training systems.

Helicopters not only look and sound different than airplanes do—they have different missions and require different crew skills. Although helicopters can be used for some of the same mission tasks as airplanes, they also can do missions an airplane could never accomplish. Helicopters are capable of operating in natural and man-made environments that are prohibitive to airplane operations. Helicopter pilots must learn how to control their aircraft in any possible combination of directions of flight. The helicopter's mechanical and electronic equipment combinations have complexities not usually found in airplanes of equal size. All these factors enable the helicopter's wonderful freedom of navigation. However, they also introduce a high potential for risk in helicopter operations that must be recognized and accommodated through effective crew training. These differences have a critical influence on the design of helicopter simulators and on the overall design of any helicopter crew training and qualification system.

Let's compare the issues that differentiate helicopter from airplane operations. In general, airplanes are used for transportation of persons or cargo between airports. Missions that airplanes and helicopters share include training, recreational flying, crop planting and protection, pipeline and power-line surveillance, livestock surveys, aerial photography, aerial search, and surveying, as well as short-range transportation between airports. Helicopters are the primary means of air transportation between off-airport landing sites and are also used in construction work, law enforcement, emergency medical transportation, and rescue operations. The special operations that helicopters can perform that airplanes cannot are too numerous to list.

Helicopter crews may be called on to perform all these missions in the same physical environment that airplanes usually operate in. However, in many instances, helicopter missions are performed in environments not shared by airplanes. There are substantial differences in the characteristics of the many landing and surface operating areas used by helicopters. In contrast, airplanes always use some form of level runway with cleared approach and departure paths. Except at permanent heliports and airports, helicopter crews must reconnoiter, select, and execute every detail of the surface operation without benefit of airport engineering and improvement activities. In many cases, helicopter operating sites are not located in controlled airspace and have only limited support from the air-traffic control systems, federal navigational aids, and weather reporting and forecasting systems.

In addition to dealing with a more complex operating environment, helicopter crews must cope with the handling characteristics of the helicopter that permit its nearly unrestricted mission capabilities. The very features that make the helicopter so versatile also increase the difficulty of its operation when compared with airplane flying. Airplane and helicopter flight-path management and control characteristics are different. Airplanes can't fly sideways or backward. Helicopters, of course, can fly in any direction. The crew knowledge and skills required for sideward and rearward flight are not a consideration in airplane operations.

Most airplanes share a lot of common handling qualities. For example, the basic handling qualities of a Cessna twin are not very different from those of a single-engine Beechcraft. This can't be said for helicopters. Handling qualities may substantially differ from one helicopter to another. Compared with airplanes, helicopters are a rather unstable aircraft with high work loads. Airplanes are mechanically simple devices when compared with helicopters. This increased mechanical complexity requires helicopter crews to learn and understand a greater number of abnormal and emergency procedures. Helicopter pilots would be quite surprised to check out in a new helicopter without learning how to cope with failure of anti-torque control. How many fixed-wing pilots have been taught what to do if rudder control fails?

Each of the differences I've mentioned can have a profound effect on helicopter flight-simulator and flight-training-device design [illegible] a direct extrapolation of our experience with airplane simulators may, there, be

inappropriate. Let's summarize what should be accounted for in helicopter simulator design.

First, let's consider the conditions that apply to airplane and helicopter simulators. Both require accurate simulation of aircraft system operation, IFR en route navigation, IFR and VFR terminal-area navigation, and airport surface operation. A second list applies to additional helicopter flight-simulation device design considerations. This second list of considerations includes VFR en route navigation, lateral and rearward flight, offshore operations, water surface operations, amphibious operations, urban congested-area operations, slopes, confined areas, flight-path obstructions, autorotations, and power-off landings.

Let's assume that in the near future we determine what helicopter simulators and training devices should be capable of and let's further assume that the FAA publishes a final version of advisory circulars for helicopter flight simulators and helicopter flight training devices. What can we use them for? In their present state, the Federal Aviation Regulations, Pilot Test Standards, and other regulatory documents permit only very limited use of helicopter simulation. Therefore, when we develop criteria for helicopter simulators and training devices, we are only half finished with the job at hand. We need to determine what the appropriate proficiency objectives are for helicopter crews and amend the FARs to enable device-based training and checking for those proficiency objectives.

Which should we develop first, the helicopter crew qualification standards, helicopter flight-simulator and flight-training device standards, or the enabling Federal Aviation Regulations? Tom Longridge and I believe we should view these three tasks as an integrated job that requires development of helicopter crew qualification standards, helicopter flight-simulator and flight-training-device criteria, and development and implementation of changes to Federal Aviation Regulations in support of modern helicopter training and qualification requirements. We believe that we can and must take a systematic approach to the development of an overall training and qualification system, because without systematically developed crew qualification standards and enabling FARs, we have no means to ensure that we will effectively be able employ any helicopter-simulator or training-device criteria.

To determine what skills helicopter pilots need to accomplish their job, we need to take a look at the mission-related tasks today's helicopter pilot must master. Qualification standards for helicopter crews can be developed and adopted for use in an integrated training and qualification system which is designed to include the flight simulator and flight-training device as essential tools for learning and evaluation.

Given the environment in which helicopters operate, their flight characteristics, and many mission tasks, high-fidelity helicopter simulation is technically very challenging. For the average commercial operator, it may in fact simply be too costly. For that reason recommendations on fidelity requirements should carefully weigh cost versus benefit in light of the purposes for which these devices will be used.

Flight simulation, by definition, always represents some degree of abstraction from reality, for the simple reason that a simulator is not an aircraft. Therefore, there will always be some degree of compromise on realism. So, a fundamental issue is the decision criteria on which basis such compromises should be determined. Certainly engineering criteria, such as the extent to which the simulator's display system duplicates the actual aircraft's field of view, or the aeromodel duplicates the actual aircraft flight characteristics, are a very important consideration in any such decision process. However, from a training and qualification perspective consideration of how the device is to be used is of equal importance. We feel that for helicopter simulators and flight-training devices, because of their many unique characteristics, a sensible decision strategy on fidelity issues must integrate both engineering and behavioral criteria.

MR. TREICHEL: Regarding Part 142 in the proposed rule-making, is there some kind of advisory team or committee that is being made up that some of us could get involved in to make sure that everything is running along as smoothly as this effort is?

MR. BIRNBACH: During one of the breaks I am going to introduce you to Warren Robbins who is here with us from the General Aviation Division. Part 142 is the product of an advisory committee. It was not quite an advisory committee when they put it together, so I would rather not talk about it to any great extent, but it included people from the simulation industry and from the training centers and the helicopter industry. And it is not a bad document. But I will get you together with Warren and you can talk directly about it. Anybody else? Yes, sir.

MR. RUTKOWSKI: You only have two simulators approved right now. What is the requirement . . . how many other operators out there do you have with the need

for that kind of fidelity? How big is the need out there to build this type of device?

MR. BIRNBACH: I cannot answer that for the Part 61 operators except for one thing. I know that what we call a Part 91 operator has a little problem in exposing the assets that they have. If someone owns an S-76, a Bell 222, or an SA-360 type of machine, it is really tough to go out and ask them to do tail-rotor failures and touchdown autorotation in these things. The insurance company knows it and FlightSafety's Greg McGowan can tell you. The real problem is the industrial-type operator, the offshore operator, the air taxi, the external load operator. These people have a little difficulty with what simulation is available to them and they cannot do the kind of tasks they need to do for their pilots. So it is difficult to answer your question from my perspective. There is not a lot of demand right now in the 135 world for helicopter simulators.

MR. RANDALL: Over the last 30 years I haven't seen a lot going on in behavioral science things. I think it is desperately needed when we transition into helicopter simulators.

MR. BIRNBACH: Let me try to answer that as best I can. First, I don't want to throw the baby out with the bath water. I don't want to restart this whole issue of what should come first and what should come second. With respect to the level of helicopter simulation available to us, that would be covered by the draft advisory circular. I think we are smart to go ahead with that right now, and the rule-making projects that we have in hand will support the use of those types of simulators. Where we really need to make sure we do this is in regard to part-task trainers or training devices. It is going to be very important to us, especially in rotary-wing, but just a little bit less so in fixed-wing training devices. How do we give part-task credit? Last year the FAA came out with an integrated human factors program. We came up with a plan which is in the final approval stage. In that plan are work resumes and intents to go out and do research on these issues. We need to do some research, we need to come up with the processes for giving credit for part-task devices. Then we need to do something about clarifying the rules. I do not see that happening in the next 6 months, but I see the first steps being taken to do it.

MR. WALKER: We have been dealing with helicopter simulator operations, and one of the issues that's been of most concern to me is in your decision criteria. In particular, I always see a problem with having part-task data that are tailored to support simulator development. Is the regulation that you are addressing going to deal with this issue?

MR. BIRNBACH: We have talked about these things between Ed Booth's shop and mine and some others, on several occasions where you talk about flight-test data to support simulator development. And there are two issues here. One is to technically assimilate a flight training device by being able to measure what it looks like, what is sounds like, and what it does.

The other is to figure out what credit you can give to the training requirement. There is no doubt in my mind that the high end of those engineering criteria is extremely important and that we have had success in simulator qualification relying on this.

I do not know what to do with this decision point that we talked about here, and looking at how we use this engineering criteria as opposed to transfer of skills criteria, is when we get down into the lower-order devices. I just do not know how to do it. We have some people who have a lot of good ideas on how to determine what to do, but until we do that I think we are going to have to rely on some of our successes. We just cannot argue with the success that we have had in fixed-wing simulation and in these two rotary-wing simulators in relying on flight test data as our beginning point. I do not know what else to say to you there.

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