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12. PROGRESS THROUGH PRECEDENT: GOING WHERE NO HELICOPTER SIMULATOR HAS GONE BEFORE

RICHARD J. ADAMS

Since it is late in the day I would like to tell you a brief story about helicopter safety which was mentioned this morning by Dick Birnbach and a few others, how we have gotten to where we are.

I would like to discuss the last 5 years of training and how we have improved and how we have reduced accidents by doing cognitive training. And finally, I would like to suggest appropriate thoughts for our discussions tomorrow.

The following is a quote from Dwight Eisenhower. Like all political quotes, it can be taken in many ways. "Things are more like they are now than they ever have been before." It made me think that we haven't come very far since the workshop in 1985. But you can also look at it as an opportunity to accomplish some things in this workshop. I hope by the end of the presentation you will understand in what way I have contributed to it.

Let's talk about safety and the general definition of safety. There are a lot of parameters that helicopter people use (accident/100,000 departures, risk of serious injury, etc.). There are a lot of parameters that fixed-wing people use (accidents/100,000 hours, accidents/100,000 passenger miles, etc.). I am limited by time to reviewing only one set of data, and I have accepted the following definition; I hope you will, too. "Safety is the identification and control of risk according to some preconceived parameters."

Historically, the FAA and NTSB supply data for accidents per 100,000 hours. The data set shown in figure 1 came from Jim McDaniel's office when we looked at safety parameters. Accidents per 100,000 departures, accidents within a mile of a heliport, and years between accidents in terms of a facility. As you can see, there is a quarter century of data shown in figure 1. It tells a very interesting story. At least in the United States you notice in 1965 we were running 55 or 60 accidents per 100,000 hours (total fatal and nonfatal).

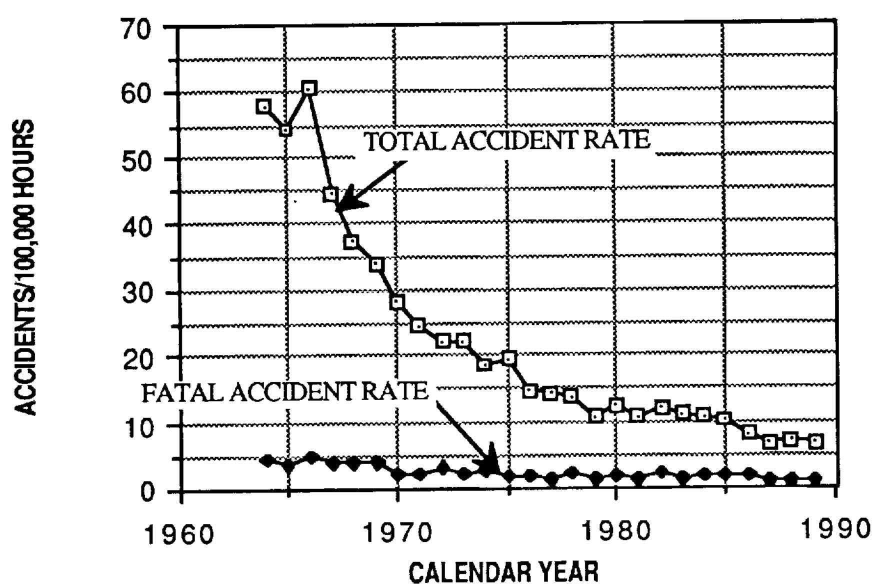


Figure 1. Safety needs.

And then over a period of about 10 years, 1965 to 1975, we dropped by almost two-thirds down to 20. Those of you in this country who have been in the industry that long realize that that was the time the turbine engine was introduced. About 1965 we were almost 100% pistons. Then the turbine was introduced, with its higher mechanical reliability, easier maintenance, and various safety improvements. I don't want to imply that the turbine was the only change, but it was one of the major changes that occurred during the 1965-1975 period.

During the middle of the time period covered in figure 1 (about 1975), we had a bunch of very experienced military pilots returning from Vietnam. Those pilots were military and human and they had good and bad habits; however, they did have a high degree of experience in risk management, which has been mentioned by several people today. They were able to work under high-workload, stressful conditions. Later, I will point out some areas where simulators may be used to provide more realistic risk-management training.

Then, about 1975 to 1980, in this country we began to realize that all of these accidents, at least a large percentage of them—65% in the entire helicopter community, if you looked at the more high-risk EMS it is nearer 80%—were all human-error related. The same thing was occurring in fixed wing; about 80% of fixed-wing accidents were also attributed to pilot error. The bottom line was to start stressing the human elements in studies. As a result, NASA developed a substantial effort in the area of cockpit resources management. And we were successful in bringing the accident rate down somewhat, although it is leveling off as you can see. I think that is the challenge we face here. Getting back to the study that generated the curve shown in figure 1, we set a goal of trying to get the rate down to 4.5 accidents per 100,000 hours by 1995.

I would like to talk about a successful human-error reduction program and about conventional training and some ways we may begin to depart. Figure 2 depicts the basic novice pilot, or *ab initio*, coming in with a lot of knowledge. He knows systems, he knows aerodynamics, he knows the ATC system, he knows weather, he knows procedures on top of that, stall practice, autorotation, things like that. He builds skills in flying the aircraft. Until recently, 1985-1986, it was always thought he could only learn good judgement or decision-making through experience. We all know that led to a lot of bending of metal and unfortunate injuries and accidents.

So the FAA set out, between 1975 and 1985, on a program to see if we could train and actually teach better decision-making in the classroom. It has turned out to be very successful, as Pete Hwoschinsky mentioned this morning. We generated 15 different manuals, everything from students' private manuals up to manuals for administrators and Part 135 operators. These have been used throughout the industry and the military.

As an example, Petroleum Helicopter, Inc. (PHI) looked at their accident data from 1982 through 1986. Correct me if I am wrong, Jerry [Golden], but you fly about 2 million takeoffs and landings annually. Before 1986 PHI could not get the accident rate below two per 100,000 hours. And in 1987 they dropped it to 1.86 per

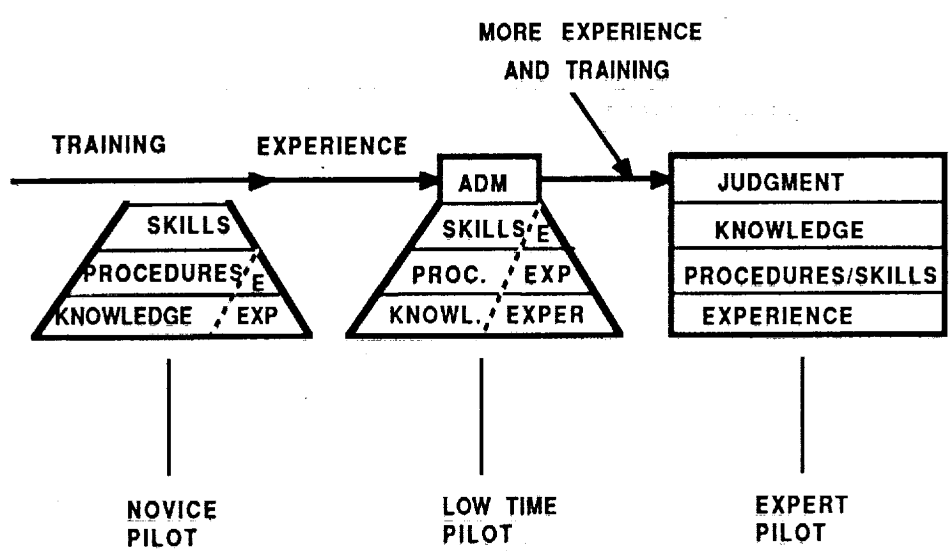


Figure 2. Training needs.

100,000 hours. The following years, after all the pilots were trained, they dropped it to 1.046.

The Navy did a similar thing and reduced the human-error factors in helicopter accidents by 51%. Bell has introduced advanced decision-making into their world-wide 206 safety seminars. They believe that even though they haven't reached all their operators, they have achieved a reduction of 31% in human-error accidents.

The bottom line is we can train decision-making, but there is a problem. The problem is that when we look closely at the procedures and the attitudinal training we developed, they work much better with the *ab initio* and less experienced (5-year-and-under) pilot.

The research I am working on now is aimed at how we get at the more experienced pilot, how does he think differently? At the same time, we were getting all the good results in the helicopter community. The air carriers were having some spectacular saves or, as Dick Birnbach said, some diabolical failures: failures of aircraft materials, the Sioux City accident, a lost engine, a lost hydraulic system. The two decompressions, Flight 811 United Honolulu, and the Flight 232 Maui accident Aloha—both aircraft incurred very large holes in the fuselages.

In the case of 232, I will just dwell on two of the successes for a minute. The captain had access to a training airman in the back who know how to control pitch and yaw with the throttles. The captain immediately accepted his volunteer and used him to control lateral movement and aircraft pitch attitude. While they were doing that and checking to make sure that passengers were prepared for an emergency, they were still fighting a tendency for a 38° right bank and severe pitch oscillations, or phugoids. Nevertheless, as you know, they successfully brought the aircraft down, at least in a partial save.

Both of these decompression accidents (UAL Honolulu and Aloha, Maui) are very interesting because the pilots and crew acted contrary to handbook training procedure, which would have had them dive to regain cabin pressure. The captain decided that would be a bad move, because it might enlarge the hole in the fuselage. As a result, he decided to slow the aircraft. However, he didn't know the speed at which the aircraft would stall, given the big hole in the fuselage and the extra drag it created.

The second important thing about all of the saves—all the time they were handling the emergencies while creating new procedures, if you will, in response to the cues they had. They were able to keep up the housekeeping chores, they communicated with ATC, they did engine shutdown checklists, all the things they were trained to do. That is a lesson we will get back to in a minute.

During the past 30 months I have been looking at the accidents, looking at the difference between experts and *ab initios*, and it turns out there are 24 different characteristics that distinguish experts from novices. I have summarized the top five in table 1. Believe it or not, in an emergency pilots go back to what their instructors told them—they fly the airplane. That is evidenced in all the accidents studied. they have instantaneous recall of training; in some cases it takes on the characteristics of instinct. They maintain their composure, they come up with a reasonable plan, and they execute it with all their available resources. It is not surprising that this is exactly what we have been trying to train for with the cockpit resources management program. Finally, as we know, pilots are goal-oriented, self-assured individuals.

Table 1. Training needs: expert characteristics

1.	Reversion to basic airmanship skills
2.	Instantaneous recall of training
3.	Reasoned approach in emergencies
4.	Positive in approach and expectations
5.	Self-assured and optimistic

I would like to look now at a few of what we call fatal fallacies (table 2). They are attributed to Dr. Walt Schneider at the University of Pittsburgh. He looked at both air-traffic control and aviation accidents and came up with these six fallacies. I don't know why he termed them fatal, but undoubtedly he has his reasons.

Basically, practice makes perfect is a fallacy because it is a bump and grind approach. It does work, but it does not have a lasting effect on most people. In some cases the procedure is never learned properly. Training a task in

Table 2. Training needs: fatal fallacies[a]

1.	Practice makes perfect
2.	Train in the form to be used
3.	Skill training is intrinsically motivating
4.	Must include high accuracy standards
5.	Initial performance predicts eventual outcome
6.	Intellectual understanding produces proficiency

[a]Dr. Walter Schneider, University of Pittsburgh Learning and Development Center.

exactly the form in which it is to be used is time-inefficient. We talked about autorotation earlier, sling loads, things like that. In the fixed-wing, we having holding patterns. All those things can be learned much better and retained better with quick reenforcement practicing, 10 or 20 an hour as opposed to 1 or 2 an hour. They are things that can best be done in a simulator.

Number 3—skill training is intrinsically motivating—is interesting because flying is fun in itself and people are motivated to learn how. But even though that might be true initially, after you have been at it for 5 years it seems that the basic thrill is usually gone and you are going through the hoops, going through the FAA-required checklist of maneuvers. But again, what they found at Pittsburgh was that if they had bells and interesting sounds and visual cues for training reenforcement, they had a 30% to 50% reduction in failure rate.

The fourth one—high accuracy standards—is particularly pertinent. That is, we all think about high accuracy standards—good steady needles, good heading and altitude control; these are very important, especially in the real world. But they are not necessarily the best way to train in a simulator. What happens when you become a very accurate, precise pilot? You may not be very good at other things, like high-workload tasks, emergencies, multiple-tasking, sharing your attention. These are best taught in a loft scenario, in a simulator, in composite high stressful situations, as Dave Green said in his presentation earlier today.

The last two of the fallacies are self-expanatory.

Early this morning I heard some words from the FAA that got me very excited. The regulations are being changed to allow the inclusion of more simulators. What is appropriate training? What can we do? What should we do in simulator versus aircraft? I submit that the current standards for simulator uses (table 3), though limited, should be retained and should not be thrown out with the bath water, as someone said. Greg McGowan pointed out that he trained nearly 10,000 pilots with these; the evidence I pointed out earlier documents that it works, as well. My perception was that at least part of the reasons for the four required aircraft maneuvers was that the FAA needs to maintain control. I again need to suggest that we have to discover whether the hover and the current four maneuvers are the correct ones to retain.

Ed Boothe suggested an exemption if somebody wants to come up with that. I think in this group, with the expertise we have, we can come up with a better set of criteria.

As far as interim uses are concerned (table 3), I have been thoroughly brainwashed by Curt Treichel and others in this room to think that if a pilot has the experience,

Table 3. Appropriate training

1. Current simulator uses	
Biannual flight review	61.56
D/N currency, instrument competency	61.57c,d,e(2)
12/24 month PIC check	61.58b,c
ATP rotorcraft type check (90%)	61.163a
Initial/recurrency testing	135.293
PIC instrument proficiency	135.297
2. Quality control	
Hover requirement versus hover proficiency	
Emergency procedures (discussion vs experience)	
3. Desired near-term uses	
FAR approval versus exemption	
ATP rotorcraft add-on type rating	61.163a
Commercial add-on instrument	61.65g
ATP airplane add-on rotorcraft category	61.165
Instrument instructor	61.191
4. Alleviate training fallacies	
5. Support overall training and licensing system	

commercial rating, ATP fixed wing, there is no reason he can't get the helicopter ATP add-on in the simulator.

And at the top of that list, I think we all would like to see FAR approval of simulators as opposed to the timely, costly exemption process. I think again, that together we can come up with scenarios and lists of tasks that can alleviate training fallacies. I am not talking about turning things upside down that we have today, but about just looking at the real world.

Finally we need to come up with an integrated approach. I haven't heard anybody come up with a systems approach from the top down to designing a training program. Far-term or blue sky, more controversial might be total licensing and testing in the simulator (table 4). We would like recognition of helicopter simulators equal to that granted the fixed-wing simulators. There is no reason that if a 727 pilot can get his type rating in a simulator that we can't get type ratings in an S-76 simulator some day. I don't know how many of you have looked at the ATP program, which allows trading off simulator time. We ought to set our sights on the rotorcraft community the next time we are talking about that for helicopter simulators.

Table 4. New frontiers: far-term suggestions

1.	Initial licensing and testing
2.	Equal recognition with airplane standards
3.	Advanced qualification program
4.	Crew testing and licensing

Finally, there is crew testing. I went over fixed-wing accidents and how the interpersonal skills of the crews were involved. You can't test that in an S-76 or in any helicopter today. There is no place for the examiner to sit back and evaluate the crew. It can only be done in a simulator. Right now Curt Treichel tells me that crew evaluations are limited because the test pilot sits in the left seat.

They think pilot in command (PIC), so we need to work on that a little bit. Getting back to our expertise and my current efforts. I think there is also an opportunity to introduce some new concepts there. When we talk about the next generation of decision-making training, the question is when to do it.

The *ab initio* pilot knows all the facts; he has the facts he needs to know to fly the airplane and to survive (fig. 3). The low-time pilot knows how to survive, he has instantaneous recall of what to do if the engine quits. But

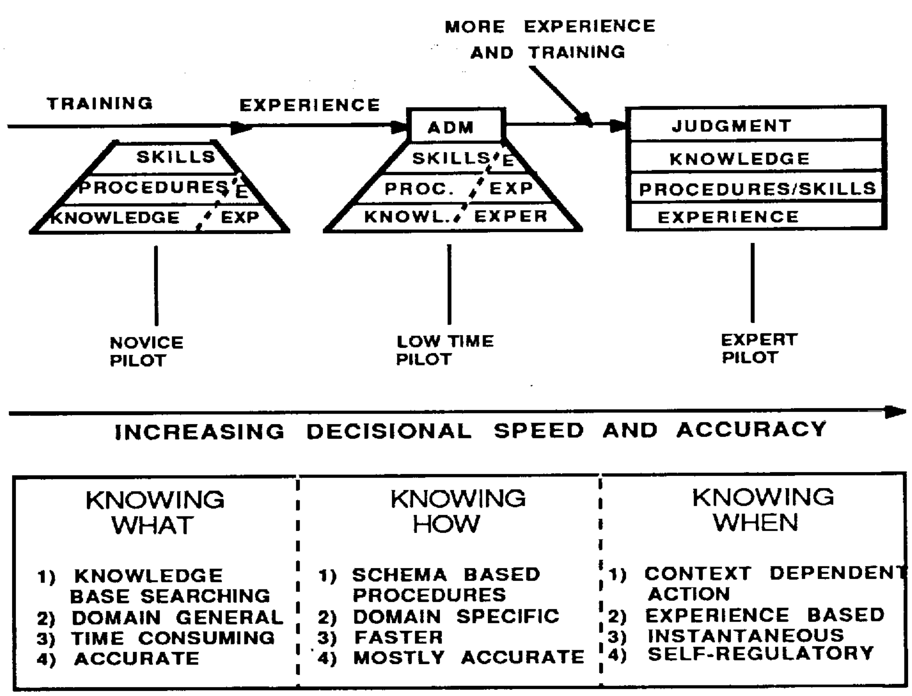


Figure 3. New frontiers.

he does not know when to alter those actions; he does not have the ability to react to novel things. Like the pilot in the cabin of Aloha 737, who looked back and saw blue sky. I don't think we can take a true *ab initio* pilot and bring him to that level; it is all in the procedural knowledge base and how we use the procedures we have learned in combination with the knowledge we have and facts that we have learned.

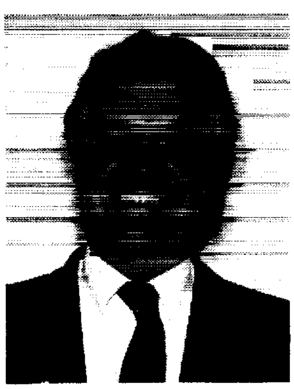
And finally, the expert pilot does all this in a self-regulatory mode. Self-regulatory means the next step in situational awareness. As I said, the expert can undergo an untrained-for emergency like those discussed and still maintain his housekeeping chores, carrying out his normal ATC communications and things like that. So they are not impossible tasks; it is just going to require some new training scenarios.

Finally, the most exciting new frontier I can think of is our being here at this workshop and that we have been invited to help the FAA generate new standards:

1. Joint industry-government simulator qualification standards development
2. Appropriate and sufficient training and testing criteria
3. Mission- and task-driven qualification standards

I think it is a great opportunity and I think from talking to the FAA people here, that it is going to be more pervasive than just in the simulator area. I welcome the chance to work with them. I think we should all think about the words "appropriate and sufficient training." I think we have a lot of components, we all know some of the weakness. I think I have an idea of some of the new ones based on research I have done. We need to think about missions and tasks to use for training concepts.

Thank you for your time and I look forward to working with you in the next couple of days.



Richard J. Adams, vice president of Advanced Aviation Concepts, has worked in civil aviation research and development for 26 years. He is the author of 69 technical reports, articles, and papers dealing with flight safety, decision-making training, pilot-error accident data analysis, air-space/route design, helicopter performance modeling, and helicopter pilot training deficiencies. Mr. Adams received a B.S. in aeronautical and astronautical engineering from the University of Illinois, and an M.S. in mechanical engineering from the University of Florida. Mr. Adams is a registered professional engineer in Florida and a private pilot.