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16. Abstract

A 10-item, voluntary questionnaire answered by 674 flight and ground schools provided information on (1) the conduct of formal instruction about disorientation, (2) the occurrence and content of lectures on disorientation, (3) use of on-the-ground demonstrations of disorientation, (4) use of in-the-air demonstrations of disorientation, (5) use of films on pilot vertigo, (6) amount of instrument flying training students receive, (7) amount of instrument flying training required of flight instructors to maintain their proficiency, (8) adequacy of the school's program on disorientation training, (9) other comments, and (10) numerical data regarding the number of students beginning and completing various flight and/or ground school courses.

More than one-third of the respondents evaluated their disorientation training program as inadequate and defined the inadequacy most often as a lack of appropriate materials, aids, and information. Tabulations of responses to the separate items suggested areas for improvement in disorientation training. Recommendations were made.

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DISORIENTATION TRAINING IN FAA-CERTIFICATED FLIGHT AND GROUND SCHOOLS: A SURVEY

I. Introduction: The Spatial Disorientation Problem in Civil Aviation.

Disorientation refers, in general, to an incorrect appraisal of an individual's position, location, or movement. In aviation, the incorrect appraisal specifically relates to the attitude (orientation) or motion of the pilot and his plane with respect to the earth (1). On some occasions, disorientation in the air consists of true vertigo (sensations of rotary motion of the external world or of the individual) and/or dizziness (sensations of unsteadiness with a feeling of movement within the head). Indeed, the three terms "disorientation," "vertigo," and "dizziness" are frequently (if inaccurately) used interchangeably to describe a variety of symptoms, such as false sensations of turning, of linear velocity, or of tilt. When referred to by pilots, "vertigo" almost invariably means their awareness of any of the various forms of disorientation. Thus, "pilot vertigo" and the more technical term "spatial disorientation" are virtually synonymous in the language of pilots. In fact, the current Flight Instructor's Handbook issued by the Federal Aviation Administration (FAA) defines vertigo as "a disorientation in space" (5).

According to the most recent annual review (1975) of aircraft accident data, 15 percent of all fatal general aviation accidents with assigned causes are attributable to spatial disorientation (12). This proportion may be an underestimate; spatial disorientation, or pilot vertigo, is probably the major factor in the 20 percent of 1975 fatal general aviation accidents attributed to pilots attempting to continue a visual flight rules (VFR) flight into adverse weather conditions requiring instrument flight rules (IFR). The latter situation presents an ideal opportunity for the development of spatial disorientation in flight, since disorientation usually occurs because of loss of visual reference with the terrain or horizon. In this regard, it is of more than passing interest that during the period from 1970 through 1975 approximately 20 percent of all fatal accidents of non-instrument-rated pilots were attributed to spatial disorientation; less than 7 percent of the fatal accidents of instrument-rated pilots were assigned this cause. Moreover, a recent review (11) of statistics on the role of spatial disorientation in fatal civil aviation accidents during the 5-year period from 1970 through 1974 indicated that (i) 90 percent of all spatial disorientation accidents were fatal and (ii) 35 percent of fatal weather-related accidents involved spatial disorientation.

Because the proportion of fatal general aviation accidents attributed to disorientation and continuation of VFR flight into IFR conditions has remained

relatively constant over the years, it seemed desirable to examine the extent and manner in which spatial disorientation has been presented to pilots during flight training. This survey was undertaken to provide some insight for assessing whether disorientation/vertigo training for general aviation pilots is adequate or needs improvement and, if the latter, how it might be improved.

II. Method.

A 10-item questionnaire (OMB 04-S73015) was used in the survey. The questions related to the: (i) conduct of formal instruction on disorientation, (ii) occurrence and content of lectures on disorientation, (iii) use of on-the-ground demonstrations of disorientation, (iv) use of in-the-air demonstrations of disorientation, (v) use of films on pilot vertigo, (vi) amount of instrument flying training students receive, (vii) amount of instrument flying training required of flight instructors to maintain their proficiency, (viii) adequacy of the school's program on disorientation training, (ix) other comments, and (x) numerical data regarding the number of students beginning and completing various flight and/or ground school courses.

A total of 1,269 schools were selected from 2,541 given in the FAA List of Certificated Pilot Flight and Ground Schools (6). All schools that taught both basic and advanced ground school courses and also provided training for all four of the major ratings (private, commercial, instrument, and flight instructor) were sampled. In addition, a few schools that met all the above requirements except for that of advanced ground school were also selected (10.6 percent of the sample). Voluntary questionnaires with preaddressed, return-postage-paid envelopes were mailed in 1973 to the selected schools. Within 2 months of the mailing date, 30.7 percent of the questionnaires had been returned. A followup letter was then mailed to those schools that had not responded; 33.8 percent of these subsequently returned completed questionnaires. Thus, 719 schools returned questionnaires during 1973-74 (56.7 percent); of the questionnaires returned, 674 (94.0 percent) were useful, 7 were blank, and 38 were unusable because the schools had either closed or no longer provided pilot training.

The "yes-no" answers to the questionnaire were tallied. Responses to open end questions were examined by two raters, empirical categories were established, and each response was assigned to the most suitable category by the raters.

III. Results.

Schools. Responding schools averaged 60 trainees per year in private pilot courses, 27 in commercial, 17 in instrument, 14 in multiengine, and 13 in instrument-instructor courses. Trainees in the multiengine courses were estimated to have the highest rate of successful course completion

(95 percent); completion rates were successively lower for instrument (83 percent), commercial (79 percent), private (67 percent), and instrument-instructor (46 percent) courses.

TABLE 1. Responses to Questions on the Use by 674 Flight Schools of Formal Instruction (Lectures, Films, and Demonstrations) on Disorientation

	Schools Responding (%)		
	Yes	No	Blank
Any formal instruction			
To students	83	16	1
To instructors	62	34	4
Lectures			
To students	74	24	2
To instructors	52	42	6
Ground based demonstrations			
To students	33	64	3
To instructors	30	53	17
In-flight demonstrations			
To students	82	11	7
To instructors	52	30	18
Films	34	60	6

Formal Instruction. Table 1 indicates that 83 percent of the responding flying schools reported they provide students with some type of formal instruction on disorientation (e.g., lectures, structured demonstrations, films). Fewer schools (62 percent) provide some type of formal instruction for their flight instructors.

Lectures. Seventy-four percent of the schools reported giving lectures on pilot vertigo to students while 52 percent provided lectures for instructors (Table 1). Of the 496 schools that reported giving lectures on pilot vertigo to trainees, most indicated that the lectures defined vertigo and explained the problems associated with it; multiple responses to this item were common. Lectures on the misleading cues a pilot can receive, such as illusions and flying problems associated with weather conditions, were cited by 127 schools;

TABLE 2. Lecture Time Devoted by Flight Schools to Disorientation

Lecture Time	Schools Responding (%)
Up to 30 minutes	22
30 - 60 minutes	24
1 - 2 hours	16
2 - 3 hours	7
Longer than 3 hours	4
Indefinite	12
No response	11

TABLE 3. Time at Which Lectures on Disorientation Were Given by Flight Schools in the Sequence of Ground School Hours and Actual Flying Hours

Hours	Lectures Given During:	
	Ground School (%)	Actual Flying (%)
First 5	7	18
5 - 10	11	13
10 - 20	23	20
20 - 50	21	8
Indefinite	16	13
No response	22	28

flying problems associated with alcohol, drugs, fatigue, and other physiological factors were mentioned 112 times; and lectures on the vestibular system and functions of the inner ear were noted by 80 schools. Other topics mentioned include facts about FAA handbooks and manuals, how to overcome vertigo, the senses, panic, noise, spins, and the need to trust instruments. The most frequently reported allocations of time for lecturing (Table 2) were up to 30 minutes (22 percent) and between 30 to 60 minutes (24 percent).

Twenty-three percent of the schools stated that lectures on vertigo or disorientation were given after 10 to 20 hours of ground school and 21 percent gave lectures after 20 to 50 hours; these were the most frequently used response categories. With regard to flying time, 18 percent gave lectures prior to any flying time or within the first 5 hours, 13 percent lectured between 5 and 10 hours of flying time, and 20 percent lectured between 10 and 20 hours of flying time (Table 3).

With regard to the occurrence of lectures on disorientation for flight instructors, the responses were divided into different categories. Ninety-eight schools (28 percent) specified that instructors receive disorientation lectures on special occasions, such as at FAA flight safety meetings. Ninety-two (26 percent) listed specific frequencies with which lectures occurred; e.g., once a year, at annual renewal clinics, during quarterly or weekly meetings. Eighty-one (23 percent) answered that their instructors received lectures at some time during their own training, during licensing, as student instructors, during various classes, etc. The remaining schools gave general answers suggesting that lectures are informal, are not scheduled at any specific time, or are provided as needed.

Films on Pilot Vertigo. Only 34 percent of the schools reported using motion picture films in their training programs. The 228 titles (and title facsimiles) cited by these users are shown in Table 4. About half the film material originated with the FAA and several of the schools reporting facsimile titles (particularly "alcohol, drugs, and flight effects" and "oxygen, altitude, and the body") may have been referring to other FAA films. Thirty schools specifically listed the Sanderson films, 26 listed the Cessna Course films, and 10 schools each noted the Moody Institute film (by either an earlier or a revised title) and the Piper film. In 90 percent of these cases, the films accompanied lectures and demonstrations.

Ground Demonstrations of Disorientation. Thirty-three percent of the schools gave ground demonstrations of disorientation-causing illusions to their students; 30 percent gave demonstrations to their flight instructors. The most common device employed for these demonstrations was some type of spinning chair, either one of the school's own devices (including a barber's chair) or a device demonstrated during an FAA meeting. Of the 282 responses (several schools gave more than one response), 170 (60 percent) indicated reliance on FAA or United States Air Force (USAF) physiological training. Moreover, only about half (53 percent) of the schools that responded positively stated that

TABLE 4. Titles or Facsimile Titles of Films on Pilot Vertigo Used by Certificated Flying Schools

	Titles		No. Schools
1.	Federal Aviation Administration		112
	FAA films (titles unspecified)	(56)	
	"Medical Facts for Pilots"	(20)	
	"One Eye on the Instruments"	(13)	
	"Charlie"	(7)	
	"Vertigo" and "Vertigo and Vision" (actual title: "Disorientation")	(7)	
	"It Only Takes Once"	(4)	
	"Stable and Safe"	(2)	
	"Aviation Medicine"	(2)	
	"R_x for Flight"	(1)	
2.	Sanderson films		30
3.	Cessna course film		26
4.	U.S. Air Force (or other military) films		15
5.	Moody film ("Freedom in Flight" or "Signposts Aloft")		10
6.	Piper film		10
7.	Aero Product Research ("Sensations of Instrument Flight")		7
8.	Audiovisual aids		4
9.	Alcohol, drugs, and flight effects		3
10.	Felsenthal A-V slides		3
11.	Oxygen, altitude, and the body		3
12.	AOPA 360 rating course		2
13.	Michigan Aeronautics Commission film		1
14.	Man and safety		1
15.	"Why Instrument Training?" (Flying Physicians Association)		1
			228

all students had an opportunity to use the device, and a similar percentage of the schools indicated at least one repetition of the experience during a student's training. Whereas 76 percent of the schools indicated repeated demonstrations for their flight instructors, almost half (44 percent) of such demonstrations involved attendance at FAA courses.

Disorientation Problems Demonstrated in the Air. Eighty-two percent of the schools gave their students specific disorientation demonstrations in the air, and at 52 percent of the schools the flight instructors received in-flight demonstrations (Table 1). Of these schools, most listed more than one form of demonstration. Of 609 responses, about 55 percent specified vertigo-producing maneuvers and 33 percent cited demonstrations with the trainee "under the hood" or "flying blind."

Hours of Instrument Flying Training (Air or Hood) Received. Responses to this item appear in Table 5. The data may be summarized as follows: Private pilot students received 2-5 hours of instrument flying training in 59 percent

TABLE 5. Hours of In-Flight Instrument Flying Training Provided by Flying Schools for Five Categories of Instruction

Instrument Hours	Courses				
	Private (%)	Commercial (%)	Instrument (%)	Instrument-Instructor (%)	Multi-engine (%)
< 2	2	0.3	0	0.2	19
2 - 5	59	0	0.2	1	21
5 - 10	29	3	0.7	7	8
10 - 20	1	83	0.2	35	3
20 - 40	0	4	34	26	0.2
40 - 60	0	0	50	3	0.2
60 - 100	0.2	0.3	3	2	0.3
Blank	8	9	11	23	46
Nonspecific	0.7	0.5	0.3	2	2

of the schools and 5-10 hours in 29 percent, or a total of 88 percent in the 2-to-10-hour range. For commercial students, 83 percent of the schools provided 10-20 hours of instrument flying training. In the instrument course, a substantial increase occurred in the reported number of hours of instrument flying training; 50 percent of the schools indicated that they gave students 40-60 hours of instrument flight training and 34 percent gave 20-40 hours.

The number of blank responses was greatest for the instrument-instructor (23 percent) and multiengine (46 percent) courses, probably because some schools rarely or never give these courses. However, 35 percent of the schools reported giving students in the instrument-instructor courses 10-20 hours of instrument flying training while 26 percent said they provided 20-40 hours. With regard to multiengine courses, 19 percent of the schools gave students less than 2 hours of instrument flying training while 21 percent gave 2-5 hours.

Actual or Simulated Hours of Instrument Flying That Flight Instructors Were Required to Fly to Maintain Their Proficiency Ratings. Responses to this item varied considerably among schools. Significant findings can be summarized as follows: Only 27 percent of the schools indicated a requirement for a specific number of hours utilizing some form of flight simulator. Actual flight requirements were in accordance with Federal Aviation Regulations (Part 61) in the majority of cases, but 47 percent of the schools reported requirements exceeding those of the FAA (8).

Adequacy of Current Disorientation Training. Sixty percent of the sampled schools reported their disorientation training program was adequate and 35 percent stated their program was inadequate; 5 percent did not respond. Almost 90 percent of those who described their program as inadequate commented on the deficiencies, which were primarily a lack of training materials. Seventy percent of these schools said they needed instructional aids, films, equipment (such as a rotating chair), and more "handout" information.

Additional Comments. Only 28 schools provided additional open end comments. Ten of these schools specifically indicated Federal Aviation Regulations should be improved in regard to disorientation training, and six others suggested the need for more FAA help (e.g., more visits from the General Aviation District Office (GADO) safety inspectors, more information). The 12 remaining comments were varied in nature.

IV. Overview.

Although it is clear that spatial disorientation is a significant factor in general aviation fatal accidents, 16 percent of the flying schools sampled indicated they did not provide their students with any type of formal instruction (lectures, films, demonstrations) on the topic and almost one-fourth of the schools indicated they gave no lectures on pilot vertigo.

Almost half the schools that did provide lectures allotted 1 hour or less to the topic. Only one-third of the schools made use of films, the vast majority of which emanated from the FAA, and some of which may not be effective in teaching about disorientation. It is likely that the data reported here are "best figures" because of the criteria used in selecting the sample of schools; the selected schools provide the widest range of training and, conceivably, should be among the best staffed and best equipped. Similarly, facilities and training aids would not likely be available to "free lance" flight inspectors who are not affiliated with a school.

Ground-school training can include disorientation demonstrations, but only one-third of the schools provided such training; more than 70 percent of those schools relied on FAA or USAF facilities or equipment. In these latter cases, only about half the students were given the opportunity to familiarize themselves with the disorientation experience. Although the majority of schools reported disorientation demonstrations in flight, 11 percent indicated they provided no such experience for students.

With regard to flight instructors, more than one-third of the schools provided no formalized training of any sort on disorientation and more than 40 percent gave no lectures to their instructors. Even among those schools reporting lectures for their flight instructors, about one-fourth indicated the instructors were exposed to the material when they were licensed, when they were being trained, or when they were instructing new students. Another 25 percent of the schools reported their flight instructors were exposed to disorientation lectures only when an opportunity arose to attend an FAA-sponsored meeting that included the topic. Similarly, of the 30 percent of schools that indicated they provided their flight instructors with ground-based demonstrations, nearly half depended on FAA courses. More schools (52 percent) provided instructors with in-flight demonstrations of disorientation.

An area of instruction that should be clearly related to disorientation is instrument flight training. Almost half the schools required more of their flight instructors than the minimal currency requirements of the FAA. With regard to trainees, the amount of instrument flying training varied, as would be expected, with type of course. In private pilot courses, more than half the schools gave 2-5 hours of instrument training (2 percent of the schools gave less than 2 hours) while 83 percent of the schools gave 10-20 hours to commercial students. For instrument courses, the number of hours of instrument training jumped to 40-60 for half the schools (and less than that for the remainder of those reporting). Because relatively few students enroll in instrument-instructor and multiengine courses and because many schools provide no instruction in the latter, data regarding these samples are based on a smaller number of responses. However, of the schools responding, 10-20 hours of instrument training were most often provided in the instrument-instructor courses and the vast majority of responses regarding the multiengine courses were about equally divided between less than 2 hours and 2-5 hours of airborne instrument practice.

More than one-third of the schools evaluated their disorientation training as inadequate and defined the inadequacy most often as a lack of appropriate materials, aids, and information.

V. Comments and Recommendations.

As noted elsewhere (2), most incidents and fatal accidents related to spatial disorientation (or pilot vertigo) in general aviation are probably attributable to normal functioning of the pilot's vestibular and visual systems in the absence of earthbound visual references coupled with inadequate instrument flying skills and questionable judgment about safe flying conditions. While it may be difficult to teach good judgment directly, certainly the causes of disorientation, the disorientation-induced dangers associated with flying in poor visibility and/or IFR conditions, the need to acknowledge to oneself when an orientation problem exists, and the ways to overcome disorientation in flight could be meaningfully presented to all student pilots and "graduate" trainees. A combination of appropriate lectures, films, and demonstrations could accomplish this objective, but the emphasis must be both on the dangers of disorientation and on how to deal with it in flight. The latter, of course, involves proficient use of appropriate instruments.

Lectures could be given at all flight schools by using the "Disorientation" lecture material and slides developed by the Aeromedical Education Branch of the Civil Aeromedical Institute in Oklahoma City. A ground-based demonstration should accompany the lectures; techniques for such demonstrations are available (1) and every student should be allowed to participate in these familiarization experiences. Moreover, an appropriate presentation should always accompany the demonstrations. Also, in-flight demonstrations should be given on more than one occasion. The first occasion should include a preflight briefing to alert the student that a portion of the flight will be used to demonstrate the unreliability of the student's position and motion senses and to convince the student that he must become skilled in interpreting and trusting his instruments. Later, the student should be given extensive opportunity to experience forms of disorientation in flight and to develop appropriate aircraft control recovery behavior and techniques. Apparently, the procedures of controlling and maneuvering an airplane solely by reference to instruments, which private pilot applicants are currently required to perform (3,7), are not presented in the context of their use in overcoming disorientation problems. However, the FAA does provide in its Instrument Flying Handbook (4) a set of controlled maneuvers designed to produce disorientation. These maneuvers should be used not just as indoctrination during instruction for an instrument rating but for all ratings and particularly those for private pilots. Moreover, private pilots should be taught (and have demonstrated to them) the experience of not perceiving changes in the attitude of an aircraft when changes have occurred.

Although not as dramatic, the failure to detect a change in attitude or position of the aircraft may have disorientation consequences equal to those of experiencing a false sense of movement.

Students and private pilots should also be encouraged to obtain an instrument rating and to maintain instrument flying proficiency. They should be strongly and repeatedly advised always to obtain preflight weather briefings, not to take off or fly into conditions of poor visibility, and, further, not to fly at dusk or at night unless they are sufficiently proficient in instrument flying to deal with problems of disorientation. Efforts should be made to increase their awareness of general aviation accident statistics, particularly those statistics that relate to fatalities and injuries where spatial disorientation is so prominently featured. Schools should schedule regular safety meetings with students and private pilots to include group discussions of general aviation "weather accidents" reported by the National Transportation Safety Board (NTSB). They should also encourage attendance at GADO and other FAA safety seminars.

Schools should formally encourage instructors to attend flight safety meetings periodically so they will thoroughly understand disorientation and can present its features to students in a serious manner; in-flight demonstrations should be presented as life-saving matters and not as amusing tricks. The demonstrations should be used to familiarize students with disorientation and its potentially hazardous effects so that trainees will learn to make appropriate, well-defined responses. Furthermore, schools should be informed periodically by the FAA about the availability of appropriate instructional literature, slides, and films on disorientation and how to survive it.

To test the effectiveness of training in disorientation, flight test examiners should quiz pilot applicants concerning their basic understanding of disorientation phenomena and test their ability to resist and cope with disorientation conditions at several points during the flight test. Finally, because loss of aircraft control during poor visibility conditions is related to the ability to resist disorientation by effective use of instruments, aircraft manufacturers and the FAA should seek improved instrument displays that provide more natural cues of position and orientation, particularly for inexperienced pilots (9,10).

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