Preparing for the Unexpected: A Psychologist's Case for Improved Training

Although design and automation help reduce human error incidents and accidents, training shortcomings must be corrected to enhance crew performance improvements.

by
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The large percentage of aircraft incidents and accidents attributed to human error has focused increasing attention on the performance characteristics of the individual pilot. Traditionally, human factors specialists have channeled their research energies toward exploration of the human information processing and perceptual aspects of the pilot's job, with the important goal of designing equipment best suited to the characteristics of the human operator.

Since it is commonly agreed that humans will always be fallible creatures, our goal has been to design and automate systems in areas where human operators are notoriously unreliable. Thus, human factors psychologists and aeronautical engineers have continually refined designs such that each generation of aircraft promises not only better performance and reliability, but also reduced pilot workload. Despite this effort, between 65 and 75 percent of accident causes (depending on whose statistics you listen to) continue to fall into the human error category.

Unfortunately, improved design and increased automation are not the only answers. If they were, we should be seeing a steady decrease in the number of human error incidents and accidents, but we are not. My colleagues at NASA have been conducting evaluations of the introduction of new generation transport aircraft into service. These studies have not been published yet, but we are seeing some potentially troubling signs. One of these "clouds on the horizon" is a reduction in some types of errors along with the creation of a new class of human error. A good example is a rash of incidents involving near stalls caused by advanced flight guidance systems left engaged in the vertical speed mode.

The point is that design and automation are not the only answers. They will only be effective to the extent that new training approaches are developed to keep pace, and I do not believe that training has kept up. I will focus upon what I believe to be three major shortcomings of current training. First, the training environment is preprogrammed so that everyone knows what to expect. We do an excellent job of training procedures to handle predictable situations, but as we all know, most accident scenarios are combinations of very unpredictable events. Psychological and learning theories suggest some potentially serious drawbacks to current training approaches and I would like to discuss some of these along with potential solutions.

Second, almost all training has been oriented toward perfecting the technical skills of individual pilots. Yet, most incidents and accidents are not attributable to the errors of a single crewmember — they are often the result of breakdowns of crews.

Third, the regulatory environment may not be able to handle some of the new training innovations that we believe will address current and future operational problems. Contrary to popular belief, this is not the fault of the rulemakers. To a very large extent, the regulations are merely a reflection of current operational practices. However, if we are to do a good job of handling problems one and two, it is likely that regulations governing training will have to evolve to take best advantage of new training approaches.

Problem Number 1 — Dangers of Preprogrammed Training Environment

The first problem area is concerned with the dangers of a totally preprogrammed training environment. Most flight training today is accomplished through the use of a highly structured training syllabus which is designed to cover everything considered important for individual pilots to accomplish their jobs safely and efficiently. There is almost no question that most advanced flight training does an excellent job of providing pilots with adequate technical knowledge in most areas. It is also doing a good job of standardizing procedures so crewmembers can theoretically work together and, of course, pass flight checks.

The basic methodology consists of the classroom presentation of technical knowledge coupled with extensive drills in procedures trainers and simulators until proficiency is achieved in all areas defined by the syllabus. Everyone knows what he or she will be expected to do. In short, every procedure is very well learned, or in psychological terms, pilots are programmed or conditioned to respond according to the appropriate stimulus cues that are defined by the training process.

It is important to point out that the training environment is usually a highly controlled situation where one stimulus at a time is presented, the appropriate conditioned response is eventually acquired with practice, and thus can be accomplished very reliably over and over again. It is also important to note that this is a very effective technique for learning discrete behaviors in isolation.

Such techniques are effective, but they may contribute to a psychological phenomenon known as mindlessness (Langer, 1980). Mindlessness refers to the fact that when certain behaviors are overlearned, humans tend to react automatically when any stimuli similar to those present when the behaviors were learned triggers the dominant or overlearned response. When a “mindless” behavior sequence is initiated, the behavioral process is often not at the level of conscious awareness.

More often than not, an individual cannot recall or verbalize the precise sequence of events leading up to the behavior or even remember components of the actual response itself. These overlearning effects are, of course, well-known with regard to various motor behaviors (e.g. walking, riding a bicycle, driving a car, even the mechanical acts involved with flying an airplane). However, recent research has found that the overlearning phenomenon extends to complex behavioral sequences involving verbal interaction and decision making.

How many times when someone asks you how are you doing, do you respond, “fine,” when actually if you thought about it you couldn’t be worse. This is an example of a mindless behavior. I have seen numerous examples of mindless behavior in air carrier cockpits such as checklists accomplished with items incorrectly or not completed because the normal overlearned response is “checked” or “set.” Bells, buzzers and whistles are ignored because you hear them too frequently. Clearances are incorrectly executed because the last 27 times you flew in to airport X on a nice day, you got the same clearance. These are all examples of mindless, highly overlearned behaviors.

This phenomenon suggests that training programs, whose underlying philosophies suggest that performance can be improved through the repeated practice of predetermined standard operating procedures, are unrealistic. What such approaches may be contributing to is a rather mindless adherence to a set of operating procedures. The problem is that you simply cannot develop a standard operating procedure for every situation. An examination of the incident and accident record confirms that these events almost always occur as a result of a number of highly unusual circumstances for which there simply is no standard operating procedure.

We often talk about crew errors caused by complacency, but I would argue that what we are really talking about in many situations are instances of mindlessness caused both by training programs that are procedures oriented and by an operational environment where equipment is so reliable that nothing ever happens. The distinction between mindlessness and complacency is important because there are two very different psychological processes involved.

The complacent pilot may be one suffering from low motivation, and training may be of limited effectiveness in dealing with motivational problems. On the other hand, I would argue that mindlessness can be decreased through various training processes, which induce cognitive processing and awareness.

There is another danger associated with overlearning procedures. Psychological research overwhelmingly indicates that in highly stressful situations, humans tend to exhibit a narrowing of perceptual attention, or tunnel vision. Cognitive processing is more difficult under such circumstances, and we tend to react instinctively. This is simply another way of saying that we tend to fall back on well-learned or dominant responses. For pilots operating in stressful circumstances, this phenomenon has significant advantages and disadvantages.

On the positive side, if the dominant or overlearned response is appropriate, it can be summoned quickly and precisely in situations where there is little time to react. On the negative side, it can lead to instinctual reactions, which are at best wrong, and at worst, tragic. In today's operational environment where "nothing ever goes wrong," pilots get very little experience in dealing with stressful, complex, decision-making situations.

These psychological principles argue for training which balances the best of both worlds. Training programs should provide pilots with well-learned and thought-out procedures for handling situations where there is very little time to react, and they generally do that very well. On the other hand, pilots need practice in dealing with unexpected, stressful, complex decision-making situations where there are not necessarily right or wrong answers; we are not taking full advantage of techniques which provide this type of experience.

Potential Solution — Line-Oriented Flight Training (LOFT)

Line-Oriented Flight Training is one way of providing pilots with experience in dealing with unexpected or stressful events. LOFT refers to the use of a training simulator and a highly structured script or scenario to simulate the total line operational environment for the purposes of training flight crews. LOFT is characterized by a combination of high-fidelity aircraft simulation with high-fidelity line operations. It involves a complete crew, each member operating as an individual and as a member of a team just as they do during line operations. LOFT involves real-world incidents unfolding in real time. Just as in the real world, the consequences of crew decisions and actions during a LOFT scenario will accrue and impact the remainder of the trip in a realistic manner. LOFT is casebook training. Often, problems have no single acceptable solution, and handling them is a matter of judgment. LOFT is training in judgment and decision making.

Realism is the key underlying the success of the LOFT concept. Good LOFT scenarios include all aspects of line operations including briefings and preflight activities, trip paperwork and ATC communications — in short, all aspects of an actual line situation. A well-scripted and developed LOFT scenario can create an almost complete illusion of the real world, which can be a powerful training experience for crews. I have observed LOFT exercises where the illusion was so complete, that during certain periods, I am convinced crews tend to forget they are in a simulator. I once saw a captain shine his flashlight on the windshield to look for ice accumulation during a simulator session.

If done well, LOFT can serve as a substitute for valuable experience that pilots no longer get because aircraft and their systems are so highly reliable. However, this is only true to the extent that LOFT scenarios provide the appropriate types of experience. The most successful LOFT scenarios are those for which there are no single acceptable solutions. The essence of LOFT training is training for the unexpected. I have heard numerous testimonials from pilots whose companies use LOFT effectively, indicating that LOFT is a tremendous confidence-building exercise, because it is the only place where they can make use of their acquired technical knowledge under highly stressful and unanticipated, adverse circumstances.

Unfortunately, LOFT is not being utilized to its full potential. Although it is gaining wide acceptance, it represents only a small fraction of all aircraft training. Its most frequent usage is in recurrent training, but in many cases, it is not utilized on a systematic basis. LOFT can also be used effectively in initial, transition and upgrade training programs. It is not, however, a substitute for technical and procedures training.

We have also seen cases where LOFT is not utilized appropriately, where it becomes little more than pre-programmed procedures training in a line context. I was told a story of an air carrier that claimed to be doing LOFT. The instructors were briefing participants on what was going to happen during the LOFT exercise so that they could more adequately prepare for it. Others have had their instructors "stop the action" when they feel they should make a point. This is not an effective use of the LOFT concept. The LOFT exercise should not be utilized as a means to teach appropriate procedures, but as a means of providing valuable experience.

Problem Number 2 — Training Focuses Almost Exclusively On the Individual

As a direct result of the limitations and imperfections of individual humans, multipilot aircraft cockpits were designed to ensure redundancy. Yet, this redundancy has failed to provide an adequate margin of safety in some cases. It has failed too often because captains have not heeded the warnings of other crewmembers. It has failed because crewmembers who possessed adequate information have for some reason not provided it to others. In fact, a review and analysis of worldwide jet transport accidents during the period from 1968 to 1976 (Cooper, White & Lauber, 1979) revealed more than 60 accidents in which breakdowns of the crew performance process played a significant role. Although individual pilot performance remains an important research topic, these occurrences suggest that more attention needs to be placed on crew performance and the factors which affect crew coordination.

Yet, the training emphasis up until recently has been almost exclusively on individual training. Unfortunately, a collection of qualified individuals does not automatically guarantee an effective team in the cockpit. Jones (1974) illustrated this assertion nicely in a study of professional athletic teams. Teams with better athletes seem to win more often, but the strength of this relationship is dependent on the extent to which the particular sport requires teamwork. Jones found that 90 percent of baseball team effectiveness was predictable from the skills of individual team members, while only 35 percent was predicated by this factor in basketball teams. In explaining this result, the author notes that basketball is critically dependent upon personal relations and teamwork. We have seen countless examples in our research and in the incident and accident record where ineffective interpersonal and management styles have caused breakdowns in information exchange and caused serious problems.

The NASA/FAA Aviation Safety Reporting System (ASRS) database is full of reports of inadequate interpersonal phenomena causing seriously unsafe situations in the cockpit. The National Transportation Safety Board, after a number of accidents, has repeatedly called for training programs including "considerations for command decision, resource management, role performance and assertiveness." NASA's full-mission simulation research has implicated inadequate crew interaction as a significant cause of operational errors.

A classic simulation study (Harper, Kidera, & Cullen, 1971) at a major air carrier illustrates the severity of the resource management problem very nicely. In this simulation, captains were asked to feign subtle incapacitation at a predetermined point during final approach. In that study, approximately 25 percent of the aircraft hit the ground because no one assumed control. These breakdowns usually do not occur because pilots are technically unqualified. They occur because interpersonal dynamics affect group interaction and performance. They occur because high-stress emergency situations require the coordinated actions of all crewmembers, and our training programs have generally not provided this type of experience.

Potential Solution — Cockpit Resource Management Training (CRM)

Recently, the extent of the crew coordination problem has become more and more salient to the aviation community. Some airlines, stimulated by this awareness, are beginning to address these issues in their training programs. CRM training seminars are often utilized, and these seminars usually cover subject matter such as: the effect of leadership styles on subordinate crewmembers, personality assessment, role playing, case studies and interpersonal encounter drills. It may surprise some persons to discover that these programs are very popular in airlines that have implemented them, but serious questions are usually raised as to their long-term effectiveness. It is probably true that these interventions provide some short-term insight, but long-term change is dependent on periodic exposure and reinforcement. Unfortunately, few organizations are providing crew members with such exposure on a recurrent basis.

Another potential shortcoming is the fact that CRM training is often provided only as captain upgrade training. The notion is prevalent that CRM training is only for the manager on the flight deck. While it is true that a captain's management approach will heavily influence crew performance, it is probably just as true that crew coordination training is vitally important for all crew positions.

One of the difficulties of providing effective CRM training is that the pilot population is heavily comprised, largely through self-selection processes, of individuals whose personality and attitudinal structures may not be conducive to teamwork. Moreover, attitudes and beliefs related to one's own interpersonal competence are extremely resistant to change.

When sitting in a seminar, which describes all of the qualities related to good cockpit management, it is fairly easy to convince yourself that you not only have them all, but a few more for good measure. In other words, people find it very easy to rationalize and justify their own behavior. If someone were to confront you and tell you that you were an ineffective manager, it would probably be fairly easy for you to decide that they are obviously a poor judge of management ability.

One of the reasons for this lack of self-objectivity is that we are rarely, if ever, provided with opportunities to view ourselves as others view us. There are some very powerful techniques which can be used in training programs that are very effective in producing attitude change. One technique concerns a psychological theory known as objective self-awareness. According to the theory, self-focused stimuli force us to examine ourselves more objectively, or more like others would view us, and we are less able to portray ourselves in an unrealistic, favorable light.

An ingenious study describes such an effect. In the study, college undergraduates were brought into a room and asked to report their SAT scores (Scholastic Aptitude Tests, the trademark of the U.S. College Entrance Examination Board) on a piece of paper. Half the subjects reported their scores while sitting in front of a mirror, while the other half did so without the mirror. The investigators then looked up the student's actual SAT scores in their records at the university. This study found that students sitting in front of the mirror reported their SAT scores more accurately than students not sitting in front of the mirror. The obvious implication is that the mirror provided a self-focusing stimulus which produced greater objectivity.

Mirrors are not the only self-focusing stimuli of course. Seeing oneself on videotape is equally powerful, and it is interesting to note that some training programs are videotaping the LOFT exercises as a means of providing their pilots with feedback on their CRM abilities. This program has proven highly successful, and has produced strong indications of attitude change.

In summary, in order for CRM to be effective, it must be reinforced at regular intervals throughout the pilot's career; it should include all crew positions; and it should be coupled with LOFT exercises and videotaped performance feedback.

Problem Number 3 — The Regulatory Environment is not Consistent with New Approaches

I have attempted to argue that current training approaches have focused upon procedures oriented training and are not providing enough experience in complex, decision-making situations. I have also argued that current training programs are oriented almost entirely toward individual proficiency and performance, and not upon, perhaps, the most significant cause of incidents and accidents: inadequate crew coordination and team performance. I have also suggested that new training approaches such as LOFT and CRM are not substitutes for either all procedures-based training or all individual-based training, and the obvious implication is that some augmentation may have to occur, and that, of course, means greater cost.

However, there are other implications of revamping training programs along these lines. Current Federal Aviation Regulations (FARs) governing training and proficiency will have to be modified to accommodate such new training approaches. Not surprisingly, they are set up to handle procedures-based proficiency, not complex decision making, and they are based on standards of individual proficiency and performance. As I mentioned in the beginning, this is not the fault of the rulemakers. The regulations are merely a reflection of our current way of doing things.

John Lauber [member, U.S. National Transportation Safety Board] and I first faced this issue when we were preparing "Guidelines for Line-Oriented Flight Training" (Lauber & Foushee, 1981) as a result of a NASA/Industry workshop on the subject. LOFT poses an interesting paradox for training departments and regulatory authorities. For maximum effectiveness, particularly when used to provide experience with complex, unanticipated, operational events; LOFT should and will induce errors. This is important because effective CRM is almost by definition the management of human error. Yet, traditionally, we have viewed training exercises characterized by errors as unsatisfactory and requiring additional work.

On the other hand, it can reasonably be argued that even LOFT exercises that result in "accidents" may be satisfactorily completed, because crewmembers have learned from mistakes that will probably never be repeated. This is especially true when the simulation is videotaped and can be reviewed by the full crew. The FAA, in approving the waiver for the substitution of LOFT for required checkrides, instituted the requirement that performance must be "satisfactory." This paradox makes evaluation an extremely gray area when using LOFT. The issue becomes even more complicated because particularly effective LOFT exercises have no single best way to complete the flight safely and expeditiously.

There will inevitably be disagreements among trainees, instructors, check airmen and air carrier inspectors about appropriate behavior and performance. If we are to train for unexpected situations, we have to subject pilots to unexpected events, and when we do, you can bet that we are going to see more errors.

Until now, this delicate issue has been largely avoided by using LOFT in "no jeopardy" training periods, usually recurrent training, and usually separated from the proficiency evaluation parts of training. However, the technique clearly has strong potential in training areas where performance evaluation is more or less inevitable. Moreover, LOFT may be the single best way to evaluate the strengths and weaknesses of individual pilots, since it probably approximates what would happen in the real world under similar circumstances. If we are to train more for the unexpected, these issues must be addressed in the FARs.

An even more difficult situation exists with respect to the regulations regarding acceptable crew performance. In short, the FARs governing pilot qualifications deal almost exclusively with the acquisition and maintenance of individual pilot proficiency. Proficient individuals do not always combine to produce a competent team. The aviation community seems to have accepted this viewpoint and with increasing momentum is embarking upon approaches to training that address the group performance problem. Since the practice of "permanent crews" (the same individuals always flying together) is rare, it is obviously going to be difficult to set standards for crew evaluation. Today, you are a member of a very efficient crew; next week may be a different story because you are flying with someone else. Thus, the burden of training will be upon those interpersonal skills that are known to contribute to good crew function.

At present, CRM training approaches are entirely nonpunitive — there is no checking procedure in place for CRM skills. However, some persons have suggested that the same standard be applied to interpersonal competence as is now applied to technical competence. This, of course, implies a wholesale reevaluation of government and industry practices in training and checking areas.

Potential Solution — Focus Upon Crew Performance

How are we going to evaluate crew performance? The answer to this question seems to point to LOFT as the best solution, but again there are a number of unresolved issues. The most serious concerns the partitioning of blame for an "unsuccessful" LOFT exercise. Let me give you a hypothetical example. Let's imagine a LOFT exercise where the crew receives an engine failure, and in the course of securing the failed engine, the first officer pulls the wrong fuel shutoff lever, causing a dual engine flameout. Let's also imagine that this happened during a LOFT used in captain upgrade training. Is it the captain's fault for not managing his crew effectively, and should he have to repeat some aspect of training because his performance was unacceptable? If this captain had flown with a more careful first officer, his performance might have been perfect.

There are no easy answers to questions such as these, but it seems safe to suggest that regulations will ultimately have to address such questions if we are serious about focusing upon crew performance.

I have argued that human factors engineering and automation approaches to the reduction of human error are promising, but that ultimately this approach will not be completely successful because inevitably a new class of human error will be created. As a result, I have suggested that training will have to take up the slack, but that our approach to training is deficient in several areas. First, current training may be overly programming pilots with procedures and not providing adequate experience with unexpected situations requiring complex judgments and decision making. Second, we have focused almost exclusively upon individual performance and proficiency while crew performance problems represent perhaps the most significant cause of incidents and accidents. And third, if we are to address these two issues effectively, government, labor and industry will be forced into a wholesale reevaluation of checking and training practices. ♦

About the Author

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Prior to joining the FAA, Foushee was the principal scientist of the Crew Research and Space Human Factors Branch at the NASA-Ames Research Center, where he headed a research program concerned with group performance factors in aviation and space.

Foushee has worked extensively with high-fidelity simulation approaches to research and training, and has participated in the development of training approaches that seek to facilitate crew performance such as cockpit resource management training.

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Technical Education — Working Within the System

The sophistication of today's aircraft requires more than basic technical skills.

by
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Today more than ever before, the preparation of students for entry-level positions in the aviation/aerospace industry presents a tremendous challenge. Rapidly advancing technology in the area of aircraft systems has changed the nature of what is required as "basic skills." Many aviation professionals have voiced concern over what they perceive as a decline in basic skill development of today's entry-level technicians.

The discussion that follows includes a brief history of the U.S. Federal Aviation Administration's (FAA) efforts to upgrade curriculum requirements, along with several suggestions as to what might be done to improve basic skills through a more comprehensive educational process.

Federal Aviation Regulation (FAR) Part 147, the basic guideline established by the FAA outlining the requirements for certification of aviation maintenance technician (AMT) schools, was amended in May 1970. The effect of this amendment was to change the name of mechanic schools to aviation maintenance technician schools and to provide new minimum curriculum requirements. According to an FAA document released at that time, the guidelines were amended to "reflect technological advancements of the aviation industry." Nearly 20 years later the FAA has once again proposed a change in FAR Part 147 for very much the same reason. The FAA's effort regarding this proposed change has received some support. Through a series of regional meetings, the agency has given both education and industry the opportunity to provide input.

However, a concern expressed by many aviation professionals regarding the latest proposed change has been whether or not it will reflect an overall increase in the basic skills of entry-level aviation technicians. The answer is no. The forthcoming changes are subtle, not sweeping, an understandable compromise considering the number of constituencies that have voiced their concerns regarding his matter. This change will more than likely reflect a general overall strengthening of the basic curriculum. It is expected to weed out archaic phrases and practices and upgrade the proficiency requirement in areas generally accepted as common practice in the industry.

Certified AMT schools should *not* look to the FAA to provide leadership in the area of academic preparedness and skill development. It is up to those who are directly involved in educating tomorrow's aviation technicians to take the lead and build a solid curriculum that incorporates today's technology, supported by the development of strong academic and technical skills. The FAA has provided the necessary foundation — what is built upon that foundation is in the hands of the educators. Certified AMT schools have the responsibility to provide an education that keeps pace with changing technology.

This be accomplished, for example, in several ways. Here are some suggestions.

Opportunities should be provided for faculty members to ensure that they remain informed concerning technological advancement and changes in industry practices. The faculty of any educational institution is its greatest resource: the institutions must be prepared to make a major investment in them. There must be support and encouragement for faculty in-service training programs and attendance at service schools. Their active participation in professional societies must be supported and they should be encouraged to seek advanced academic credentials. They must have structured opportunities to apply advanced technology to existing classroom and laboratory situations. Opportunities for personal and professional growth will be aggressively seized by most professional staff members.

Opportunities to initiate changes in existing curricula should be a priority, rather than efforts to find reasons why this cannot be done. FAR Part 147 provides the minimum curriculum requirements. Many basic principles can be taught in the context of today's more sophisticated technology. To this end, AMT schools should continually seek to upgrade all existing laboratory experiences.

Local advisory councils are comprised of the consumers of the educational product, and they can be a valuable resource. Seek their advice, listen to their comments and act on their recommendations. The advisory council can be the vehicle used by aviation and aerospace professionals to ensure that their needs are being addressed. The industry should support participation on advisory councils, and seek out opportunities to become active members.

Instill the feeling in all aviation professionals that a partnership exists between industry and education. Most educational institutions work with limited resources and are in great need of modern, state-of-the-art equipment. The aviation industry has a good record of supporting the AMT schools, yet much usable modern equipment still gathers dust because the needs of the schools have not been effectively communicated to industry. The industry should be considered a major resource and utilized to its fullest extent.

Expand co-op and work-study programs. The educational experience of the student is enhanced and on-the-job-training requirements of employers are shortened. This benefits both student and employer. Every effort should be made to develop these programs.

Education, not just training, is necessary if we are to provide certified aviation technicians whose skills keep pace with advancing technology. Individuals involved with maintaining today's modern fleet of aircraft need more than basic skills. AMT schools must broaden their curriculum and seek more than compliance to minimum curriculum requirement as outlined in FAR Part 147. The sophistication of today's aircraft requires a substantial appreciation and understanding of the principles of mathematics and science, and an even greater command of communication skills, both oral and written.

The latest proposed change in FAR Part 147 will not reflect a great change in basic academic or technical skill levels of entry-level technicians. It is up to those who are responsible for educating these individuals to see that these skills are improved. And it is up to industry professionals, who seek a better prepared technician, to become more involved with the educational process. ♦

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Reports Received at FSF Jerry Lederer Aviation Safety Library

Reports:

Aerospace Facts and Figures [89/90]. — Washington, D.C.: Aerospace Industries Association of America, 1989. Available through AIA, 1250 Eye Street, N.W., Washington, D.C. 20005, $20.00 *174p.*

Key Words
1. Aeronautics — Yearbooks.
2. Astronautics — Yearbooks.

Contains tables, graphs and text describing aerospace activity in the U.S. through 1988 and includes some estimates for 1989 and 1990. Historical data on aircraft production, missiles and space programs, air transportation, research and development, foreign trade, employment and finance is also included. [press release]

Aging Aircraft: FAA Needs Comprehensive Plan to Coordinate Government and Industry Actions, Report to the Secretary of Transportation. — Washington, D.C.: General Accounting Office, December 1989. Report No. GAO/RCED-90-75, *27p.* GAO.*

Key Words
1. Airplanes — Airworthiness — United States.
2. Airplanes — Fatigue — United States.
3. Airplanes — Maintenance and repair — United States.

GAO presents an overview of FAA efforts and initiatives to meet the aging aircraft challenge. GAO recommends that FAA develop a plan describing present and anticipated actions to meet the aging aircraft challenge, their time frames, and the resources necessary to complete these actions and report periodically to Congress on the progress made toward accomplishing the plan's goals. Appendix II presents a profile of the U.S. fleet as of July 1989. Appendix II is a summary of actions in response to conclusions and recommendations made at the aging aircraft conference held in June 1988.

Aviation Safety: FAA is Considering Changes to Aviation Medical Standards; Fact Sheet for Congressional Requesters. — Washington, D.C.: U.S. General Accounting Office, January 1990. U.S. General Accounting Office Report GAO/RCED-90-68FS,*11p.* GAO.*

Key Words
1. Air pilot— Medical examinations — United States.
2. Aeronautics, commercial — Safety regulations — United States.
3. Air pilots — Legal status, laws, etc. — United States.

This fact sheet provides information on the nature and status of the revisions the FAA is considering for aviation medical standards. No assessment was made of the medical appropriateness of the changes under consideration. The changes overviewed include visual; ear, nose, throat and equilibrium; mental and neurological; cardiovascular; and general medical conditions. The chronological information indicates a Notice of Proposed Rulemaking will be published in June 1990, at the earliest. The final rule will not be issued until 1991.

Aviation Safety: Facility Ranking of Controller Survey Responses. Report to Congressional Requesters. — Washington, D.C.: General Accounting Office, November 1989. Report No. GAO/RCED-90-39. *109p.* GAO.*

Key Words
1. Air traffic controllers — United States.
2. Air traffic control — Evaluation — United States
3. Work environment.

Air traffic controllers are still troubled by working conditions and the extent of their concern varies among facilities. Twenty-seven questions in six areas of this 1988 controller work force questionnaire — workload, staffing, overtime, training, system safety and morale — are tabulated for each of the 84 largest air traffic control facilities in the United States. Overall, controllers at Boston and Washington centers had the most negative survey view, whereas Albuquerque, Houston, and Minneapolis had the least negative view. This supplements reports GAO/RCED 89-112 and 89-113FS. GAO.*

Aviation Security: Training Standards Needed for Extra Security Measures at Foreign Airports; Report to the Secretary of Transportation. — Washington, D.C.: General Accounting Office, December 1989. Report No. GAO/RCED-90-66 *11p.* GAO.*

Key Words
1. Airports — Security measures.
2. Airports — Employees — In-service training.
3. Airlines — Employees — Training of.

FAA is examining the training and testing of host government security personnel who screen passengers and baggage at high-risk airports. GAO believes FAA needs to do the same for U.S. airline security personnel charged with carrying out extra security procedures at these airports. Greater FAA scrutiny of training can help ensure that airline security personnel at high-risk overseas airports are adequately trained to carry out the required procedures.

Deicing of Aircraft Turbine Engine Inlets, Final Report, October 1986-June 1988./H.A. Rosenthal, D. Nelepovitz, H. Rockhold (Rohr Industries).— Washington, D.C.: Federal Aviation Administration; Available through the National Technical Information Service, June 1988. Report No. DOT/FAA/CT-87/37; Contract No. DTFA03-86-C-0050 *50p.* NTIS.*

Key Words
1. Airplanes — Ice prevention.
2. Deicing chemicals.

This document presents the results of an FAA investigation to determine the effects of using deicing, as opposed to anti-icing, in aircraft turbine engine inlets. This report describes the icing/deicing process, discusses deicing system operation and performance, ice detector characteristics, and presents a method for determining the effects of the deicing process on the turbine engine and its associated induction system.

Flight Deck Automation: Promises and Realities (Proceedings of a NASA/FAA/Industry Workshop held at Carmel Valley, California, August 1-4, 1988)./Susan D. Norman, editor (NASA Ames), Harry W. Orlady, editor (Orlady Associates). — Moffet Field, Calif.: NASA Ames Research Center; Available through the National Technical Information Service, September 1989. Report No. NASA CP-10036. *215p.* NTIS.*

Key Words
1. Airplanes — Piloting — Automation.
2. Airplanes — Piloting — Human factors.
3. Airplanes — Cockpits — Automation.
4. Air pilots — Training.
5. Flight crews — Workload.
6. Airplanes — Glass cockpit.

The workshop goal was to clarify the implications of automation, both positive and negative. Workshop panels and working groups identified issues regarding the design, training and procedural aspects of flight deck automation, as well as the crew's ability to interact and perform effectively with the new technology. The proceedings include the invited papers and the panel and working group reports, as well as the summary and conclusion of the conference.

Ground Aircraft Deicing Technology Review, Final Report, September 1984-March 1986./ Deborah Mayer, Joseph Michitsch, Rosie Yu (ARINC Research Corporation). — Washington, D.C.: Federal Aviation Administration; Available through the National Technical Information Service, March, 1986. Report No.DOT/FAA/CT-85-21, *125p.* NTIS.*

Key Words
1. Airplanes — Ice prevention.
2. Deicing chemicals.

This report provides a review and update of operational, procedural and system information regarding deicing of aircraft prior to flight. It reflects current practices of the different segments of aviation with the preponderance of information addressing the procedures employed by the airlines. Survey results presented in this report reflect the airlines' adherence to the "clean aircraft concept" as presented in Advisory Circular 20-117, and also indicates the need for a better understanding of the different types of deicing fluids and facilities currently available.

Proceedings of the Workshop on Flight Instruction for the 1990s./ University of Newcastle Institute of Aviation . — Newcastle, N.S.W., Australia: University of Newcastle, 1989. Workshop held October 3, 1989.

Key Words
1. Flight training — Australia.
2. Air pilots — Training — Australia.

Table of contents: Keynote Address, Capt. Trevor Thom/ Evaluating the Training Effectiveness of Flight Simulators, Michael Ross/Integrating Theory and Practice in Flight Training, Len Yates/Pleasures and Pitfalls in Teaching Aviation Meteorology, Howard Bridgman/Pilot Learning Styles, Ross Telfer and Phil Moore/Aviation Psychology Course Developments at Massey University, Ross St. George/Training the Quantas Captain of the 1990s, Capt. Richard L. Wilkinson/Towards a Theory of Flight Instruction for Ab Initio Pilots, Robert Loretan, Trevor Cook, and Len Lambeth/Problems and Solutions in Flight Instructor Training, Irene Henley.

Study of the Engine Bird Ingestion Experience of the Boeing 737 Aircraft (October 1986 — September 1987); Interim Report./Peter W. Hovey, Donald Skinn (University of Dayton Research Institute): U.S. Federal Aviation Administration Technical Center; Available through the National Technical Information Service, October 1989. Report No. DOT/FAA/CT-89/16. *100p.* NTIS.*

Key Words
1. Airplanes — Motors.
2. Bird pests — Control.
3. Airports — Bird control.
4. Jet transports — Safety measures.

In October 1986, the FAA Technical Center initiated a study to determine the numbers, sizes and types of birds that are being ingested into medium and large inlet area turbofan engines and to determine what damage, if any, results. Bird ingestion data are being collected for the Boeing 737 which uses the Pratt Whitney JT8D medium inlet area turbofan engine or the CFM International CFM 56 large inlet area turbofan engine. This interim report analyzes the first of 3 years of data collection.

U.K. Airmisses Involving Commercial Air Transport, January-April 1989.— London: Civil Aviation Authority, 1989. 36p. ISSN: 0951-6301.

Key Words
1. Aeronautics, commercial — Great Britain — 1989.
2. Airplanes — Near midair collisions — Great Britain.
3. Airplanes — Collision avoidance — Great Britain.

An "airmiss" is said to have occurred when a pilot considers that his aircraft may have been endangered by the proximity of another aircraft. Only the pilot of the aircraft can file an airmiss report. If the air traffic controller considers that flight safety has been hazarded, he will file an Aircraft Proximity Hazard report which will be investigated, but separate from, the airmiss system. Available from the Civil Aviation Authority, CAA House, 45-59 Kingsway, London, WC2B6TE, England.

Aircraft Accident Report: Delta Air Lines, Inc. Boeing 727-232, N473DA, Dallas-Fort Worth International Airport, Texas, August 31, 1988. — Washington, D.C.: National Transportation Safety Board; Springfield, Va. Available through the National Technical Information Service, September 26, 1989. report No. NTSB/AAR-89/04, PB89-910406. *135p.*

Key Words
1. Aeronautics — Accidents — 1988.
2. Aeronautics — Accidents — Takeoff/Landing.
3. Delta Air Lines — Accidents — 1988.

Delta Air Lines Flight 1141, August 31, 1988 — Boeing 727-232, regularly scheduled passenger flight en route to Salt Lake City, Utah, with 101 passengers and seven crewmembers, crashed shortly after takeoff. Twelve passengers and two crewmembers were killed, 21 passengers and five crewmembers were seriously injured, and 68 passengers sustained minor or no injuries. The NTSB determined that the probable cause of this accident was the captain's and first officer's inadequate cockpit discipline that resulted in the flight crew's attempt to take off without the wing flaps and slats properly configured, and the failure of the takeoff configuration warning system to alert the crew that the airplane was not properly configured for the takeoff. Contributing to the accident was Delta's slow implementation of necessary modifications to its operating procedures and lack of sufficiently aggressive action by the FAA to have known deficiencies corrected by Delta. The safety issues discussed in the report include flight crew procedures, wake vortices, engine performance, airplane flaps and slats, takeoff warning system, cockpit discipline, aircraft rescue and firefighting, emergency evacuation and survival factors.

Report of the accident to Boeing 747-136 G-AWNM on approach to runway 27L at London (Heathrow) Airport on 11 September 1988. — London: Department of Transport, Air Accident Investigation Branch, 1989. Aircraft Accident Report 5/89, ISBN 0115509445, iii, 25p, 3 appendices, color photos.

Key Words
1. Aeronautics — Accidents — 1988.
2. Aeronautics — Accidents — Flaps.
3. Aeronautics — Accidents — Inspection.
4. British Airways — Accidents — 1988.

British Airways Boeing 747 was on a scheduled international passenger flight from Abu Dhabi to London's Heathrow Airport with a total of 378 persons on board. The flight had proceeded normally until the final stages of an Instrument Landing System approach. Shortly after 30 degrees of flap had been extended, there was a noticeable "thump" and immediately the aircraft started to yaw and roll to the right. The captain maintained control by use of considerable control wheel deflection and the aircraft was landed without further incident. Examination of the aircraft after landing revealed that stress-corrosion cracking, initiated from a corroded forward bolt hole, induced fast brittle fractures of the steel flap track at a point where the design was not fail-safe. A contributory cause was the failure of a special inspection to detect such cracking before full fracture occurred despite many revisions of its requirements following other instances of flap track cracking and failure. Available from HMSO Publication Centre, P.O. Box 276, London SW8 5DT, England.

Report on the accident to Concorde 102 G-BOAF, over the Tasman Sea, about 140 nm east of Sydney, Australia on 12 April 1989. — London: Department of Transport, Air Accident Investigation Branch, 1989. Aircraft Accident Report 6/89, ISBN 0115509429, iii, *19p.*, color photos.

Key Words
1. Aeronautics — Accidents — 1989.
2. Concorde.
3. British Airways — Accidents — 1989.

A chartered British Airways flight carrying approximately 100 passengers, was en route from Christchurch to Sydney. While accelerating through Mach 1.7 and climbing through flight level 440, a "thud" was heard by the crew and passengers. As the aircraft was descending through FL 400 and decelerating through Mach 1.3, moderate vibration occurred, lasting two to three minutes. The top wedge of the upper rudder aft of the main spar separated from the aircraft. Aircraft handling was unaffected and an uneventful approach and landing was carried out at Sydney Airport. The following casual factors were identified: The in-flight breakup of the bonded honeycomb structure of the upper wedge of the upper rudder occurred as a result of extensive prior delamination of the skin from the honeycomb core; moisture ingress past the rivets in the trailing edge lead to corrosion between the honeycomb structure and the skin of the upper wedge, and to deterioration of the adhesive bond strength. Available from HMSO Publication Centre, P.O. Box 276, London SW8 5DT, England.

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Telephone: (202) 783-3238

U.S. General Accounting Office (GAO)
Post Office Box 6012
Gaithersburg, MD 20877 U.S.
Telephone: (202) 275-6241

Aviation Statistics

A Decade of Progress and Difficulty

A Review of U.S. Airline Growth and Safety Performance 1979-1989

U.S. Air Carrier

In 1989, U.S. airlines operating large aircraft (FAR Part 121 operators) in scheduled and nonscheduled worldwide operations were involved in 28 accidents, 11 of which were fatal. During the year, 278 fatalities occurred, down from 285 in 1988, according to preliminary statistics released by the U.S. National Transportation Safety Board (NTSB).

The 11 fatal accidents recorded in 1989 represented the highest number of the decade. However, it should be noted there were no passenger fatalities involved in four of the 11 accidents. In one of the four accidents, the pilot was incapacitated while inspecting the cargo bay at the ramp. In the second accident, a groundguide was struck by the aircraft during pushback. The third accident involved a ramp worker who was fatally injured by lightning during pushback from the gate, while the fourth accident involved a stowaway found in the stairway after landing. If these four random events are not included in the passenger fatal accident statistics, the fatal accident rate for 1989 is much lower. The total accidents, fatal accidents and fatalities for 1989 and the 10 preceding years are shown in Table 1.

An annual comparison of total accidents and fatalities reveals that the most deadly year of the decade was 1985, when 525 people aboard aircraft were fatally injured in seven accidents. In terms of passenger fatalities, the year 1980 was passenger-fatality free. In other words, all 255 million U.S. airline passengers arrived at their destinations safely. The single fatality that involved airline operations in that year was a parachutist who was struck by an airliner.

Although U.S. airlines operating large aircraft had difficulties during the decade, Table 1 also shows that the industry has enjoyed continuing growth since 1979. Federal government statistics show that flight time jumped from 6.878 million hours in 1979 to 11.05 million in 1989, an increase of 61 percent. Aircraft-miles flown

Graphic not available

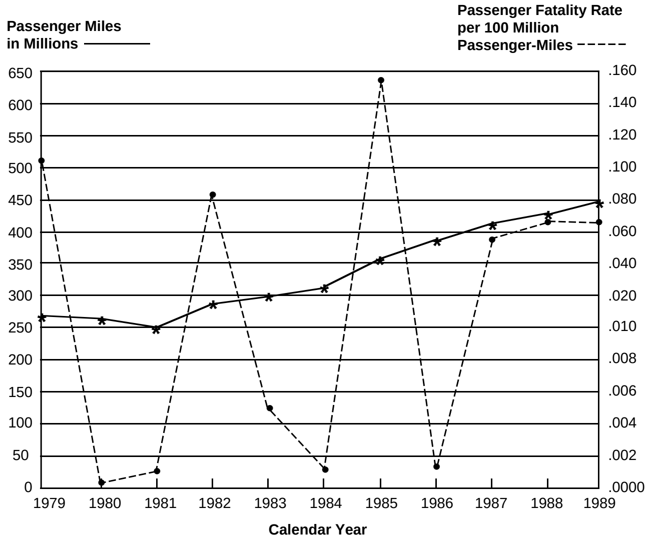
increased 60 percent. In terms of the average number of passengers carried since 1980, U.S. airlines carried an average of 15,000,000 more passengers each succeeding year (see Table 2). The average trip length in domestic flights steadily increased about seven miles a year; the average trip length in international flights increased about 50 miles a year.

The airlines had steady growth but an analysis of safety indicators over the decade, as displayed in Table 1 and in Figure 1, shows that annual safety performance, in terms of total accidents, fatal accidents or passenger fatalities rates, is not improving. The total number of accidents per million departures for 1980-1984 was essentially the same as for 1985-1989 while passenger fatalities per 100 million passenger-miles was *higher* in 1985-1989 than in 1980-1984. These passenger fatality statistics do not prove there has been a safety degradation for Part 121 operations during the 1980s, because the number of accidents involved is small, but they reinforce the need for constant vigilance by air carriers, pilots, aviation mechanics and all others involved

Table 2 — Passenger Enplanements, Passenger-Miles Flown and Trip Length, U.S. Airlines Operating Large Aircraft 1979-1989

Year	Enplanements	Passenger miles flown in millions	Trip length/miles Domestic	Trip length/miles International
1979	320,595,000	269,719	714	2,199
1980	299,746,000	260,415	736	2,258
1981	290,450,000	260,063	749	2,427
1982	299,586,000	272,434	766	2,505
1983	324,688,000	295,143	765	2,506
1984	351,621,000	319,503	759	2,599
1985	390,330,000	351,073	758	2,642
1986	426,314,000	378,922	767	2,570
1987	455,516,000	417,823	779	2,589
1988	463,124,000	437,492	786	2,655
1989	469,543,000	450,412	780	2,643

Figure 1–U.S. Airline Passenger Miles Flown and Passenger Fatality Rate 1979-1989

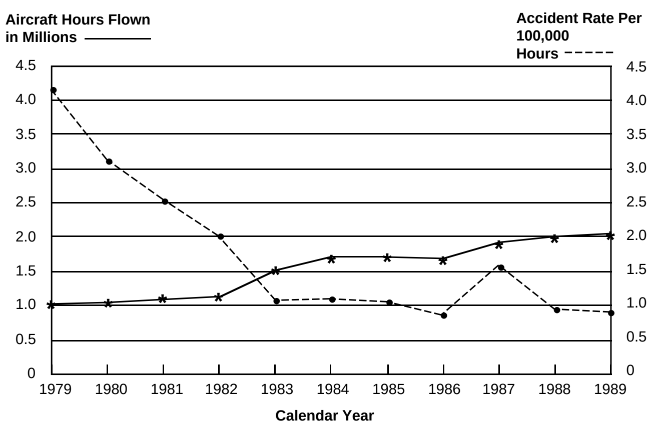


in aviation to improve the current high level of passenger safety.

Commuter Air Carrier and Air Taxi (FAR Part 135 operators)

In 1989, commuter air carriers, according to the NTSB, had 18 accidents, down one from the previous year, but

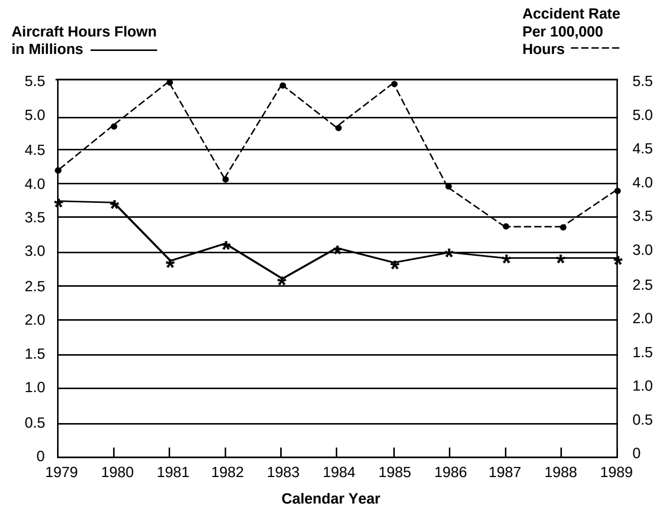
Figure 2–U.S. Commuter Air Carrier Aircraft Hours Flown and Accident Rates 1979-1989



had five fatal accidents, up from two in 1988, resulting in 31 fatalities, ten more than in 1988. The air taxi accidents increased from 98 in 1988 to 110 in 1989 while the number of fatal accidents decreased from 27 to 23. Fatalities in air taxi operations rose from 58 in 1988 to 80 in 1989.

The growth and safety records for commuter air carriers and air taxis in the decade are depicted in Figures 2 and 3. The annual growth and safety records for commuter air carriers appears more encouraging than for air taxis. For commuter air carriers, annual aircraft hours

Figure 3–U.S. Air Taxi Aircraft Hours Flown and Accident Rates 1979-1989



flown increased from 1,169,921 hours in 1979 to 2,040,000 hours in 1989, an increase of 74 percent while the accident rate decreased from 4.445 accidents per 100,000 aircraft hours in 1979 to less that one (.880) accident per 100,000 aircraft hours in 1989, a decrease of 80 percent. On the contrary, the air taxi hours flown decreased from 3,684,000 hours in 1979 to 2,870,000 in 1989, a decrease of 22 percent. Accident rates peaked at 5.46 accidents per 100,000 aircraft hours in 1985 but tended to taper off for the last four years of the decade.

Tables 3 and 4 detail the 11 fatal U.S. air carrier accidents:

Table 3
Fatal Accidents and Fatalities
U.S. Air Carriers Operating Under 14 CFR 121
All Scheduled Service (Airlines)
1989 (Preliminary Data)

Date	Location	Operator	Service	Aircraft	Fatalities: Psgr	Crew	Other	Total	Total Aboard
2/09	Lubbock Texas	Evergreen, Intl.	Cargo	DC-9	0	1	0	1	2

Pilot was incapacitated while inspecting cargo bay.

Date	Location	Operator	Service	Aircraft	Fatalities Psgr	Crew	Other	Total	Total Aboard
2/19	Puchong, Malaysia	Flying Tigers	Cargo	B-747-200	0	4	0	4	4
Crashed while landing.									
2/24	Honolulu, Hawaii	United Airlines	Psgr	B-747-122	9	0	0	9	355
Ten by 40 foot section of fuselage tore away in flight.									
3/18	Saginaw, Texas	Evergreen, Intl.	Cargo	DC-9	0	2	0	2	2
Crashed during emergency landing.									
7/12	San Juan, Puerto Rico	American Airlines	Psgr	Airbus A300-600ER	0	0	1	1	244
Ramp worker was run over while aircraft was being pushed back from gate.									
7/19	Sioux City Iowa	United Airlines	Psgr	DC-10	110	1	0	111	296
Crashed during emergency landing after loss of engine and hydraulic system.									
9/20	Flushing New York	USAir	Psgr	B-737-400	2	0	0	2	63
Aircraft departed the end of the runway following a rejected takeoff.									
12/27	Miami, Florida	Eastern Airlines	Psgr	B-727	1	0	0	1	54
Body found in aft airstair after arrival from Barbados.									

Table 4
Fatal Accidents and Fatalities
U.S. Air Carriers Operating Under 14 CFR 121
All Nonscheduled Service
(Airlines)
1989 (Preliminary Data)

Date	Location	Operator	Service	Aircraft	Fatalities Psgr	Crew	Other	Total	Total Aboard
2/08	Santa Maria Azores	Independent Air	Psgr	B-707	137	7	0	144	144
Collided with terrain.									
3/15	West Lafayette, Indiana	Mid Pacific Airlines	Cargo	Nihon YS-11A-600	0	2	0	2	2
Collided with terrain.									
10/7	Orlando Florida	USAir	Psgr	DC-9-31	0	0	1	1	107
Ramp worker was fatally injured when aircraft was struck by lightning while being pushed back from gate.									

Source: NTSB

One Thing Led to Another

Boeing 737: Minor damage. No injuries.

The twin-jet air carrier was arriving on a summer day that included cumulus clouds and rain showers in all quadrants around the airport. Visibility was good. The aircraft was carrying 12,000 pounds of fuel beyond that which was required for the flight, a normal practice for the flight segment when conditions permit. The hourly reports had not indicated that light rain had fallen at the destination airport, but this information was included in two special reports that did not appear on the hourly printout.

Winds were calm when the aircraft approached, and the crew accepted a straight-in approach to a runway other than the one they had planned on. Aircraft weight was 106,500 pounds and the crew felt the 6,200-foot runway length was acceptable. Because a training aircraft was performing touch and go landings on the cross runway, the 737 had to make minor adjustments to the approach.

As the air carrier entered the touchdown flare, the crew noticed that the runway was wet — their first indication of this condition. The tower controllers had not mentioned it. Another aircraft had landed on the cross runway and had encountered standing water at the intersection with another runway, but the pilot failed to report this to the tower in time for the information to be passed to the 737 crew.

Touchdown was made at 138 knots approximately 1,900 feet along the runway, which left 4,300 feet. The aircraft's decelerating devices operated properly and reverse was selected normally. However, both pilots realized that the aircraft was not decelerating properly and they both applied brakes. The captain applied maximum reverse thrust.

They almost made it. The aircraft drifted to the right of the centerline and came to a stop 10 feet beyond the end of the runway.

There was no major damage. Due to the unhurried nature of the evacuation, and the assistance of the crew and fire personnel, there were no injuries when the passengers left the aircraft via the slides.

Examination of the flight data recorder revealed that deceleration decreased near the end of the rollout. When this was checked against maintenance records, it was found that one of the four brakes had been reported as cold after landing a week before, but checked out normally after a test. This time the brake was dismantled and the fuse spring was found to be broken in five pieces because a component had been installed improperly during the previous overhaul 8,000 flight hours before. With the spring approximately an inch shorter than normal, the brake could have operated intermittently, a possible cause for the decrease in deceleration.

These pilots did not have all the information they needed to make the proper decisions and, when they needed a break, the brakes were against them.

Rainy Night, Unstabilized Approach

McDonnell Douglas DC-9: Major damage. Minor injuries to four passengers.

During its approach approximately an hour before midnight, the aircraft was vectored around Southern U.S. winter weather. A special observation shortly before the DC-9's landing indicated a measured 900-foot ceiling with visibility of two miles in moderate rain and fog, and a wind change that would give a quartering tailwind. This update was passed to the crew, along with the additional information that the glideslope transmitter for the intended runway had just gone into the alarm mode.

The crew acknowledged the weather update and stated that the localizer approach would be used if the glideslope was indeed unusable. With the tailwind, a downsloping, and possibly wet, runway, and a heavy aircraft, the captain elected to use 50 degrees of flaps rather than the normal 40 degrees and the crew prepared for localizer-only minimums. More power was needed with the extra flaps to maintain desired airspeed and descent rate.

The glideslope signal was received, as reported by the crew, but they did not rely on it. The tower reported that the transmitter was still in the alarm mode and cleared the aircraft to land. When the aircraft broke out of the clouds at about 800 feet in rain, the crew continued the landing approach using the visual cues provided by the approach lights and the runway profile.

Approximately a half mile from the approach end of the runway, the first officer advised the captain that the aircraft was too high. In response, the captain pushed the nose over and reduced power; the resulting excessive sink rate activated the ground proximity warning system. The aircraft continued descending at a higher-than-normal rate after the landing lights illuminated the runway. The first officer advised the captain to flare, but the roundout was not sufficient and the aircraft touched down nose first, bounced and came down hard on the main gear.

The hard landing set off several warning lights and the flight attendant in the forward cabin heard a loud crack and saw the top of the cabin open up as the fuselage fractured and the aft part of the aircraft sagged down and dragged along the runway. (Later examination revealed no evidence of corrosion or preexisting cracks.) Although the aircraft did not respond normally to flight controls and the crew was unable to reverse the engines, normal braking was available and they were able to maintain directional control. Tower was advised and the aircraft was stopped on the runway. Emergency equipment personnel reported driving through heavy rain on the way to the aircraft, arriving within three minutes. There was no fire and the evacuation was carried out with only a few minor injuries.

Later, the captain, with more than 4,000 hours of experience in type, reported that he had been comfortable with the runway and the approach, and had not thought he was high on the glideslope. Both pilot and copilot stated that they were focusing their attention outside the cockpit during the approach rather than on their instruments. They reported that the rain was moderate to heavy during the approach and landing but that it did not restrict visibility and that there was no glare from the landing lights. The rate of rainfall was later estimated at up to 1.5 inches per hour.

A DC-9 first officer had occupied the cockpit jumpseat during the landing and reported that the rain was fairly heavy from the initial approach fix to the runway, and that he saw the approach lights but not the runway edge lights after breaking out from the clouds. He said the aircraft seemed to level off just prior to reaching the flashing sequence lights and that the glideslope indicator moved quickly to a bottom full-scale reading.

The jumpseat rider stated that he lost sight of both approach lights and the end of the runway, commenting that it was like a "black hole" with no depth perception. He saw the runway coming up quickly in the illumination provided by the landing lights and believed the aircraft touched down on the nose wheel first.

The probable cause of the accident was attributed to the captain's failure to maintain the proper descent rate on final approach or to execute a missed approach, and his improper flare that allowed the aircraft to impact the runway with a sink rate that exceeded the aircraft's design limits. A contributing factor was the failure by both pilots to make the required callouts and to properly monitor their flight instruments during the approach.

Air Taxi
Commuter

Not in Top Form?

de Havilland DHC-2 Beaver: Substantial damage. No injuries.

The charter flight had flown from an originating airport to pick up seven passengers at a second airport. It then proceeded to another airport.

After landing at the third airport and the aircraft had been slowed to about 20 mph, the pilot began a left turn to exit the runway. During the turn, the pilot noticed an increasing rate of turn and tried to control the aircraft with brakes. However, the turn could not be stopped and directional control was lost. The aircraft ground-looped to the left and skidded sideways off the left side of the runway. The right main gear and tailwheel dug into soft ground. The aircraft bounced, during which the tailwheel and fuselage twisted and the right main gear attachment bolts bent. There was no fire and all occupants evacuated the aircraft unhurt.

The brakes were checked and found to be serviceable. The pilot reported that he was preoccupied and tired because he had not slept well the previous night.

Who Put on the Brakes?

Piper PA-31 Navajo: Substantial damage. No injuries.

The charter aircraft was en route to a remote drilling site in the Canadian north during March. On board were the pilot and five passengers.

Upon arrival in the area of the destination field, the pilot was informed on the Unicom frequency of departing helicopter traffic. He observed a rotorcraft in the vicinity of a snow-covered airstrip and considered that to be the airstrip at which he was to land. He made a normal traffic pattern and landing. After touchdown, however, the pilot found that the deceleration was much more rapid that he expected.

The pilot realized he had landed on the wrong airstrip. He applied full power in an attempt to go around but the nose gear collapsed before he was able to lift off. The aircraft came to rest in 18 inches of soft, wet snow.

The pilot was new to the area. He had been briefed that the destination airstrip was adjacent to a refinery and that a second, unused and unplowed strip that was oriented in the same direction was five miles away.

Corporate Executive

The Trap of Assumption

Grumman American Gulfstream II: No damage. No injuries.

The corporate aircraft landed on runway 33 on a January night and cleared the runway at taxiway Hotel. The ground controller instructed the pilot to turn left on taxiway Romeo, left on Golf and to hold short of runway 15.

The aircraft taxied along Romeo but, instead of turning left on Golf, taxied straight along Romeo and crossed active runway 24 right. The pilot held short of runway 15 at taxiway Juliett. The ground controller then discovered the deviation from instructions.

The pilot had anticipated a more direct routing by the controller, who was assigning a longer routing to runway 33 arrivals to prevent traffic conflicts with aircraft taxiing for departures on runway 24 right. Although the pilot had heard the controller's directions correctly, he did not question the purpose behind the circuitous routing and incorrectly assumed the controller had made an error. So he taxied along the route he thought was proper. Because visibility was restricted by snow and the surface detection radar was inoperative, the controller was unable to detect immediately the deviation from directions.

A Load of Trouble

Cessna 185 Skywagon: Aircraft destroyed. Fatal injuries to one.

The company aircraft was carrying a heavy load of freight on a midday, VFR flight. The trip, of slightly more than 100 nm, was through mountainous terrain with peaks along the route that exceeded 9,000 feet. The pilot, who had filed a verbal flight notification, was the only person on board.

The aircraft failed to arrive at its destination and did not return to the point of departure. The wreckage and the body of the pilot were found six months later where the aircraft had crashed into a mountain within five miles of its destination.

The pilot was thoroughly familiar with the geography of the route, having flown the identical route 16 times during the preceding month. But here is where the good news begins to sour. The pilot turned back to the point of origin three times because of poor weather. His instrument privileges expired nearly four years earlier. The aircraft's weight was calculated to be 3,688 pounds, 488 more than the maximum allowable. The center of gravity was calculated to be an inch in excess of the rearward limit. Enter the confidence factor: the pilot had operated the aircraft with similar loads on 16 occasions.

The weather had been VMC at the time of departure and the en route conditions were generally good with fog and low clouds in the valleys, according to another area pilot. The pilot of the accident aircraft had flown the route earlier the same day and reported that he had descended through a hole in the clouds in the area of his destination to search for the landing strip. However, the weather had deteriorated during the day, according to another pilot who was unable to fly along the track of the missing aircraft during search operations.

Investigators believe that the pilot of the Cessna 185 had arrived over his intended landing area when it was obscured by low clouds and fog and descended though clouds in an attempt to regain visual contact with the ground. They estimate that he probably lost control during the descent; the aircraft struck the side of the mountain in a steep, nose-down attitude.

Continued Visual Flight into … ?

Piper PA-28: Aircraft destroyed. Fatal injuries to one.

The owner of the single-engine aircraft, planning a business flight in the early July morning, filled the fuel tanks to capacity and called Flight Information Service to check the weather. Weather at his destination was cloudy with the base at 1,200 feet, and visibility was 4.5 to five miles in haze.

The pilot did not file a flight plan and was cleared for takeoff at 0830 hours. Latest local weather, slightly more than a half-hour old, was five miles visibility in haze and five-eighths cloud cover at 1,200 feet with a higher overcast. About six minutes after takeoff the pilot reported he was at 2,000 feet in VMC conditions and was changing frequency. That was his last transmission.

Radar returns of the aircraft, identified by its transponder code, showed the Piper headed east from the departure airport for four minutes after takeoff and then turned northeast. Within two minutes it turned right to east again but almost immediately reversed the turn back to a northerly direction. The left turn continued and tightened progressively until the aircraft turned through about 540 degrees and disappeared from the radar screen. The aircraft's groundspeed had been constant at 110 knots until it entered the final left turn, after which the groundspeed increased to 140 knots; further speed checks were not possible after the turn tightened.

A short time before the aircraft disappeared from radar, two ground witnesses reported hearing the sound of a light aircraft in or above the clouds, with engine noises that sounded to them as if the aircraft were doing aerobatics. They looked up and saw the aircraft emerge from the clouds in a steep, left-hand descent followed by a large piece of white material. Other witnesses reported seeing the aircraft descending vertically from the clouds followed by a separated wing section. The aircraft crashed less than 10 nm east-northeast of the departure airport. The pilot died of multiple injuries. The aircraft was destroyed by the impact, but there was no fire.

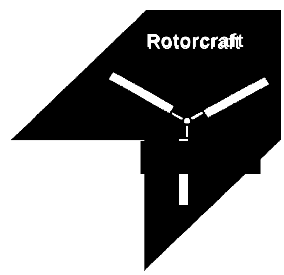
Poor Choice of Runway

Piper PA-28: Substantial damage. No injuries.

The pilot had taken two passengers on a local pleasure flight. Upon his return to the home airport in mid-afternoon, he was given the choice of either runway 12 or runway 17. Surface wind was from between 120 and 140 degrees at between 25 and 30 knots.

The pilot chose runway 17.

The aircraft was landed from a high approach. However, shortly after touchdown, the right wing rose and the propeller struck the runway. The pilot stopped the aircraft and the occupants evacuated with no problems, and there were no injuries. The aircraft suffered substantial damage to the propeller, engine and left landing gear.



Disappeared in Rain

Bell 206B Jetranger: Aircraft destroyed. Fatal injuries to five.

The incident helicopter and three others had been chartered to carry 12 passengers to a sporting event. After fueling the aircraft at its hangar, the pilot air-taxied to the ramp beneath the control tower adjacent to the executive terminal where the passengers were waiting to board. The four persons were taken aboard and the helicopter took off at noon on the December day.

The rotorcraft was cleared to depart eastward VFR and was expected to rendezvous with one of the other helicopters. The pilot advised ATC of this meeting and was instructed to notify the controller at the departure airport when the rendezvous had been accomplished. However, approximately three minutes after taking off, the helicopter pilot reported to controllers that he was unable to maintain visual meteorological conditions and that he was returning to the departure airport. After ATC acknowledged the report nothing more was heard from the helicopter. The controller tried calling the helicopter but received no response. Shortly after that the police reported that the rotorcraft had crashed into a wooded area on the side of a small valley. Examination of the wreckage and the accident site indicated that the rotorcraft had contacted the trees while on a heading of about 310 degrees magnetic, generally level in roll but pitched up, descending at a steep angle to the horizontal at a high rate. The aircraft was destroyed and all aboard received fatal injuries. There was no fire.

A weather observation at the departure airport taken less than 15 minutes before the helicopter took off included recent rain, three-eighths stratus at 600 feet, six-eighths stratocumulus at 3,000 feet, temperature 48.4 degrees F and dewpoint 48 degrees. Weather to the southeast of the airport was reported by observers and pilots to be somewhat worse than conditions at the airport.

The Carburetor Ice Gremlin?

Robinson R22 Beta: Substantial damage. Minor injuries to one.

The pilot experienced some trouble starting the engine of the helicopter for a positioning flight. However, the maintenance company responsible for the aircraft later considered that this may have been caused by improper priming.

The pilot noted that he had to apply approximately one inch of movement to the carburetor heat control during engine warm-up to maintain a plus 10 degree C indication on the carburetor air temperature gauge. The control was left it that position during the departure.

The pilot arrived at his destination early and notified the destination airport's control tower that he was going to execute a practice autorotation to a practice field about two nm west of the airport. He applied an additional inch of adjustment to the carburetor heat control and lowered the collective control to begin the practice autorotation.

After the rotorcraft had stabilized in a 65-knot descent while the pilot was monitoring the rotor rpm, the engine rpm suddenly dropped to zero. The pilot raised the collective control lever but that caused the low rotor warning horn to sound, so he lowered the control again. The pilot made one unsuccessful attempt to restart the engine during the descent. At approximately 50 feet agl, he began the flare, which arrested the descent. However, the aircraft landed hard and rolled over to the right, sustaining extensive damage. The pilot, uninjured, and the one passenger who sustained injuries to a hand and foot, evacuated through the shattered windshield. A portable telephone carried in the helicopter was used to call for help.

A weather observation taken shortly before the accident recorded a relative humidity of 97 percent and a dew point of 2 degrees C. The carburetor icing chart for the aircraft indicated that serious icing was possible at any power setting under these conditions. The engine was examined and showed no defects that could have contributed to the accident, and there was no water in the fuel. The pilot noted that he may not have applied full carburetor heat prior the the practice autorotation and also had not allowed enough time for carburetor heat to have taken effect before he lowered the collective control lever. The aircraft manual requires full carburetor heat during autorotation or operations at reduced power regardless of the gauge temperature. ♦