FLIGHT SAFETY FOUNDATION

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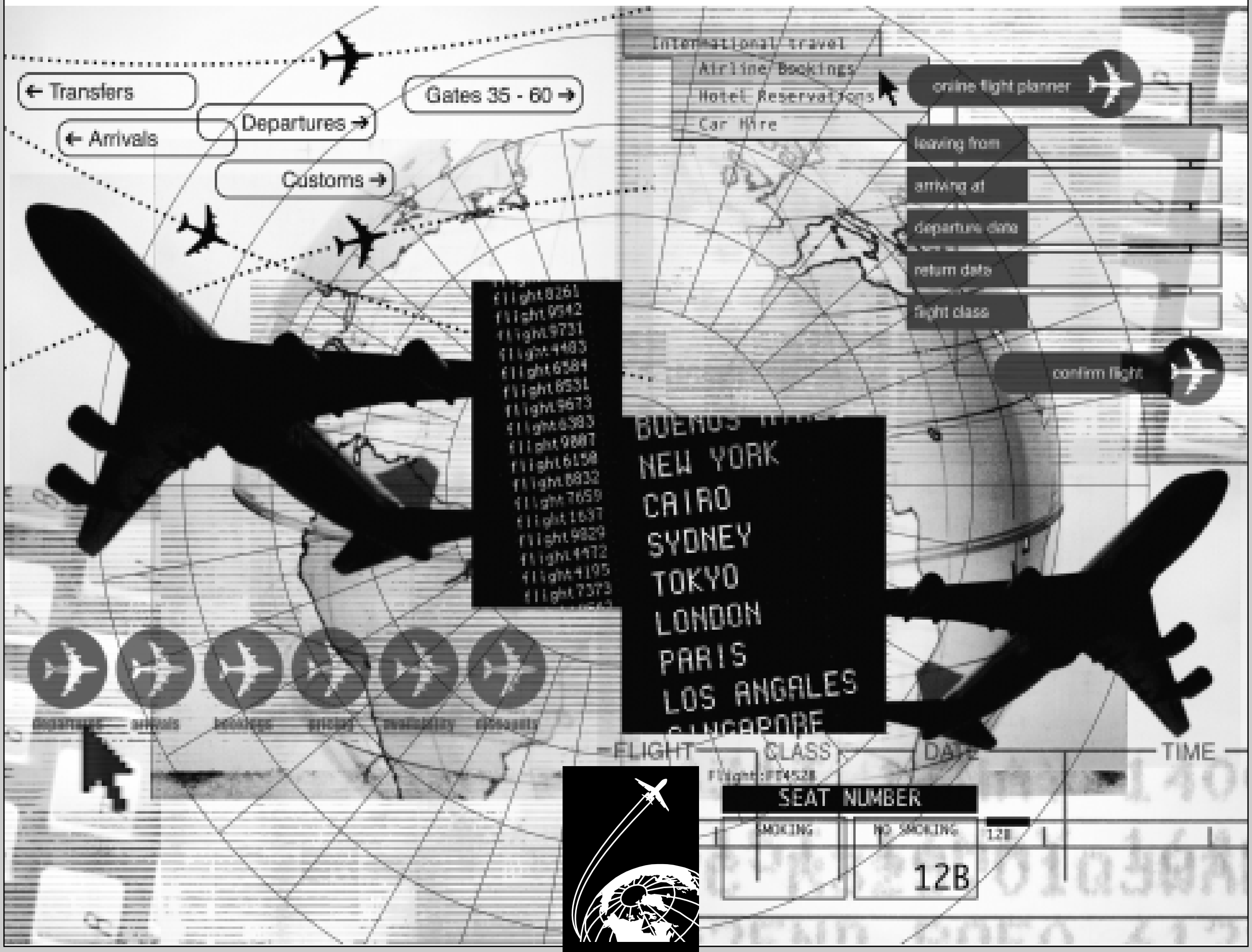
D I G E S T

Future Developments and Challenges in Aviation Safety



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Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 910 member organizations in more than 142 countries.

Future Developments and Challenges In Aviation Safety

Continued dedication and hard work will be required to maintain a high level of safety as the coming years bring increased growth in air travel and the attendant demands on personnel and the infrastructure.

—

Stuart Matthews

Concern for safety has been a constant companion to aviation throughout its long history in myth and fact. Greek mythology instructs us, through the tale of Icarus and his father Daedalus, that the limits of man and machine are ignored at one's peril. Pioneering flights in balloons and gliders were rife with accidents, and the quest for powered flight brought its own unique set of hazards. The advent of successful powered flight continued the accumulation of lessons on safety.

Ignorance, in one form or another, generally has always been at the root of safety problems, in that flight has continually pushed the boundaries of man's knowledge. Ignorance about aerodynamics, structures, weather and fire often resulted in humans straying into areas where operational knowledge did not exist. Pressures to challenge the boundaries of knowledge grew from the seductive economic potential of the air transportation of people and cargo, as we sought to fly higher and faster and carry ever-heavier loads. As aviation grew, some spectacular accidents brought unrelenting focus on our ignorance.

Accompanying the trial-and-error improvements made by learning from mistakes through the developing art of systematic accident investigation, scientific research and technical development sought to anticipate problems and to increase knowledge and understanding of the environment in which airplanes are flown. Substantial research into aerodynamics in Europe and in the United States provided a wealth of baseline knowledge to improve efficiency and safety.

The knowledge gained about structures, materials and powerplants enabled the industry to design and operate aircraft better and more safely. As mastery of structural design and reliable powerplants have made failures of these airplane features extremely rare; the resulting improved reliability of the machine has, in effect, "unmasked" the human operator's frailties and shortcomings, which resided within the operational system from the beginning.

A new term was coined: *human error*, replacing *pilot error*, recognizing that human failures in judgment and decisions are not limited to the cockpit. Just as our ignorance of the machine has given way to new understanding, so we now are beginning to recognize external factors that allow errors to be made and to understand the human-machine relationships in ways that reduce the risks of flight.

Understanding weather and acquiring the means to forecast it accurately were a focus of research begun in the late 1930s and accelerated during World War II. In more recent years, focus on improving the gathering and analysis of weather information has given us a fine-scale resolution of weather phenomena that has led, in turn, to means of accurately detecting and forecasting clear air turbulence, wind shear and other hazardous conditions.

These are the foundations upon which modern safety practices and international safety developments are based.

Aviation Industry Growth

The growth of the aviation industry, especially in recent years, often has outpaced the ability of the infrastructure to permit the full realization of new efficiencies and the satisfaction of customer demand.

Commercial Air Transport

Aviation has enjoyed steady growth in both passenger traffic and air cargo shipments. The worldwide fleet has expanded to satisfy this growth, and this is expected to continue for the foreseeable future. Notwithstanding the current slowdown, according to the International Civil Aviation Organization (ICAO), total world airline scheduled passenger traffic, in terms of passenger-kilometers, is expected to grow at an average annual rate of 4.5 percent during the current decade, continuing a similar record for the previous 10 years. Total freight traffic growth, measured in freight ton-kilometers, over the same period is expected to be even stronger, at 6.0 percent per year.[1]

International traffic (passenger-kilometers) is expected to continue to grow faster than the overall rate, at 5.5 percent per year; 6.5 percent per year for cargo (ton-kilometers). In terms of aircraft departures on scheduled services, the next decade is expected to see an increase of about one-third, with the number of aircraft-kilometers flown growing by about half.[2]

Regionally, Asia-Pacific airline traffic is expected to grow well above the world average for both passengers and freight. The fastest-growing international route groups for passenger traffic are forecast to be the North America–Central America–Caribbean and the North America–South America routes, with the Transpacific and Europe–Asia-Pacific routes a close third.[3]

Corporate Aviation

Though the statistics of corporate aviation activity are not as complete as those for the airline industry, the information that is available indicates a similar expansion in terms of aircraft fleets and numbers of people carried. Studies have indicated that corporate boards and managements increasingly are realizing the benefits of utilizing business aircraft from the standpoints of convenience, timesaving and security of personnel. Within the past several years, new entrepreneurial activity has provided specific security advice for businesses that are engaged in global activity, using business aircraft flying into many airports not normally served by scheduled air carriers.

Shifts in traditional corporate aviation patterns include the emergence of aircraft-sharing among two or more companies, and the formation of business jet units by commercial airlines, such as United Airlines' BizJet Holdings.

General Aviation

While the preponderance of personally owned aircraft activity takes place in North America, there has been a strengthening of the industry in virtually every region of the world, as reflected by the 55-plus member countries of the International Council of Aircraft Owner and Pilot Associations (IAOPA).[4]

Manufacturing

Fueled by the increasing demand in air commerce, forecasts for the next 20 years indicate that the air transport business will be one of the world's great growth industries, requiring over 15,000 new transport aircraft with a value of US$1.3 trillion. The air cargo or freighter fleet is expected to double over the next 20 years — from 1,742 to more than 3,500 airplanes — and, as a share of the total fleet, is expected to remain at about the current level of 11 percent to 12 percent. Taking into account the anticipated retirement from the current fleet of about 1,238 airplanes, more than 3,000 additional airplanes will be added to the freighter fleet by 2020.[5]

Fragmentation of the market over the last 20 years has led to the design, development and production of jet transports optimized for specific markets. As an example, before U.S. airline deregulation, Trans World Airlines (TWA) had one Boeing 747 flight daily from Chicago, Illinois, U.S., to London, England. Today, American Airlines and United Airlines, using smaller B-767s and B-777s, serve 11 destinations in Europe with 22 daily flights out of Chicago. By 2020, on the North Atlantic alone, the outlook is for the addition of nearly 200 nonstop routes connecting new city pairs due to fragmentation. Similar expansions are forecast for other regions' city pairs.[6]

The regional jet market has had explosive growth that has galvanized traffic on feeder routes. Service and comfort levels have been improved, and there is increasing potential for the development of direct flights between smaller city pairs now served only via a major hub. On the other hand, despite the attraction of smaller aircraft, there are concerns that they have contributed to ever-increasing congestion and attendant delays out of proportion to their size.

In the corporate aviation arena, manufacturing is being driven by a change in corporate thinking, as corporate executives respond to the need for more effective use of their time. Airline flight delays and increased overall airport waiting times in the commercial airline system, in addition to the corporate jet's ability to fly direct to the ultimate destination rather than through a hub, have become strong drivers of the increased demand for this type of aircraft. Companies are calculating the costs of the downtime of airline flight delays in determining their approach to utilizing business jets, either through outright purchase or through fractional-share programs. As a result of this situation, forecasts call for an increase of 80 percent in the production of business jets for the next decade, compared with that for the previous 10 years. It is expected that airplane manufacturers will produce about 775 corporate jets in 2001. For the next decade, forecasts of in excess of 7,000 new business jets have been made, compared with 4,030 produced from 1991 to 2000. The so-called big-cabin jets would comprise about 847 aircraft during the next 10 years, and the production forecast for new long-range business jets is about 1,050.[7]

In the general aviation manufacturing industry, aircraft shipments are recovering from a nearly two-decade hiatus, and a slow but steady growth in the small-airplane market is taking place.[8]

The increasing capabilities of automated processes in manufacturing and computer-aided design have offset, to a great extent, increasing costs of production. Accompanying this revolution in computers and software is an unprecedented increase in complexity in software, due in part to increasing functionality.[9] Entirely new career fields have emerged that are involved solely with managing and operating such design-and-manufacturing processes. Management of the overall process is an enormous challenge, requiring new ways of thinking and new skills. This change also has impacted the nature of oversight by the authorities and has required a review of training for inspectors and for designated manufacturers' representatives.

There is no doubt that a continuance of long-term economic trends and user demand will stimulate substantial growth in aviation. The continued increase in the number of aircraft produced and the expansion of current fleets will have their effects on other elements of the aviation system, many of which can impact the safety of air travel.

Some Consequences of Air Transport Growth and Community Concerns

With the steady increase in dependence on air travel for both commerce and pleasure, a new challenge has arisen — that of air traffic separation in increasingly crowded airspace, particularly in terminal operations areas around airports. Crowding of skies and runways has given rise to a new hazard of potential collision in the air and on the ground, with the high likelihood of injury or death.

Present growth and growth forecast over the foreseeable future place great strains on the existing and planned supporting infrastructure, including air traffic management; airport runways, aprons, terminals and other facilities; and emergency-response facilities. In addition, concerns about noise and pollution in the airport vicinity have emerged in recent years as factors that can no longer be ignored, either by the operator, the airport or the relevant authorities. As population density increases, not only in the airport vicinity but also beyond, risk exposure is increased for people who may find themselves in the vicinity of a controlled-flight-into-terrain (CFIT) accident or an approach-and-landing accident (ALA).[10] Additionally, the public is much more likely to notice objects falling from aircraft overhead, no matter how rare the occurrence. Such occurrences have given rise to an increase in litigious actions among the general population, even outside the United States, and an increasing fraction of the energies of the aviation system will be devoted to dealing with public complaints and lawsuits.

Congestion in both airside and groundside operations plagues a number of major international and domestic air terminals. Some "choke points" in the en route system result from saturation of the airspace in these locations (e.g., over Central Europe, Chicago and the U.S. Northeast Corridor). Delays introduce instabilities into the smooth flow of traffic that present opportunities for system error and human error in traffic management both in the air and on the ground, so that proper separation of aircraft could be threatened.

International Safety Developments

Safety Achievements

The air transport industry fundamentally is extremely safe. In 2000 worldwide, there were some 35 million commercial flights with, perhaps, more than 1.2 billion passengers carried, and there were only 18 accidents involving 755 passenger fatalities. In 1999, there were 499 passenger fatalities from 21 accidents. The higher number of fatalities in 2000 resulted in an increase in the passenger fatality rate from approximately 0.020 per 100 million passenger-kilometers in 1999 to 0.025 in 2000. For non-scheduled air services in the same aircraft size category, there were 22 accidents involving 291 passenger fatalities in 2000, compared with 129 fatalities in 1999 (the latter including all-cargo services with passengers aboard).[11]

The differentiation between the safety of first-generation aircraft, second-generation aircraft and third-generation aircraft continues. The number of fatal accidents per million flights during the 1980–1998 time period ranged from 3.5 for first-generation aircraft (e.g., B-707, Douglas DC-8), 1.6 for second-generation aircraft (e.g., Airbus A300, DC-10) and 0.5 for third-generation aircraft (e.g., A340, B-777 and Fokker 50). The rates for worldwide full-cargo operations and worldwide passenger operations were 3.3 (cargo) and 1.1 (passenger).[12]

The following are illustrations of some of the specific safety developments and safety practices within different sectors of the aviation industry that can affect operational efficiencies and capacities of the overall system.

Design and Manufacture

The entire field of aircraft design, system integration and construction has produced a very reliable, safe airplane today. Software developments and modern computer technology have given us unprecedented levels of design integrity in airframes, engines and systems. Though the number of large-airplane manufacturers has decreased in recent years, sufficient competition remains to ensure high-quality products from each factory.

Manufacturing techniques vary, but innovation has led to efficiencies that permit increasing aircraft sophistication in an extremely competitive air carrier market. Many of these large-airplane-manufacturing efficiencies find at least partial application in smaller-aircraft design and construction.

Flight Operations Safety

Close monitoring of aircraft flight operations and systems, including powerplants, has made possible continuous refinement of reliable designs and increased performance. Enabling this operational monitoring has been the continual development of ever more sophisticated and miniaturized data-recording components and systems with steadily growing capacities.[13] Feedback into maintenance and engineering processes and into crew training has raised safety levels. Coupled with accident-investigation information, operational data extracted from flight data recorders have made it possible to refine the air transport operation to a very high standard of efficiency while, at the same time, reducing accident risk exposure. The flight operational quality assurance (FOQA) program, developed from Flight Safety Foundation (FSF) studies, is being adapted by many airlines throughout the world as an internal system of operations monitoring.

Newer-generation-aircraft cockpits offer displays aimed at easing flight-management tasks and control tasks for the flight crew. Head-up guidance system technology (HGST) has been shown to be beneficial, not only in operating to lower weather minimums at difficult airports, but also in providing a higher level of safety. The advent of global positioning system (GPS) navigation, combined with detailed terrain-mapping information, now enables automated approaches to be made at many airports that previously were inaccessible in instrument meteorological conditions (IMC).

The FSF-led Wind Shear Study Group, CFIT Task Force and Approach-and-landing Accident Reduction (ALAR) Task Force (each composed of numerous specialists from all sectors of the industry worldwide) have defined the hazards in these operational regimes and have developed guidance and training materials for hazard reduction and avoidance. Coupled with new developments in hardware technologies, such as laser turbulence-detection equipment, terrain awareness and warning systems (TAWS is the term used by the European Joint Aviation Authorities and the U.S. Federal Aviation Administration to describe equipment meeting International Civil Aviation Organization standards and recommendations for ground-proximity warning system [GPWS] equipment that provides predictive terrain-hazard warnings; *enhanced GPWS* and *ground-collision avoidance system* are other terms used to describe TAWS equipment) and HGST, the risks associated with these regimes have been reduced. Wind shear training has been credited with the avoidance of potentially severe accidents on a number of occasions.

TAWS should be a high priority for fleet-wide installation by all airlines and be made a mandatory requirement if necessary. It is probably the most significant safety hardware/software improvement developed in recent years, offering, with a well-trained crew, exceptional protection against CFIT and ALAs. Yet, quite a few airlines have not installed TAWS or are fitting the systems only on later aircraft, neglecting older models that may continue in service for many years to come.

Flight operations safety depends to a great extent on efficient and effective air traffic control. Nowhere is this more evident than in Central Europe and parts of the United States. In many parts of the world, human controller resources are being stretched to their limits. Airport capacity and airspace capacity are exceeded at times; thus, growth cannot satisfy demand. Passenger demand should be restudied with a view to providing relief in sharing short-range operations with high-speed ground transport connecting with hub airports for a truly integrated transportation system. The advent of GPS navigation already has proved its value, especially as the position accuracy has improved to within a few meters. Coupled with traffic-alert and collision avoidance systems (TCAS) now installed in many aircraft, HGST, automated cockpits and area navigation (RNAV), the way is now prepared for “free flight,” which will allow removal of the constraints of following established air routes. Notwithstanding these advances, all flights eventually must emanate from or converge at increasingly busy airports, where present capacities cannot accommodate the potential increase in flights made possible by the aforementioned technologies. However, again, the capability of GPS also holds promise for extremely accurate approaches in IMC, as well as for precision flight-path holding. Eventually, a universally equipped fleet could employ software that virtually could eliminate the threat of mid-air collisions worldwide.

Increasing traffic at a given airport and along heavily traveled air routes places heavy demands on communications. There is a finite amount of time in which to communicate, and even with the data-link airborne communications addressing and reporting system (ACARS) relieving some of this load, increases in traffic will rapidly consume such gains. Offloading some of the voice communication to ACARS carries a corresponding loss of "listen-in" situational awareness that is enabled through listening to other controller-pilot communication. A new problem has arisen in the reallocation of radio frequencies and threatens to impact frequencies that have been reserved for aviation. This will compound the communications "crunch," and the potential impact on safety is obvious. Until flights are automated totally, there will continue to remain a requirement for voice communication to ensure safe and efficient traffic separation, and approach and departure metering. However, while voice communication remains, there undoubtedly will be continued problems resulting from misunderstanding of the spoken word, especially between non-native English-speaking operatives.

Airport construction and expansion are very difficult at the present time due to increasing property development in the vicinity of existing airports. Airport expansion also is discouraged by heightened public awareness of potential impacts of congestion, noise, environmental pollution and general disruption of the lifestyles many had pursued in moving to locations that are now threatened by air commerce developments.

Since these developments put great pressures on those decision makers who manage the system and its elements, the opportunities for mistakes from rushed decisions that could, in some cases, diminish safety and increase risks are very real. Rational thinking might argue for a more gradual rate of increase of capacities, but that is not how supply and demand works. Market fragmentation can help in relieving some of the congestion by establishing links between less-crowded airports. This might satisfy overall passenger demand and offer economic development opportunities for the cities affected.

The common denominator must be that operational safety margins are protected from the effects of decisions that consider only the economic aspects of the challenge in meeting growth objectives.

Human Factors

Just as in other industries, human error is probably today's "Achilles' heel" in aviation safety. While some progress has been made in human error research, much remains to be done in terms of determining how errors occur and why humans make them. Training and experience are no guarantees of an error-free operation. The exploration of human behavior in both flight situations and ground situations is shedding light on how and why errors are committed. An examination of "normal" operations should provide insight into the latent conditions that can become active accident chains if intervention is not made.

Human error also can extend to management levels. The way in which an operation is conducted can be affected by the safety culture of an organization, either increasing or decreasing the risk exposure and the level of safety. Changes to management structure or changes in management personnel may affect individual attitudes that, in turn, may either strengthen or erode a company's safety culture.

Advances in research have given us useful new insights into decision-making processes in the cockpit and in the corporate and operations planning processes. Improvements in screening, selection and training of air personnel and ground personnel can flow from application of these insights to operations needs.

Airport Safety

Airport safety encompasses many facets, from properly constructed and configured runways and approaches to operating conditions on the apron. Surrounding terrain or city development may present less-than-desirable terminal area operations situations, often becoming a safety factor only as time and increased operations have overtaken the airport's original condition. Indeed, a number of today's busy operating airports would not meet present safety criteria for construction. However, the economic necessity of maintaining operations at these sites has spurred development of compensating technologies that maintain acceptable safety levels. The primary technology that has enabled this is probably precision instrument approach guidance, now coupled with highly reliable on-board automatic landing equipment. TAWS is providing unprecedented unsafe-terrain warning, having overcome the few shortcomings of earlier GPWS equipment, while HGST can compensate for airport layout problems.

Runway and taxiway lighting improvements have assisted in compensating for increased congestion on the ground by maneuvering aircraft. Stop bars for taxiways crossing active runways and surface-monitoring radar systems are recent developments that reduce ground-collision risks. The importance of surface-monitoring-radar capability was illustrated dramatically by the takeoff accident in Taiwan, where a segment of a partially closed runway was being used for taxiing purposes and was mistaken in poor surface visibility for the active runway.[14]

An apron operation is one of the largest cost centers of airline operations. The apron environment is a dangerous place to work, and many injuries and some fatalities have occurred therein. Property damage (e.g., aircraft, servicing vehicles, structures, etc.) amounts to millions of dollars annually in airline operations. There appear to be several factors involved in this, among which are: apron supervision, skill levels, process and procedures, equipment condition and multiplicity of involved organizations (e.g., catering, fueling, baggage handling, jetway operation, etc.). Data on losses are difficult to obtain, but some progress is being made in accumulating information that should lead to investment in apron safety improvements. This is also an area where such investments would lead to tangible and very significant cost savings that would be immediately recognizable.

As airlines provide ever more services to and from less-developed countries, particularly those that depend on tourism to improve their national economies, operations into airports now having marginal or substandard emergency support will increase. Added to the complications is the trend toward larger-capacity aircraft, which, in the case of a serious landing accident, would swamp the emergency-response capability of the airport and local community. Furthermore, the danger from blood-borne pathogens in treating injured survivors is a problem that needs remedying. This is a problem that probably is beyond the airline industry's ability to solve by itself. It will require international cooperation and support to reduce such potential personal risks to acceptable levels.

As a result of several recent accidents near airports, focus on third-party risks around airports has prompted at least two thorough studies of such risks. Among the accidents was that near Amsterdam (Netherlands) Schiphol Airport in 1992, when an El Al Israel Airlines cargo B-747 lost an engine and struck a heavily populated suburb with nearly 50 ground resident fatalities.[15] Other similar off-airport accidents have occurred in Africa, North America, Russia, South America and Sweden. In many less-developed countries, people have moved into the less-desirable airport zones under or close to the flight paths, thus increasing their own risk exposure to injury or death. As land around airports is developed and occupied, the probability of involvement of ground residents or workers in an aircraft accident near an airport will increase, and serious attention must be paid to approach routes and departure routes, land zoning for non-risk uses in high-probability areas, and to preventive safety measures that reduce the likelihood of off-airport accidents.

Even when authorities attempt to impose occupancy-and-use zoning around airports, powerful local interests often have overturned these risk-mitigating measures to sell residential properties in the affected zones. Transportation departments should intercede in such cases to prevent misuse of high-risk land around airports.

Safety Oversight

The applicable civil aviation authority (CAA), augmented by the operator's internal safety oversight procedures, normally exercises safety surveillance and oversight of individual airlines and other operations. International signatories to the Chicago Convention implicitly agree to abide by ICAO operational standards. The respective authority is the means by which this agreement is satisfied. Regrettably, however, there is great variation in the level and degree of oversight exercised, from close monitoring to virtually none. In a few cases, a strong internal quality process within the airline itself counteracts the effect of a weak CAA; but most often, weak oversight leads to inadequate discipline in the affected airlines' operations, thus increasing the exposure to accident risk. A strong authority, on the other hand, coupled with a strong internal quality program in an airline, provides a level of integrity that reduces risk. Many airlines augment this oversight with periodic safety reviews performed by outside independent auditors to ensure that they not only are in compliance with applicable international and national regulations, but also that they are operating in accordance with their own operations policies and procedures. Such attention to safety practices has proven to be an effective defense against laxness in safety awareness and contributes to a strong safety culture within an organization.

Safety Culture

Safety culture has become one of the latest terms in aviation, but it defies precise definition. Flight Safety Foundation views it as a situation that is achieved within an organization where there is total "buy-in" to placing safety before operational expediency. Properly introduced and nurtured, a safety culture will operate far "upstream" of daily operational situations, so that operational expediency is not hampered. Such practices have been around for many years in different airlines, but not until recently has executive management become really aware of their benefits and importance in helping to reduce risk. A major chemical company, DuPont, is one of the leaders in instilling a company safety culture in its explosives manufacturing-and-handling business, and many of the processes that it has developed in more than 200 years of operation are now finding adaptation within the airline industry. Scandinavian Airlines System (SAS) developed a quality system in the mid-1980s that achieves a high level of operational integrity. The British Airways Safety Information Service (BASIS) program, TAP Air Portugal's Operations Analysis program and KLM Royal Dutch Airlines' Total Flight Quality program and confidential incident-reporting system are other examples of European operators' approaches to establishing a safety culture. In the Western Pacific, All Nippon Airways' safety secretariat has fostered a strong safety culture within that airline. There are many other examples of such good operating practice. In the United States, such programs continue to be used hesitantly as a result of potential "loss of confidentiality" concerns that might result in regulatory enforcement actions or litigation.

Flight Data Analysis and Confidential Reporting

The essence of a good flight data analysis-and-reporting system is that it should be confidential and non-punitive. The concept is that it is better to know about a potential problem — so that it can be analyzed and the underlying reasons corrected in order to prevent its reoccurrence before it leads to something more serious — than to punish those who might have made an inadvertent error — in the belief that the punishment will solve the problem and that the underlying causes will go away. Most of the programs mentioned in the previous section operate under conditions that tend to rely on “agreements” between management and unions and/or “understandings” with the relevant regulatory authority. These agreements and understandings offer assurances of no punitive action; they are necessary to ensure that personnel are not reluctant to submit error reports. In the United States, such programs operate hesitantly due to continued concerns that inadvertent mistakes, which have been revealed as a result of flight data analysis or from confidential reports, will be made public and lead to punitive action by management, enforcement action by the regulatory authority or even litigation. Moves are afoot in various countries to introduce legal protections to ensure that confidential reporting systems do remain confidential; legislation already has been introduced in Denmark. There is no doubt that such legislation will do much to remove concerns regarding punitive action and offers the potential to make considerable progress in identifying problems, particularly those related to human factors, before they lead to an accident.

Security Technologies and Air Safety

The constant threat of terrorism and other criminal acts against travelers, crew, staff and property has led to considerable investment in hardware and software designed to screen baggage, cargo and personnel to lessen the risk of operational catastrophes. Few countries today are able to safely avoid check-in screening at airports. Though new technologies now permit the detailed identification of individuals, individual privacy concerns and public privacy concerns and fears of possible misuse by authorities have prevented full use of the technologies. There is a delicate balance between maintaining the highest states of operational safety and interfering with basic personal liberties. Innovation that avoids these problems has yielded some new techniques, hardware, software and manual processes that appear to counteract new assaults by criminal and terrorist elements.

Business Decisions and Safety

Corporate mergers, acquisitions and fleet expansions have become commonplace in recent times and are likely to continue in the future. These changes often are the result of business decisions and are sometimes made without the consultation with the operating elements of the organizations involved, such as flight operations and maintenance and engineering, that might be necessary to accomplish due diligence. Business decisions should be preceded by competent operational analysis to ensure that the organizations and resources are in place to support the anticipated changes. Changes that are introduced without adequate preparation of involved personnel often can lead to costly, inefficient processes and procedures that might be avoided with preparatory actions. As an example, change-of-management training should be a prerequisite to ensure that preoccupation with the changes does not obstruct attention to maintaining safety throughout and after the change process.

Outsourcing certain functions of a company’s business has always been present in one form or another. However, in recent years, some aviation companies have found to their dismay and downfall that outsourcing critical safety functions without adequate oversight of the work itself is an invitation to potential catastrophe.

The concept of “virtual companies” has appeared within the air carrier industry and should be sending alarm signals to those concerned with safety, so that in moving toward such arrangements, adequate safety and quality oversight of all elements of outsourced activity are centralized to ensure that company standards are satisfied and that operational risks are strictly controlled. Many companies have successfully accomplished this with maintenance that is performed by an external maintenance, repair and overhaul (MRO) organization, by assigning to the external facility a resident inspection team whose role is to monitor and track the work being performed, to ensure that it is in compliance with the company’s standards.

Pressures on management to maximize return on investment can result in disproportionate attention to short-term matters and a neglect of the development of a sound basis for long-term survival and growth. In some respects, this situation is detrimental to safety and reliability, the touchstones of successful air commerce that are based on stability and gradual change. Safety audits performed by different organizations often identify understaffed departments trying to accomplish company objectives without adequate resources or time to ensure the integrity of the process. Management should be aware of this trap and seek a balance between company, stakeholder and stockholder interests.

Strategic Considerations Relating to Safety

Non-uniformity of Safety and Risk Levels

For the most part, our safety knowledge and applications are well grounded. Examined in a global sense, however, the picture is lopsided and unacceptable. Less-developed nations lacking infrastructure and trained personnel resources present a hazard to the worldwide level of safety because of the integrated character of modern air transport. A highly sophisticated airplane and its occupants operating into a primitive environment are exposed to higher risks that the airplane technologies themselves cannot fully counteract.

ICAO, the International Air Transport Association (IATA) and the Foundation are engaged in vigorous activities designed to overcome the disparities in safety levels around the world. Concentration on providing safety surveillance and oversight, safety organization in companies, safety audits of all elements of operations, training and instruction to avoid CFIT, ALAs and wind shear accidents through workshops, individual consultations, publications, training videos and other materials are under way. But it will take concerted and cooperative actions on the part of all airlines that enjoy a high level of safety achievement to help the companies and countries in greatest need.

Language capabilities are highly variable. English is acknowledged to be the widest-deployed communication language, yet the levels of fluency are widely divergent. Not only is fluency important, but attention must also be given to diction to overcome heavily accented English that may be as incomprehensible as a lesser-known language.

Improvement of primitive-area infrastructures (air navigation, air traffic control, airports, weather information, communications, emergency-response capabilities, etc.) is a challenge for the industrialized world.

Harmonization and Enforcement of Air Regulations

Great progress has been made in recent years to harmonize the U.S. Federal Aviation Regulations (FARs), European Joint Aviation Requirements (JARs) and Russian regulations. However, a few countries still are interpreting these regulations and converting them to a unique national code that often results in confusion in compliance situations, especially with the emergence of cross-national mergers and partnerships. This is an unnecessary encumbrance to the smooth-flowing integration of international air transportation and squanders scarce resources that could be better directed to safety matters.

Skill Shortages

Given the forecasts for continued growth in virtually all sectors of air transportation, considerable concern has been voiced within the industry at international and national meetings about ensuring a continuing pool of qualified workers. The reduction or demise of many military air forces around the world has diminished a previously reliable source of skilled pilots and maintenance technicians. Shortages of skills, both in the cockpit and on the shop floor, can result in attempts to over-schedule work, which in turn can lead to lowered morale, rushed work, industrial actions and other problems. Inevitably, such problems also might jeopardize safety and risk management.

The worldwide industry should give some attention to promotion of the career fields in aviation to recapture young people's interest. The often prohibitively high cost of self-funded flight training is a deterrent to many would-be pilots, to say nothing of the rigid and constraining seniority system under which they have to work if they wish to make a career in the commercial transport sector. As a result, there has been a drift toward other potentially more lucrative industries, particularly the high-tech fields. In many countries, colleges and educational groups have demeaned vocational education, which might lead to an aviation industry career as a technician, in order to lure young people into academic pursuits, rather than vocational pursuits. While academic activity has its virtue, a vocational career can be satisfying and rewarding to many, and the industry needs to address this matter carefully to remove the stigmas that discourage young people from pursuing aviation careers.

Higher, Faster, Longer?

Economic return on investment is a major driver of increased performance and increased efficiency. Since the early days of aviation, the quest has been for higher altitude, higher speed and longer range. The balance with safety often was punctuated by tragedy, but today's modern aircraft have achieved economies unforeseen only a few decades ago while providing swift nonstop transport over the major ocean routes. Because of the costs associated with its operations, Concorde has appealed to only a relatively small fraction of the traveling public. Nevertheless, it has shown that it is possible to conduct trans-Atlantic business in one day, returning home within 24 hours.

Technologies exist that promise even faster, higher and longer air journeys. It might be argued that though an airplane can be designed for operation beyond today's performance levels, the human occupant may be reaching his or her limits of medical and psychological tolerances for long-range flights. Cases of thrombosis (blood-clot formation in blood vessels) have surfaced in recent months, allegedly caused by long periods of immobility that are not helped by cramped high-density seating. Airbus's proposed A380 is initially presented with ocean-liner-like room for passengers' mobility during a long-range flight. The introduction of the B-747 likewise provided a lounge area for passenger use during flight, but as passenger demand increased, more revenue could be generated from seated passengers than from a piano/cocktail lounge in the aircraft's midsection. There is no reason to believe that the A380 may not suffer a similar fate to accommodate increased passenger loadings.

High-latitude flights have previewed increases in cosmic radiation received by airplane occupants, and higher-altitude capability at lower latitudes may provide similar radiation exposure. This exposure can only be exacerbated by the ultra-long-haul, transpolar operations now being introduced. Shielding against damaging radiation may be weight-prohibitive; yet, new materials and combinations may be developed that provide acceptable levels of protection.

The trans-Pacific routes are the time/distance challenges in attempting to reduce the current 12-hour to 14-hour flight times to a more tolerable duration. Boeing's proposed Sonic Cruiser offers slightly faster subsonic speeds, saving perhaps 10 percent of the current flight time on longer routes, and its cabin layout is more spacious than the traditional current modern airliner. However, the increased speed and operating altitudes requiring increased fuel consumption raise more environmental concerns.

In the long term, hypersonic technologies offer the promise of a two-hour to four-hour trans-Pacific crossing but involve edge-of-the-atmosphere flight, with accelerations and decelerations at takeoff/climb and approach/landing that may be beyond the comfort or health tolerance levels of the ordinary passenger. Further, the special fuels needed for such operations could give rise to new problems requiring the development of new handling systems to ensure that safety standards both in the air and on the ground are not eroded.

Increased seating comfort might make long-duration flights less uncomfortable, while in-flight entertainment and enhanced communications might increase passenger satisfaction, making longer flights more tolerable.

Catering to passengers' needs also involves assuring the safety of food and its service. Recent reports of questionable health standards used by caterers in preparing in-flight food packages highlight the need for adequate safeguards in food preparation, on-board storage and proper serving.

Very Large Aircraft (VLA)

Airplanes with considerably increased size, having passenger loads that are double those carried on today's largest aircraft, raise questions about on-board health requirements and medical-attention requirements, especially for longer flights. In-flight reports by cabin crew and cockpit crew frequently detail health problems among passengers that sometimes require a physician's attention. Failing that, flight diversion to an airport having adequate hospital facilities nearby may be necessary.

Operations of large-capacity aircraft into popular tourist areas may encounter primitive capabilities for emergency response and care for injured passengers in case of an accident. An aircraft with 700–800 passengers could easily exceed a moderate-size city's medical resources. This is especially true of remote airports that, in an emergency, might be used as diversion points for long-range operations over water or polar regions. At the present time, some such airports are ill-equipped to cope with even a full load of passengers carried on current aircraft. Delayed VLA flights, particularly if there were several as a result of weather or other reasons, might entail several thousand "stranded" passengers and could cause landside congestion that would strain the facilities and resources of even the largest of airports.

Accommodation of VLA on the airport apron also will present special challenges for many existing airports. Surface loads, parking and maneuvering space, servicing points and other such challenges almost certainly will introduce potential new safety problems. The sheer size of the aircraft will introduce its own set of servicing-equipment requirements. Connection of the VLA to the airport terminal via passenger bridges or jetways will exacerbate the existing potential for catastrophe in case of a terminal fire or apron fire.

Servicing of VLA will produce greater volumes of flammable trash that must be removed from the aircraft, and cleaning crews will be faced with much larger volumes to deal with. Safe disposal of waste and spilled fuel may introduce new problems unique to the VLA. Deicing will require greater volumes of deicing fluids that must be captured effectively and processed to comply with environmental-safety requirements.

Emergency passenger egress from a damaged or crashed VLA may introduce unique problems, such as the physical distance between the passenger-cabin deck and the terrain surface. This may necessitate new approaches to escape-slide designs or a totally new escape paradigm. Depending on how densely a VLA is loaded, managing passenger egress in an efficient way may be disproportionately more difficult than for current aircraft. Given the larger amount of fuel that would be carried on a VLA, moving passengers on the ground far away from the airplane may require special attention.

Finally, consideration must be given to the safety aspects of airport access by the significantly increased amount of passenger traffic that VLA and the overall industry growth imply. Safety improvements at the airport must not be offset by increased risks getting to and from the airport, either by road or by rail.

In-flight Passenger Hazards

Unexpected turbulence accounts for the preponderance of in-flight passenger injuries in today's air travel regime. Airlines generally do a good job of accommodating passengers' needs to move out of their seats, particularly on long flights, by signaling when turbulence encounters are unlikely. However, even when forecasts of turbulence are relayed to the passengers, there are continued injuries to those passengers who choose to ignore the directives of flight crew or cabin crew to fasten their seat belts. Turbulence-detection and turbulence-forecasting technologies have improved dramatically over the past three decades; but, in remote areas of the world, the fine-scale information is not available and unexpected encounters with turbulence are more frequent. The intertropical convergence zone over the southwestern Pacific is a case in point. Although detectable by satellite, this area occasionally surprises aircraft with turbulence because satellite data are not relayed to flight crews in a timely fashion.

On-board turbulence-detection science is dependent upon the development of a reliable hybrid detection system that unequivocally warns of turbulence from return radiation signatures across a broad frequency spectrum and that can be reasonably accommodated in instrument-mounting space. Work has been underway in this arena but needs to be addressed more aggressively.

Information Technology (IT)

Information technology has become ubiquitous in the aviation system, finding applications in virtually every element from baggage sorting to aircraft-system-failure detection. It is at the heart of the human-machine interface, where its applications are limited only by the imagination of the systems designers. Cockpit displays now can present unambiguous position information and aircraft-state information, allowing the pilot to concentrate on managing the flight, instead of inferring critical flight information from traditional instruments.

IT is evolving with new capabilities being realized regularly in the six aviation systems: manufacture, flight crew, dispatch/flight operations, maintenance, air traffic management and airports. Coordination among these different systems always has been a necessity but generally has been minimal because of the growing complexity of the aviation system. IT now permits the system to evolve into an integrated (but perhaps not yet coordinated) system of systems. A resulting concern is to ensure that the IT being built into the aviation system will enhance the safety of the entire system. This concern must be addressed at three levels: computer and software; aircraft; and the entire system within which aircraft are being operated.[16]

Industry-government committees have addressed each of these levels with mixed success. The air traffic system continues to defy resolution. Aircraft design and maintenance are making considerable progress; however, hardware/software issues tend to revolve around the use of commercial off-the-shelf software and its increasing complexity. Of particular concern is the difficulty sometimes encountered of ascertaining the basic code for commercial off-the-shelf software, which makes its validation a challenging task. People involved in the details of the IT system often lack real-world aircraft and airline-operations experience, which can lead to mismatches of requirements knowledge and software design.

The involvement of a multiplicity of IT in aircraft design and certification is changing radically the traditional certification methods and may outpace the adaptability rate of the people it is supposed to help. IT's capabilities in automating routine manual functions of flying the aircraft also may introduce new problems among crews who now lack meaningful manual tasks to involve their attention. As a result, workload reduction may not reduce pilot fatigue. Some balance must be struck to retain the optimal benefit of both workload and automation.

As IT continues to be introduced into the system, it will bring with it totally new methods of operating, new roles for the human in the system and new operational capabilities. The human has not made very much progress in resolving all of the new challenges brought by IT; and if they are addressed inadequately, safety may suffer, rather than improve.

Predicting the Unknown

Perhaps the most difficult task for a safety manager is to anticipate problems that might affect the safety and well-being of the aviation operation. This is made doubly difficult if the business emphasis is on a short-term financial result that encourages short-term expediency. To assess the future, however, there must be some semblance of stability and long-term building of a solid technical and operational foundation that can weather short-term changes. This foundation also prepares a well-organized company for the best chance to foresee future threats to safe operation. The successful anticipation of problems requires a means of maintaining an awareness of how the many influences on aviation are behaving and if a change in one parameter will have a domino-like effect on other parameters. How will the introduction of a new technology impact present processes and procedures? Given the gradual dependence upon IT, how would an airline respond to a failure of the system backbone for a short time or a longer time? How would safety be impacted? What are the alternatives? How would a merger affect the operation? How would a mega-merger of two rival airlines affect one's own operation? As new technology enters the operations arena, the flight regime may encroach on the boundaries of previously well-known knowledge and understanding. How will this affect the operation? Will higher takeoff speeds threaten the integrity of the landing gear system? Will higher cruise speeds affect the structural life of critical components? Are new wire-insulation products adequately tested for all environmental situations — such as moisture, fungus, aging and embrittlement — to assure the maintaining of electrical and insulating design properties?

In an operational sense, safety must be anticipatory or "proactive" to counteract the establishment of a catastrophic chain of events. This requires detailed knowledge of how the entire system is operating. Consequently, the manager of safety must have sufficient experience, knowledge and understanding of how myriad factors interact to interpret and make critical decisions regarding safety.

These are some of the questions that must be asked to guard against severe "surprises."

Conclusion

This article has touched on a number of aspects of safety in today's commercial aviation industry and some thoughts about the future. Certainly, the advent of the computer age has transformed aviation and the way in which we will operate in the coming years. Management cannot escape the responsibility for ensuring operation at the highest practical levels of safety and must organize their companies with competent leaders who can inculcate a strong safety culture in the organization that inspires the best performance among the employees.

Aviation has become an extremely complex venture, with rapid change and new requirements that can be satisfied only through new knowledge and understanding of the interplay between all elements involved. This requires continued, directed research and, while industry-government partnerships are desirable, enough government-conducted research to ensure impartiality and objectivity. Safety-research results should be shared without restriction, so as to benefit all who fly, wherever they are.

A generally high level of safety has been achieved through the hard and dedicated work of many people and organizations over the years. To maintain that high level in the face of all the changes being envisioned to the system will require a continuance of this hard work and dedication.

This paper has described representative areas where attention is needed. It is by no means an exhaustive coverage of safety but is intended to provide the basis for a vision of how the future of aviation safety development may take place.

Moreover, the significant events of Sept. 11, 2001, have radically changed the aviation world. For the moment, and rightly so, the paramount focus of the industry will be on security issues. Inevitably, the development and installation of more stringent security defenses by carriers on their aircraft will take time, while enhanced ground security measures will create more delays and inconvenience to the traveling public.

Notwithstanding the need to address security from a completely new standpoint, it will be important not to curtail the existing high level of safety-management systems that the industry has in place and that have created, by far, the safest mode of mass transportation. The temptation to think that, for the time being, air safety is "good enough" and to relax the safety-management defenses — perhaps to save costs — would be a folly. It could possibly lead to a safety-related accident that the industry could not afford at the best of times.

Another area highlighted by the Sept. 11 events relates to the ground situation. The virtually instantaneous closing of U.S. airspace and the immediate grounding of some 5,000 aircraft strained many airport facilities, but none more so than in Canada, where numerous Eastern-seaboard cities suddenly were inundated by large numbers of westbound trans-Atlantic flights. While perhaps on a larger scale than the scenario discussed in this paper, it certainly highlights the problems that might occur if a full VLA of the future suddenly was diverted to a remote airport having inadequate facilities. On Sept. 11 and for several days following, it was necessary in numerous cases to call upon the combined resources of entire local city populations to provide accommodation, sustenance and support for the thousands of unexpectedly stranded passengers.

Above all else, the events of Sept. 11 demonstrate the most difficult task of all — that of predicting the unknown. While this may be the case in any industry, and even in life itself, the fallout from this situation shows the vulnerability of the aviation industry to dramatic events affecting the public's perception of its safety.

Having said that, we can probably all agree that air transport undoubtedly is here to stay. It is an integral part of the world economic infrastructure, and the need to fly will continue. It is the most efficient means of travel over long distances. Consequently, the necessity of maintaining and continuously improving both safety and security levels will remain. Together they are never-ending tasks.♦

[FSF editorial note: This report has been adapted from *Essays on Aviation: A Reconnaissance Flight for Policy Renewal*, a collection of 14 essays on aviation policy published by the Netherlands Directorate-General of Civil Aviation in April 2002 as part of a continuing policy-evaluation process. Some editorial changes were made by FSF staff for clarity and for style. John H. Enders, former FSF vice chairman, and FSF staff contributed to the research and preparation of this report.]

Notes

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2. Ibid.

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10. Controlled flight into terrain (CFIT) occurs when an airworthy aircraft under the control of the flight crew is flown unintentionally into terrain, obstacles or water, usually with no prior awareness by the crew. This type of accident can occur during most phases of flight, but CFIT is more common during the approach-and-landing phase, which begins when an airworthy aircraft under the control of the flight crew descends below 5,000 feet above ground level (AGL) with the intention to conduct an approach and ends when the landing is complete or the flight crew flies the aircraft above 5,000 feet AGL en route to another airport.

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About the Author

Stuart Matthews has served as president and CEO of Flight Safety Foundation since 1994. He previously held senior management positions with several airlines and aircraft-manufacturing companies, including Fokker Aircraft USA, where he served as chairman, president and CEO from 1974 through 1994. He is a member of the executive committee of the U.S. Commercial Aviation Safety Team and chairman of the curriculum-oversight committee of the Aviation Safety Alliance. A chartered engineer and fellow of the Royal Aeronautical Society, Matthews holds an equivalent degree in aeronautical engineering and mechanical engineering from Hertfordshire University. While a student, he built and flew his own aircraft at age 19.

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Data Show 393 Accidents Among Western-built Large Commercial Jets From 1992 Through 2001

Data compiled by The Boeing Co. show that 52 percent of the accidents were controlled-flight-into-terrain accidents or approach-and-landing accidents.

FSF Editorial Staff

Data compiled by The Boeing Co. show that, of 393 accidents that occurred from 1992 through 2001 among Western-built large commercial jet airplanes, 161 accidents involved current-generation airplanes,[1] which had an accident rate of 1.5 per 1 million departures (Figure 1, page 14).

The data include commercial jet airplanes with maximum gross weights of more than 60,000 pounds/27,000 kilograms. The data exclude airplanes manufactured in the Commonwealth of Independent States because of a lack of operational data. Commercial airplanes in military service also are excluded.

During the same period, first-generation airplanes,[2] which had a 10-year accident rate of 27.2 per 1 million departures, were involved in 49 accidents; second-generation airplanes,[3] with an accident rate of 2.8 per 1 million departures, were involved in 130 accidents; and early wide-body airplanes,[4] with an accident rate of 5.3 per 1 million departures, were involved in 53 accidents.

Of the 393 accidents during the 10-year period, 205 accidents (52 percent) were controlled-flight-into-terrain (CFIT) accidents and approach-and-landing accidents (ALAs).[5]

Data show that from 1959 through 2001, the hull-loss accident rate was highest (14.56 hull-loss accidents per 1 million departures) among airplanes no longer in commercial service — the Breguet Mercure, Convair CV-880/-990, de Havilland Comet, SUD-Aviation Caravelle, SUD-Aviation Trident and Vickers VC10 (Figure 2, page 15; Boeing defines a hull-loss accident as one in which damage to an airplane is substantial and beyond economic repair; or in which an airplane is missing, a search for the wreckage has been terminated without the airplane being located or an airplane is substantially damaged and inaccessible.)

The data showed that there were no hull-loss accidents among three airplane types — the Boeing 777, B-737NG and B-717.

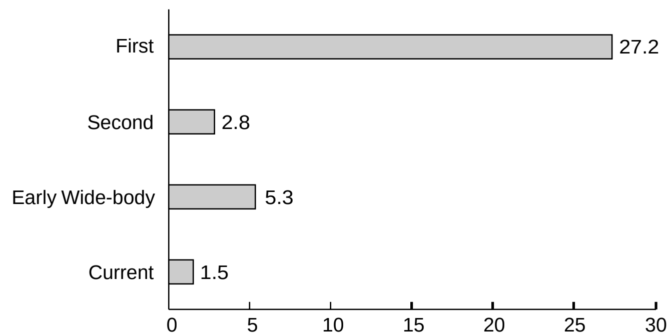
Data for three airplane types — the Airbus A330 and A340 and the BAE Systems/EADS (European Aeronautic Defense and Space Co.) Concorde — are not included in Figure 2 because the aircraft have accumulated fewer than 1 million departures. There have been no hull-loss accidents involving A330 and A340 airplanes. Concorde airplanes, which accumulated about 83,000 departures from 1959 through 2001, have been involved in one hull-loss accident.

Accident Categories by Airplane Generation

Selected Accidents — Western-built Large Commercial Jet Operations — 1992–2001[1]

Airplane Generation	Controlled Flight Into Terrain	Loss of Control	Midair Collision	In-flight Fire	Fuel Tank Explosion	Landing: Off End on Landing	Landing: Off Side on Landing	Landing: Hard Landing	Landing: Landed Short	Landing-gear Collapse/Fail/Up	Ice/Snow	Fuel Management/Exhaustion	Wind Shear	Takeoff Configuration	Refused Takeoff — Off End	Off Side on Takeoff	Runway Incursion Vehicle/People	Wing Strike	Engine Failure/Separation	Ground Collision	Ground Crew Injury	Boarding/Deplaning	Turbulence Fatality	Miscellaneous[2]	Fire on Ground	Aircraft Structure	Unknown	***Total***
First	5	7	0	1	0	6	3	3	4	8	0	1	0	1	1	0	0	2	3	0	0	0	0	1	1	0	2	**49**
Second	15	8	1	4	0	18	22	15	10	11	2	2	1	1	6	1	1	1	1	2	1	0	0	1	1	2	3	**130**
Early Wide-body	4	1	1	1	1	4	3	5	1	4	1	1	1	0	3	3	1	0	5	3	1	1	1	2	3	2	0	**53**
Current	12	16	0	1	1	24	13	35	3	14	1	1	1	1	4	3	8	0	3	4	1	3	1	3	2	2	4	**161**
Total	**36**	**32**	**2**	**7**	**2**	**52**	**41**	**58**	**18**	**37**	**4**	**5**	**3**	**3**	**14**	**7**	**10**	**3**	**12**	**9**	**3**	**4**	**2**	**7**	**7**	**6**	**9**	**393**

10-Year Accident Rate by Airplane Generation



Airplane Generation

First	Boeing 707 and B-720; Breguet Mercure; Convair CV-880/-990; de Havilland Comet 4; McDonnell Douglas DC-8; and SUD-Aviation Caravelle
Second	Boeing 727 and B-737-100/-200; British Aircraft Corp. BAC 1-11; de Havilland Trident; Fokker F.28; McDonnell Douglas DC-9; and Vickers VC10
Early Wide-body	Airbus A300, Boeing 747-100/-200/-300/SP, Lockheed L-1011 and McDonnell Douglas DC-10
Current	Airbus A300-600, A310, A320/319/321, A330 and A340; Avro RJ-70/-85/-100; BAE Systems 146; Boeing 717, B-737-300/-400/-500, B-737NG, B-747-400, B-757, B-767, and B-777; Fokker 70 and Fokker 100; and McDonnell Douglas MD-11 and MD-80/-90

[1]Data include airplanes heavier than 60,000 pounds/27,000 kilograms maximum gross weight, except those manufactured in the Commonwealth of Independent States and commercial airplanes in military service.

[2]Miscellaneous accidents included the following: coffee-maker explosion, jet blast, instrument error, pilot incapacitation, airplane taxied across ditch and flight attendant fell from door.

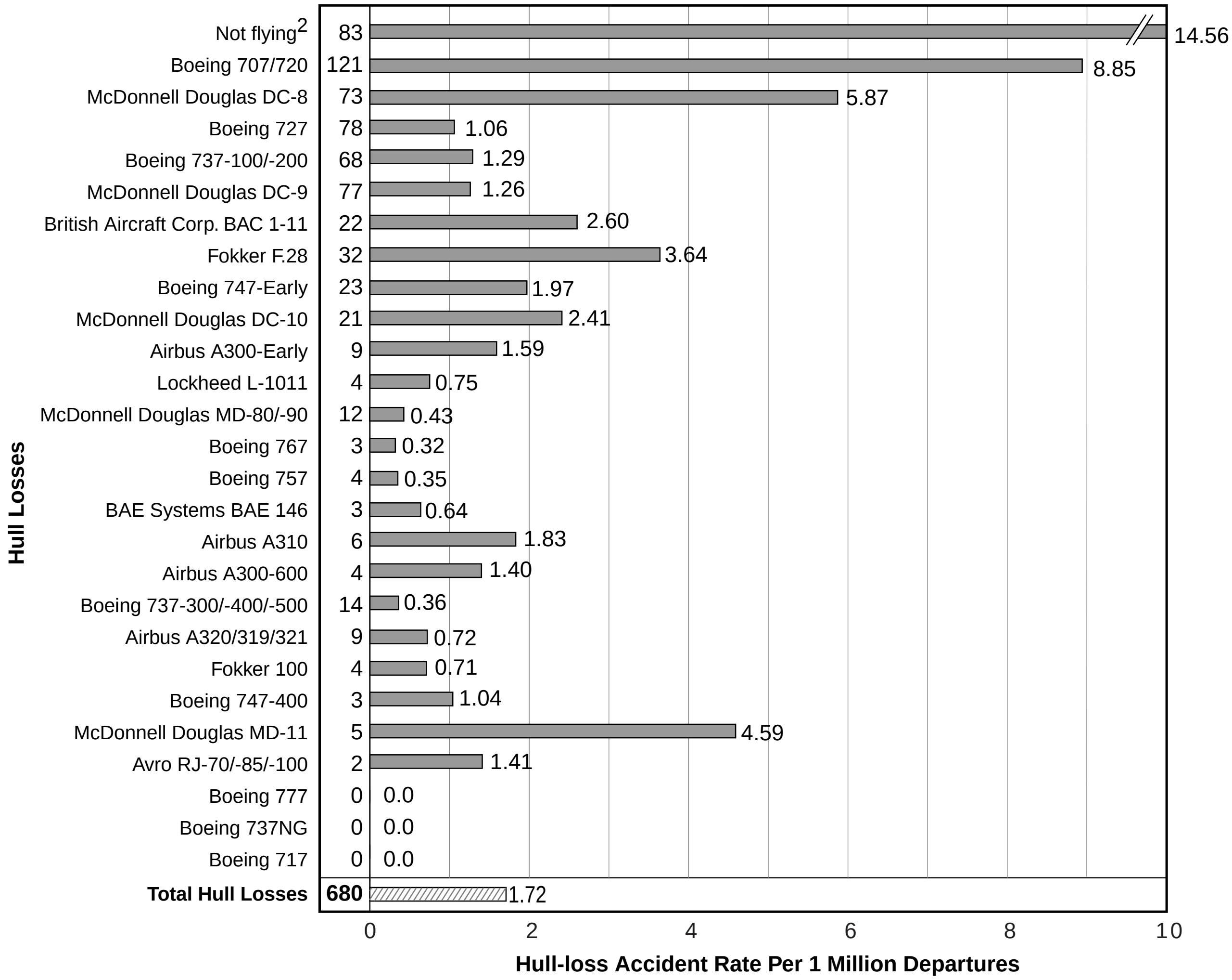
Source: The Boeing Co.

Figure 1

The hull loss and/or fatal accident rate for current-generation airplanes was 1.04 per 1 million departures in 2001, compared with 0.66 per 1 million departures in 2000 (Figure 3, page 16). For early wide-body airplanes, the hull-loss and/or fatal accident rate in 2001 was 6.71 per 1 million departures, compared with 4.46 per 1 million departures in 2000. For second-generation commercial jet airplanes, the 2001 hull-loss and/or fatal accident rate was 2.38 per 1 million departures, compared with 1.65 per 1

Accident Rates by Airplane Type

Hull-loss Accidents — Western-built Large Commercial Jet Airplanes — 1959–2001[1]



[1]Data include airplanes heavier than 60,000 pounds/27,000 kilograms maximum gross weight, except those manufactured in the Commonwealth of Independent States and commercial airplanes in military service. Also excluded are data for three aircraft types — the Airbus A330 and A340 and the BAE Systems/EADS (European Aeronautic Defense and Space Co.) Concorde — that have accumulated fewer than 1 million departures. There have been no hull-loss accidents involving A330 and A340 airplanes. Concorde airplanes, which accumulated about 83,000 departures from 1959 through 2001, have had one hull-loss accident.

[2]The Breguet Mercure, Convair CV-880/-990, de Havilland Comet, SUD-Aviation Caravelle, SUD-Aviation Trident and Vickers VC10 are no longer in commercial service and are combined in the "not flying" data.

Source: The Boeing Co.

Figure 2

million departures in 2000, and for first-generation commercial jet airplanes, the 2001 hull-loss and/or fatal accident rate was 62.30 per 1 million departures, compared with 24.19 per 1 million departures in 2000.♦

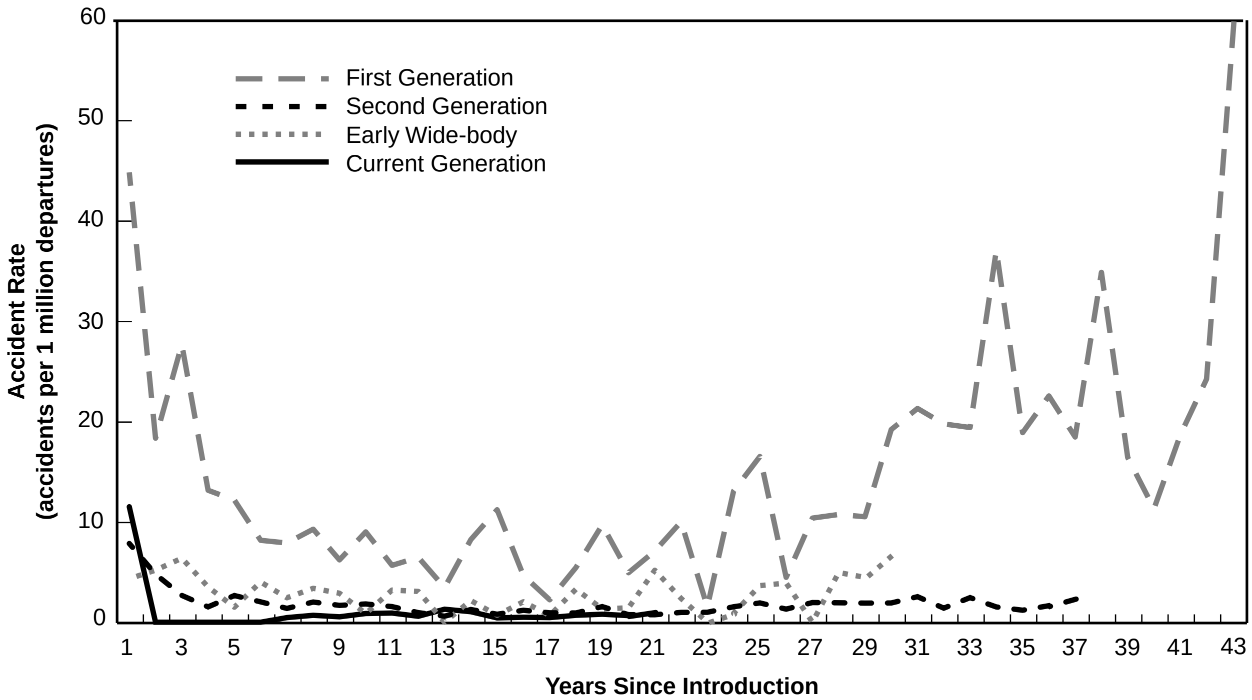
Notes

1. The Boeing Co. includes in its definition of current-generation commercial jet airplanes the Airbus A300-600, A310, A320/319/321, A330 and A340; Avro RJ-70/-85/-100; BAE Systems 146; Boeing 717, B-737-300/-400/-500, B-737NG, B-747-400, B-757, B-767 and B-777; Fokker 70 and Fokker 100; and McDonnell Douglas MD-11 and MD-80/-90.

2. Boeing includes in its definition of first-generation commercial jet airplanes the Boeing 707 and B-720; Breguet Mercure; Convair CV-880/-990; de Havilland

Accident Rates by Years Following Introduction

Hull-loss and/or Fatal Accidents — Western-built Large Commercial Jet Airplanes — 1959–2001[1]



Airplane Generation

First	Boeing 707 and B-720; Breguet Mercure; Convair CV-880/-990; de Havilland Comet 4; McDonnell Douglas DC-8; and SUD-Aviation Caravelle
Second	Boeing 727 and B-737-100/-200; British Aircraft Corp. BAC 1-11; de Havilland Trident; Fokker F.28; McDonnell Douglas DC-9; and Vickers VC10
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[1]Data include airplanes heavier than 60,000 pounds/27,000 kilograms maximum gross weight, except those manufactured in the Commonwealth of Independent States and commercial airplanes in military service.

Source: The Boeing Co.

Figure 3

Comet 4; McDonnell Douglas DC-8; and SUD-Aviation Caravelle.

3. Boeing includes in its definition of second-generation commercial jet airplanes the Boeing 727 and B-737-100/-200; British Aircraft Corp. BAC 1-11; de Havilland Trident; Fokker F.28; McDonnell Douglas DC-9; and Vickers VC10.

4. Boeing includes in its definition of early wide-body commercial jet airplanes the Airbus A300, Boeing 747-100/-200/-300SP, Lockheed L-1011 and McDonnell Douglas DC-10.

5. Controlled flight into terrain (CFIT) occurs when an airworthy aircraft under the control of the flight crew is flown unintentionally into terrain, obstacles or water, usually with no prior awareness by the crew. This type of accident can occur during most phases of flight, but CFIT is more common during the approach-and-landing phase, which begins when an airworthy aircraft under the control of the flight crew descends below 5,000 feet above ground level (AGL) with the intention to conduct an approach and ends when the landing is complete or the flight crew flies the aircraft above 5,000 feet AGL en route to another airport.

Publications Received at FSF Jerry Lederer Aviation Safety Library

Report Describes Study of Airport Decision-making Processes

The Eurocontrol project, conducted at Barcelona (Spain) Airport, was intended to improve operations by increasing information-sharing among airport personnel, aircraft operators, the handling agent, air traffic services providers and Eurocontrol.

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Reports

Collaborative Decision Making (CDM) at Barcelona Airport. Gottlinger, W.; Fakhoury F. France: Eurocontrol Experimental Centre (EEC), 2002. EEC Note 03/02. 181 pp. Figures, tables, glossary, appendix, references. Available on the Internet at <www.eurocontrol.fr> or from Eurocontrol.*

To improve operations at Barcelona (Spain) Airport, the airport and its aviation partners participated in a review of their operating processes and procedures. The project was a collaborative effort involving the Eurocontrol Experimental Centre's performance, flow management, economics and efficiency (PFE) group; the airport operator (Aeropuertos Españoles y Navegación Aérea [AENA]); aircraft operators (Iberia and Spanair); the handling agent (Eurohandling); and the air traffic services provider (AENA), including flow management, tower and area control center.

The primary objective of the Barcelona project was to improve operations and decision-making processes by "making the best use of available information through increased information-sharing by airlines, air traffic service providers, airports, the European Central Flow Management Unit and meteorological offices."

The main goals of the project were the following:

- Establish a common awareness by allowing participants to share data;
- Allow each decision to be made by the person in the best position to make that decision; and,
- Make decisions in an open manner so that all partners know what is happening and can contribute as necessary or as desired.

The report provides detailed information on business processes and operational processes before and after the project. The report includes analysis of multiple information systems and the flow of information or gaps in information (from origin to final destination) within the same organization and among organizations. A discussion of major influences on current decision-making processes and design of new processes and systems for collaborative decision making is included.

Terrorism Insurance Coverage in the Aftermath of September 11th. American Academy of Actuaries (Academy) Extreme Events Committee. Washington, D.C., U.S.: American Academy of Actuaries, May 2002. 20 pp. Figures, appendixes. Available from the Academy.**

The Academy is the public policy organization for actuaries practicing in the United States. [An actuary is a business professional who uses mathematics, statistics and financial theory to study and analyze uncertain future events to determine their financial risks and consequences.] The Academy is nonpartisan and prepares reports regarding proposed legislation for the U.S. Congress.

In this report, the Academy discusses the current condition of property/casualty insurance, reinsurance markets and the availability of terrorism coverage. The report said that the terrorist attacks of Sept. 11, 2001, resulted in the largest insured loss ever recorded in the United States. As a result, global reinsurers, which in the United States are not subject to regulation of policy language, are beginning to exclude or to limit substantially coverage for terrorism. Corporate risk managers are anticipating premium increases of 40 percent to 50 percent. The financial consequences of additional terrorist events could overwhelm industry capacity, the report said.

Books

The Flight Instructor's Manual. Kershner, William K. Ames, Iowa, U.S.: Iowa State Press, fourth edition, 2002. 480 pp. Figures, appendixes, bibliography.

This book is written as a guide for new flight instructors and as a reference for students working to earn a flight instructor certificate. Kershner discusses flight instructors' general responsibilities to themselves, their students and safety; technical requirements of instructors; and the personal qualities that instructors should possess, including integrity and professionalism. Goals for successful teaching are to instill high standards in students; to teach precise habits; to reduce tolerance for errors as instruction proceeds; to detect unsafe habits and correct them or, preferably, to teach safe habits from the beginning. Kershner writes that "the flight instructor exerts more influence on flight safety than any other pilot."

The Flight Instructor's Manual may be considered an instructor's text for other manuals by Kershner — *The Student Pilot's Flight Manual*, *The Advanced Pilot's Flight Manual*, *The Basic Aerobatic Manual* and *The Instrument Flight Manual.*

Regulatory Materials

Avionics, Installations — Acceptable technical data. Civil Aviation Authority of New Zealand (CAA). Advisory Circular (AC) 43-14. Revision 1. Oct. 7, 2002. 37 pp. Figure, appendixes. Available from CAA.***

This AC discusses acceptable methods of installing aircraft avionics. The AC is divided into two parts. The first part provides general background information applicable to most modifications. The second part is a series of appendixes with technical instructions and data for repairs, modifications and installation of several types of electronic equipment and systems.

Emergency Medical Equipment. U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 121-33. Aug. 14, 2002. 8 pp. Figure. Available from GPO.****

The U.S. Congress passed the Aviation Medical Assistance Act of 1998 directing FAA to determine whether existing minimum requirements should be modified for air carrier emergency medical equipment and crewmember emergency medical training. For one year, FAA collected data about in-flight medical events that resulted in death or near-death. Analysis of the data showed that 119 of 188 events were cardiac-related, and of those, automated external defibrillators (AEDs) were used in 17 medical events; of the 17, four passengers survived. Subsequent FAA investigations found similar successful outcomes when AEDs were used. FAA determined that U.S. Federal Aviation Regulations Part 121 should be amended to require emergency medical enhancements, including training, emergency medical kits (EMKs) and AEDs.

As of April 12, 2004, AEDs and enhanced EMKs will be required for Part 121 operators. This AC is a guide for air carrier operators to develop protocols for medical equipment and cabin crew. The AC lists required items for EMKs and aircraft minimum equipment lists and describes the purpose or intended use of many items. Equipment storage, inspection, safety standards and use also are explained.

Emergency Medical Equipment Training. U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 121-34. Aug. 14, 2002. 5 pp. Available from GPO.****

This AC provides guidance for training programs for crewmembers, particularly flight attendants, on automated external defibrillators (AEDs) and emergency medical kits (EMKs). The AC describes minimum requirements for initial training and recurrent training, issues to be addressed in medical training programs and certification of training instructors. Crewmember training must be completed before April 12, 2004, the date the FAA will require U.S. Federal Aviation Regulations Part 121 operators to carry AEDs and EMKs. The AC also discusses liabilities of air carriers and individuals who provide or attempt to provide in-flight medical assistance to passengers.♦

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*** Civil Aviation Authority
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U.S. Government Printing Office (GPO)
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Abrupt Rudder Deflection Prompts Emergency Landing

The captain of the Boeing 747-400 said that asymmetric engine thrust, full right rudder and full right aileron were required to maintain the correct heading during the emergency landing at an airport in the United States.

FSF Editorial Staff

The following information provides an awareness of problems through which such occurrences may be prevented in the future. Accident/incident briefs are based on preliminary information from government agencies, aviation organizations, press information and other sources. This information may not be entirely accurate.

Inspection Finds Break in Rudder-control-module Housing

Boeing 747-400. Minor damage. No injuries.

The airplane was being flown at Flight Level 350 (approximately 35,000 feet), with the autopilot engaged, from the United States to Japan. The airplane rolled abruptly into a 30-degree to 40-degree left bank. The captain said that there were "indications that the lower rudder went to full-left authority and remained there."

The captain declared an emergency and diverted to an en route airport in the United States. The flight crew conducted several emergency procedures but could not correct the problem. Then, as the airspeed decreased during approach to landing, the lower rudder deflected further to the left, and full-right upper rudder and full right aileron did not hold the airplane on course, the captain said. He said that asymmetric engine thrust was used to maintain the correct heading.

After landing, the lower rudder remained deflected fully to the left. An inspection revealed that the cast-metal housing of the lower rudder-control module was broken. The report said that the "end portion of the control-module housing that houses the yaw damper actuator had completely broken away from the main portion of the housing" and that the broken end contained a metal plug that had been safety-wired to the main housing. The investigation was continuing.

Retreaded Tire Fails During Landing

Airbus A330. Minor damage. No injuries.

Visual meteorological conditions prevailed as the airplane was flown on an instrument landing system (ILS) approach to Runway 26L at an airport in England after a flight from Italy. Winds were from 230 degrees at 17 knots, with gusts to 30 knots, light turbulence to moderate turbulence and possible wind shear.

The airplane was hand-flown, the autothrottle system was engaged and the managed-speed mode was selected throughout the final approach and landing. The report said that the touchdown was "not particularly firm, given the gusty, part-crosswind conditions," that the landing roll was smooth and that the autobrake system was set to "low."

"As the aircraft vacated the runway, [air traffic control] advised that the aircraft appeared to have burst a tire on landing," the report said.

The crew stopped the airplane on the parallel emergency runway for a preliminary examination, then taxied the airplane to a gate, where the passengers disembarked.

Further inspection revealed marks made by tire tread on the inboard side of the right engine nacelle and impact damage on the right inboard flap. The failed tire had been retreaded twice. Records showed that 234 landings had been conducted before the first retread and that 160 landings had been conducted before the second retread. An additional 22 landings were conducted before the tire failure.

The manufacturer said that a perforation through the tire casing was not detected during the second retreading. When the tire was inflated, nitrogen leaked through the perforation and gradually caused the tread to separate and peel off during the landing.

Smoke Prompts Return to Departure Airport

Boeing 747-400. Minor damage. No injuries.

After takeoff from an airport in Australia, the flight crew smelled smoke and observed a forward-cargo fire-warning message on the engine indicating and crew alerting system (EICAS). Smoke also was observed in the passenger cabin.

The flight crew conducted the appropriate checklist, activated the fire-suppression system, declared an emergency and returned to the departure airport, where they conducted an overweight landing.

While the airplane was being flown on final approach, the fire warning ceased and the flight attendants said that there was no smoke in the cabin, although the smell of smoke remained. After landing, the airplane was stopped on the runway, and emergency officials determined that no fire was visible. The passengers deplaned using mobile stairs at the front left door.

An inspection of the forward cargo bay revealed that fire had damaged a section of the sidewall lining near the main-deck galley-chiller boost fan. The report said that the fuselage insulation blanket was burned between body stations (BS) 880 and BS 900, and the fuselage skin, stringers and frame structure showed "signs of being heat-affected."

"The boost fan was found to have a hole burned in its housing adjacent to the electrical connector, with four of the seven electrical wires burned through," the report said. "All of the fan impeller blades were also found to have failed."

Air Taxi Commuter

Accident Results in Plan to Require Training in Mountain Flying

Cessna 207. Destroyed. Six fatalities.

Visual meteorological conditions prevailed for departure from an airport in New Zealand. About 30 minutes after takeoff, the airplane struck the side of a mountain at about 4,400 feet as the pilot attempted to fly the airplane across a mountain ridge.

The accident report said that the pilot probably realized that the airplane was too low to be flown safely across the ridge and turned the airplane left to fly to an area where he could conduct climbing turns until reaching a safe altitude of 5,500 feet. Examination of the wreckage showed that the airplane had completed a left turn and was in a wings-level attitude at the time of impact.

The report said that although the pilot was qualified and authorized to conduct the flight and had received some training in mountain flying, he was relatively inexperienced and "may have misjudged the strength of the tail wind and thus the aircraft groundspeed and the strength of any downdrafts" while approaching the ridge. The pilot's delay in turning away from the ridge "was probably a prime contributing factor to the accident," the report said.

As a result of the accident, the Civil Aviation Authority of New Zealand (CAA) began drafting a rule to include training in mountain flying as a requirement for pilot licensing. Implementation of a final rule is not expected before 2003. CAA also said that detailed information about mountain flying would be included in advisory circulars to aid operators that conduct routine commercial flights into mountainous areas.

Hydroplaning Cited in Off-runway Excursion

Fokker 50. Minor damage. No injuries.

The airplane was flown on an instrument landing system (ILS) approach to Runway 17 at an airport in Ireland. Air traffic control (ATC) said that winds for the late-afternoon approach were from 250 degrees at 12 knots and that the runway was wet. The flight crew said that they initially wanted to land the airplane on Runway 25 but requested Runway 17 because it was longer and had an ILS approach.

After touchdown, the airplane drifted toward the right side of the runway. The captain (the pilot flying) said that the airplane was hydroplaning. His attempts to regain directional control failed, and the airplane continued onto soft ground adjacent to the runway and proceeded 195 meters (640 feet) before stopping.

An investigation revealed that 25.3 millimeters (one inch) of rain had fallen during the day before the airplane was landed. Although ATC described the runway as "wet," an actual assessment of the runway condition had not been conducted and the crew was not told of the actual condition of the runway surface, which included a "sufficient amount of standing water."

The accident report said that the loss of directional control was a result of hydroplaning, which was caused by standing water. The report also said that the landing roll-out technique was "inappropriate for crosswind, wet runway conditions" and that "more decisive use of left rudder, right control wheel and forward pressure on the control column on the initial part of the landing run might have reduced the first increase in heading and drift to the right."

Section of Wing Separates During Takeoff

De Havilland DHC-8 Dash 8 Series 300. Minor damage. No injuries.

The airplane was being flown from an airport in Canada to the United States. After takeoff, the aircraft vibrated and the crew returned to the departure airport, where they conducted a normal landing.

A preliminary investigation revealed that a three-foot (0.9-meter) section of the leading edge of the left wing, including the deicing boot, had separated during the takeoff. The section later was found on the departure runway. The investigation was continuing.

In-flight Fire Damages Landing Gear

Embraer EMB-110P1 Bandeirante. Substantial damage. No injuries.

The airplane was being flown at 10,000 feet in cruise during a charter flight in Australia when the master caution light and the warning light for the right generator illuminated. The pilot reset the generator, and operations appeared to return to normal.

Soon afterward, the master caution light again illuminated, a number of circuit breakers were activated, several master alarm panel warnings illuminated, the fire warning light on the "T" handle of the right-engine fire extinguisher illuminated, and the aural fire alarm sounded. The pilot conducted the "Engine Fire" emergency checklist but was unable to select the fuel cut-off position with the right fuel-condition lever. He also was unable to feather the right propeller and said later that the propeller lever moved forward from the feathered detent to an intermediate position. The firewall shut-off valve also remained open. The pilot discharged the fire bottle. Soon afterward, the fire alarm sounded again. The pilot, believing that the fire had been extinguished, declared an urgency and began a rapid descent to an airport 35 nautical miles (65 kilometers) to the south. Fog prevented a landing, and the pilot then flew the airplane to another airport 27 nautical miles (50 kilometers) south-southwest.

When the airplane was nine nautical miles (17 kilometers) from the second airport, thick smoke entered the cabin and the pilot declared an emergency. When he moved the landing-gear lever to the "down" position, there was no indication that the landing gear had extended. Because he wanted to land the airplane as quickly as possible, he did not use manual gear-extension procedures. He extended the flaps, moved the propeller levers to the feathered position and moved the condition levers to the fuel cut-off position. The airplane touched down with the right-main landing gear extended, skidded and veered off the runway. The pilot and eight passengers exited the airplane through the cabin door and the left over-wing emergency exit. Maintenance personnel extinguished the fire in the right engine nacelle with portable fire extinguishers.

The accident report said that "vibration from the worn armature shaft of the right-engine starter-generator initiated a fatigue crack in the fuel-return line. Fuel leaked from the fractured line during the flight and was ignited by sparks or frictional heat from the generator after the armature shaft failed." Because the pilot did not successfully complete all items on the "Engine Fire" emergency checklist and the firewall shut-off valve was open, fuel continued to flow to the fuel-control unit and to feed the fire. The heat damaged components in the wheel well.

The accident report said that the occurrence "demonstrates the need for error-free and complete checklists to be available to pilots during emergency situations … [and] the need for pilots to be familiar with the systems of the aircraft they operate and the emergency actions to be taken in the event of abnormal [situations] or emergency situations."

Corporate
Business

Airplane Overruns Runway During Tail-wind Landing

Cessna 525A Citation. Substantial damage. Two serious injuries, two minor injuries.

The airplane was being flown in visual meteorological conditions on descent to an airport in the United States. The pilot described the approach as stable and without turbulence. He said that there was a "sink rate" alert from the terrain awareness and warning system (TAWS), but that this was not unusual and that, in the past, the alarm had sounded even during a 500-feet-per-minute descent using a visual approach slope indicator (VASI). He said that the airplane touched down in the first quarter of the 3,000-foot (9,843-meter) runway at an airspeed slightly faster than V_{REF} (landing reference speed).

The pilot extended ground flaps and applied the brakes. He said that he "could feel the anti-skid pulsating through the brake pedals, but the airplane did not decelerate as expected." About halfway down the runway, the pilot "became concerned about stopping within the distance remaining" and removed his feet from the brake pedals, advanced the throttle levers and adjusted the flaps to the takeoff position. The pilot said that the airplane then did not accelerate as expected but departed the end of the runway. Wheel marks were found in a grassy overrun area that extended about 180 feet (55 meters) past the runway to a drop-off area. The airplane stopped about 120 feet (37 meters) beyond the overrun area on an upslope perpendicular to the runway.

The pilot said that, although the winds favored Runway 16, he landed the airplane on Runway 34 because the tail wind component was "negligible" and because a landing on Runway 16 would have required a steeper approach.

A preliminary investigation revealed that winds were from 180 degrees at seven knots about 30 minutes after the accident at an airport 24 statute miles (39 kilometers) southeast of the accident site and from 180 degrees at nine knots and gusting to 15 knots about 12 minutes after the accident at an airport 38 statute miles (61 kilometers) southwest of the site. Skid marks began 642 feet (2,106 meters) from the runway threshold and continued to the end of the runway, where wheel marks were seen in the grass-covered overrun area.

The report said, "Both main-landing-gear tires were in serviceable condition and inflated. The condition of the nosewheel tire could not be confirmed. The left and right flaps were approximately 15 degrees, and the flap handle was up, along with the flap indicator. The thrust attenuators were stowed, and the control switch was in the 'AUTO' position. The anti-skid control switch was 'ON.' The power brake accumulator was discharged and the brake-fluid reservoir was full. The parking brake was off, the gear and brake emergency pneumatic accumulator was charged, and the emergency brake handle was stowed."

Pilot Observes Smoke From Instrument Panel

Cessna 208 Caravan. Minor damage. No injuries.

Instrument meteorological conditions prevailed for the descent to an airport in Canada. The report said that the pilot observed smoke at the lower right side of the instrument panel and smelled fumes "with a burning electrical odor."

The pilot began conducting the emergency checklist and told air traffic control of the problem. Before the checklist was completed, the smoke dissipated, and the pilot ventilated the cabin.

The pilot observed that several circuit breakers had been activated and that the autopilot was not functioning. The pilot manually activated all circuit breakers related to the autopilot, and the flight continued to its destination. The investigation was continuing.

Airplane Departs Runway During Pilot's First Landing at Site

Lancair IV. Substantial damage. Two fatalities, one serious injury.

Visual meteorological conditions prevailed for the flight to a private landing site in the United States. The pilot was conducting his first landing at the site on Runway 7, which was 2,206 feet (7,238 meters) long and had a 1.5-degree slope and a "moderate terrain downslope" at the approach end, the report said.

The airplane was being flown on short final at a higher-than-typical altitude and with a higher-than-typical nose attitude. The airplane touched down with the right-main wheel in dirt and gravel next to the runway, then bounced and settled. A witness heard power being applied, but the airplane remained on the runway and veered to the right, striking several trees.

Other General Aviation

Airplanes Collide During Practice of Night Landings

Cessna 172. Destroyed. One minor injury.
Cessna 172. Destroyed. One fatality.

Night visual meteorological conditions prevailed as the pilots of the two airplanes conducted takeoffs and landings at an airport in Australia. Both airplanes were being flown on short final approach to the same runway when they collided, with one airplane — flown by a single pilot — becoming entangled atop the other airplane — flown by a student pilot and a flight instructor. Both airplanes then struck the runway and were destroyed in a post-impact fire.

The student pilot and flight instructor exited their airplane; the pilot of the other airplane received fatal injuries.

The airport's air traffic control tower was not operating at the time of the accident; instead, pilots of the six aircraft being flown in the airport traffic pattern were using mandatory broadcast zone procedures under which they arranged mutual separation of their aircraft.

Bright Sunlight Limits Pilot's View Of Landing-gear Indicators

Yakovlev Yak-52. Minor damage. No injuries.

The pilot flew the airplane to an airport in England, intending to conduct a low approach and a go-around. Instead, during final approach, he decided to land the airplane.

The pilot said that he simultaneously extended the flaps — using his left hand — and the landing gear — using his right hand — and that he heard the pneumatic system operating and therefore believed that the landing gear had extended. (The pneumatic system provides pressure to operate flaps and landing gear.)

The landing-gear selector has two position-indicating systems — an electrically operated light system with six lights in the front cockpit and six lights in the rear cockpit and a mechanical indicator system with indicator rods in each wing and in the upper fuselage in front of the cockpit. Each indicator rod has colored bands and white bands, all of which are visible when the landing gear is extended and locked.

The report said, "The pilot reported that the difficult sunlight conditions, with the sun low in the sky, possibly contributed to his failure to notice that the landing-gear mechanical-warning rods were not visible. This lack of positive confirmation resulted in the aircraft touching down with the landing gear retracted."

Damage was minor because, even with the landing gear retracted, the wheels of a Yak-52 protrude from the underside of the wing surface.

Fuel Contamination Cited In Engine Failure

Piper PA-36 New Brave 375. Minor damage. No injuries.

Visual meteorological conditions prevailed for the agricultural-operations flight in South Africa. The airplane was landed on a private airstrip on a farm to load more fuel and more agricultural spraying liquid. After takeoff, at about 200 feet, the pilot noted a propeller overspeed condition. The report said that he dumped the agricultural spraying liquid and extended the flaps to 20 degrees in an attempt to gain altitude, but he was unable to stop the airplane's descent. He then conducted an emergency landing in an uncultivated field.

An investigation revealed that the probable cause of the accident was the loss of engine power after takeoff. The power loss probably was a result of a decrease in fuel flow caused by fuel contamination, the report said.

Rotorcraft

EMS Helicopter Strikes Terrain During Flight in Dark-night Conditions

Bell 222UT. Destroyed. Three fatalities.

Dark-night visual meteorological conditions prevailed and a company visual flight rules flight plan had been filed for the emergency medical services (EMS) flight to pick up a patient at the site of an automobile accident in the United States.

Witnesses said that the helicopter was flown "low and very fast" across the highway, then struck the ground in a nose-low attitude. Just before the accident, the flight crew had told emergency personnel on the ground that they required no further information about the location of the automobile accident. There were no further communications from the crew.

Helicopter Strikes Tree During Low-visibility Flight

Robinson R44. Destroyed. Two fatalities, one minor injury.

The helicopter was being flown from a campsite in a national park in New Zealand to transport two hunters out of the park. The flight was delayed three days because of adverse weather. As the passengers boarded the helicopter, the pilot said that he "had to sneak in" through the fog to land at their campsite and that he would try to fly them out of the park, but if weather conditions were adverse, they would return to the campsite to wait for better weather.

Weather conditions at the time of the accident included patches of clouds at 1,500 feet or lower, overcast clouds at 3,000 feet and drizzle, with visibility of about 1,500 meters (458 feet) and northerly winds at 3,000 feet of about 15 knots to 20 knots.

The rear-seat passenger said that the pilot flew the helicopter beneath low clouds, following ravines and valleys and turning to avoid fog banks. The accident report said that the passenger "saw that they were at treetop level just before he heard a 'bleep' sound and saw the main rotor taking off the top of a tree on his left. He heard the pilot say 'sorry, guys' and saw that they were falling alongside the tree." (The report said that the "bleep" probably was the low-rotor-speed warning immediately after the helicopter struck the tree.)

The passenger helped the pilot exit the helicopter but was unable to help the other passenger because of a fire, which destroyed the helicopter. The pilot died about 15 minutes after the accident because of severe chest injuries; the surviving passenger was rescued two days later.

The accident report said that the helicopter pilot, who had 894 flight hours, "was not experienced in conducting this type of operation in weather conditions of low cloud and poor visibility" and that he "probably treated the flight as an emergency because he understood that a passenger was running out of his medication."

Helicopter Strikes Terrain After Loss of Yaw Control During Takeoff

Eurocopter HT.Mk2. Destroyed. No injuries.

Winds were from the west to northwest at four knots to five knots when the pilot conducted the takeoff from a grass helipad in England. The helicopter was on a heading of about 350 degrees, and the pilot expected to apply the right anti-torque pedal during takeoff. Just after takeoff, the helicopter yawed left.

The pilot applied more right pedal, but the rate of yaw increased. The accident report said that as the helicopter passed a heading of 180 degrees, "the rate of yaw was too high to land, and the pilot became confused. He applied right cyclic to try to counter the yaw, but the aircraft rolled to the right, and the main-rotor blades struck the ground."

An inspection revealed no problem with the helicopter. The report said that five similar events had occurred involving loss of yaw control in the helicopter model during hover in light wind.

"The problem of apparent loss of tail-rotor control in these circumstances is well known and has been the subject of Eurocopter service letters, and advice on the matter was included in the *Military Aircraft Manual*, which was the reference document for [the accident helicopter], the report said. "A common factor in all the previous events … was a lack of pilot experience on type, and the pilot involved in this accident cited his lack of type experience as one of the possible causal factors." (The pilot had 167 flight hours, including 21 hours in the type.)

Loss of Power Results in Water Landing

Bell 206L-1 LongRanger. Substantial damage. No injuries.

Visual meteorological conditions prevailed for an afternoon flight between two landing sites in the Gulf of Mexico. During the flight, the engine lost power and the pilot began an autorotation. As the helicopter touched down on the water, a main-rotor blade struck the tail boom, resulting in separation of a section of the tail-rotor drive shaft and damage to both vertical winglets. The pilot and passengers were rescued by occupants of a boat.

The helicopter was placed on a barge and transported to the operator's base. An examination of the fuel system revealed debris in the main fuel tanks. Discolored fuel was found in the fuel line to the fuel filter; clear fuel was found in the fuel line from the fuel filter to the fuel control. Examination of the fuel system was continuing.

Man Lifted Into Air During External-load Operation

Bell 212. No damage. No injuries.

The helicopter was being flown to move fuel drums in Canada. After a delivery of four barrels, the pilot observed that the barrel straps had been disconnected and received a signal from ground personnel that they were clear of the helicopter. He then began to depart to pick up another load of fuel drums.

The report said that a barrel strap "became tangled around the foot of the aircraft's engineer, who had been assisting at the drop zone. The engineer was lifted smoothly into the air. Now dangling by his foot and about 150 feet in the air, the engineer was able to reach for his radio and contact the pilot. The pilot slowed and subsequently landed the engineer 300 [feet] to 400 feet [92 meters to 122 meters] from the drop zone."

The engineer was not injured.♦

Call for Nominations

Flight Safety Foundation Business Aviation Meritorious Service Award

This award has been presented by the Foundation since 1975 for outstanding service and contributions to corporate aviation safety. The award, which was established during an era in which the role of business and corporate aviation was expanding, recognizes individuals whose work enhances safety in this segment of the industry. Recipients have included industry leaders, government officials, members of the news media and researchers whose findings were especially relevant to corporate aviation. The award includes a handsome, wood-framed, hand-lettered citation.

The nominating deadline is February 7, 2003. The award will be presented in Hollywood, Florida, USA at the FSF Corporate Aviation Safety Seminar, April 22–24, 2003.

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Submit your nomination(s) via our Internet site.
Go to http://www.flightsafety.org/merit_award.html

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