

A Stellar CAST

Joint U.S. government and commercial aviation initiatives invented new ways to reduce accident risk.

BY ROBERT MATTHEWS

Over the last decade airline travel has become significantly safer, measurably safer, because of groundbreaking, meticulous work by the Commercial Aviation Safety Team (CAST), formed in the aftermath of an unusual series of major accidents 10 years ago. While CAST is originally a United States project, the impact of what it has done has spread benefits far and wide, particularly in China, South Asia and all of the Americas.

The landmark government-industry group set out to reduce the risk of fatal accidents by 80 percent in 10 years, a goal many observers said was utterly beyond reach. Strictly speaking, they were right: The risk of fatal accidents declined 73 percent in the United States as aviation safety professionals worldwide adopted novel approaches to reducing risk, such as devising and implementing safety interventions guided by analyses of incidents and errors once considered inconsequential.

CAST still brings together virtually the entire commercial aviation industry, including major manufacturers, major airlines and labor organizations, plus the U.S. Federal Aviation Administration (FAA), National Aeronautics and Space Administration (NASA), Department of Defense, other national governments and international organizations such as Flight Safety Foundation (FSF).¹

One of CAST's most important accomplishments has been demonstrating that government and industry can work together, reach consensus on the major risks to safety and develop detailed implementation plans in which specific sectors of aviation commit to specific actions. Thus far, CAST has developed 65 safety projects, including 47 near-term and 18 long-term projects. Forty safety projects had been completed as of October 2007, and 25 are under way.

Crisis of Confidence

CAST was established in 1997 while the U.S. aviation community was facing a crisis of public confidence in air travel. In the 30 months from July 1994 through January 1997, U.S. airlines had 13 major fatal accidents with 841 fatalities and 90 serious injuries. Something meaningful had to be done to lower the fatal accident rate quickly and permanently.

In response, the White House Commission on Aviation Safety and Security, chaired by Vice President Al Gore, was established in August 1996. The U.S. Congress soon formed the National Civil Aviation Review Commission chaired by former Rep. Norman Mineta, who later became secretary of transportation under President George W. Bush. Other government and industry groups were developing their own

responses to the crisis, including the FAA's Safer Skies initiative and the formation of the Industry Safety Strategies Team, a coalition of manufacturers and airlines.

In February 1997, the White House Commission set a goal of an 80 percent reduction in the fatal accident rate within 10 years and said that government and industry should develop partnerships to improve safety, with the FAA and industry jointly developing a comprehensive strategic safety plan to implement existing safety recommendations. The Review Commission also urged joint government-industry efforts to develop performance measures and milestones to assess the plan's progress and periodically review safety priorities.

How Could It Work?

Agreeing to work together was the easy part for industry and government. The tough part was deciding exactly how to do it. The FAA, NASA and the Industry Safety Strategies Team began by forming the Commercial Aviation Safety Strategy Team and recognizing that, to be effective, it had to include the Department of Defense and key labor groups, including the National Air Traffic Controllers Association (NATCA), the Air Line Pilots Association, International (ALPA), the Allied Pilots Association (APA) and others. The expanded group, adopting the current name, committed itself to the White House Commission goal.

The member organizations agreed that CAST would operate with one

co-chairperson each from industry and government, and that each member organization would be represented on the CAST Executive Committee by senior officials with authority to commit the organization to specific actions. Issues might require consultations within each member organization, but other member organizations subsequently could expect action to follow.

CAST quickly created a team to develop the accident baseline, an initial point for measuring risk reduction. The baseline included fatal accidents and nonfatal hull losses from 1987 through 1996 that involved U.S. Federal Aviation Regulations Part 121 passenger or cargo operations, and scheduled passenger flights in aircraft with 10 to 30 passenger seats, a category of operation then transitioning to Part 121. With the criteria for the data set established, each accident was assigned to a single accident type. The CAST data set for the United States has been updated regularly since 1997 to include all hull-loss accidents, and a worldwide data set also has been established by including comparable hull-loss accident data from other countries.

Another key agreement was that CAST would remain strictly a voluntary group. The representatives involved in CAST are safety professionals who understand that if the data identify risks that can be mitigated, it is incumbent upon them to take the appropriate action. Once an agreement is reached, every member is expected to support it.

Similarly, CAST has observed a rule of personal and intellectual trust. Representatives can raise any issue, say precisely what is on their minds and expect their opinions to be treated confidentially. Sensitive data presented to CAST cannot be shared with others unless the owner of the data agrees.

First Three Targets

CAST started its work by addressing the three biggest killers in aviation: controlled flight into terrain (CFIT), approach-and-landing accidents (ALAs) and accidents involving loss of control in flight (LOC). For each accident category, CAST planned to create and direct a joint safety analysis team (JSAT) and a joint safety implementation team (JSIT). In fall 1997, CAST directed the first team, the CFIT JSAT, to develop and document a data-driven analytical process, apply that process to CFIT accidents and recommend specific interventions to reduce their frequency.

The CFIT JSAT adopted a case-study approach in developing a methodology to help understand accidents, identify high-leverage interventions and reduce the risk of future accidents, documenting detailed chains of events and identifying problems. The process was fully documented in the *JSAT Process Handbook*, which will include future changes.

The CFIT JSAT used 10 well-documented reports on CFIT accidents from accident investigation authorities in several countries. The team established

a detailed sequence of events for each accident and identified problems of omission or commission, some of which may not have been explicitly noted in the accident report. Possible interventions were developed for each problem, and each intervention was evaluated for its effectiveness against CFIT accidents.

Because this was its first joint study, CAST also directed the CFIT JSAT to review CFIT reports by other organizations, including the International Civil Aviation Organization (ICAO), National Aerospace Laboratory–Netherlands, Flight Safety Foundation and others. This review ensured that CAST had the benefit of other high-quality work and provided a reality check on the results of the JSAT process.

In November 1998, CAST received the *CFIT JSAT Results and Analysis Report*, which became the model for later teams. The analysis team identified 106 possible interventions, with an estimated effectiveness score for each intervention. The interventions were forwarded to the CFIT JSIT, which assessed each one for overall effectiveness in reducing accidents within a category. The CFIT JSIT — setting the pattern for subsequent JSITs — then assessed the feasibility of implementing each recommendation. Feasibility decisions were based on the following considerations:

- Technical criteria — Can the recommendation be implemented?
- Financial criteria — Can it be financed?

- Operational criteria — Can it be integrated into the system and produce results?
- Schedule criteria — Can it be accomplished within the stated time?
- Regulatory criteria — Can it be accomplished without a lengthy regulatory process?
- Sociological criteria — Will it be acceptable to the public?

After interim reviews and approvals by CAST, the final product is a manageable number of safety enhancements, with detailed implementation plans that identify the precise actions to be taken, by whom, when and at what estimated cost. While the CFIT JSIT was finishing its tasks in summer 1998, CAST created the Approach and Landing Accident Reduction (ALAR) JSAT. The scoring process was refined, but the ALAR JSAT used the same core analytical process introduced by the CFIT JSAT.

The ALAR JSAT identified 192 possible interventions and rated the effectiveness of each. Because some of the recommended interventions addressed problems already well known to the CFIT teams, CAST created a combined CFIT-ALAR JSIT, which eliminated low-ranking interventions, consolidated the strongest ALAR interventions into five broad safety projects and added them to the eight CFIT safety projects. The ALAR-related safety projects focused on these areas: aircraft design; flight crew training; maintenance procedures;

organizational policies and culture; and upgrades or installation of equipment to improve flight crew situational awareness and checklist completion.

CAST recognized that as safety projects emerged from future JSATs and JSITs, competition for resources would increase. Consequently, CAST decided to create a separate and centralized team — called the joint implementation measurement data analysis team (JIMDAT) — primarily to develop a method for prioritizing the safety projects from the JSITs. Unlike the JSATs and JSITs, the measurement team does not disband after completing an assigned study or task; instead, it provides ongoing staff support to CAST.

Initially, the JIMDAT made a categorical distinction between LOC accidents and ALAs. Consistent with the occurrence categories in a taxonomy developed later with ICAO, which allows analysts to associate any occurrence with multiple categories, the team distinguished types of accidents and incidents by criteria other than whether they occurred during the approach and landing phases of flight (Figure 1).

To prioritize safety projects, the JIMDAT computed scores as a measure of the severity of each accident in the CAST accident data set. Considering each accident as weighted by its severity score, the team then estimated each safety project's potential for reducing the risk of each accident in the data set. The JIMDAT then could track safety-project implementation and assess a safety project's actual contribution to reducing the risk of fatal accidents. This has remained the basic CAST process for evaluating risk reduction.

CAST also assigned the JIMDAT additional tasks. One was to develop a methodology for estimating the cost



of an accident and the cost savings that might be associated with safety projects.

As progress was made toward the 80 percent reduction goal, a major advancement occurred when the JIMDAT was assigned to develop a methodology for analyzing incident data to identify risks before they lead to accidents. This assignment also included considering the emergence of new risks, as well as those from the original data set.

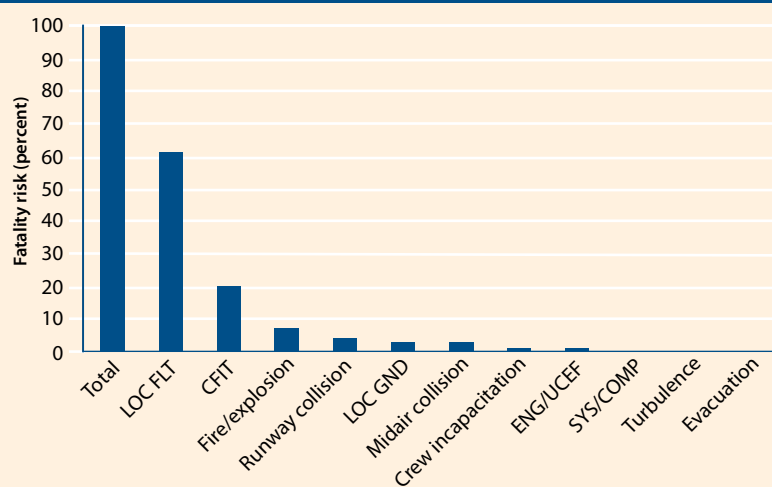
In September 1999, CAST created the LOC JSAT, which developed 292 possible interventions. CAST accepted the *LOC JSAT Results and Analysis Report* in December 2000 and forwarded it to a newly created LOC JSIT, which again applied the process documented by the other JSITs. This implementation team consolidated the most effective interventions into the following three broad areas and safety projects:

- Aircraft design comprising autoflight design in new airplane designs; display and alerting features in new airplane designs; criteria for flight in icing conditions for new airplane designs; flight-envelope protection in new airplane designs; and vertical-situation displays in new airplane designs;
- Policies and procedures comprising risk assessment and management; standard operating procedures (SOPs); dissemination of essential safety information and procedures; flight crew proficiency; and,
- Training comprising human factors and automation, and advanced maneuvers training.

More Safety Projects

After the CFIT, ALAR and LOC work, CAST created several more JSATs and JSITs. The Turbulence JSAT began working in late 1999. Although turbulence had caused four fatalities in 50 years, these events had caused the largest share of all serious injuries, with flight attendants especially exposed to turbulence-related injuries. The Turbulence JSAT studied all turbulence accidents from 1983 through 1999 and developed 30 possible interventions. A Turbulence JSIT, created in January

Historical Part 121 Risk, 1987–2000



LOC FLT = loss of control in flight; LOC GND = loss of control on the ground; ENG/UCEF = engine or uncontained engine failure; SYS/COMP = system/component failure or malfunction—powerplant

Notes:

All security-related events were excluded.

Part 121 of U.S. Federal Aviation Regulations pertains to air carriers.

Source: U.S. Commercial Aviation Safety Team

Figure 1

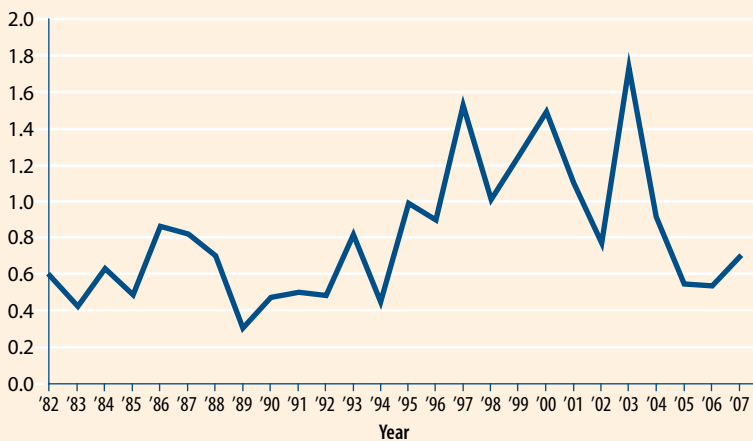
2001, combined the highest-ranked recommendations into the following broad safety projects: best practices for turbulence avoidance; improving the quality of turbulence information, such as manuals, standardized language and training/education; pilot training; and improved cabin procedures and design. Turbulence-related safety projects did not get under way until 2003. Recent statistics show that the projects — particularly those involving best practices and procedures — appear to have reduced turbulence accidents (Figure 2, p. 26).

Next was the creation of the Runway Incursion JSAT. Because of the nature of the data and the types of risks involved, this team included extensive representation from the Joint Steering Committee, the U.S. general aviation industry-government counterpart to CAST. The Runway Incursion JSAT also was the first team to begin CAST's long-intended transition to incident analysis as a basis for identifying risk.

The Runway Incursion JSAT developed 22 possible interventions, from which the Runway Incursion JSIT distilled seven safety projects.

Turbulence Accidents per Million Flight Hours

U.S. Part 121 Operations, 1982–2007

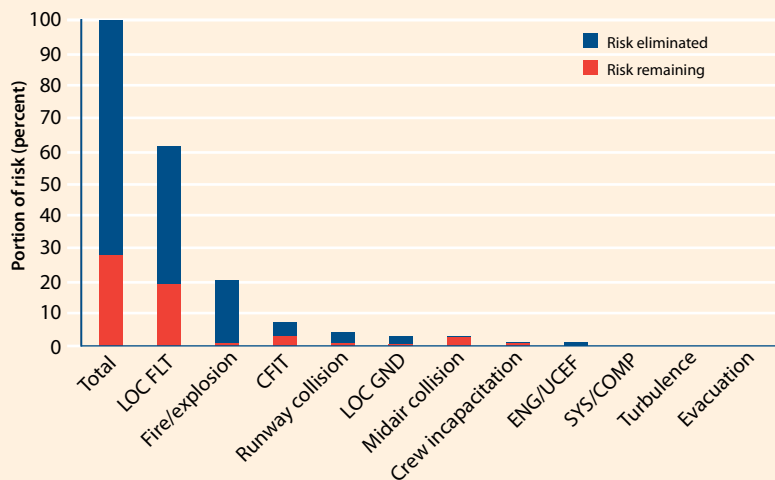


Note: Data include operations from 1982 to 1997 that were subject to U.S. Federal Aviation Regulations (FARs) Part 135 but became subject to FARs Part 121 in spring 1997. Part 135 pertains to commuter and on-demand operations; Part 121 pertains to air carrier operations. The rate for 2007 was estimated based on data through Aug. 15.

Source: U.S. Commercial Aviation Safety Team

Figure 2

Preventing U.S. Fatal and Hull-Loss Accidents: Portion of Total Fatality Risk Mitigated by the CAST Plan 2007 Implementation Values



LOC FLT = loss of control in flight; CFIT = controlled flight into terrain; LOC GND = loss of control on ground; ENG/UCEF = engine or uncontained engine failure; SYS/COMP = system/component failure or malfunction–powerplant

Note: Data are from the U.S. Commercial Aviation Safety Team *Fatal/Hull Loss Data Set 1987–2000*. All security-related events were excluded.

Source: U.S. Commercial Aviation Safety Team

Figure 3

The safety projects emphasized SOPs for pilots and all other surface operators, air traffic control training and procedures, and technologies to improve situational awareness on the surface, such as airport movement area safety system, automatic dependent surveillance-broadcast, airport surface detection equipment model X, moving maps and on-board alerting systems.

With the completion of safety projects by JSATs and JSITs in five accident categories, the “big killers” in U.S. commercial aviation largely were addressed. Nevertheless, residual sets of risks had not been addressed. Consequently, CAST created the Remaining Risk JSAT to address cargo operations, midair collisions and issues related to maintenance and icing that may not have been addressed by the earlier efforts.

The JIMDAT estimated that these additional efforts brought the total risk reduction to 73 percent by the end of the government’s 2007 fiscal year (Figure 3). While a hair short of an 80 percent risk reduction, no one disputes that substantial and permanent improvements have been achieved.

In addition to basing its processes on analytical rigor, CAST is rooted in the practical world and applies practical tests before endorsing and adding a safety project to the *CAST Plan*, the document that reflects all these decisions. Clearly, neither government nor industry has infinite resources. Choices must be made. Consequently, with support from the JIMDAT, CAST consistently has required a good “return on safety” (Figure 4) — similar to return on investment in business — before committing financial and other resources. Unfunded recommendations would have imposed prohibitive costs for industry and government in return for little additional safety improvement.

CAST estimates that the 73 percent reduction in risk will cost the U.S. government and industry US\$540 million, but the safety benefit far exceeds the cost. The JIMDAT also developed a methodology for theoretically allocating the cost of accidents and risk across all Part 121 operators. This methodology produced an estimate that the risk of accidents imposes an

average cost of \$90 per flight. At current commercial air traffic volumes, this computes to about \$1.05 billion annually in the United States. The JIMDAT also estimated that the *CAST Plan* will reduce this cost to just \$32 per flight. Notably, the estimated \$540 million cost has been based on an allocation over 13 years — yet the reduction in accident-related costs will exceed \$670 million every year. Safety really is good for business.

International Cooperation

CAST recognized early that risks cross international borders and wished to ensure its access to the perspectives and expertise of the other governments and organizations like Flight Safety Foundation, the International Air Transport Association (IATA), the Joint Aviation Authorities (JAA) Safety Strategy Initiative in Europe and others. CAST's partnership with the ICAO Cooperative Development of Operational Safety and Continuing Airworthiness Program (COSCAP) has been particularly productive in China and South Asia, where CAST has worked closely with the regional COSCAPs. For example, the latest revision of China's civil aviation regulations has fully incorporated many CAST recommendations and FAA advisory circulars that responded to CAST recommendations. China also has committed to implementing 27 CAST safety enhancements. Similar results have been achieved in Korea and other states. Examples include risk-assessment procedures, and incorporation of the *CAST ALAR Handbook* — developed by the FSF CFIT/ALAR Action Group emphasizing the use of the FSF *ALAR Tool Kit*. CAST also is active in the COSCAP in the Commonwealth of Independent States.

In the Americas, the Pan American Aviation Safety Team implemented many of the safety enhancements from CAST's CFIT and ALAR safety projects. The safety enhancements involve aircraft equipment, area navigation procedures and incorporation of the *CAST ALAR Handbook* into regulations and training. More than 12,000 pilots from countries with PAAST participants have received ALAR training.

Resource Cost Versus Risk Reduction for CAST Plan Safety Enhancements

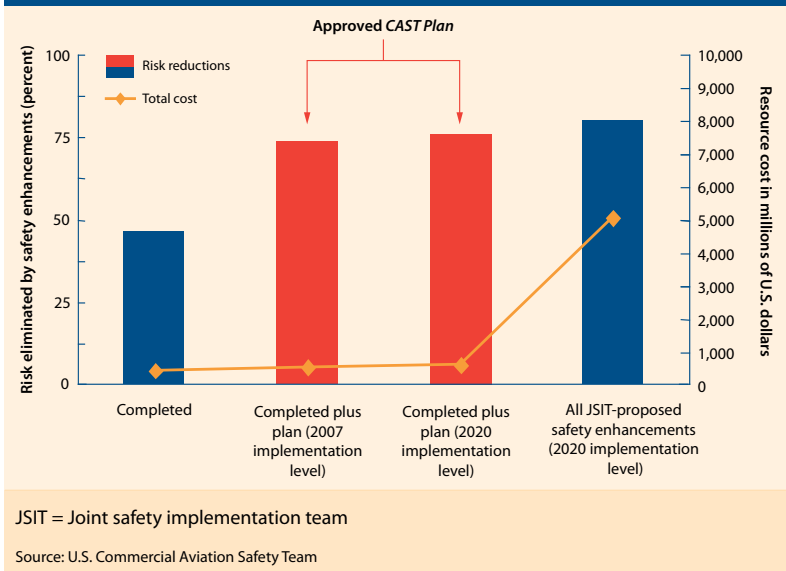


Figure 4

CAST demonstrates that government and industry can act quickly to reduce risk by advancing a robust methodology and a cooperative structure to continuously monitor data from voluntary reporting systems and incidents. ●

Robert Matthews, Ph.D., the senior aviation safety analyst in the FAA Office of Accident Investigation, for more than 10 years has been an active participant in the U.S. government's contribution to safety partnership with commercial aviation through CAST.

Note

1. The CAST membership includes the Aerospace Industries Association; Airbus; ALPA; Air Transport Association of America with active participation from many airlines; APA; Boeing Commercial Airplanes; Department of Defense; engine manufacturers' representative (Pratt & Whitney with GE Aircraft Engines as alternate); FAA; Flight Safety Foundation; International Federation of Air Line Pilots' Associations; JAA and European Aviation Safety Agency; NASA; NATCA; Regional Airline Association; and Transport Canada. Observers include the Air Transport Association Canada; Association of Asia Pacific Airlines; Association of Flight Attendants—Communications Workers of America; Civil Aviation Safety Authority, Australia; IATA; ICAO; National Air Carrier Association; and National Business Aviation Association.