The Acquisition and Use of Incident Data

Investigating Accidents Before They Happen

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BACKGROUND

Man's intelligence and technology have worked toward a goal of greater system safety. As a consequence, the aviation industry has witnessed vastly improved aircraft, avionics, air traffic control equipment, and ground-based facilities. As the hazard profile of these "hardware" elements has diminished, the reality of the presence and magnitude of human error as a causal factor in accidents has been indelibly impressed on those agencies, organizations, and individuals vested with the responsibility for minimizing the risks associated with aviation operations.

Aircraft accidents are frequently caused or severely aggravated by human error. In tracing the chain of causation of these accidents, safety investigators and researchers have been generally effective in determining the "what" of the event, but they are not as effective in addressing the "why" of the event. The why of an event very often involves the human factors associated with that mishap. Unfortunately, the nature of accidents results in several significant problems in the investigation of human performance issues.

First, and fortunately, accidents are rare events; consequently, the investigator or researcher is provided with relatively few data points to study and from which to draw insight.

Second, it is an unfortunate truism that pilots are usually the first at the scene of aircraft accidents; they are often unable to be of much help after the smoke clears.

Third, in a litigious society, concepts of legal and financial liability effectively distort or hinder the investigation process. Even if a crewmember survives the accident, the potentially staggering consequences of an admission of error frequently thwart timely and accurate fact-finding.

Because of these problems the investigation of aircraft accidents is characterized by a "post hoc" reasoning process, often using incomplete facts, in an effort to determine a plausible chain of causation. The factual findings and determination of probable causes resulting from this reasoning process are subject to inaccuracies and may or may not yield reliable data usable in pursuit of enhanced system safety; this is particularly true with regard to human error data.

The three problems cited above are not present in a confidential, incident reporting system. Compared to accidents, incidents occur frequently. Pilots and crewmembers survive incidents, albeit sometimes with difficulty, and are characteristically willing to share the experience in the presence of assurances of protection. Finally, since the vast majority of incidents do not result in any liability the threat of adverse legal or financial consequences is usually not present.

Safety investigators have long been aware of, and concerned about, the monotonously repetitive pattern of human failure characteristic of accident statistics. This awareness and concern has been particularly well-developed within the aviation community. Many attempts have taken place over the past decades to obtain comprehensive information concerning operational problems in aviation, particularly in the case of those events that fortunately fell short of being accidents. One of the responses to this need for more and better information concerning operational and human error problems has been the implementation of incident reporting systems. The history of aviation incident reporting systems can be traced back to the early 1940's; the idea is not a new one. However, despite the anticipated potential of incident reporting programs, the desired productivity has not materialized; this is primarily due to the fact that many contributors were, and are, hesitant to describe their own errors and misconceptions, especially to an authority which has the power to discipline or economically penalize the reporter.

In recognition of the need for more and better information concerning operational and human problems in the United State's National Aviation System, the Federal Aviation Administration in May, 1975, implemented an Aviation Safety Reporting Program (ASRP), whose purpose was to improve the flow of information of possible significance to air safety investigations and research. To encourage the submission of reports, the agency offered a limited waiver of disciplinary action to those who provided timely information concerning incidents, and to others involved in those incidents, unless the occurrences involved a criminal offense, an aircraft accident, reckless operation, willful misconduct or gross negligence.

Notwithstanding the FAA's promise that information reported under the ASRP program would not be used against the provider of the data, it soon became obvious that there were misgivings in the aviation community regarding the regulatory and enforcement agency's role in the collection and use of the often sensitive incident data. For that reason, the FAA asked the National Aeronautics and Space Administration (NASA), an independent research organization without regulatory or enforcement authority, to act as a "third party" in the program. NASA was requested to design a modified incident reporting program and to take over responsibility for the receipt, processing, analysis and deidentification of those aviation incident reports. In addition to its ability to fulfill the role of a disinterested intermediary, NASA saw a unique benefit to its research capability deriving from ongoing access to the human factors data generated by an incident reporting system. NASA accepted the FAA's proposal; the Aviation Safety Reporting System (ASRS) began operations on April 15, 1976.

CHARACTERISTICS OF THE SYSTEM

The designers of the ASRS had as their objective an incident reporting system that would have the characteristics of utilization, utility, and effectiveness. Essentially, the mission was to design and operate a system that the community trusted and with whom it would communicate; in addition that system had to be capable of constructively using the data received, and the program's product had to be reflected in effective applications within the aviation system.

The objectives of NASA's ASRS program are as follows:

* To make available a confidential reporting system which can be used by any person in the national aviation system.

* To operate a computer-based system for storage and retrieval of processed data.

* To provide an interactive analytical system for routine and special studies of the data.

* To maintain a responsive system for communication of data and analyses to those responsible for aviation safety.

The basic statement of purpose of the program can be found in the ASRS Memorandum of Agreement between NASA and the FAA ..."This system will be designed primarily to provide information to the FAA and the aviation community to assist the FAA in reaching its goal of eliminating unsafe conditions and preventing avoidable accidents." More specifically, the purpose of the ASRS program has been defined as:

"Identifying deficiencies and discrepancies in the national aviation system to provide a knowledgeable basis for improving the current aviation system; and providing data for planning and improvements to future systems."

In an age of information and communication, the acquisition of safety data regarding aviation incidents should not present a significant challenge to program planners and managers; and in fact, most members of the aviation community have historically exhibited a willingness to share information, especially about accidents, hardware, and other partys' actions. However, the mission of the Aviation Safety Reporting System is to obtain incident data provided by the participants in those events; more specifically, the ASRS database is designed to reflect the participant's assessment of the situation or occurrence and his or her role in that condition. Other information systems exist to assemble descriptive, statistical, or second and third-party data; but the ASRS mandate involves the task of gathering analytical first-party data, especially information that addresses the "why" of an event as reflected in the behavior exhibited by the participants.

The first step toward satisfaction of the ASRS mandate was to design a system in which the aviation community, both individually and collectively, could place a high degree of trust; furthermore, that trust from the community needed to be matched by consistent credibility on the part of the ASRS program and the program's management. It was decided that the elements of trust and credibility could be best served by an incident reporting system that was voluntary and promised total confidentiality.

While mandatory reporting systems may produce greater quantities of data, the quality of data from such systems may suffer from superficiality and doubt on the part of the report source as to its ultimate use. Voluntary information systems, on the other hand, have usually been characterized by higher quality reporting from individuals motivated by a genuine desire to see an issue pursued beyond the filling-in-the-blanks phase of safety investigation. By providing the motivated volunteer with the equally important assurance of absolute confidentiality, the ASRS design accommodates both the researcher's need for quality, comprehensive data and the reporter's desire for selectivity and anonymity.

One of the major attributes of the ASRS program is its cooperative nature. Since the inception of the ASRS, a vital degree of oversight and guidance has been provided by virtually every segment of the aviation community. The result of this cooperation is the existence of an incident reporting system that is viewed as a safety information resource to be utilized by all elements of the aviation community.

Of equal importance to the elements of voluntariness and confidentiality is the lack of an enforcement mandate in the charter of the organization vested with the responsibility for the incident reporting program administration, data analysis and information management. This consideration made the selection of the National Aeronautics and Space Administration a logical one in the search for a disinterested third-party. NASA's role as third-party intermediary between the members of the aviation community and the Federal Aviation Administration has often been characterized as that of an honest broker attending to the best interests of both sides.

A collateral issue to the design of a system which encouraged voluntary incident reporting was that of immunity for those individuals electing to report to the ASRS. The issue of immunity is bifurcated. Immunity protection can apply to the use of the data obtained, in which case the issue is termed "use immunity"; by the same token, immunity protection can refer to the shielding that the individual obtains from disciplinary action in exchange for his or her information; this is referred to as "transactional immunity". In conjunction with the NASA pledge of confidentiality for report sources, the FAA offered both forms of immunity to contributors to the ASRS program. The first, use immunity, was established in the form of promises contained in the FAA Advisory Circular and the FAA/NASA Memorandum of Agreement which set forth that "...FAA will not seek and NASA will not release to the FAA any information that might reveal the identity of [persons filing reports and persons named in those reports]". The concept of use immunity was further strengthened in 1979 with the implementation of Federal Aviation Regulation #91.25 which states:

> "The Administrator of the FAA will not use reports submitted to the National Aeronautics and Space Administration under the Aviation Safety Reporting Program (or information derived therefrom) in any enforcement action, except information concerning criminal offenses or accidents which are wholly excluded from the Program."

To a large degree, use immunity and confidentiality are intertwined; in the context of the ASRS program neither of these two basic elements has been altered or even challenged by any party to the system.

From the beginning of the ASRS program in April of 1976, the issue of reporter protection from enforcement actions, transactional immunity or the "waiver of disciplinary action", has been a point of contention. Although not specifically requested by the aviation community in the 1975-1976 period, the waiver of disciplinary action was offered by the FAA as an element of the ASRS concept.

It should be noted at this point that the waiver of disciplinary action associated with ASRS incident reporting has always been viewed by NASA as an issue between the FAA and the aviation community. While recognizing it as an element of the overall ASRS concept, NASA, which has no authority to pursue enforcement actions or grant any immunity from them, has essentially taken an observer position on the issue of transactional immunity.

The original waiver of disciplinary action that accompanied the ASRS in April of 1976 remained in force until July 1, 1979. Following a period of controversy over the need for the existence of transactional immunity for ASRS reporters, the waiver of disciplinary action was modified, to the satisfaction of the ASRS program's industry advisory group and to the FAA. The revised waiver, although not as broad nor lenient as the original immunity, permitted transactional immunity to continue for the life of the ASRS program. There seems to be general agreement that in a era requiring effective enforcement, as well as effective data acquisition, retention of the broader waiver would have eventually resulted in the total termination of that waiver and the incident reporting program. Therefore, while the 1979 changes to the waiver of disciplinary action did "tighten" the immunity option, it probably also permitted the existence of the ASRS as a long-term program as opposed to a short-term experiment. The current provisions of the FAA's waiver of disciplinary action are set forth in FAA Advisory Circular 00-46C:

"The filing of a report with NASA concerning an incident or occurrence involving a violation of the Act or the Federal Aviation Regulations is considered by the FAA to be indicative of a constructive attitude. Such an attitude will tend to prevent future violations. Accordingly, although a finding of a violation may be made, neither a civil penalty nor certificate suspension will be imposed if:

(1) The violation was inadvertent and not deliberate;

(2) The violation did not involve a criminal offense, or accident, or action under Section 609 of the Act which discloses a lack of qualification or competency, which are wholly excluded from this policy;

(3) The person has not been found in any prior FAA enforcement action to have committed a violation of the Federal Aviation Act, or of any regulation promulgated under that Act for a period of 5 years prior to the date of the occurrence; and

(4) The person proves that, within 10 days after the violation, he or she completed and delivered or mailed a written report of the incident or occurrence to NASA under ASRS."

Transactional and use immunities have become a primary consideration in the ASRS concept. It is conceivable that a successful incident reporting system could be launched without transactional immunity, but use immunity is essential.

Reports containing information relating to aviation accidents (as defined by National Transportation Safety Board Regulation 830.2) and criminal activities (as codified in Title 18 of the U.S. Code, Annotated) are exempt from both the immunity and confidentiality provisions of the ASRS program. Because the ASRS and its staff members can not be above the law in the sense of withholding accident or criminal information, all such information is forwarded to the appropriate investigatory bodies and not retained in the ASRS database. It should be noted that the individuals who have submitted the reports of accidents or criminal activity are notified after the data's receipt of the requirement placed on the ASRS to forward the information to the proper federal agency; this courtesy is extended primarily to let the person know what happened to the data; it is also done to explain the loss of immunity and confidentiality.

Two coincidental, but different categories of motivation prompt contributors to the ASRS program to report their experience. The first category, direct personal advantage through confidentiality and immunity, has already been discussed. The second, enhanced system safety, is a product of what the ASRS staff does with the data that has been volunteered. In essence this issue simply requires ASRS to recognize that it must achieve and feedback program results, otherwise the majority of data submitters will stop seeing value in program participation and not report their experiences.

Feedback to the aviation community can be both direct and indirect. The most immediate response to the reporter community is the direct feed-back provided to the reporter following submission of an ASRS report. Few frustrations match that of voluntarily submitting data derived from personal experience to a governmental body which has been requesting such data, and then not having that contribution acknowledged. Immediately upon deidentification of each ASRS report form the individual who submitted that report is provided, by return mail, with the following:

(1) The Identification Strip section of the ASRS report form, date-stamped and bearing the internal tracking number for that I.D. strip; in addition, where possible, ASRS analysts are encouraged to add a short, personal note to each I.D. strip from reports they have worked;

(2) Two blank ASRS Reporting Forms to replace the one submitted to ASRS;

(3) A letter of appreciation to the reporter for his or her contribution to the ASRS program;

(4) A copy of the current issue of *Callback*, the ASRS's monthly safety publication. This enclosure not only passes on safety information, it also exhibits the ASRS's capability- for constructive data usage and timely dissemination of contributed data.

This direct return response is accomplished within days of the date of receipt of the report at the ASRS offices. Not only has the reporter received the I.D. strip for immunity purposes, he or she is also made immediately aware of the report's receipt, data usage, and acknowledgment of the government's appreciation for his or her efforts and concern in pursuit of enhanced aviation safety.

The indirect feed-back to the reporter community takes the form of evidence of data usage through various alert messages, periodic technical reports, the ASRS's safety publications *Callback* (monthly) and *Directline* (quarterly), and awareness of the community's ability to access the ASRS database for legitimate safety investigations and research. In other words, the individual reporters, and their professional organizations or trade associations, are made aware of the fact that useful information is coming out the production end of the ASRS process in a timely fashion.

THE REPORT ANALYSIS PROCESS

In the more than nineteen years of its existence, the ASRS has received over 297,000 reports; human errors can be found, and confessed to, in more than 70 percent of these reports. Most reporters are frank to admit to their own mistakes, and will go into detail in describing the circumstances, character, and outcome of the incident. Contributors to the ASRS seem to genuinely care about their role in an event and take pains to report actions, emotions, and perceptions accurately in the face of often critical circumstances. We have been impressed with the care and effort put into the writing of most of the reports while at the same time we have lamented the lack of detail in a few others, some of which described possibly serious potential problems. We have thought that many reports were probably trivial in terms of any impact on safety - until later, when it became clear that reports which appear trivial in isolation can help to point to an underlying factor of real importance. The ASRS staff is frank to admit that we are unable to characterize a "trivial" report, for in concert with other reports, it may assist in understanding a genuine problem. Many reports stand as monuments to the dedication of their authors to aviation safety; some of the best are reprinted in full, after deidentification, in ASRS program reports.

ASRS reports are received and processed daily by members of the ASRS staff. The reports are read by an attorney who has a background in aviation law and aviation safety. If they involve criminal acts, they are transmitted in identified form to the U.S. Department of Justice for Investigation. If they refer to an aircraft accident, they are forwarded, identified, to the National Transportation Safety Board. If, in the NASA reviewer's opinion, they contain time-critical safety data, they are singled out for priority handling.

The ASRS program managers made an early decision to use the services of a civilian contractor to assist in the design and management of the ASRS program. Following the usual competitive procurement processes, Battelle Memorial Institute's Columbus Labs was selected as the ASRS program contractor. Battelle has established a base of operations for ASRS activity adjacent to NASA's Ames Research Center, thereby allowing for quick and easy communications between NASA's ASRS management and the program's contractor, who is now responsible for the majority of ASRS report processing and database research.

The reports are given to analysts, each of whom is an expert in the area of air traffic control, general aviation or air carrier operations. The analysts study the reports, and decide whether further direct contact with the reporters is necessary or desirable. If so, they initiate such "callbacks" by telephone. Callbacks have the unique advantage of increasing the rapport between reporter and analyst, while at the same time enhancing the post-event learning and analysis process for both parties. Thereafter, or if further contact is not desired, they remove the identification strips; the strips are logged out by serial number and returned to reporters with a new report form.

By the time the reports have passed through the initial analysis phase, all identifying information contained in the original report has been removed. This deidentification process includes the removal and return of the reporter's identification strip; in addition, any individual or company name, as well as any aircraft names or numbers, are deleted from the report and appropriate substitutions entered in their place.

Analysts study the information provided by reporters either in their reports or in subsequent contacts. If they believe that a report contains time-critical safety data, it becomes the basis for dissemination of an alerting message, either an Alert Bulletin (AB) or For Your Information Notice (FYI). They may augment the information provided in the report by constructing or adding charts or other graphic material. They are not permitted to verify or refute the information provided by a reporter through contact with other persons; the ASRS mandate prohibits this, and the System's resources do not permit investigation of reported incidents.

Analysts then add to the reporter's narrative a synopsis, their analytic comments and informal notes. It should be noted that when ASRS reports are analyzed and evaluated an attempt is made to discern both human and system factors associated with the reported event or situation. It is often impossible to attribute cause and effect relationships to such factors; although it is usually possible to categorize various factors as having an "enabling" or "associated" relationship to the chain of causation. In addition to coding these enabling and associated factors, the analysts also determine and code the "recovery" factors involved in the event, thereby recording their analysis of the reasons this event was an incident and not an accident. The analysts code the report to incorporate data describing the attributes of the occurrence; descriptive and diagnostic terms are added as a final step. The entire package is then checked by a second reviewer-analyst for completeness and prepared for computer entry.

Typists transfer each report package to magnetic tape; the tapes are copied and sent to a computer facility where they are read onto disk files for storage. The information management system which houses the ASRS data is Battelle's Automated Search Information System (BASIS). BASIS is a very effective, flexible analytic tool for large bodies of free text and coded data. Report narratives, synopses and analyses are entered in the computer in free text format. A substantial number of coded entries describing each report is also available; these entries, along with the descriptors and diagnostic terms, are indexed and are therefore readily available as search terms.

SYSTEM OUTPUT AND ACCOMPLISHMENTS

The ASRS program's output has two basic functions. The first is to notify the FAA and the aviation community of the existence of alleged hazards in the system. The second function is to attempt to provide an explanation for the presence of hazard conditions; essentially an attempt to achieve an understanding of the "why" of certain conditions or situations.

The ASRS is capable of disseminating data in several ways. The output of the program to date consists of:

More than 1128 Alert Bulletins (ABs) and over 553 For Your Information

Notices (FYIs) -- time-critical notices from the ASRS to persons or organizations in a position to effectively investigate, and possibly cure, an alleged hazard reported to the ASRS.

4,100+ search requests -- responsive database searches requested of the ASRS by the FAA, NTSB, and other members of the aviation community. Requested studies vary from the simple to the extremely complex; responsive searches have ranged from a few database statistics to lengthy studies.

Eight years of biweekly telephone conference calls between the FAA Office of Aviation Safety and the ASRS Office highlighting safety items, discussing emerging issues, responding to requests for ASRS data, and maintaining a constructive dialogue between the FAA and ASRS.

14 Program Reports -- periodic publications containing samples of constructive deidentified reports received by the ASRS, selected Alert Bulletins and the responses to them, and one or more reports on research studies performed by the project staff.

37 Research Reports and Technical Papers -- single topic research reports dealing with aviation safety problems; addressing primarily human factors issues, these reports have dealt with subjects such as fatigue, information transfer problems, controlled flight toward terrain, cockpit distraction, and altitude deviations.

Over 189 monthly safety publications - *Callback*, an easy-to-read one-page newsletter designed for the light, but timely, expression of safety issues relevant to the entire aviation community.

Six issues of *Directline* - the ASRS safety publication designed for reuse and duplication by safety, training and management offices. Produced using in-depth sets of topical incident reports, *Directline*, has been an instant success in using incident data to address aviation hazards.

The products of ASRS data usage are distributed to the aviation community by several means in order to publicize the uses and value of the incident reporting system. ASRS Program Reports are supplied to over 40,000 individuals through company or organizational distribution channels, direct mailings from a list maintained by the ASRS staff, and through the National Technical Information Service. Technical and Contractor Reports are distributed by direct mail from a recipient list created and maintained by the ASRS staff, these publications are also available, subject to stock on hand, on request. The *Callback* publication is provided to any member of the aviation community who has expressed to the ASRS office a desire to be placed on the mailing list for that publication. Finally, special requests for deidentified information from the ASRS database are available to the aviation community for legitimate safety investigations, research, and training activities.

In addition to the ASRS products cited above, the incident reporting system continues to be a key source of data for aviation safety review bodies, regulatory organizations and Congressional interests engaged in the formulation of national aviation policy.

Non-documentable and intangible contributions to safety constitute a second class of program accomplishments from the ASRS. ASRS has significantly improved communication among the various segments of the aviation community, including FAA, DoD, NTSB, and NASA. All elements of the community have worked together on the system; all have used its data in the pursuit of solutions to safety problems. The common database has made it possible to reach consensus on some issues; in other cases, it has permitted more rational and focused advocacy by the proponents of differing points of view. In several cases involving national aviation policy, ASRS has been virtually the only source of incident, as opposed to accident, data. There is no other similar database, and there is considerable doubt whether one could be accumulated under different ground rules.

While there appears to be no effective means of measuring the impact of ASRS data in the field of aviation education and training, it is known that there has been widespread use of ASRS material by flight instructors, flight schools and air carrier training facilities, as well as military training and safety organizations. The contents of the ASRS program's research publications and *Callback*, the monthly safety bulletin, are frequently reproduced in airline, flight crew, and military safety education publications.

Directline is a new quarterly publication produced by the ASRS technical staff and serves as a forum on selected topics. It is supplied to aviation management, safety, and training offices for information, as well as for assistance in program and policy development.

Among the subtleties of the impact of ASRS activities on system safety is that of moral suasion for the purpose of leverage. It is not an uncommon occurrence for a request to be made of the ASRS staff to provide data or a publication to support a legitimate safety improvement that is on the verge of acceptance but needs a little extra push. Because of the depth of information in the ASRS database, particularly human error data, and because of the program's credibility within the aviation community, ASRS alert bulletins and research data have been used to achieve safety objectives in need of impartial support. This use of ASRS product has been evident in actions and communications instituted by elements of the community, the military, and governmental agencies.

One of the important benefits of incident reporting to a program like ASRS takes place before the report ever reaches the program office. Program participants have expressed the notion that the act of having to organize and express the relevant facts and issues associated with a given event or situation has proven to be an extremely valuable learning experience for the reporter. Because of the program's assurances of confidentiality, reporters have often gone beyond a basic recitation of the facts to probe their own motivations, misconceptions, proficiency, and other considerations that may have contributed to the factors that made up the incident. The event analysis and performance critique that takes place at both ends of the reporting process is clearly a significant, but unmeasurable, benefit of the ASRS program.

The most obvious, as well as the most undocumentable, category of ASRS achievements is the element of accidents avoided and deaths prevented. It is impossible to document a non-event. However, given the array of research, alert bulletins, publications and assistance offered and utilized as a result of ASRS operations, it seems reasonable to assert that the presence and products of the ASRS have prevented accidents and saved lives.

Summary

When you want to know more about an occurrence, or why a person did what they did in the course of events, the best approach seems to be to simply ask the participants. First-hand experimental input is not a foolproof method of data acquisition. It is subject to the biases and fears of the reporter; but it is usually better than interrogation of witnesses and non-participants, or second-guessing. It is our experience that a voluntary, confidential, non-punitive incident reporting system is a logical and effective means of acquiring unique data, as well as supplementing data generated by conventional accident investigation techniques and other system monitoring programs. A properly-structured incident reporting system's great advantage is that it has the strength and the means to ask, and frequently answer, the question "why?" whenever one is confronted with a "what". There is no substitute for knowing why a system failed or a human erred. If we understand why things happen, we may be able to prevent them from happening again or at least protect the participants, or the system, from the consequences of subsequent events. The potential for constructive uses of incident data seems to be especially promising in the field of human behavior; incident reporting is a tool which permits the cooperative examination of human behavior in complex systems, using data supplied directly by the participants in that system. ASRS activities and research have been oriented toward issues associated with the role of the human in the operational aspects of aviation. The program's structure and principles have permitted the ASRS to compile an extensive body of incident data; more specifically, the assurances of confidentiality and the availability of transactional immunity have resulted in the creation of a large and comprehensive human factors database for use by aviation investigators, researchers, planners and policy-makers throughout the world.

The success of the Aviation Safety Reporting System in the United States, and the international emergence of programs similar to ASRS, support the position that incident reporting in other nations and other disciplines can be effective in achieving a better understanding of system deficiencies and human error.