Corporate and Regional Operations: The Safety Challenge

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Introduction

In this introductory paper, I would like to start with an overview of the worldwide and European growth in regional operations and the accident record and trend. I would then like to discuss the implications of the work of the Joint Aviation Authorities (JAA) regarding new and harmonized requirements and, finally, to suggest possible future regulatory initiatives.

Growth Rate

Complete statistics on corporate and regional operations are not easily available. However, the European Regional Airlines Association has provided figures for their recent growth in Europe:

Year	% Growth in Passengers	% Growth in Seats	Average Aircraft Seat Capacity	% Growth in Flights
1987			30.0	
1988	24%	26%	31.5	18%
1989	22%	23%	35.0	10%
1990*	14%	16%	36.0	9%

* first 9 months

The recent European growth rate in flights has thus been around 10-20 percent a year; one might expect this growth to continue in 1991, but at a reduced rate.

I have no data on the worldwide growth. I suspect, however, that it would be a safe assumption that growth in the United States has been at least of that magnitude. It is quite clear, therefore, that regional and corporate operations are very much a growth industry.

Accident Data

The worldwide accident trends continue to improve. International Civil Aviation Organization (ICAO) statistics show that the airliner hull losses per million departures have fallen from 45, at the beginning of the jet age in the late 1950s, to 1.4 in 1990. However, the fatal accident statistics for commuter aircraft, when compared to larger airliners, do give cause for some concern. U.S. data, for the decade 1980 to 1990, show that the fatal accident rate for commuter aircraft was approximately seven times greater than that for the larger airline operations. If we also accept that 75 percent of all aviation accidents are caused by human errors, it becomes clear in which direction any future initiatives should be going. One area where we can see a real safety benefit is in the fitment of ground proximity warning systems (GPWS), but I will return to that subject later.

CAA carried out an analysis of the generic causes of worldwide fatal accidents for different classes of aircraft (see below). This confirmed the ICAO figure of around 75 percent of accidents being of operational origin, showed maintenance to be a relatively minor cause, and indicated that airworthiness failures were much more significant in helicopter accidents.

	Commuter Airplanes	Light Twins	Large Jets	Large Helicopters
Airworthiness	24%	16%	17%	40%
Operations	73%	77%	77%	50%
Maintenance	1%	6%	5%	10%

A further analysis of the airworthiness causes in the aeroplane accidents is also of interest:

Joint Aviation Authorities (JAA)

The Development of JAA

The emergence of cross-border leasing of aircraft, multi-national manufacture, liberalization of air transport economic regulation, and, for Europe, the implications of the Single European Act (effective January 1, 1993) now means that the aviation industry needs safety requirements to be common throughout Europe, to be specific in detail, and to be given the same interpretation by the member States. Within Europe, the inescapable logic of this argument has caused a number of safety authorities — known as the Joint Aviation Authorities (JAA) — to work with industry to develop common procedures, practices, and safety regulations covering design and certification, continued airworthiness, and operational standards which will maintain safety levels and generally improve them, and which will also be as close as possible to the U.S. requirements (U.S. Federal Aviation Regulations — FARs).

The current JAR situation on requirements is shown in Chart 1.

Considering the scale of the work involved, progress on the Joint Requirements has been rapid. The airworthiness design codes applicable to large aeroplanes and engines (and certain other codes) have been completed without any national variants and are in full use.

The arrangements signed in September 1990 by the European Joint Aviation Authorities has an objective to enable all member countries to adopt Joint Aviation Regulations (JARs) as their "sole codes," not just as an acceptable alternative to their previous national codes. JAA now has 18 members; the present membership is summarized in Chart 2.

Work on JAR 23 (excluding commuter category) is close to completion. The first draft has been finished, but further consultation and processing

Joint Aviation Requirements

Purpose	Code	Status
Large aircraft design	JAR 25	Complete
All-weather operations	JAR AWO	Complete
Engine design	JAR E	Complete
Propeller design	JAR P	Complete
APU design	JAR APU	Complete
Sailplanes & powered sailplanes	JAR 22	Complete
Very light aircraft design	JAR VLA	Complete
Equipment	JAR TSO	Part complete
Light aircraft and commuter design	JAR 23	Part complete - in consultation
Helicopter design	JAR 29 }	To be started in 1991.
	JAR 27 }	Preparatory work in hand
Certification procedures	JAR 21	In preparation
Maintenance organizations	JAR 145	In consultation
Operations (commercial air transportation)	JAR-OPS Part 1	In preparation
Certifying staff qualifications	JAR 65(E)	In preparation
Recreational aircraft maintenance	JAR 91	Not started
Operators maintenance	JAR 121(L)	Prepared awaiting JAR 121
Operations (helicopters)	JAR-OPS Part 2	In preparation
Operations (other than public transport)	JAR-OPS Part 3	Not started
Airworthiness Directives	JAR 39	Not started

Chart 1

has been delayed to try to achieve greater harmonization with FAR 23. It is intended that this will be published by the end of 1991. The extension to cover commuter aircraft will follow and is due for completion in 1992. JAA countries are now not only adopting identical requirements but are working together in joint teams to certificate aircraft types through a single evaluation on behalf of all the member countries. To underline its commitment to work in the European framework, CAA has shelved the introduction of its Phase 2 helicopter performance requirements (designed to ensure safety in the event of an engine failure at any stage of the flight) so that they can be considered in a European context for JARs.

Maintenance Requirements

JAR 145, Maintenance Organizations, has been agreed upon by the authority and industry members on the Joint Committee and will shortly be sent out on formal consultation. This will enable all countries adopting this code to ac-

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Chart 2

cept maintenance carried out by organizations (expected to number 2,000) approved in accordance with the agreed procedures. Staff in authorities responsible for approval will be trained in common procedures and the approvals granted against JAR 145 will be subject to an international standardization system. The complementary Advisory Circular with essential interpretative material to JAR 145 is now agreed upon and is therefore to be published as an “Orange Paper.” JAR 121(L) is virtually complete although work has yet to start on the associated Advisory Circular, and the table shown earlier indicates the position on other codes.

Operational Requirements

A JAA operations committee was established in May 1989 to deal with the whole range of operational requirements. Work aimed towards public transport aeroplanes is being conducted in equipment and flight operations sub-committees and in several associated study groups. The aim is to produce common standards and the general format of ICAO Annex 6 is to be used as the authorities and industry have agreed that FAR 121 and the associated codes have developed in a rather illogical and confusing form. A cross-reference index will be provided and the detailed requirements will be identical to

FAR paragraphs wherever possible. JAR-OPS Part 1 is due to be completed in draft by the end of 1991 and published by the end of 1992.

Similar work is proceeding on helicopter operating requirements but work has not yet started on a JAR-OPS for general aviation aeroplanes.

The JAA will, of course, affect corporate and regional operations in many ways; most of them, we believe, for the good. New aircraft types will all be jointly certificated by the JAA so this should result in very few additional, national certification requirements — hopefully none. The result should be a reduction in the costs of modification and an improvement in international standardization — spares would be common in all countries. Costs should also be reduced by the JAA's efforts to harmonize standards with the U.S. Federal Aviation Administration (FAA). The JAA is also committed to charging for its work, with a uniform system in all countries, and to achieving full cost recovery; this would at least provide a "level playing field" in Europe. Flight time limitations are being tackled as part of JAA-OPS and they are at this stage using the framework of the U.K.'s scheme; the separate EC Commission initiative on flight time limitations (FTL) appears to be concerned with social issues as well as safety and its future is uncertain. The Commission now sends a representative to the JAA FTL Study Group — as an observer.

Future Regulatory Initiatives

In the first part of this paper, I mentioned the subject of ground proximity warning systems (GPWS). A move to the more widespread fitment of GPWS is an example of a probable future regulatory initiative.

Beginning in the 1970s, a number of studies conducted by the U.S. National Transportation Safety Board (NTSB), the U.K. Civil Aviation Authority and independent researchers looked into accidents that were classified as "controlled flight into terrain" (CFIT). In this type of accident, an aeroplane, under the control of a fully qualified and certificated crew, is flown into the ground (or water, or obstacles) with no apparent awareness on the part of the crew of an impending disaster. The studies led to the mandatory fitment of GPWS to the big jets. More recent studies by the NTSB have shown that a number of CFIT accidents, involving turbo-propeller powered aeroplanes, might have been avoided had they been fitted with GPWS. Statistics certainly seem to support the studies. For the decade 1980 to 1990, CFIT fatal accidents involving commuter aeroplanes world-wide occurred 1.94 times per million hours (45 percent of the total fatal accidents); this compared with 0.17 times per million hours (24 percent of the total) for the larger jet airliners. In other words, the commuter CFIT fatal accident rate was approximately ten times that of the larger jet airliners; U.S. statistics match this almost exactly. In April 1990, the FAA published a Notice of Proposed Rule Making requiring that all turbine powered (rather than just turbojet) aeroplanes, with ten or more seats, be equipped with GPWS. This rule is expected to become final in September of this year. This would seem to me to be an essential and well justified safety improvement.

Conclusion

In my short introduction, I hope I have shown that the commuter industry plays a vital and growing role in the aviation scene. Continued effort is needed further to lower the accident rate to match that of the major airlines. I hope that I have also given you some indication of the implications for the industry of the work of the JAA and the possible direction in which future regulatory initiatives might go.

Air Safety in Regional Airlines — Who Owns the Problem?

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Introduction

Safety in airline operation is not something which just happens. It must be planned into the operation, and the plans must be managed and their effectiveness monitored. This paper sets out some of the reasons which lead to those conclusions, and examines some of the ways in which plans can be implemented in a small airline with necessarily limited resources. It suggests ways in which those resources can be usefully deployed. The structure of an organization to safeguard and monitor the safety objectives of the organization will be looked at, and some possible problems identified. Finally, the relationship with the regulatory authority will be reviewed.

The Objective

Aviation has a good record of safety, though at the 1990 Flight Safety Foundation Seminar in Rome, several speakers made the point that the safety record is no longer improving and may in fact (on a world basis) be worsening. There is clearly no room for complacency.

The safety of any particular operation — by which I mean the safe arrival of that airplane at an airfield — depends on the people concerned with that flight doing their job properly. Everyone in aviation knows that, and everyone is concerned to see that it happens. Moreover, the key personnel involved hold licenses from their regulatory authority, and the organization itself has undergone some sort of scrutiny before it was allowed to offer a service to the public. Is there a need to do more?

I believe that there is. The aim must surely be to create within the organization a climate which makes as sure as possible that everyone will do his job properly, and that if he fails, for whatever reason, the failure will be identified and corrected before it matters.

Let me give two examples of occasions where things have gone wrong in organizations which had the best possible intentions.

In November 1987, a disastrous fire occurred at King's Cross Underground station in London which cost 31 lives. The report of the accident states that "Many witnesses emphasized that safety was enshrined in the ethos of railway operation, and that staff at all levels were aware of their responsibilities for passenger safety." Nevertheless, London Underground developed a blind spot to the hazard of fire on wooden escalators, due at least in part to lack of clear thinking as to who was responsible for what.

In December 1988, British Rail had a collision at Clapham Junction which cost 35 lives. The report of that accident states "BR's commitment to safety is unequivocal. The accident and its causes have shown that bad workmanship, poor supervision and poor management combined to undermine that commitment. The appearance of a proper regard to safety was not the reality."

I have reviewed these two accidents with others in a paper presented at Rome, so I do not propose to develop that analysis further in the present paper. I will simply remark that a good intention coupled with an assumption that everyone is aware of the need for safety is no guarantee that safety will, over a period of time, be achieved.

In my view, the objective of an airline with regard to safety can be stated very simply. It is the primary aim that a safe operation be achieved at all times. Of course, an airline will, very properly, have a number of other objectives. Making a profit is obviously likely to be one of them, unless there are special circumstances. But I suggest that even the most profit-conscious airline must have safety as its first objective, for if it fails in that, it is unlikely to survive for any length of time.

Management of Safety

I have already said that good intentions will not, of themselves, produce safety and it may be useful to look at some of the reasons why this may be the case.

There is no doubt that employees often identify very closely with the aims of their company, and such identification is usually to be applauded. However, it can sometimes prove counterproductive. An employee may consider that getting a service away on time has a very high priority and that a short cut (which appears to him at the time to be adequately safe) will be in the best interests of the company. On a rare occasion he may be tragically mistaken — the short cut omitted some check or procedure which, on that occasion, was vital.

Or consider the supervisor who knows well the excellent quality of one of his staff, and does not make sure that he really has understood an instruction on how to perform a certain task.

And what about the occasion when the time to do a job was misjudged, and a tired employee misses an important check, due to fatigue?

You may think the above examples are hypothetical, and somewhat theoretical. In fact, they all come from accidents involving major organizations over the past five years or so.

Safety will not just happen. It must be managed. Of course, an airline will not be allowed to operate unless it has some safety management arrangements in place to the satisfaction of its regulatory authority, but my point is that the perception must be that we have this machinery in place because we need it to do a good job, not because the authority says we must. Of course an authority should not impose standards without good reason, and must be able to demonstrate that reason to the operator, but it is also essential that the operator takes ownership of the result. No "we do it because we must, but we don't understand why."

Safety of staff in their workplace, at least in the United Kingdom, is governed by different legislation. However, from the point of view of the attitude to safety in the organization, the two are really indivisible, The machinery may be different. The aim must be the same.

Therefore, the following are the essential elements of safety management:

- The safety objectives of the organization must be clearly defined
- The organizational structure to achieve those objectives must also be clearly defined, with a clear definition of the role of each component of the whole
- The terms of reference of staff must explicitly define their responsibilities on safety matters
- There must be machinery for assuring the senior management that what they intend to happen is indeed happening.

This may look ponderous for a small organization. I do not believe that it is in reality. A big organization may need specialists, full-time staff in various roles. In a small organization it is usually possible for the safety role to be combined with some other task, provided that it is made clear that time must be provided for the safety duties, and that they may not be set aside or deferred for other, apparently more urgent tasks. A council of perfection? Not if there is proper monitoring of what is happening, so that senior management can become aware if something is being omitted or skimped.

The Structure of a Safety Organization

With the above thoughts in mind, we can now think about the structure of a safety organization. I will first look at the general principles involved, and then consider their application to a modest size airline.

Any airline has two essential operational elements — engineering and flight operations. This is true even if the engineering work is sub-contracted to another organization. Clearly the needs of these two arms of the company differ, and great care must be taken that they communicate properly with each other, and that they have compatible safety objectives, even though they may be expressed differently.

I suggest that the only satisfactory way of achieving this is to have a cascade arrangement, whereby the objectives of the company are set out in a document which is 'owned' by the Board of the organization, and then each arm sets out its own objectives which are drawn from those of the company, elaborated as appropriate to suit the needs of the particular part of the organization. In turn, each sub-department should have its own objectives, again based upon those for the department as a whole and appropriately set out to suit its needs.

Such a structure of documents carries with it another aspect of the task. The documents must, in my view, be living documents, regularly reviewed and amended to accommodate the ever changing circumstances of any real organization. There must therefore be someone responsible for maintaining the documents, both at corporate level and at departmental level. Also, it is necessary for there to be a positive and continuing check that the various documents are compatible with each other, and, very importantly, that there are no gaps between them. It is also appropriate to have a way of ensuring that some departments which may appear peripheral on safety matters are drawn in on any aspects which are safety related. For example, in many airlines, cabin crew report to a commercial department. They have, of course, a vital safety function to perform, so that aspect of their work must be correctly woven into the safety structure. And finally, all parts of the organization have responsibilities relating to health and safety at work objectives. While this may diverge from the operational safety stream at Board level, it may none-the-less be seen as appropriate for the general structure to incorporate these aspects also.

Finally, and very importantly, there must be, built into the safety structure, means of checking that it is working, and of reporting that this is the case to the highest levels of management.

All the above may seem very bureaucratic and sound horribly like 'management by objective.' I do not believe this to be the case.

First, the actual arrangement in terms of people must be visibly related to the task in hand. Secondly, the people whose task it is to achieve the objective should either write the local instructions, or be responsible for agreeing with them, so that they have 'ownership.' Moreover, the question of 'ownership' must start at the very top, as I have already indicated. The Board cannot avoid its responsibility for safety, even though it may have experts such as a Flight Operations Director or an Engineering Director who will in fact be responsible for most, if not all, of the day-to-day preservation of safety.

What does this mean in the small airline?

First, the Board must make its intentions clear. It can do this in more than one way. It can and should issue a statement on its overall objectives showing safety as the highest priorities. I believe that in this respect it is necessary for the objectives to be comprehensive, so that it is clear to staff where safety stands in the priority order. If a statement such as "Safety is paramount in our operation" is issued in isolation, there is the risk that it may nevertheless be seen as equal to, or even subservient to some other objective expressed in a different way on a different occasion. The Board must make it clear that, if a responsible member of staff decides that a particular flight cannot be carried out safely and aborts it, or that a particular aircraft is no longer airworthy and should be withdrawn from service, he will be supported, even if subsequent more leisurely study suggests that he had acted over-cautiously.

Second, the Board should make clear its continued interest in safety matters. There may be a number of ways in which it can do this, depending upon the particular skills and responsibilities of the Board members. The concept of a Safety Committee chaired at Board level and having some independent membership — such as non-executive directors — is one which has been adopted by a number of airlines.

The role of the Chief Executive is an important one on safety related matters. He may be someone with little technical knowledge, in which case he will be very reliant on his senior management for advice. In this case, he must make it clear that he is a part of the safety team, even if only in the sense of aiding and supporting his managers. If, on the other hand, he is someone with operational experience, he must be very careful not to usurp the roles of his senior managers and appear to second-guess their decisions. In each case, great tact and skill must be displayed by the Chief Executive.

Below the Board and the Chief Executive will be a number of departments, some of which will have operational safety responsibilities, and all of which will have general safety responsibilities. The responsibilities of each department must be set out, and the responsibilities for safety of the various key staff must also be defined. Thus, the Director of Flight Operations should have something like "To achieve and maintain a safe operation" as one of his terms of reference. The manager responsible for recruiting may not need any reference to safety in his job description.

Within each department, there must again be a structured set of objectives, cascaded down as far as is appropriate. It may not be necessary to carry this to the same level in all parts of the organization. For example, there may be safety support for a particular task at a main base which has to be provided differently at a line base, and so the terms of reference may need to be different in the two cases.

Someone must be responsible for making sure that the various documents knit together properly and do not contain gaps. In a small organization this is unlikely to merit full-time attention, and so someone must be picked who will have that responsibility even though he may also have departmental responsibilities. As I have already said, I believe that, to the fullest extent possible, the documents should be written by those who have to apply them. In a small organization this may not always be possible. If it is not, then the author must develop a close relationship with those for whom he is writing, so that what emerges is indeed appropriate and applicable.

Someone must also be responsible for ensuring that the Board is supplied with the information which it needs in whatever form is defined. While the information will undoubtedly largely emerge from the line departments, there must be a way in which concerns (perhaps from junior staff) that a safety gap exists can be highlighted and properly dealt with. If the Board has a safety committee this may be the right place to report any such matters.

It is important to recognize that an organization such as a safety committee exists to keep the Board informed. It must not become an executive body, taking away responsibility from the nominated directors (who may or may not be Board members). At the same time, it must be properly serviced and should meet (and be known to meet) at regular intervals.

An operational incident form which has been found to work well in practice will be found at Appendix 2.

The Role of the Senior Management

Much of the role of senior management has already been described above, but it may be helpful to summarize here.

- The Board must make known its objectives for safety and must keep itself informed as to the achievement of those objectives

- The senior executive management must ensure that the overall objectives are interpreted into departmental objectives, and that the terms of reference of staff are clear

- Middle management must in turn ensure that they understand their own role and that those reporting to them are also clear.

The experience of accidents shows quite clearly that it is not enough to assume that everyone will understand the need for safety and the means by which it is to be achieved. Without laboring the point, each level of management must from time to time remind those reporting to them of the objectives. For example, if a notice is issued drawing attention to the need to improve timekeeping, it could be coupled with a reminder that this must not be at the expense of safety. A further quotation from the report of the Clapham accident may not be out of place. Mr. Hidden, the author of the report, states:

"...it is the task of management to be aware of the working practices to which its workforce works and to ensure that those standards are of the highest. It is the task of management to ensure that its instructions to its work force on how work is to be done are clear and that they are in fact being obeyed. It is the duty of management to see that its workforce is properly trained and that such training is renewed from time to time. It is the duty of management to ensure that the efforts of the workforce are properly monitored and supervised so that the quality of the work may be maintained at the proper levels."

Relationship with the Safety Authority

A temptation to think that none of the above applies to an airline would be understandable. A great deal of effort is devoted both by the airline and by its supervising authority to ensuring that good systems are in place and working. I am not advocating any change in this system which has served the industry well over a long period of time. However, it is not a perfect system. The resources of any authority are limited — indeed, tiny compared with those of the airlines which it supervises. Sadly, experience demonstrates that airlines, even with those disciplines, can still suffer accidents. Earlier, I remarked that the safety record may no longer be improving. What I am now suggesting is that some improvement may be had if all airlines act in accordance with the tenets of the best. This means making clear beyond any misunderstanding the company's aim for impeccable safety, and also emphasizing that this is the company's wish, not simply an act of compliance with the edict of one outside body.

Who Owns the Problem?

The title of this paper poses that question. I hope that I have shown here that many people in an airline own part of it. The greatest degree of responsibility, as in so many other matters, lies with the Board, who must ensure that their wishes are clear, followed through and effectively implemented.

"Ask not for whom the bell tolls. It tolls for thee."

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Reference

1. Chaplin, J. C., "The Management of Safety — Some Lessons from Accidents." Flight Safety Foundation, *Proceedings of the 43rd International Air Safety Seminar,* Rome 1990.

Appendix 1

Air Safety Committee Terms of Reference

Function

The Air Safety Committee (ASC) will report to the Board. The function of the ASC is to stimulate thought and action towards promoting safe methods of operation and to encourage preventive action against unsafe operation. It will monitor the safety performance of the airline and ensure that appropriate action is taken to correct deficiencies. The ASC does not reduce in any way the responsibility of the General Manager, Flight Operations * or of the Chief Engineer * under the terms of the Air Navigation Order * or the conditions of the Company’s Air Operators Certificate.

Constitution

The ASC will have at least the following membership:

Chairman*
Managing Director*
Non-executive member

Secretary: Air Safety Officer

In regular attendance:

General Manager, Flight Operations*
Chief Engineer*

The ASC will meet at monthly intervals. (Author’s note: in practice once every two months may prove adequate). If GMFO or CE are unable to attend, they will send deputies.

The Air Safety Officer will be responsible for collating and delivering all items of safety for review by the Committee.

Procedure

In its function as a recommending body for safe practices, the ASC will give its findings on correction or prevention to the Departmental Heads concerned. Departmental Heads will in turn advise what corrective/preventive action has been taken on the various matters before the Committee.

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* These titles, and other references (e.g. CAA) will need amendment to suit the structure of the relevant organization if the text is used as a model for other airlines.

The ASC has the power to investigate any incident affecting the safety of either flight or ground operating practices. It will maintain a regard for the experience of other operations relevant to the BEA operation. It is totally independent of either the Operations or Engineering Departments and has direct access to CAA should the need arise.

On matters such as hijacking or bomb threats, the purpose of the ASC is to investigate how the airline responded. Security will investigate how such an incident happened.

A record will be kept of all meetings of the ASC.

Matters for the Committee

The ASC will review, as a matter of routine, the following:

Mandatory Occurrence Reports
ADDs and in particular the reason for any adverse trend.
Any safety report from any member of either the airline staff or their agents not thought to warrant an MOR.

It will keep these matters under review until they are closed.

In addition, the Air Safety Officer will bring to the attention of the ASC any reports from other operators which may be relevant to the BEA operation.

All members of the Committee should be alerted in the event of an accident involving serious injury or equipment damage.

Action

Because the ASC is not an executive body, all actions will be taken by the appropriate staff in accordance with normal procedures. It is important, however, that safety actions are not delayed pending a meeting of the Committee. The ASC is a reviewing body only.

Conclusion

It is important that the Committee is accessible to anyone who has a safety concern. To that end excessive formality in approaching the Committee is not appropriate, and staff should be encouraged to put forward worries without ponderous paperwork. The Committee is, however, the mechanism by which the Board's dedication to the safe operation of the airline is made known to staff.

Appendix 2

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John C. Chaplin

Graphic not available

The Potential for a Major Improvement In Aviation Safety

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John P. Desmond
President
Flight Dynamics Inc.

Aviation safety has improved significantly since the introduction of commercial jet aircraft 30 years ago. Much of this improvement is attributed to major technological advances, improved maintenance and training, and the widespread introduction of regulated safety equipment. Following this trend of equipment and services improvement, most accidents are now attributed to pilot error. With recent advances in airborne technology and an increased understanding of human factors, the opportunity exists for another significant advance in air transport safety: improving flight crew situational awareness and their ability to recognize and cope with adverse conditions.

This paper reviews the distribution and contributing causes of airline accidents. It addresses the specific problem of pilot awareness and control of the vertical flight path. Enabling information for addressing this problem is presented. The verification of the effectiveness of this information and its potential for improving commercial aviation safety is reviewed.

Commercial Jet Aircraft Accident History, Projections

With the introduction of the jet aircraft to commercial aviation in the 1960s, the initial fatal accident rate, nearly 15 per million departures, was reduced to roughly two per million departures by the end of the decade. The next reduction in fatal accident rates came in the mid 1970s, following the regulatory requirement for the installation of ground proximity warning devices, when the rate declined to between 1.5 and 2 per million departures. This is where it remains today.

Because of the stabilized accident rate and an increasing number of departures, Boeing has projected that by the year 2005 the number of fatal accidents worldwide could increase from 15 to 20 per year.[1]

Accidents Attributed to Pilot Error

Of those accidents with known causes, nearly 70 percent are attributable to pilot error (Figure 1), and over 50 percent of all accidents occur in the approach and landing phase (Figure 2). Weener recently reviewed 83 accidents for one commercial aircraft type and found that 40 of the 83 occurred during approach and landing; these accidents were nearly evenly distributed between short off-airport ground impacts, short on-airport ground impacts, hard landings, and overruns. "The first two, landing short on and off the airport, involve accidents in which the airplane was lined up with the runway approach. These two categories plus hard landings and overruns typically involve problems with vertical guidance or speed control. They can also result from a poor transition from instrument to visual flight at or near approach minimums."[2]

In 1977 Bateman[3], reviewed 25 large air carrier undershoot accidents and incidents occurring between 1972 and 1977. He found that 66 percent occurred at night, 66 percent were conducted to a runway where ILS was available, and over 75 percent occurred with restricted visibility.

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Figure 1

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Figure 2

Miscues for the Outside World

In late 1965 and early 1966, four accidents involving Boeing 727s occurred at Chicago, Cincinnati, Salt Lake City and Tokyo. In each accident the aircraft descended below the desired glide path and struck terrain or water short of the runway. After simulating these accidents, Kraft concluded that the common cause was "an error in pilot space perception, i.e., a visual illusion...In making a visually guided approach at night, the pilots rely on the relatively unchanging visual angle provided by the distant light pattern to judge altitude. If the terrain is flat such cues are adequate and the estimated altitude is accurate. However, when the terrain is sloping the pilots nevertheless respond as if they were approaching flat terrain, with the result that they overestimate their actual altitude. This misleading cue is potent enough to induce experienced pilots to descend to dangerously low altitudes."[4]

Mertens[5] found a natural tendency to overestimate the approach angle when only lights are visible. Moreover Nagel, in his article on Human Error in Aviation Operations, concluded "The lesson from all of this is that the visual scene, although adequate for aircraft guidance when visual information is excellent, may mislead when the quality of the information degrades for a variety of reasons. The errors which occur are systematic; under conditions of reduced visibility, the misrepresentation of both static and dynamic visual cues leads pilots to fly low approaches."[6]

The Control Problem

In an extensive review of operational requirements and problems concerning the pilot's visual task relating to cues used for approach and landing, Jenney, et al. concluded, "To control the approach and landing path, the pilot needs information on the displacement, rate of displacement, and acceleration (rate at which displacement is changing) of the aircraft with respect to the desired path in the horizontal and vertical dimensions — making a total of six variables. Successful accomplishment of these control tasks by visual reference alone depends primarily upon the pilot's ability to see and interpret cues derived from the relative position and movement of the horizon, the extended centerline, the zero-velocity point (X-point), and the aiming point on the runway. Supplementary information in the form of instrumental indications of altitude, rate of descent, and airspeed may be needed to corroborate these visual judgments. The effect of reduced visibility is to obscure or confuse the visual cues, creating control problems — primarily in the vertical dimension. This leads to the conclusion that some way is needed to enhance the visual cues or to replace them so as to assure the safety of VFR as well as IFR approach and landing."[7]

Enabling Information

Tests conducted by Douglas,[8] the FAA and NASA,[9] Boeing,[10] and Flight Dynamics Inc.[11] all demonstrate that there is a significant potential for improvement in pilot cognizance and control of aircraft flight path when certain out-the-window cues are provided, especially in reduced visibility and in difficult environmental conditions.

The following describes enabling information that allows the pilot to determine directly the climb or descent angle of the aircraft with respect to the desired angle (displacement), the flight path or velocity vector of the aircraft with respect to the desired flight path (displacement rate), and aircraft acceleration available to adjust flight path or speed.

Approach to Portland

Photograph not available

Figure 3

Figure 3 is a photograph taken on an approach into Portland, Oregon's runway 28R. It represents one example of an approach path difficult to judge because of restricted visibility and, in this case, low clouds obscuring the horizon. Figure 4 is from the same position on the approach with an inertially defined artificial horizon and vertical scale overlaid on the visual scene. Since the information is inertially stabilized, the horizon enhances attitude awareness and the vertical scale permits accurate estimation of the approach angle to the runway. The dashed line, adjustable by the pilot, is used to determine approach angle. In Figure 4 it is set to 3^0. This information alone, an airborne VASI, is useful in improving approach precision because the position of the desired touchdown point on the vertical scale provides an accurate indication of approach angle, or displacement from desired angle.

Two relatively new and very significant flight information symbols are depicted in Figure 5. The circle with the angled legs is the instantaneous flight path of the aircraft. When this symbol is centered on the horizon (horizon through the circle) the aircraft has zero vertical speed. With flight path above the horizon, a climb is indicated and the climb angle can be determined accurately from the position of the

Artificial Horizon and Vertical Scale

Photograph not available

Figure 4

symbol against the vertical scale. Figure 5 shows a descent angle of 3^0. This information allows the pilot to determine not only that the aircraft is positioned on the desired 3° approach path, (zero displacement), but also that the velocity vector of the aircraft is along the approach path (zero displacement rate).

Flight Path Symbology

Photograph not available

Figure 5

Projected flight path provides advance information — out-the-window conformal to the real world. When maintained on the runway and at the 3° mark of the vertical scale it provides a precise 3° approach. A deviation of the aircraft's velocity vector from either of these two requirements is instantly indicated by a repositioned flight path symbol. From the displayed flight path symbol the pilot is able to determine and control flight path directly. (A more conventional attitude display provides pitch information, only one factor affecting flight path.)

Once the pilot is controlling flight path, speed and potential flight path become controllable from a fortunate bit of physics; an aircraft's differential flight path is equivalent to the aircraft's acceleration along its actual flight path. When differential flight path is displayed relative to actual flight path, it indicates potential flight path (see Figure 6). The potential flight path symbol, the chevron in Figure 5, is scaled to indicate achievable flight path with airspeed held constant. With this information the pilot is able to determine constant airspeed potential climb or descent angles from the position of the potential flight path symbol against the inertial vertical scale. A potential flight path below the current flight path indicates a deceleration and therefore a potential, or soon-to-be-realized, flight path below the present one. A potential flight path above the actual flight path indicates acceleration and therefore climb potential (Figure 7).

Since the pilot is able to directly view flight path and flight path acceleration, it is possible to immediately determine if sufficient thrust is available to achieve the desired flight path and whether the aircraft is accelerating or decelerating to the desired speed. To assist in attaining a selected speed, a speed error indication has been added. Figure 8 shows the speed error symbol, indicating a present speed above the selected speed by the symbol rising from the left leg of the flight path symbol. A speed below selected speed is indicated by a speed error symbol below flight path. Con-

Gra;hic not available

Figure 6

stant flight path speed corrections are made by adjusting thrust so that acceleration opposes speed error, as in Figure 8.

To complete the display, information from the basic "T" has been added (Figure 9). Aircraft attitude, boresight with respect to the horizon, is indicated by the gull wings near the center of the display; pitch is determined from the vertical distance of the gull wings from the horizon. Roll information is enhanced by the semi-circular scale at the top of Figure 9.

The boresight symbol represents the extended center line of the fuselage (the fuselage reference line in Figure 6). If the aircraft centerline were projected forward, it would run through the center of this symbol. From this symbol the pilot can determine where the aircraft is pointing; however, in a dynamic environment this is of small assistance. Figure 10 shows the relative position of boresight and flight path in a crosswind approach; flight path overlaying the runway, boresight pointing into the wind.

Referring again to Figure 9, the rest of the information from the basic "T" is presented on the display digitally. The heading numbers along the horizon indicate 30° of the magnetic compass. Airspeed is displayed on the left and barometric altitude on the right. Vertical speed is displayed below. Groundspeed has also been added at lower left and radio altitude, when less than 500 feet, is displayed at lower center. A wind direction and strength indicator is provided at the upper right.

Whenever performance is limited by aircraft or environmental conditions (e.g., engine fail-

Climb Potential

Photograph not available

Figure 7

ure, a misconfigured aircraft, or windshear) operation near stall limit may be required. To assist the pilot in coping with these conditions, a symbol indicating margin to stall is displayed when this margin is reduced. This symbol (shown in Figure 11 just above flight path), in conjunction with flight path and the horizon, presents a performance limit, or escape window, if one exists.

Airspeed Control

Photograph not available

Figure 8

Windshear

Flight path, potential flight path and speed error combine to describe the windshear. An increasing head wind is indicated by increasing airspeed and a decreasing potential flight path; an increasing tail wind is indicated by an increasing potential flight path and decreasing airspeed. In either case, the shear is indicated by the opposite movement of these two parameters. Downbursts are indicated by a depressed flight path.

Primary Display Symbology

Photograph not available

Figure 9

In an extreme windshear, where aircraft climb potential is severely affected, the word “WINDSHEAR” is displayed along with an aural warning and a flight path based recovery guidance command, the solid ball shown in Figure 12.

Flight Performance Improvement Evaluations

To evaluate the improvement in flight performance resulting from this enhanced information, Flight Dynamics Inc. (FDI) conducted a test program[12] which provided airline pilots with conventional head-down instrumentation and the flight path information described above, by means of a wide field of view head-up display. The tests were conducted in a Boeing 727 simulator, the "M-Cab" at Renton, Washington. Each pilot flew a number of difficult approaches (day, night, varying visibilities down to 1200 RVR, mild shears, sidesteps, snow cover obscuring texture) using both types of instrumentation. Figure 13 compares touchdown dispersions achieved with conventional displays to those achieved with an advanced flight path display head-up, the Head-Up Guidance System (HGS) developed by FDI. Note the elimination of go arounds using head-up flight path.

Flight Path and Crosswinds

Photograph not available

Figure 10

Boucek conducted a similar test program to compare approach and touchdown precision using conventional head-down instruments with head-up flight path displays. He concluded: "The primary objective of the study was to evaluate the use of a head-up display and flight-path information in a variety of visual conditions...The most general statement that can be made is that when compared to either head-down flight-path display or conventional instruments, the head-up presentation resulted in superior performance, both in accuracy (i.e., smaller errors) and precision (i.e., smaller variations) on all flight parameters at each point in the flight path for the low visibility conditions. The touchdown performance showed that, even in conditions of low and no visibil-

Escape Symbology

Photograph not available

Figure 11

Windshear Symbology

Photograph not available

Figure 12

Graphic not available

Figure 13

ity, the pilots were able to put the aircraft on the runway at a much higher rate of accuracy with the HUD and head-down flight path display than with conventional instrumentation. The scatter at the threshold was less; the landing footprint showed the least scatter; and the sink rate was the least with the HUD.”[13]

Other Flight Crew Benefits

In addition to providing enhanced information for evaluating and controlling the approach, head-up information eliminates the required transition from head-down instrumentation to real world cues. Using panel instruments the pilot views displacement and then must estimate displacement rate and correlate this information with the out-the-window view of the real world.

From the Douglas tests, Stout and Naish reported: “The HUD buys the pilot time. Time is the most precious commodity on board the aircraft, especially during the last 200 or 300 feet before touchdown. A few seconds saved at points scattered along the approach course is all that is needed to appreciably lower the pilot’s workload. Lowering the workload automatically decreases the anxiety buildup. A low anxiety level increases a greater degree of pilot confidence both in his own ability and in that of the total system.”[14]

Accident Review

The Flight Safety Foundation (FSF), as one of its functions, reviews emerging technologies “that have potential to reduce human error by providing valuable information to flight crews.”

From a recent FSF review: "Each reported available commercial jet Total Loss and Major Partial Loss Accident that occurred between 1959 and 1989, inclusive, was reviewed for the potential of HGS to prevent the accident." They concluded: "For all Total Loss Accidents Reviewed, HGS could have prevented or positively affected the outcome of 33 percent. For all Major Partial Loss Accidents reviewed, HGS could have prevented or positively affected the outcome of 29 percent."[15]

Economic Benefits

At FDI we have developed a flight path display technology for the commercial airlines which enhances operational capability. Flight path information is presented on a wide field of view holographic display incorporating a sophisticated flight guidance command (the circle within flight path in Figure 14) and a patented monitoring function[16] to allow the pilot to control and land the airplane without ever seeing the runway. The system has been certified by the FAA to provide stand alone landing operations in visibilities as low as 700 feet and take off operations in visibilities of 300 feet. Alaska Airlines is operating its fleet of 23 Boeing 727s with the HGS (Figure 15) to minima of 700 feet landing and 400 feet takeoff. Federal Express is installing the systems in aircraft to be operated in Europe, and Canadair has selected the HGS to provide low visibility capability for the Regional Jet.

Head-Up Guidance Display

Photograph not available

Figure 14

HGS® on Alaska Airlines Boeing 727

Photograph not available

Figure 15

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Regional Airline Command Training

Photograph not available

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Training Captain
Air UK Ltd.

As we in the European Regional Airlines approach the prospect of greater liberalization from 1993 onwards, many of us have experienced, and will continue to experience some difficulties in recruiting and training pilots able to meet the standards we require, and from the available pool of acceptable candidates we must find aircraft commanders and potential commanders of the highest quality. I hardly need to tell anyone here that the passenger, our customer, when seated in the back of an aircraft that has suffered an engine fire and is descending into an airport in mountainous terrain with a low cloudbase and horizontal rain has every expectation of, and indeed a right to, the same level of care and skill from his regional airline captain as he would from the commander of an aircraft of a heavily funded state carrier. Marketing men may have a neat stereotype of the "regional passenger," but to us in the flight-deck, a passenger is a passenger, whatever his provenance. To paraphrase the famous quotation: "If you cut him, he bleeds just the same."

How then do we in the regional airlines, with limited resources, ensure that our captains are of the highest quality? I would not dream of telling you how "it should be done," but I would like to share the Air UK approach to these problems with you in hopes that some of our ideas may provoke discussion within your own training departments. Before I begin I would like to deal briefly with who we are and what we do.

Air UK is a scheduled regional carrier whose route network is shown in Figure A. You may be acquainted with our sister airline, Air UK Leisure; although within the Air UK Group, they are operationally separate with their own training department.

We have a mixed turboprop and jet fleet comprising 2 Shorts SD360s, 14 Fokker F27s and (by the end of 1991) 14 BAe 146s.

Recruitment is exclusively to the turboprop fleets and therefore all BAe 146 pilots are drawn from the SD360 and F27. Although we have a provision in our “Pilot’s Agreement” for direct-jet recruitment, it has never occurred. Over 90 percent of command training takes place on the F27 fleet, since the preferred company career progression is F/O Turboprop to F/O Jet to Captain Turboprop to Captain Jet. It is not possible to progress from Captain Turboprop to F/O Jet as in some airlines, our principle being “Once a captain, always a captain.” However, some F/Os are able enough to progress from F/O Turboprop to Captain Turboprop and, very rarely, F/O Jet to Captain Jet. We have also recruited a large number of direct-entry captains to meet the demands of our continuing expansion. I will return to this subject later.

Graphic not available

Figure 1

In conducting all of our training, we have been very fortunate, firstly in having an enlightened commercial management who has the vision to see that their pilots, and particularly their captains are part of, and inseparable from, the commercial product; and secondly, in having a strong training department with a manager who is strong enough, and silver-tongued enough to talk on budgetary matters authoritatively, and sell the vital importance of safety training at boardroom level.

I cannot stress enough the importance of these two assets. If you cannot make the commercial department see beyond the bare bones of the balance sheet, your pilot training will be back in the dark ages. There are still too many airlines whose command conversion course consists of a few circuits in the spare aircraft on a Sunday afternoon followed by sewing a couple of extra gold rings on a uniform jacket. In today’s aviation environment, this is no longer good enough. In fact, it never has been good enough.

We believe that a training program is only as good as the people who run it and so our training staff is selected extremely carefully. Seniority is not taken into account at all when considering a new training captain, and neither is the requirement to have thousands of hours on type. Personal qualities and demonstrated ability are the prime criteria.

For the pilot employed by Air UK as a first officer, assessment of command potential commences at the initial interview and command training effectively starts on his first day with the airline. Recruitment is, therefore, one area where we may differ significantly from a large state carrier. We, although employing first officers, are not looking for first officers. Whereas the state airline's recruitment may be aimed at the individual who is psychologically completely comfortable with the prospect of 10 to 15 years as a co-pilot, our recruitment is geared to the person who has obvious qualities of leadership and maturity which can be developed within a much shorter timescale. Clearly, we cannot always succeed in this aim, individuals do not always fulfill their early promise, but our success rate is high enough to justify continuation of this recruitment philosophy.

The Air UK first officer's first step to the left-hand seat is an initial training course which involves all the extra aircraft handling elements to permit the aircraft type rating to be in the "pilot-in-command" section of the pilot's license. No first officer in Air UK has a "co-pilot" type rating. In this way, we establish the aircraft handling qualities of our crews at an early stage. Anyone not able to cope with the higher demands of the "pilot-in-command" type rating is rejected. This system also enables us to fulfil a British legislative requirement (set out in CAA Civil Air Publication No. 360) that the biannual recurrent check for captains and first officers must be of the same content.

During this time as a first officer (and to digress, I very much include her time as a first officer) the pilot is encouraged to participate in the decision-making process at all levels during the flying day. When he is the handling pilot on a sector, he is expected to act as if he were the pilot-in-command (although clearly under supervision); indeed, under British legislation, the entries in the F/O's logbook after flight indicate that the co-pilot acted in this capacity. We expect him to decide such matters as non-standard flight levels and descent and approach profiles without waiting for instructions from the left-hand seat. In short, we try to avoid the captain flying the sector using the F/O's hands, and company policy is to fly "leg and leg about" as far as possible. We believe that an individual does not become a pilot merely to push a pen around a flight-log and for our part, we want a candidate for a command course who has been exposed to as many of the problems faced as a captain as possible; given the confines of the right-hand seat. Obviously, we have to exercise discretion and restraint in these areas, especially with very junior pilots and particularly with difficult weather and difficult airfields. At Innsbruck, for instance, we restrict landing to captains only. We do try, however, to place as few restrictions on the F/O as possible within a sensible framework of defined duties.

We note with dismay, a recent trend in some regional airlines to reduce the role of a first officer to that of captain's secretary; indeed, one company will not allow its F/Os to start engines, taxi or handle the aircraft when the cloudbase is lower than 1,000 feet. They are not even permitted to speak to the passengers on the public address system. It must be assumed that these restrictions are imposed in order to reduce risk, but I believe the long-term effects are likely to be highly counter-productive. Restrictions like these are classic symptoms of the defensive approach to training, where the crew is surrounded by such rigidly defined areas of responsibility and so many "do not(s)" that, the theory goes, they don't step into risky situations. Air UK is unashamedly of the opposite view: you **attack** the problems by providing sufficient and deeper training so as to reduce the risks. The spin-offs are numerous: good flight-deck atmosphere, good pilot-management and pilot training staff relations to mention a few. As a general once said, "The problem with a defensive policy is that it inevitably ends in defeat." For my part, having spent many years in training, I have learned one thing: if you treat people as fools, they will not let you down; they will go right ahead and behave as fools.

Throughout his career as a first officer, the pilot's ability is monitored through recurrent checks and an established biannual assessment system and if he has sufficient seniority, experience and ability (which must have been assessed as “high average” as a minimum) he is put on the roster for a “command assessment.” The experience requirements are shown in Figure B.

You may think these experience levels low, especially for turboprop captains and you would be correct. To put it into context: no captain in our company currently has experience levels as low as these. We have again attacked the problem of having a rare, but gifted pilot who is relatively inexperienced but is clearly ready for an early command by being flexible enough not to exclude him. The experience levels also cater for the ex-military pilot who has often packed a lifetime’s experience into relatively few hours.

Type	Captain	F/O
Turboprop	2000 Total Flying Hours 1000 Flying Hours as P1 or P1/US Multi-engine	Minimum Acceptable for Licensing
Jet	4000 Total Flying Hours 2500 Flying hours as P1 or P1/US Multi-engine	1500 Total Flying Hours 750 Flying Hours as P1 or P1/US Multi-engine

Figure B

The command assessment is crucial to command training and is in fact “Phase One” of the course. The process involves the candidate being invited to “act” as the captain on a series of flights over a number of days. The training captain is charged with assessing command potential as opposed to command ability and given the difficult nature of this task, we only use the most experienced trainers for this role. The command assessment criteria are shown in Figure C.

You will note the importance to us of the pilot’s personal qualities. Always difficult to assess and even more difficult to remedy, they nevertheless represent the key to the individual’s success as a commander. Remember that the pilot’s pure aircraft handling ability has already been established at this stage. We take particular note of such areas as cabin-staff liaison: a pilot who can fly an ILS blindfolded but cannot be civil to a stewardess will probably not be able to effectively manage an emergency which involves the co-operation of the whole crew. Similarly, personal appearance and demeanor are vital; a person may be assessed as a brilliant natural pilot, but if he shambles around the airport terminal with dirty fingernails and a cigarette dangling from his mouth, he will get rid of your passengers like lightning, and they won’t come back. Counseling pilots to overcome shortcomings like this is a tricky and unpleasant task, but fortunately it is not often we have to do so.

The results of the command assessment are presented to the promotion board, comprising training, management and union pilots, and there the decision is made whether to proceed with command training or not.

“Phase Two” is the aircraft conversion phase; carried out in the simulator after any required ground school technical training. We have no cockpit procedures trainers, so much time is spent in an actual flight deck before proceeding to the simulator. It is at this time that emergency equipment and emergency evacuation training takes place; and as often as we can, we try to coincide with an ab-initio or refresher cabin staff course. We regard good flight deck/cabin staff liaison as being of paramount importance both in the aircraft and at departmental level.

The aircraft conversion is in no way unusual and follows a standard syllabus which I am sure would be familiar to you. However, as far as we are able, we are to make the training line-oriented, although not fully adhering at this stage to all the principles of full LOFT. In an industry unusually prone to jargon, we have added our own contribution; we tend to call this training "SEMI-LOFT." Clearly, this phase is variable in time, depending on where the pilot has come from. A command trainee new to the aircraft type will take an average of 20-24 hours on the F27 simulator, split equally between handling and non-handling roles. For someone gaining a command on his current type, the time taken can be as short as two or three simulator sessions for the mechanics of changing seats. However, we firmly believe in training to a standard and not to a time; although, with a command trainee, one does not expect such training to be open-ended. A failure at this phase is exceptionally rare.

General Demeanor and Conduct

Appearance

Cabin and Ground Staff Liaison

All Aspects of Pre-Flight Planning

Use of Checklist

R/T Procedures

Passenger Liaison and Comfort

General Flying Quality

Adherence to SOPs

Overall Flight Management

Figure C

The "Third Phase" is again in the simulator and is the keystone of our command training — Line Oriented Flight Training (LOFT) and this is our "captain-factory," if you like. It is here that both the airline and the candidate find out the real suitability for command, and it is here that we have experienced the majority of our failure. I am sure that I need not explain all the principles of LOFT to you, but there are some elements which we feel are vital to successful command training, and I would like to highlight them.

We put enormous efforts into making the flight scenarios as realistic as possible. Pilots report at their normal airport report time and are given real weather, AIS and load documents. We use real flights from our timetables; watches and the simulator clocks are set to reflect the scheduled time of departure. In the 146 simulator we have daylight visuals and can use any timings; but, the F27 simulator is night/dusk only and so we only use flight from the timetable that departs at these hours.

We simulate cabin staff and ATC on all LOFT sessions and insist that they are briefed properly during any emergency. Furthermore, the trainee captain is required to speak to the "passengers" on the P.A. during flight. His F/O may be a regular line pilot rostered for the duty, another command trainee or, if available, another training captain. We never use a new F/O on his initial training course.

Although Air UK has not yet finalized a formal cockpit resource management program, we find that we are constantly applying its principles during LOFT. The training captain's golden rule that there must be no instructional input is rigidly adhered to, unless there is a simulator failure. The candidate(s) must be left to resolve the problems that have been set unaided whatever the outcome. This is the only way to measure progress from one LOFT session to the next.

A scenario must not be constantly replayed to candidate after candidate so that everyone knows what is coming. The true value of LOFT is lost if it becomes stale.

The problem content of the LOFT session should never be solvable solely from the emergency and abnormal checklist. Emergency drills and procedures will have been hammered home during the conversion phase and will have been signed as being satisfactory. So the content must test and develop the candidate's ability to creatively think his way out of the dilemma you have posed, which should not be something that is out of the standard emergency textbooks.

We do not subscribe to the multiple unrelated failure style of training — the “leave him with three engines out in icing with no hydraulics, no flaps and a first officer with food poisoning” school of thought. Indeed, we find that it is what appears to be a simple event that generates the greatest information about a candidate. To give you an example, on one session I introduced only one event: a simple management problem — a “passenger” became ill (as reported by a simulated cabin-staff member) and needed rapid hospitalization. The weather was poor at both ends of the route and the candidate’s (on this occasion) poor management of the flight and judgment of where to land began to tell us and him a great deal about his thinking ability and flight management skills. It is significant that his dealing with textbook emergencies up to this point had been superb.

We insist that the training captain take detailed and comprehensive notes of everything that needs comment, including minute details. These notes form the basis of an exhaustive debrief which can occupy a great deal of time. Because of this, we only allow one LOFT session per training captain per day. We also have, on the F27 simulator, a video camera and recorder which has been of great benefit when used selectively during the debrief. The 146 simulator is having a video camera and recorder installed. Some of you may have union difficulties with using video cameras in training, but so far we have been fortunate in this respect.

One of our greatest surprises in employing LOFT in command training has been the extraordinarily steep learning curve from one session to the next. We have all now seen the confirmed first officer change into a clear thinking captain in as little as three or four LOFT sessions. Similarly, the unsuccessful candidate will tend to show little or no progress at all during LOFT, usually owing to an inability to cope with the unexpected, or situations not in the “book.”

We do not impose an upper limit on the number of LOFT sessions, although we do have a lower limit of three full simulator details. Most pilots who fulfill our expectations complete LOFT in three to five sessions and proceed to base and line training in the normal way.

If a pilot fails the command course, he is rested for a few days and then counseled by his fleet manager or senior training captain. We believe that any failure is shared between the candidate and the training and selection system. We are aware that our selection system should not have put a candidate through the burden of a course that was beyond him. In this way, by accepting some part of the responsibility, our selection procedures are analyzed and refined. We allow candidates to be re-coursed, but not normally before a year has passed.

I do not want to give the impression that we believe we have achieved perfection in our training. We think that our training programs must continuously evolve to avoid stagnation. We are, as I have said, studying formal CRM training packages and we are currently evaluating computer-based training. I would like to see an input from our commercial department during the command course, so that the new captain can understand what these people expect from him when he is “in the field.”

When the new captain emerges at the other end of the training system, we believe that having trained him, we must trust him. Constantly querying every decision he makes will undermine his confidence, or worse, shatter his respect for the training and management system. As an example, some companies dictate exactly how much fuel may be uplifted for a given sector and where it must be uplifted. We do not do this; we give our captains the fuel price list and request them to be economical with fuel loading. Some 99.9 percent do exactly that; we trust them and they don’t let us down. We achieve the same results, but with a happier pilot establishment.

I must now return to the subject of direct-entry captains. Many of you will have been down this road and will be aware of the pitfalls. Some of you may have not, and if I may respectfully offer some advice: exercise extreme caution. Any expanding regional airline may eventually run out of F/Os with sufficient experience to promote and will have to resort to direct-entry captain recruitment. We have had our problems with this, and were frankly taken off-guard at first, especially when recruiting captains from airlines which have a totally different philosophy. Some captains may have spent 20 years in an environment which is totally opposed to your way of doing things. In an airline like Air UK, where SOPs are firmly established, just one or two people can probably quite unintentionally undermine your procedures in weeks. Comments such as "we didn't do it like this in "X" airline" or "don't take any notice of that — it's utter nonsense" will be listened to by your junior F/Os, and before you can blink, your SOPs are shot to pieces. We have gone past this now, but not before some fairly rapid surgery.

We have taken a somewhat unusual step in recruiting a small number of ex-military fast-jet pilots directly as turboprop captains and this has proved an almost unqualified success.

We have found these people to be highly motivated, exceptionally capable at absorbing a totally new environment and very importantly, they generally do not want to move on, being mostly settled with families. They appear to be, at least in the United Kingdom, an almost untapped resource which you like to examine.

May I sum up our command training philosophy with a few simple statements:

1) Select the new first officer with future command training in mind.

2) Start that training on day one.

3) Expose the first officer to as much experience as he can get.

4) ATTACK training problems; don't defend them with short-term restrictions.

5) Train the commander properly and then TRUST him.

An airline captain can be either a superb ambassador for your company or a liability. It is largely his training department and management's philosophy and attitude which will determine which he will be.

The Effect of Passenger Motivation On Aircraft Evacuations

Photo not available

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Foreword

The accident literature indicates that in a serious life-threatening emergency, such as an aircraft accident, people are extremely frightened and will compete with each other when their opportunity to escape is limited. A series of investigations have been performed which were to assess the influence on evacuation flow rates of (a) passengers competing to evacuate the aircraft, as can happen when conditions in the cabin become life threatening and (b) passengers evacuating in an orderly manner, as occurs in aircraft certification evacuations and in some accidents.

Volunteers were recruited from the public in groups of approximately 60, to perform a series of evacuations. A total of 2,262 volunteers took part in the evacuations from a Trident aircraft. In order to introduce an element of competition, on each evacuation the first half of the passengers to egress the aircraft were given a bonus payment.

The results indicated that the introduction of competition between passengers was found to lead to blockages and to reduce the rate at which passengers could evacuate the aircraft. It was concluded that the technique involving competitive evacuation can be of value in the human factors assessment of changes to the aircraft design or procedures for use in an emergency.

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Introduction

One of the objectives of new or modified safety regulations, requirement or procedures must be to increase the probability of survival in aircraft accidents. Recently in the United Kingdom, a number of steps have been taken by the Civil Aviation Authority to achieve this objective. These have included regulations relating to the introduction of fire blocking materials for aircraft seats, floor proximity lighting, smoke detectors in the toilet compartments, crew rest areas and cargo holds, together with additional access at the overwing exits. The objective to improve passenger survival rates has also led to a demand for human factors evaluations of new and existing safety provisions. It is hoped that if we had a better understanding of behavior, in conditions which for many people are highly stressful and disorientating, we could determine which additional steps should be taken to improve the probability of a successful evacuation of all passengers from the aircraft.

While no two accidents can ever be the same, it is possible to learn from the similarities and differences between the causes of the accidents, their location and the environmental conditions present, the types of passengers onboard and their responses to the emergency. For instance, there were many similarities between the accident which occurred at Manchester in 1985 and the one which occurred at Calgary in 1984, in that they were both caused by an engine fire at take off. However, they differed in one important respect, namely that at Manchester there were 55 fatalities whereas in Calgary everyone survived. We know that in some aircraft accidents everyone files out of the plane in a rapid although orderly manner. In other accidents however, the orderly process is not adhered to and confusion in the cabin can lead to blockages in the aisles and at exits, with a consequent loss of life.

From the reports of a number of accidents, it is possible to build a picture of the exits typically used by passengers who survive an emergency where there is smoke and fire, as can happen following crash landing.

From this we know:

(a) that some passengers exit by their nearest door, as would be expected.

(b) that other passengers do not exit by their nearest available door, but travel for considerable distances along the cabin, e.g., extreme cases of back to front. Why and in which circumstances do they choose to do this?

(c) that other passengers, apparently near exits, do not survive. Do they panic and freeze, give up, get crushed by other people from behind or around? Do they have their seat backs pushed onto them?

(d) that blockage can occur in the aisles and at exits in some accidents, when this does not occur in evacuation demonstrations for certifications.

There are, in fact, a great many questions which as yet we are not able to answer about the behavior of people in emergencies; including the important question of why in some accidents the passengers evacuate in an orderly manner, and in other accidents the behavior is disorderly.

It is suggested that one of the primary reasons for the differences in behavior, between the orderly and disorderly situations, must rest with the individual motivation of the passengers. In some accidents, as in the aircraft certification evacuations, all of the passengers assume that the objective is to get everyone out of the aircraft as quickly as possible, and they, therefore, all work collaboratively. In other emergencies, however, the motivation of individual passengers may be very different, especially in the presence of smoke and fire. In a situation where any immediate threat to life is perceived, rather than all passengers being motivated to help each other, the main objective which will govern their behavior will be survival for themselves, and in some instances, members of their family. In this situation when the primary survival instinct takes over, people do not work collaboratively. The evacuation can become very disorganized, with some individuals competing to get through the exits. The behavior observed in the accident which occurred at Manchester, and other accidents in the United Kingdom, including the fire at the Bradford City football stadium, supports this theory.

In August 1987, the U.K. Civil Aviation Authority (CAA) commissioned the Applied Psychology Unit in the College of Aeronautics at Cranfield Institute of Technology to conduct a program of research into passenger behavior in aircraft emergency evacuations.

At the initiation of the investigation the CAA indicated that their requirement was for an experimental program in which the behavior of passengers competing to evacuate an aircraft would provide information relating to the following areas:

(a) the influence of increasing the width of the passageway through the floor to ceiling bulkhead leading to floor level Type I exits, on the time taken for passengers to evacuate the aircraft.

(b) the extent to which an increased distance between the seat rows adjacent to the overwing exit, or the removal of the outboard seat beside the overwing exit, would improve the rate at which passengers could pass through the exit in an emergency.

In 1986, the CAA introduced Airworthiness Notice No. 79 in which it was stated that two alternate minimum requirements would apply to the seating beside the overwing exit. In one of the alternates, it was specified that the vertical projection between the seat rows should not be less that 13 inches. In the other alternate, a minimum vertical projection of 6 inches between the seat rows was specified. However, this configuration required the removal of the outboard seat beside the exit. (Ref 1)

Information from aircraft accidents had indicated that there had been instances of blockages of passengers at both the entrance to the galley and in the overwing Type III exit during some emergency evacuations. It was therefore hoped that the data from the research program would also enable the CAA to explore:

(i) the extent to which the individual behavior of some of the passengers contributes to the finding that, in some accidents, problems occur which were not apparent during the evacuation demonstration conducted for the certification of the aircraft.

(ii) the reason why, in some aircraft emergencies, there appears to be certain seats in the cabin which are relatively near to exits, but from which passengers seem to find it difficult to evacuate the aircraft.

An experimental program was planned in which volunteers from the public completed a series of evacuations from a stationary aircraft parked on the Cranfield Airfield. In these evacuations a range of seating configurations adjacent to the Type III overwing exit, and range of aisle widths through the bulkhead at the entrance to the galley beside the Type I exit, were assessed.

Two independent series of evacuation trials were conducted which included tests of all of the configurations under consideration. In the first test series, a system of bonus payments was introduced in order to increase the individual motivation of the volunteers to get out of the aircraft as quickly as possible. In the second test series, all of the volunteers were simply told to evacuate the aircraft as quickly as possible and no bonus payments were made. The bonus payments were introduced in order to simulate experimentally the competition which is known to occur between people trapped in a confined space fighting for their lives. The second test series (in which no incentive payments were made) was conducted in order that comparisons could be made between the evacuation rates for the configuration being evaluated in the first test series and the evacuations conducted by the airframe manufacturers at the time of aircraft certification.

It was anticipated that with the data from the experimental program of evacuations, it would be possible to determine whether there was an optimum aisle width through the bulkhead leading to the Type I exit, or an optimum seating configuration adjacent to the Type III exit.

Method

Research Design

The primary objective of the research program was to investigate the effect on passenger behavior and flow rates, during simulated emergency evacuations of:

(i) changes to the width of the aisle through the bulkhead, leading to the floor level exits.

(ii) changes to the configuration of the seat rows which form the access to the overwing Type III exits.

A Trident Three aircraft permanently sited on the airfield at Cranfield Institute of Technology was used for the evacuations. Volunteers from the public were recruited in groups of approximately 60 to take part in evacuations from the Trident. The aircraft provided an element of realism which was considered necessary. Additionally, the aircraft had a similar cabin layout to many of the narrow-bodied aircraft in operation at the time of the evacuations.

(a) EVACUATIONS THROUGH THE BULKHEAD

The following configurations were assessed:

(i) the international minimum, a width between the galley units of 20 inches (51cm)

(ii) a bulkhead which is typically seen on aircraft, a width between the galley units of 24 inches (61cm)

(iii) a width between the galley units of 27 inches (68cm)

(iv) a width between the galley units of 30 inches (76cm)

(v) a width between the galley units of 36 inches (91cm)

(vi) port galley totally removed

The configurations are illustrated in Appendix A.

The flow of volunteers through the bulkhead was of prime importance in the evaluation of the optimum width between the galley units. It was therefore important that the number of volunteers attempting to reach the bulkhead was not influenced by a blockage at an exit downstream of the bulkhead. Consequently, both of the port Type I exits forward of the vestibule were utilized in all of the evacuations through the bulkhead. (See Appendix C)

(b) EVACUATIONS THROUGH THE TYPE III OVERWING EXIT

The following configurations were assessed:

(i) The minimum configuration complying with CAA standards prior to Airworthiness Notice No. 79, which are also the FAA minimum standards, with a seat pitch of 29 inches (73cm) and a vertical projection between the seat rows of 3 inches (7.6cm). The outboard seats in the rows bounding the exit were modified to allow minimal recline and break-forward movement.

In conditions (ii) to (vii), the movement of the backs of the seats in the rows bounding the routes to both the port and starboard Type III exits were restricted. The limited recline and break-forward of seats, ensured that the configurations were in accordance with the specification of Airworthiness Notice No. 79. The configurations are illustrated in Appendix B.

(ii) A configuration in which the access to the exit between the seat rows was 3 inches (7.6cm) with a corresponding seat pitch of 29 inches (73cm).

(iii)The CAA standard in Airworthiness Notice No. 79 paragraph 4.1.2. (Ref 2) in which 'Seats may only be located beyond the center line of the Type III exit provided there is a space immediately adjacent to the exit which projects inboard from the exit a distance no less than the width of a passenger seat and the seats are so arranged as to provide two access routes between seat rows from the cabin aisle to the exit. In the research program the seat row adjacent to the exit had the outboard seat removed and the seat rows fore and aft of the Type III exit were at a seat pitch of approximately 32 inches (81.2cm), with the vertical projection between the seat rows being 6 inches (15.2cm).

(iv)The CAA standard, specified in Airworthiness Notice No. 79, paragraph 4.1.1. (Ref 2), in which all forward or aft facing seats are arranged such that there is a single access route between seat rows from the aisle to a Type III exit, the access shall be of sufficient width and located fore and aft so that no part of any seat which is beneath the exit extends beyond the exit center line and the access width between seat rows vertically projected, shall not be less than half the exit hatch width including any trim, or 10 inches, whichever is the greater. In the research program the seats fore and aft of the Type III exit were at a seat pitch of approximately 39 inches (99cm), with the vertical projection between the seat rows being 13 inches (33cm).

(v) A configuration in which the access to the exit between the seat rows vertically projected was approximately 18 inches (46.1cm), with a corresponding seat pitch of 44 inches (111cm).

(vi)A configuration in which the seat pitch between the seat row fore and aft of the exit was 51 inches (129.5cm). The resultant vertical projection between the seat rows was 25 inches (63.5cm).

(vii)A configuration in which all of the seats located in line with the exit were removed, leaving a pitch of approximately 60 inches (152cm) between the seats fore and aft of the exit. The resultant vertical projection between the seat rows was 34 inches (86.3cm).

In all of the evaluations of the seating configurations bounding the Type III exit, the egress took place through the port overwing exit (see Appendix C). Although it had initially been suggested that there might be differences between the ease of egress through the port and starboard exits, data which had been collected by the U.S. Federal Aviation Administration (FAA) indicated that laterality of exits did not affect the rate of evacuation (Ref 2). The FAA report indicated that an interaction was obtained between the method of opening the Type III exit and the seat configuration on egress rate. To remove this interaction, the method of opening the exit was held constant throughout the trials. This was achieved by a member of the research team being employed to open the exit, and hand it to a trained observer on the wing.

Procedure

The experimental program comprised two separate series of evacuations involving volunteer numbers of the public. The first series included making bonus payments to the first half of the volunteers to evacuate the aircraft (competitive evacuations). In the second series no bonus payments were made and the procedure for the volunteers was the same as in an aircraft certification test (non-competitive evacuations). The procedure for each of the test series will be described separately.

Procedure for the Competitive Evacuations

Volunteers were recruited in groups of approximately 60 to take part in each experimental session which comprised four evacuations from the Trident aircraft. In two of the evacuations all of the volunteers passed through the bulkhead and evacuated from the aircraft through either of the two port Type I exits. In the other two evacuations all of the volunteers evacuated through the port Type III overwing exit. The configurations were all tested on a minimum of eight occasions, with the exception of the configuration (b) (ii) above. This was considered to be of secondary importance and was tested on four occasions.

The test program involved 28 separate test days of four evacuations. In order to account for the effects of fatigue and practice the order in which the configurations under review were tested, was systematically varied using a counterbalanced design based on a latin square. Although the volunteers were told that they would be required to take part in some evacuations from the aircraft, they were not given any information about the configurations under review, or the order in which the evacuations would be performed.

The volunteers were members of the public. They were recruited by local advertising and were told that they would be paid a £10 attendance fee after they had completed four evacuations. The volunteers were instructed that their task was to evacuate the aircraft as quickly as possible once the exits had been opened by the Cranfield staff. In addition, a £5 bonus would be paid to the first half of the volunteers to pass through the exits which were used on each evacuation.

The bonus payments were made immediately after each evacuation. The seating plans which were developed for the volunteers on the four successive evacuations from the aircraft, gave every volunteer an equal chance of receiving the monetary incentive. Volunteers were not allowed to take part in a test session more than once in any six-month period (this requirement is also specified for volunteers taking part in evacuations for aircraft certification).

The safety of volunteers was an important consideration. To this end, only volunteers who claimed to be reasonably fit and were between the ages of 20-50 were recruited. On arrival all volunteers were given a medical examination. They were also asked to complete a questionnaire indicating that (i) they had fully understood the purpose of the trials, (ii) the medical information which they had supplied was correct and (iii) that they were satisfied with the insurance cover. A doctor and the airfield fire service were present at all times. A system of alarms was employed to stop any evacuation should a real emergency occur or should there be concern for the safety of any volunteer.

In order to introduce as much realism as possible, not only did the evacuations take place from a real aircraft, but on their arrival at the airfield the volunteers were met by members of the research team trained and dressed as cabin staff. After boarding the aircraft, they were given a standard preflight briefing by the cabin staff, they then heard a sound recording of an aircraft starting up and taxiing to a runway. This sequence of recording lasted for approximately five minutes before giving way to the simulated sounds of an aborted takeoff. The sequence was subsequently followed by a period of silence, in which time the pilots were supposedly shutting down engines and liaising with the cabin staff. The shutdown period was predetermined for each evacuation, being either seven or 25 seconds. The variation ensured that the subjects could not anticipate the precise time at which the call to evacuate would be given. On the command 'Undo your seatbelts and get out,' the appropriate exits were opened by research personnel, and the volunteers evacuated the aircraft.

After each evacuation all of the volunteers were required to complete a questionnaire indicating the route which they had taken from their seat to the exit, whether any person or object had hindered their progress and their assessment on a scale of 1 to 10 of the difficulty of their evacuation. Additional questions were included on the questionnaire completed after the fourth evacuation asking volunteers for information about whether they had adopted or changed their strategy for egress during the course of the evacuations. Demographic information relating to each volunteer's age, sex, height and weight was also collected.

Before volunteers left the site they were given a debriefing in which they were reminded of the safety of air travel and advised that they should get back in touch with Cranfield if they experienced any physical or mental problems as a result of the evacuations. At the end of the test program the volunteers were invited to return to Cranfield to attend a lecture about the work in which they had participated. This feedback to volunteers proved to be very popular and was a useful source of volunteers for other investigations.

Procedure for the non-competitive evacuations

Volunteers were recruited in groups of approximately 60 to take part in one experimental session which comprised two evacuations from the Trident aircraft. In one of the evacuations all of the volunteers passed through the bulkhead and evacuated from the aircraft through either of the two Type I exits. In the other evacuation, all of the volunteers evacuated through the port Type III overwing exit.

The six bulkhead configurations at the entrance to the galley unit and the overwing seating configurations (ii)-(vii) which were tested in the competitive evacuations, were each tested on two occasions. The test program involved 12 separate test days of two evacuations. In order to account for the possible effect of practice, the order in which the configurations under review were tested was systematically varied using a counterbalanced design. As in the competitive evacuations, the volunteers were told that they would be required to take part in some evacuations from the aircraft, but they were not given any information about the configuration under review, or the order in which the evacuations would be performed. On arriving at Cranfield they were told that they would be paid a £10 attendance fee after they had completed the two evacuations. The volunteers were instructed that their task was to evacuate the aircraft as quickly as possible once the exit(s) had been opened by the Cranfield staff.

Results

A full description of the results of these trials are given in Ref 3. However in summary, the following two tables compare the results obtained from the competitive and non-competitive evacuations through the bulkhead and the Type III overwing exit.

Table 1 Competitive and non-competitive mean evacuation times for the 30th person to exit over the six bulkhead conditions

Bulkhead Aperture	Competitive trials		Non-Competitive trials	
	Mean	SD	Mean	SD
20"	26.3	2.9	25.1	2.0
24"	24.5	5.8	21.8	1.4
27"	23.2	7.1	23.7	2.7
30"	18.4	1.9	23.4	0.0
36"	17.2	3.1	21.4	3.4
PGR	14.7	1.4	17.6	0.5

PGR = Port galley removed
SD = Standard deviation

Discussion

Evacuations through the bulkhead

The results from the evacuations which were conducted involving competition between volunteers for bonus payments clearly indicated that as the width of the aperture in the bulkhead was increased, passengers were able to evacuate the aircraft more quickly. During these evacuations, there was a sudden rush towards the front of the cabin once the call to evacuate the aircraft had been made. This frequently led to temporary blockages caused by people struggling to get through the gap in the bulkhead ahead of those beside them. The smaller the aperture in the bulkhead, the more pronounced and more frequently the blockages seemed to occur. The blockages and people struggling against each other contributed to the slower evacuation times found in the results. The fact that the evacuations times for 20 inches, 24 inches and 27 inches apertures were significantly slower than for the 30 inches and 36 inches and the port galley unit removed conditions, suggests that consideration could be given to a minimum width of 30 inches for a passageway through a bulkhead.

The most rapid evacuation occurred when the port galley unit had been removed. This configuration had the disadvantage that the member of cabin staff responsible for opening the aft Type I exit, had no bulkhead to protect her from the sudden rush of people following the call to evacuate the aircraft. As a result she frequently experienced difficulty opening the exit and on a number of occasions she was pushed out of the aircraft by the surge of passengers. In an emergency, cabin staff are not only responsible for the opening of the exits to be used, but they must also ensure that the chutes are inflated. They are also expected to direct and if necessary assist passengers. If a member of cabin staff is evicted from the aircraft by the rush of passengers, the resulting evacuation may become disorganized and less efficient, resulting in an increased probability of injuries and fatalities.

Table 2 Competitive and non-competitive mean evacuation times for the 30th person to exit over the six overwing conditions

Vertical projection	Competitive trials		Non-Competitive trials	
	Mean	SD	Mean	SD
3"	71.4	15.0	53.2	1.8
6"(OBR)	53.2	10.0	39.6	2.5
13"	55.9	10.3	39.9	3.3
18"	53.7	8.2	37.2	0.2
25"	54.9	11.5	40.8	2.7
34"	62.3	8.1	35.3	0.6

OBR = Outboard seat removed

Evacuations through the Overwing Type III Exit

In the competitive evacuations when the configuration of the seating adjacent to the overwing exit involved a vertical projection of 3 inches, and the movement of the backs of the outboard seats only was restrained (condition (i)) there was a continuous series of people temporarily trapped in the exit aperture. This was caused by groups of passengers pushing and all trying to get out at the same time. On three occasions the blockages became so severe that the safety officer had to halt the evacuation. It was apparent from the video data how easily this exit could become blocked with passengers in an aircraft accident.

A comparison of the data from the evacuations through the two configurations which involved a vertical projection between the seat rows of 3 inches clearly indicated the importance of restricting the movement of the backs of all of the seats in rows adjacent to the exit. When the movement of the backs of these seats was restricted (condition (ii)), the evacuation flow rate was significantly faster than when only the movement of the back of the outboard seat was restricted (condition (i)). Furthermore, in the evacuations in which the movement of all the backs of the seats in the row was restricted, and the vertical seat projection was 3 inches (condition (ii)), there were no instances of abandoned evacuations as a result of blockages in the exit aperture.

In the configuration in which the outboard seat was removed and the vertical seat projection was 6 inches, two of the eight evacuations were halted when the exit became blocked. The evacuation flow rates for this configuration varied widely. This seat configuration caused passengers to arrive at the exit in two streams which met in the space vacated by the removal of the outboard seat. If one stream became dominant, the passengers from this stream would egress with the injection of the occasional passenger from the other stream. In this instance, the evacuation was rapid and the space created by the removal of the outboard seat was of considerable benefit. If, however, there was continuous competition at the exit between individual passengers from the two streams, this reduced the speed of the evacuation and on two occasions led to a complete blockage at the exit.

As the distance between the seat rows was increased, the tendency for blockages to occur in the doorframe was reduced. The results of the evacuation flow rates indicated, that as the vertical projection between the seats was increased from 3 inches to 25 inches the speed of the evacuation of the first 30 volunteers was increased. However, when the vertical projection between the seats was increased from 25 inches to 34 inches, the evacuation time became longer. A 34-inch vertical projection is equivalent to the removal of a whole row of seats. Once the vertical projection exceeds 25 inches it would appear that the channel which is made between the seat rows allows more people into the area than can get through the exit at once. Thus the blockages tend to recur, and this in turn causes the evacuation to take a longer period of time. It was interesting to note that the volunteers reported more instances of being obstructed on their route to the exit in the 3 inches and 34 inches vertical seat projection configurations than in the other four configurations tested.

The times obtained from both the competitive and non-competitive evacuations clearly indicate that the two seating configurations introduced by the CAA in Airworthiness Notice 79 have significantly increased the rate at which passengers can be expected to evacuate through a Type III overwing exit. As Table 2 illustrates, the evacuation times in both the competitive and non-competitive evacuations for the 13-inch, 18-inch and 25-inch vertical seat projections are not significantly different, although an 18-inch vertical projection would appear to be the optimum.

Conclusions

1. The experimental program successfully met the objective to produce a series of simulated emergency evacuations in order to explore the influence of passenger motivation on aircraft evacuations.

2. The results from the program of evacuations involving competition between passengers suggested that increasing the width of the aperture through the bulkhead will lead to an increase in the speed at which passengers can evacuate the aircraft in an emergency.

3. Type III overwing exit tests indicated that changes to the distances between the seat rows either side of the exit will influence the speed of the evacuation.

4. The results from a comparison of the video data from the competitive and non-competitive evacuations indicated that the non-competitive evacuations provided an effective simulation of passenger behavior in precautionary evacuations, and in aircraft evacuations when the physical conditions in the cabin have not deteriorated.

5. The introduction of incentive payments to volunteers successfully induced a simulation of the behavior reported to occur among passengers, when conditions in the cabin are perceived to be life threatening.

6. The use of incentive payments to produce

a competitive evacuation has been shown to have the potential to provide both the behavioral and statistical data required for the assessment of design options or safety procedures for use in emergency evacuations which maximize the degree of realism. Nevertheless, the technique should be used sparingly since it can be potentially hazardous for volunteers.

References

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2. Rasmussen P. G. and Chiltum C.B., "The Effect of Proximal Seating Configuration on Door Removal Time and Flow Rates Through Type III Emergency Exits." Memorandum No. AAM-119-86-8 U.S. Federal Aviation Administration, 1986.

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Appendix A

Graphic not available

Appendix B

Graphic not available

Appendix C

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Understanding and Defusing the Sources of Stress

Photo not available

GISÈLE RICHARDSON
President
Richardson Management

Stress is an important, complex, misunderstood subject. It is relevant to us all who want to perform better in our job, be more present in our relationships, maintain a high level of positive energy, be more reliable in our problem-solving, and generally live better lives. It has a direct bearing on safety.

It is a multi-faceted subject. In this talk, I want to accomplish the following things: remind you all of the difference between stressful events, and the resulting experience of stress on an individual — too often the difference between the two is muddied, both in the way we refer to them and in the way we think about them. Clear thinking facilitates problem-solving. Secondly, I want to emphasize that I will be dealing with the aspect of self-induced stress (which is most of what we experience as "stress") — that is to say, the peculiar ways in which individuals process stressful events (often referred to as "stressors"). Then I want to indicate some of the reasons why the same stressful event has different consequences for different persons. And finally, since I am results-oriented and often critical of information that has no practical application, I will give some clues you might use to recognize your own manner of creating and enhancing stress and to be able to mitigate it.

Ordinary life events are an unavoidable part of living. People are promoted, demoted; children are born, leave home; couples are married, they quarrel, they divorce; drivers cut you off on the highway and don’t move when the light turns green; people over-extend themselves financially; employers are unstable — in other words, living is stressful. It places constant demands on us, demands which allow us to grow and to learn and to be challenged; but demands, too, that don’t always come at the right time, or demands we should have preferred to live without. Positive or negative, they require us to accommodate, to adapt.

The patterns we have developed early in life to react to these events will dictate whether we experience low or high levels of stress at specific times in our life and in our life generally. The degree to which we can — under pressure — retain our ability to think clearly, to respond appropriately, and to close the book on them and move on with our life, is a pattern established early in life and is, fortunately, a pattern we can learn to modify, not only in responding to unexpected conditions on the flight deck, but also in our personal life, at home, in our relationship with our spouse and children, and perhaps most important, in one’s relationship with oneself.

Several years ago, a group of psychologists got together and said, “We know all about sick people. What do we know about healthy people? We never see any.” So they selected a group of 268 young men whom they had tested and found to be better adjusted emotionally than the average population. And they followed them for 35 years. They followed them from a distance in a way that would skew the process as little as possible. The outcomes were very interesting. Three pieces of their conclusion seemed particularly interesting to me. First, that these “healthy” people did not have fewer reverses and tragedy in their life than did the control group. Rather, the difference was that they dealt with them more effectively and moved on. That is to say, a measure of our health is our way of reacting to problems, not an absence of them. Secondly, they also found that the group under study was more likely to use difficult experiences to grow, much as “the means by which an oyster, confronted with a grain of sand, creates a pearl.” And finally, they also concluded that members of this “healthy” population succeeded in reaching their own goals and helping others around them reach theirs, where a less well-adjusted person’s life would consist of making more enemies than friends and frustrating their own desires.

In other words, they found that their select population had developed better techniques for adapting to and surmounting life’s difficulties. That is what we mean by a stress-resistant person.

Why should the same event be more stressful, more demanding, more lasting in its sequels for some people than for others? Our contention is that some of us have developed better habits than others to deal with painful or trying circumstances - and, MORE IMPORTANTLY, that we can continue deliberately and effectively to improve those habits throughout our life. This is the belief on which our seminars, “The Human Element in Aviation,” are based: that it is possible for us to identify our current ways of responding and to improve them — for greater safety, for better performance, and for a more rewarding life.

Here is a simplistic illustration that will, in the short time we have available here today, illustrate our point:

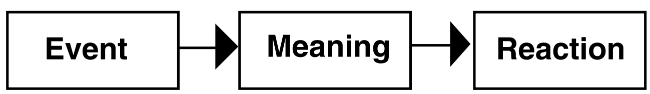
Example: Someone makes a suggestion for improvement in some procedures at the weekly pilots’ meeting. One boss thinks, “That’s a good idea; we can do that,” and feels excited at the prospect of improvement; another thinks, “Why didn’t I think of that?” and feels inadequate, and begins to question his ability to do his job. Another boss thinks, “He’s trying to make me look like a fool again,” and feels angry and mistrustful and starts planning how he’s going to ‘fix’ the fellow.

Same stimulus. Different responses. Why?

Each reaction is based on the individual chief

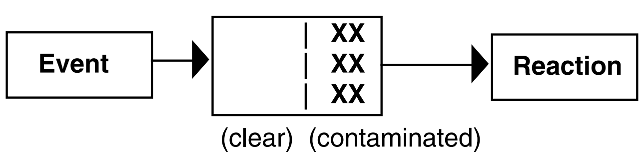
pilot's construct of reality — how he chooses to see himself, others and life.

Most of us tend to believe that our response, whether it be external (words or behaviors, a smile or a frown, a slap or a caress) or internal (feelings, plans for rewards or revenge) are caused by the event. In fact, the catalyst for our response is the way in which we make meaning of the event: the interpretation we give it, and its implications for us.



Most of the time, if we are functional in our life, we are operating from what we will call the "clear" part of our head: the part which is objective, connected with reality and able to accurately assess evolving events around us, and to correct ourselves.

This is how we learn, this is how we grow, this is how we acquire wisdom. However, another part of our head, which we might call "contaminated," contains a map of the world which is less subject to self-correction.



Each one of us has created for ourselves a psychological map of the world that is peculiar to us. We have developed a way of judging ourselves and others, created a set of expectations from life, and we are constantly measuring our life experiences against these pre-conceived ideas. When our evaluation takes place in the "clear" part of our head, the evaluation tends to be connected with reality and rests on valid appraisal of the information available; when, however, the "contaminated" part of our head is dominant, the interpretation that results is based on obsolete and inaccurate assumptions made early in life that have remained resistant to self-correction. This is the part of the faulty processing that accounts for our all being "normal neurotics."

This sounds more complicated than it really is. Let's see how it works. The emotional need for control is not something that needs to be explained to a group of pilots. This characteristic is one which is not limited to your profession though it may be experienced more intensely there than in other parts of the population. It is, in fact, a basic human hunger. It can be satisfied with information: if I know what is going on, I can take care of myself. "Better bad news than no news at all."

Children begin to experience this very early in life, and in their attempts to make sense of their world, start looking for patterns and formulas. The answers they reach are sometimes exceedingly creative and accurate; at other times, seriously flawed; at other times, conclusions are appropriate in their family setting, but not necessarily elsewhere. These conclusions tend to refer to the child himself (a definition of who I am), others (a definition of how they are) and life (what can I expect, and what do I have to do to manage). These conclusions, which we call Early Life Decisions (E.L.D.), especially when made under stress, are filed away in the pre-conscious and surface when external events serve as triggers.

Enough. Let's have some examples. There are six kids in a five-pork-chop family. There is a high likelihood that one or more of these children will decide that the only strategy that works in life is to fight for what he wants. That may, in fact, be true while he is small. But he will — unwittingly —resort to that strategy later in life, often inappropriately, in situations where another approach would be more useful, and likely, less stressful. Quite apart from the expenditure of energy that this implies, and perhaps more important, his attention is diverted away from those events on which he should be focusing.

Take another little kid whose father is never satisfied with his work. "100 persent in arithmetic? That's nice. Will you be able to keep this up for the rest of the year?" His E.L.D. may be to drive himself constantly, to never experience his own success, to be an overachiever - or he may say to himself, "No matter what I do, it's never good enough," and give up too often too early.

Another little boy, whose father makes fun of his intelligence, may say to himself, "I'll show you how smart I am," and grows up to be a know-it-all, or a sarcastic one-upper. (Most "I'll show you ..." decisions are made in anger: "I'll show you I don't need you," "I'll show you even if it kills me.")

Another way of explaining this is that sometimes we are connected with reality and really aware of the evolving situation around us and how we fit in it; at other times, we might be compared to a closed circuit television: we are bent on counterproductive behavior such as aggression, distrust, inhibition, self-criticism, avoidance of others, and that is sustained over time even in the face of clear high costs we pay for such behavior. These are all examples of the contaminated part of us. In other words, whether a child concludes that the world is a hostile or a hospitable place, whether the child concludes that he is or is not a decent, likeable person, whether the child concludes that others are trustworthy or not, all these early conclusions will be reflected at certain moments on a daily basis in his life. The intensity, the frequency and the duration of these misconceptions will be a measure of how much work the individual needs to do to become more effective and better connected with reality, and to perform in a safer and more reliable manner.

Positive early life decisions result from experiences of kindness, of love, of acceptance, of achievement. A little kid who puts together a complicated Lego structure or rides a two-wheeled bike for the first time, says to himself, "Wow, I can do it!" and that experience and sense of mastery may become a generalized element in that man's self-esteem. "They like me!" concludes another child, in the face of his parents' obvious delight in him, and he continues to meet new people with an expectation of acceptance. A child who has a refuge, who has a person in his life who will hear him uncritically and comfort him appropriately, concludes, "I can always find support when I need it," and continues to live his life with that expectation.

All of us have filled our early years with such conclusions, about ourselves, about others, and about expectations of life out of our need to find structure, to take care of ourselves in ways that are dictated by these views of the world, to make life predictable, and to have a sense of control. We have, of course, added some since then as we continue to learn to grow, to get wiser. Some of our positive conclusions are unshakeable, and provide critical — sometimes life-saving — support (survivors of prison camps, or people experiencing a series of family tragedies who somehow don't lose their hope in a good life). Some of our negative conclusions get corrected as we continue to learn, to grow, to get wiser. Some of them, though, prove unshakeable and continue to cloud our judgment of ourselves, of others, and of our expectation of life, sometimes at moments where bad judgment is disastrous and life-threatening, or destructive of important relationships You say to yourself, observing him, "It doesn't make sense! Why does he do this?" But it does make sense in his contaminated view of the world.

Let us look back at the three chief pilots. Each one of them is telling us something about his psychological map and his early life decisions. The first one is operating from the "clear" part of his head. He sees an opportunity for improvement, he is acting appropriately as the leader, and his attention and feelings are directed to the task at hand.

The second chief pilot has, as one of his early life decisions, "There is something wrong with me" or "No matter what I do it is never good enough." You can readily see that — at least momentarily — his attention is on his internal process rather than on the task at hand. He is unlikely to make good use of the suggestion, or if he does, it will be at some cost to himself. The third one is telling us that one of his early life decisions is "You can't trust anybody" or "There is always someone out to get you."

Another example: If one of my early life decisions were the same as the third chief pilot's and someone said to me, "Gisèle, you look 10 years younger with your hair short!" my interpretation of that might be "The witch is telling me I used to look old!"

These behaviors are not isolated. The man who thinks, "No matter what I do … ." illustrates, by his behavior, an underlying sense of inadequacy in a dozen different ways, just as the suspicious man frequently illustrates his distrust in small or insignificant ways. If you, as an acute observer, recognize those signs, you will have a better understanding of the driving forces in that person's character. Since they are responses that are based on a "conclusion" that is intended to make life predictable (to guarantee some control), they will be a recurrent theme in his life, in his relationships.

Clearly, good communication, as well as clear thinking, depends on our operating in the "clear" part of our brain, both at work and at home.

When the contaminated part of our self is dominant, when we are processing events from that part of our brain, we are not in touch with the current situation, we have set aside our ability to respond to the evolving events around us, our energy is in the part of the brain concerned with the past or with fantasies about the future. In other words, we are in a state of momentary (or prolonged) disconnection from the here and now. Only part of our "computer" is available for observing, for analyzing, for problem-solving.

As I said before, we are all, as a consequence, "normal neurotics." The degree to which we are hooked in some of these old - unresolved - events will determine the degree to which we are reliable under pressure. We can look at these "hooks" on a scale of 1 to 10; a person whose decision is I'll-Show-You on a measure of 2 is mildly rebellious, on a measure of 9 he will be unemployable. (I'll Show You is a dangerous generator of poor judgment calls.)

Individuals can learn to identify their own "hooks" and assess their influence by looking at their frequency, their intensity, and their duration. That is to say, the interpretation and the accompanying feeling might be experienced daily or rarely; as a mild annoyance or as a raging desire to kill; and last for a few minutes, or be the basis for a three-day sulk.

You may have by now had a flash of someone you know whose behavior betrays one of these early life decisions, or you may have had a glimpse of one of your own.

Once these psychological habits are in place, they become knee-jerk responses to stimuli that will provide the needed catalyst for us to play the whole scenario in our head, whether or not we externalize it in our behavior with others. Now, emotions have an important role to play in all of this. The "pictures" we generate in our head and the meaning we give to them predictably result in certain emotions, emotions that we refer to as Favorite Bad Feelings, given that each individual has a feeling or a constellation of feelings that he habitually turns to when things go wrong. The smorgasbord from which we make our choice is rich and varied: sadness, guilt, mistrust, anger, low self-esteem, self-righteousness, hate, anxiety, rejection, loneliness. Take your pick! (And chances are, you have.)

To illustrate, I will offer you an exercise. Will you close your eyes and relax as well as you can, yawn or stretch and take a few deep breaths to relax? And now, will you do what you need to do to experience some bad feeling? Take your time, and make some pictures in your head, recall or predict some happening, and allow yourself to really get into it. Take some time to do this.

Notice what you are feeling. And notice the process by which you created that feeling. What pictures did you make? How did you select them? What did you say to yourself? What meaning did you give to that scene? How familiar is that process for you?

Well, that’s how we do it. 0-10, frequency, intensity, duration.

What you selected just now — the emotional channel you chose — may be your Favorite Bad Feeling — in other words, the most familiar, “comfortable,” “natural” response to unwelcome events. Except, of course, that it is not natural at all — it is learned, it has become a habit, it is a habit you can drop.

Look for patterns in the feeling and in what you said to yourself. (“You can’t trust anybody. If you want anything done right … .”) See if this is a familiar experience in some guise or other, and look for possible clues that will tell you whether you have made a habit of turning to this particular feeling whenever things go wrong for you.

Incidentally, it might be interesting for you to guess at your spouse’s F.B.F. and reflect on whether or not you have a good match! If your bag is anger and guilt, and hers is hurt or self-pity, you have a deal. You say or do something angry — she feels hurt — you feel guilty. Bingo! Everybody “wins.” You might want to think about the role of your respective F.B.F. in your less happy moments with each other. (A word of warning: don’t go home and use your new knowledge on “psychologizing” your wife unless you want both of you to get into your Favorite Bad Feelings!)

Bear in mind that you can as easily — if you wish — select a channel which delivers joy, laughter or tenderness, or solve-this-problem excitement. Mental health consists of deliberately choosing a productive channel, of making a positive interpretation a more prevalent habit than the former.

Where do negative emotions fit as a stress factor? Well, a few weeks ago, we had a Chief of Maintenance in one of our seminars — a dictatorial, critical, demanding fellow, very intelligent, and an expert at concealing his warmth and his caring from the people who worked and lived with him. Half-way through the week, the penny dropped, the light came on, and he said, “You know, it takes a lot of energy to be an S.O.B. all day long.”

There you have it! It takes a lot of energy to be angry and distrustful all day long, it drains a lot of energy to batter one’s own self-esteem all day long, it takes a lot of energy to maintain years of guilt all day long, etc., etc., etc!

Quite apart from the stress (expenditure of energy) that is required to maintain bad feelings, perhaps more important, the individual’s attention is diverted away from those events that surround him, events that he really should be focusing on, whether they are evolving danger in the cockpit or an S.O.S. in his son’s voice.

So to sum up. The degree of stress each one of us experiences in a day, a year, a lifetime, is largely defined by our ability to react to stressful events in a way that is appropriate and economical, in a way that costs as little as possible in energy, joy and clarity.

Our ability to do this depends on our willingness to identify faulty early life decisions that are currently occasionally muddying our judgment, to identify our Favorite Bad Feelings and do what we need to do to shift to problem-solving when they arise. Dealing with these two items alone will considerably increase a person’s reliability under pressure, as well as his well-being and comfort with himself and with others.

After this brief introduction to these concepts, you have at least a sketchy framework to start identifying some of the less productive ways you may have developed to give meaning to events in your life. You can begin to monitor your thoughts and your feelings, the ways in which you speak to yourself and the emotional outcomes which result. By noticing them, you will soon identify which are repetitious reactions and you can develop "an early warning system" that allows you to start changing channels, and to start modifying them; you have a clue about unproductive feelings you entertain, cultivate, fertilize at times, feelings that cut you off from living - and you can start "changing channels."

Of course, all of our emotional carryover from childhood cannot be dealt with by a relatively superficial self-exploration. Many of us benefit from some assistance in the form of teaching or counseling. Yet, with a minimum amount of diligence, if you keep these ideas in mind, you will start noticing yourself: your words, your feelings, the kinds of pictures you make in your head, the recurrent phrases you say to yourself, their likely connection with childhood experiences — and that is how we gradually reduce our "contaminated area", and reduce our habit of muddying part of our effectiveness and happiness. You can also, as a result of this brief exposure, become curious and seek more information. You can change the culture in your flight department and make it legitimate to examine and respect psychological issues, and if need be, you can choose to get some assistance to accelerate your own process. It is high time aviation pays attention to these normal human processes and helps its people in their psychological development as they now do so well in the advancement of technical skills.

There are, unfortunately, no magical solutions, no perfect clean-up, no Nirvana that I know of. But there are steps you can take to contribute to your own development and so to lessen your susceptibility to stress. The outcome? A safer pilot, a better companion, a happier person.

Learning From the Experience of Others

Photo not available

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Since the beginning of time, man has always wanted to fly. This desire of flying was only tempered by the fear of flying. These two conflicting feelings resulted in civil aviation becoming one of the most efficient and safest modes of transport.

Every day several millions of people board big or small aircraft and fly safely between two points which could be at the opposite ends of the earth. Do all these people realize that they have a greater chance of dying in a car accident, from a heart attack, or even from a domestic accident at home, than they do during the flight?

However, even if we can justifiably be proud of this achievement we all know that too many accidents still happen and that we have to go on fighting not only to improve but also even to maintain the safety record of civil aviation. The dramatic increase in the number of passengers transported by air, forecast till the end of this century, means that if we do not improve significantly the accident rate, we could see a rise in the absolute number of fatalities. This could prove to be unacceptable to the travelling public because, even if an aircraft accident is fortunately a very rare occurrence, it makes the headlines of the newspapers, and strikes the imagination of the public. Therefore, there is no place for complacency and, on the contrary, we have to look for new ways of improving wherever possible the prevention of accidents. But any sensible policy of accident prevention depends on the availability of reliable data to identify potentially dangerous trends or situations and areas of particular concern. The main sources for these data can be found in the experiences, in particular the bad ones, from the passengers and crews who have suffered from an accident or incident.

The value of the information which could be derived from accidents has been recognized for a long time by International Civil Aviation Organization (ICAO), since the Chicago Convention of 1944 contains, in its article 26, provisions for the institution of accident investigations. The detailed Standards and Recommended Practices for the conduct of such an investigation are contained in Annex 13 to the said Convention and more guidance material can be found in the Manual of Aircraft Accident Investigation.

According to Annex 13 to the Convention on International Civil Aviation "The fundamental objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability."

This statement clearly defines what the technical investigation of an accident should be — and what it should not be. We can draw from this a number of conclusions as to the conduct of the investigation:

- the investigating body must be objective, impartial and independent. This means in particular that this body must be totally separated from the national Civil Aviation Authority. As, in effect, this authority could be implicated in an accident through its involvement in airworthiness or air traffic control;

- the investigating body must have at its disposal sufficient resources to carry out an investigation in case of a major accident. This means sufficient human resources both in quality and quantity (e.g., a number of full-time professional investigators with operational experience), the possibility to call on the advice from other sources of technical knowledge, such as manufacturers and independent laboratories, and the financial resources necessary to proceed to detailed analyses of material or for the recovery of wreckage;

- the investigating body must also have sufficient legal power to give it unconstrained access to all information, in particular flight data and cockpit voice recorders or evidence of witnesses;

- and finally, the investigating body must be in a position to publish its findings as soon as possible, independent of any outside influence, including its recommendations to remedy any perceived weaknesses in the system discovered in the course of the investigation.

Experience has shown that it is difficult to comply with all those requirements and that there is plenty of room for improvement. At the level of the European Community, a first step in improving the cooperation in aircraft accident investigation was realized in 1980 when a Directive was adopted which organizes mutual assistance, providing that, at the request of the Member State conducting the investigation, each Member State must endeavor to make available installations, facilities, equipment and experts. It also provides for the exchange of information on accidents involving aircraft of less than 5,700 kg.

In view of the progress towards European integration and the completion of the internal market, the time has come to take account of the experience gained up to now and to try to improve the cooperation and strengthen the position of the investigating bodies.

In order to obtain the necessary information to launch new Community initiatives, studies were carried out at the Commission's request and consultation with the national experts from the Member

States were organized last year. Representatives from all sides of the civil aviation sector were also associated in these consultations.

This enabled the Commission’s services to identify a number of areas where Community action could be desirable and beneficial to improve the present situation. I will try to summarize these for you.

It is clear that any Community intervention in the field of aircraft accident investigation will have to be grounded on the principles established by the ICAO and, in particular, the Standards and Recommended Practices set out in Annex 13 to the Convention on International Civil Aviation, and that approximating the different national laws governing aircraft accident investigations, in the spirit of Annex 13, would give Member States the opportunity to bring their rules and regulations up to date.

Among the measures which could be envisaged, it will be necessary to start with preliminary harmonization measures, because the organization of aircraft accident investigation bodies differs greatly from one Member State to another in terms both of human and material resources and independence vis-à-vis the national aviation authorities. It seems therefore that a first attempt should be directed to the establishment of basic common principles for all national bodies with regard to material resources and the number and training of staff.

Other measures could be aimed at strengthening the hand of national technical investigation bodies. This could include the freedom of access to the information sources necessary to complete the investigations such as the accident site and wreckage, the victim’s bodies, the witnesses and particularly the flight data recorder and the cockpit voice recorder. Under this heading we could also add a revised definition of the status of the investigators, particularly with regard to their relationship with the judiciary.

A third kind of measures could be designed in order to strengthen the cooperation between Member States. Investigators from the different national bodies could be grouped in a Task Force from which, at the request of a Member State, a reinforcement team or specialized investigators could be drawn. In the same spirit, newly appointed investigators could be invited to join teams in the field to gain the fortunately scarcely available experience. There is moreover no doubt that cooperation between the Community’s different investigative bodies can only be improved by the establishment of personal contacts between investigators from different Member States and between the heads of these bodies. To increase this kind of personal contacts, regular meetings of heads of investigating bodies could be organized at Community level and common training sessions for investigators from all the Member States could be set up under the Commission’s auspices.

There is a final set of measures which could improve the functioning of, and the lessons which can be drawn from, accident investigations. These measures deal with the dissemination of information. Many problems impede the flow of information during or after an investigation. During the course of investigation, the investigator is often under pressure from a number of people who try to obtain advanced information, particularly from journalists, lawyers and relatives of the victims but also from insurance companies, members of the judicial inquiry, manufacturers or pilots’ associations. It could be of help to investigators if rules were established regarding the information investigators could release, and protect them from outside pressure. When the investigation is completed, a report is usually published. It could be useful to standardize the format of these reports (on the basis of ICAO requirements) and to take measures to ensure the distribution and publication of the report, or of significant passages of it, to all interested parties.

But if the technical investigation can significantly improve our knowledge of those actual circumstances which led to the accident, it only enables us to act “a posteriori” to try to prevent the same accident from happening again. In addition to that, as — fortunately enough — the number of accidents is very limited, we usually are faced with a statistically insufficient basis for discerning trends or to identify common patterns useful for a true accident prevention policy.

However, we know that every day, worldwide, thousands of incidents happen. Those incidents which are often considered as no more than a slightly unusual event could become very significant for safety if it appears that the same circumstances have been observed repeatedly. Needless to say, other types of incidents are considered so significant that they are treated as an accident and are submitted to the full investigative process similar to that of an accident.

It is, therefore, very important to keep track of those numerous incidents and a number of systems do already exist at different levels: ICAO, national aviation authorities, individual airlines, etc.

But before examining what additional initiatives could be taken in this field, it is important to clearly separate the incident reporting systems into two separate categories: the mandatory and the voluntary systems.

The mandatory reporting systems are usually administered by the national authorities and keep track of incidents of a more technical nature. By voluntary reporting system I mean those confidential systems whereby a pilot, or an air traffic controller (or any other interested person), sends voluntarily a report in which he explains circumstances that have probably not been noticed by anybody else, and that result usually from his own mistake or misunderstanding. In order to motivate people to report these errors, confidentiality is guaranteed to the reporter as well as a certain level of immunity.

But let us come back first to the mandatory reporting systems. In view of the value of such systems in accident prevention, it would be desirable that all incidents happening in the Community could be recorded. But, according to a study carried out at the Commission's request, seven Member States of the Community have their own mandatory incident reporting systems. These vary widely in their organization and sophistication and are usually operated by their civil aviation authority. As systems already exist, it would probably be a waste of resources to create from scratch a new Community system. Unfortunately, the existing systems are incompatible but as the significance for safety increases with the area covered and the number of incidents recorded, it would certainly be desirable for each State to have access to the data of the others. For this reason we have asked the Community's Joint Research Center (JRC) to study the feasibility of a system interlinking the existing national databanks.

The second problem is that a number of states have no mandatory reporting system. It would therefore be necessary either to create new systems in these countries or to suggest they join one of the existing systems or even better to join directly the central interlinking system to be created by the JRC. One of the prerequisites to enable such a Community action in this field will be to define a number of basic parameters in order to facilitate the exchange of data and to give guidance for the States wanting to create their own new system.

The situation is completely different with regard to a voluntary reporting system. There is at present only one system in operation in the Community. This system is called CHIRP, which stands for Confidential Human Factors Incident Reporting Program. It is administered by the Royal Air Force Institute of Aviation Medicine and funded by the U.K. Civil Aviation Authority. There is, however, considerable demand (particularly from future users) for such a system which could allow the detection of potentially dangerous situations caused mainly by human error. Knowing that about 80 percent of accidents are influenced by human factors, it cannot be denied that a European voluntary confidential reporting system could constitute a very valuable tool to improve air safety. The Commission therefore intends to study the possibility of setting up such a scheme at Community level. For this, the Commission’s services will take into account the existing CHIRP system and the development efforts which are presently envisaged in Germany but they will also insist on having the closest possible compatibility with the American ASRS (Aviation Safety Reporting System), which is managed by NASA. This ASRS has been considered as very successful and, since its beginning in 1976, must have received well in excess of 150,000 reports! The amount of information contained in ASRS has been put to good use for a number of safety related research projects and for the publication of a number of studies addressing various aspects of aircraft operation both from the perspective of the pilot and of the air traffic controller.

As this system is so successful, one may wonder why we should develop a European System instead of encouraging European people to report to ASRS. The answer is simple: European operations are very different from American ones. Our airspace is more constrained by available space, military areas, etc.; our weather conditions are very different and changing over a smaller distance; pilots and controllers communicate in a language which is often not their mother tongue and the culture and training of the Europeans is totally different than that of the Americans. This last point is particularly important when studying human factors. For this reason, a specific European system would be better suited to our specific needs, but compatibility with ASRS will also be absolutely essential.

In conclusion, I would like to stress that there is still plenty of scope to improve the safety of civil aviation. Some of those improvements could be obtained through a better knowledge of accident and incident circumstances. For this, we need to gather data on a wider-than-national basis. For this reason, if we can realize the initiatives I described in this presentation, the European Community could play a useful role in building cooperation between its Member States with the ultimate goal of enhancing the safety of the travelling public.

Individual Pilot Input to Flight Safety Programs

Photo not available

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Introduction

Most presentations at seminars of this kind are about the responsibilities of the operator. Safety programs and training schemes are discussed between safety specialists. The pilot is often regarded merely as an element in the system, to be kept within limits like the other elements. Such a mind-set can easily occur in a major airline where a separate safety department exists, grouping safety experts, instructors and check airmen.

The safety function becomes another item in the list of things to be trained and checked. Operating regulations spell out in detail the content and timing of checks and training sessions. In a setting like this, the temptation is always present to consider the safety situation to be well in hand. Two factors may yet be present which make a closer look advisable. Firstly, a system that conforms to the regulations on paper may well be deficient in practical implementation. Secondly, a system that works well for the airline as a whole is not necessarily optimum for an individual pilot at a given moment.

Clearly then, even the most elaborate safety program will be amenable to improvement by individual pilot input, quite apart from the fact that training results are so much better if recipients of the training adopt a positive attitude.

At the other extreme there are situations where there is no flight safety program to speak of. In this case, pilot input will have to be more extensive. Although it may be necessary to invest a great deal of time and probably some money the advantage is that any amount of effort will result in an improvement.

This paper is written for those many pilots, in regional airlines, in corporate aviation and in other professional pilot positions who feel the need to critically examine their personal flight safety situation and do something about it.

Defining a Flight Safety Program

A Flight Safety Program can be defined by deciding what is to be achieved and how this will be achieved.

The Objective

A Flight Safety Program should prepare a pilot to:

- recognize hazards to safe operation of his or her aircraft;
- prevent these hazards from causing incidents or accidents;
- minimize the damage if an incident or accident does occur anyway.

The Program Dimensions

There are three dimensions to a program:

- Certain ares have to be covered to ensure compliance with the objective;
- In order to be effective, training and checking must be repeated at certain intervals;
- The thoroughness and methodology used in administering the program are important quality determinants.

Clearly a program scoring high on all three of these dimensions is likely to work well. Conversely, a deficiency in the program may be rooted in any of the three dimensions. This is the case when, for instance, a program that looks complete in its coverage on paper is administered by sloppy procedures in practice.

Areas to be Covered

Flying has evolved into the operation of a complex man-machine system in a complex environment. Hazards to safe operation have multiplied accordingly and all of them must be considered in a Flight Safety Program.

Pilots must be aware of hazards in their own man-machine system as well as those in the environment. In the first group one finds hazards associated with the pilot himself, his or her fellow crewmembers and sometimes the passengers. Also in this category are hazards associated with the aircraft. The group of hazards associated with the environment contains such elements as weather, traffic, terrain proximity, ATC and airport conditions. Having recognized the hazard, pilots must be able to prevent an incident or accident from occurring. Basic flying skill, knowledge of the aircraft, of human nature and of the environment must be available as the basis for quick and correct analysis and action. Pertinent, correct and timely information is also required. Finally, if an incident or accident does occur anyway, pilots must be able to carry out prescribed emergency procedures and take post-accident survival action.

Frequency of Training and Checking

Critical training and checking of the kind under discussion must be repeated at intervals to ensure retention and correct behavior when the need arises. Initial training for new aircraft types is in itself a refresher on basic airmanship if carried out correctly. In many cases regulations require that some recurrent training or checking takes place when licenses are renewed at each six- or 12-month intervals.

Non-required recurrent training should be added as indicated by operational circumstances. Safety considerations would indicate that material critical to the operator's specific operational environment including any special hazards involved be most frequently repeated. Whereas some aspects of pilot training may be repeated at longer intervals, none should be assumed to be adequately covered for life by a once-only course.

Thoroughness and Methods

A good program will be well designed and administered in all of its aspects. Methods and training techniques should be used which are appropriate to the situation.

Initial Pilot Input — Taking Stock

A pilot who desires to evaluate the flight safety program offered to him or her should first of all look at the existing situation. Are any of the areas mentioned before glaringly absent from the program as it stands today? Is any area, though not totally absent, deficient at first sight, in content, frequency or methods? Does any aspect of the operation cause misgivings about flight safety?

Note the answers as a first step of what will be, in essence, a personal safety audit and risk analysis. They will be useful as you examine all of the program's areas in turn for content, frequency and methods, as well as for ways to obtain improvements.

Having come this far, you have taken a most important aviation decision: You have decided to be a safe pilot.

If you feel that no improvement in the safety program is necessary (you are already very well trained) or that it is pointless (you can do very little in case of an accident anyway - or for any another reason); do yourself, your fellow crewmembers, your passengers and your family a favor. Get the various manuals on aeronautical decision-making and study the part that deals with hazardous attitudes of the pilot. It could be that your own attitude to safety flying is the most dangerous component of the situation.

Aircraft Initial Type Training

For those aircraft types and operational situations where a type rating is required, regulations establish a minimum baseline. This is not to say that deficiencies are unlikely. While initial ground courses generally are sufficiently thorough, some pilots making rapid promotions (such as going from light aircraft straight to jets) may find the amount of new material overwhelming. This is especially so in the case where basic theoretical training to obtain the license has been to a minimum standard.

If a training establishment serves a variety of users, it often has problems keeping focused on the exact specification of the aircraft the individual pilot is going to fly. Many options and other differences may exist between aircraft dealt with on one, and the same, ground course. Pilots from different operators may be present in the same class.

Most often missing is the thorough initial training in the use of the same avionics equipment the pilot will find in practice. With the advent of a diversity of more or less integrated systems, the consequences of insufficient attention to avionics training have increased by an order of magnitude.

Moving on to simulator training, we find some of the same shortcomings. Special points to watch for at this stage of training stem from the fact that in simulator training we are getting closer to the actual operating environment. Consequently, we need to look at the portrayal of the expected area of operations with the particular airspace, airport and weather hazards associated with it during the different seasons. We need to examine the way in which resource management is integrated into the syllabus with particular focus on crew coordination and company standard operational practices.

Suggested Pilot Action Before Initial Type Training

Unless you or your colleagues have prior experience with a particular training establishment, you have no advance warning of possible deficiencies that you may want to compensate for. Some action can be taken in advance of going on the course that will help you in identifying and dealing with these matters as they arise.

If you take a big career step, read some general material on the class of aircraft or new environment you will be entering. This will make you aware of the many new concepts that may be presented to you in rapid-fire order during the course.

In any case, make a general study of the aircraft you will fly and note where it is likely to have characteristics, systems or procedures which are new to you. Study the manuals and ask your maintenance people to notify you when they have an aircraft of that type in for inspection. Get them to show you the insides while these are accessible. You will learn something, but you will also begin to establish a good rapport with your colleagues from maintenance. That in itself is a considerable safety factor.

Be sure to have a list of the optional equipment on your aircraft as well as its status with regard to service bulletins and modifications. These are often related to aircraft serial numbers. Have these with you as well.

Check the regulations governing your operation. If these require an operator's manual or a training manual, study them to know what you are supposed to learn during the course.

If there is some form of cockpit resource management training, you will probably be given pertinent materials for prior self-study. Give them your full attention. If there is no such aspect to the course, prepare anyway by studying material on aeronautical decision-making. For a single pilot operation, you could use the manuals directed to commercial pilots and instrument pilots. For operating as a crew, substitute the manual on cockpit resource management for the commercial pilot one.

Suggested Pilot Initial Type Training Course

Use all available resources of the training establishment. Request feedback from instructors, if this is not forthcoming, and also supply your feedback to them if you feel you are not receiving sufficient instruction on items in which you are required to become proficient.

Initial Type Training on Aircraft

For many operators, regulations will prescribe required flight training, especially when a type rating is mandatory. Even then, over-concentration on the maneuvers contained in the standard-type rating flight check may leave little time and attention for making the pilot truly proficient in the aircraft. In those cases where a type rating is not required, it is also unlikely that synthetic type trainers are available. There is an acute need to make sure that pilots in these circumstances receive sufficient training to achieve proficiency in type.

Suggested Pilot Input — Type Training in Aircraft

Do not accept quick checkouts, especially if prior simulator training has been patchy or absent. Insist on training that is adapted to specific hazards in an operational situation, to particular characteristics of the aircraft and to equipment and procedures new to you.

The notes made when taking stock will help you identify critical items. Further reflection will turn up the need to pay attention to such matters as engine-out performance in Part 23 twins, working with a new class of engines such as your first turboprop or jet, first exposure to high speed-high altitude operation, etc.

Don't be a nagging pupil, but act as the professional pilot you are, using the instructor's knowledge and experience to become well qualified in the new type. If financial considerations limit the amount of flying, spend some extra time with the manuals, preferably in the cockpit of the aircraft you will be flying.

Recurrent Training and Checks

The basic ideas dealt with for initial training are valid for recurrent training as well. To obtain maximum benefit, a slightly different focus is appropriate. Pilots coming to recurrent training are qualified for the task. Getting to know the aircraft should no longer be an issue and other considerations can be given more attention. Exactly which items need to be covered is best determined by the specific hazards encountered or expected during operational flying.

Suggested Pilot Input — Recurrent Training

Just like in the case of initial training, it is advisable to go through the manuals before coming to recurrent training. It will help you set priorities. When on recurrent training, bring up safety considerations resulting from operational flying:

- Any disagreements between pilots on how to operate on aircraft?
- Any other lack of company standard procedures, such as crew coordination?
- Any persistent technical problems with the aircraft?
- Any special hazards, such as short runways, obstacles or weather hazards in your operation?
- Any unfamiliar trip coming up for which you would like to prepare?

Approach such matters with a constructive attitude avoiding personal criticism. The instructors will be happy to provide as much as they can, and it will make your recurrent training more useful as well as more interesting.

During recurrent training, there may be occasional periods of slack time due to such causes as simulator failure or otherwise. Keep in mind such valuable subjects as basic EFIS instruction, aeronautical decision-making, winter operations or systems review on another aircraft you fly. These may well be available at the flick of a video or computer switch.

Working Within the Organization

Safety consciousness should not be limited to training and checking activities. The end result must be safe day-to-day operations.

If a pilot feels that factors within the flight operation itself are contributing to hazards it is possible to work towards improvement, but caution is needed. When professional advisers audit a safety situation, they are in the organization for a limited time and purpose. A pilot working inside generally wishes to continue in the position, or even advance in his or her flight operation. Proposing changes inevitably causes resistance and care must be taken not to jeopardize working relationships.

Suggested Pilot Input Within the Flight Operation

Work towards identified goals, but proceed in small steps if necessary. When company rules are non-existent, by word-of-mouth only, or changed to fit the situation, suggest written instructions. If the organization uses written, but loose-leaf instructions, suggest collating them into a manual format. If a manual is used, but not all subjects of interest are covered, suggest comparing it with such standards as the U.S. National Business Aircraft Association (NBAA) operations manual outline or International Civil Aviation Organization (ICAO)/U.S. Federal Aviation Administration (FAA) type manual outlines.

Aim to enhance working relationships rather than endanger them. Discuss your safety concerns with receptive co-workers and arrange to let proposals come from a number of different individuals rather than from yourself alone. See if you can, over time, build up a group of pilots who will put in some extra effort towards safety. Apart from a flight safety specialist you can aim to have type specialist pilots alongside with training and checking captains. In a small group, combinations are advisable. Always make sure everyone agrees on the basic safety issues in your operation.

Be aware of the resources available in your organization. The gold mine of information found in good maintenance technicians should not be neglected. Show your interest in their work, write up the technical log clearly and find out what they know about the aircraft. Many service bulletins and alerts, mandatory and optional modifications are not discussed with pilots unless a change in flight procedures follow from them. If you want to know about such things as frequent systems failures, cracks in structures, critical wing bolts and the like, be on good terms with maintenance.

Avoid putting the safety label on everything you propose. It is a potent weapon that must not be blunted unnecessarily. You can often use arguments with more direct appeal to management. Quality can be improved by better regularity (caused by good maintenance and a well-compiled OPS manual), by better passenger service standards (passenger safety briefing cards and rules on loose luggage in the cabin). Less risk of diversions is obtained when dispatching rules are applied and weather is checked carefully before departing.

Demonstrate safe operational practices at all times. Your actions speak so much louder than a lifetime of words. Do not limit briefings to "Let's go" before takeoff. Do not roll a business jet to show how good a fighter pilot you were. Let your fellow crewmembers, other co-workers and ATC know how you aim to keep the flight safe. Encourage them to correct you if you are about to make a mistake or if they are unhappy about any aspect of the flight. You will find most of them quite as safety minded as yourself.

Expected Results of the F27 and F28 Aging Aircraft Programs

Photo not available

EELCO A. WAGNER
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As is well known within the industry, the unfortunate accident with a Boeing 737 of Aloha Airlines resulted in widespread action by jet transport aircraft manufacturers and operators.

This action was inspired by the U.S. Congress and channelled with the assistance of the U.S. Federal Aviation Administration (FAA) and Air Transport Association of America (ATA) guidelines in the so-called structures working groups. These working groups consisting of manufacturers, operators and airworthiness authorities representatives reviewed the structural integrity of the aircraft. Separate working groups existed for 707, 737, 727 and 747 Boeing aircraft, DC8, DC9 and DC10 aircraft, Airbus 300s, Tristar, BAC One-Eleven, Convair 580 and of course the Fokker F28.

Nearly all of these working groups have completed their tasks resulting in mandatory modifications and a corrosion control program (CCP).

These mandatory requirements have resulted in a booming airframe repair and overhaul business.

This, however, is not caused by the Fokker products as we will explain further on.

First, a look at the F28-fleet history and the current situation before we look at the outcome of the Structures Working Group.

The F28 was built between 1969 and 1987 in two main versions, the Mk 1000, a 65-seater jet with two rear mounted Rolls-Royce Spey engines and the Mk 4000, an 85-seater. Currently, 217 aircraft are in service with more than 200 in airline operation. There are four aircraft close to the design fatigue life of 90,000 cycles. All four were owned by Braathens of Norway until 1986 where they flew from 1969 onwards with approximately 4,500 cycles per year. One of these aircraft will pass 90,000 cycles in the fall of this year. Fokker is currently working on the RLD approval to make this life extension possible. Apart from these four aircraft all others are still below 60,000 cycles.

F28s operate on all continents, with five operators using more than 50 percent of them — USAir in the United States (42), Linjeflyg in Sweden (19), TAT in France (20), Garuda in Indonesia (36) and Ansett in Australia (13).

All these operators were represented in the Structures Working Group with USAir providing its chairman.

Now on to the results of the Working Group:

The modifications that were made mandatory by the RLD in June 1990 to ensure structural integrity were:

- <u>Five Existing modifications to prevent fatigue problems.</u>

  Two of these concern flap vane rail mods and are only applicable for the first 25 aircraft. One concerns an inspection panel ensuring easy access in the wing- to fuselage attachment area in case bag-tanks are installed in the center wing.

- <u>15 Modifications to prevent corrosion occurring.</u>

  Nine introduce drainholes or flappervalves at very low cost. The other introduce some smaller parts to prevent corrosion such as titanium bolts and beryllium/copper bushes, etc. If all these modifications needed accomplishment, which is extremely unlikely as most of them were introduced as production line improvements 15 years ago they would require approximately US $10,000.

- <u>Three New modifications are being developed</u>.

  These will be more expensive. At least two of these are:

  New belly cargo door hinges in 7075 aluminium i.l.o. 7079 to prevent stress corrosion cracking. As these are forged they are relatively expensive, but need replacement at 60,000 cycles or more. Modified rear pressure bulkhead. This mod will not involve much expensive hardware. It will, however, involve a substantial amount of man-hours to accomplish. However, it must by carried out at 60,000 cycles only which means today applicable to only four aircraft. The Service Bulletin describing this modification will be issued in late 1992.

From the above it can be derived that the mandatory modification package for the F28 is a real bargain. It is typically a factor 10 cheaper than a similar sized U.S.-built aircraft.

The second major part of every aging aircraft program is the corrosion control program. This basically consists of a mandated part of the maintenance program, with specific directions based on reported findings, aimed at detecting corrosion damage on primary structure. Included is often an additional preventive action in the form of spraying water-displacing compounds such as LPS 3 or Castrol DWX 41.

Fokker believes that this last aspect is the most important new element in the aging aircraft program.

Take action to prevent corrosion. This will always save money. Not by saving whole aircraft, but by preventing expensive repairs and all the logistics that go with repair or primary structure, such as unique repair hardware per location, approval from DERs, painting, sealing, etc.

Also in the corrosion control program the F28 product proved to pose less corrosion problems than similar sized U.S. aircraft. The amount of inspection/prevention tasks is typically a factor five less. The accumulated additional maintenance man-hours burden over a number of years will be substantial.

The second part of this exposé is devoted to the most widespread turboprop airliner: the Fokker 27.

Although in the past we have often mentioned, proudly, the similarity with the Fairchild built F27, structurally they are definitely not similar. This difference was introduced on purpose to adapt to American production techniques, metal gauges, rivet sizes etc. Also metal bonding was much less used on the Fairchilds. This means that instead of the often quoted over 700 aircraft we devote this discussion to the 580 Fokker built F27s of which approximately 460 are still flying, and of these, some 350 in regular airline service. The Fokker F27 was built from 1958 till 1986. No aircraft has reached 90,000 cycles, the current declared fatigue life. However, seven aircraft are between 70,000 and 80,000 cycles and about another 35 above 60,000 cycles.

Fokker took the initiative as one of the few companies producing jets and turboprops, to pave the way for turboprop manufacturers with an aging aircraft program broadly based on the experience gained with the F28. The F27 Structure Working Group does not report to ATA but to the Dutch Airworthiness Authority, the RLD. Observers from the FAA, U.K. Civil Aviation Authority (CAA), CAA Australia and the Norwegian CAA participate, as well as approximately 12 airlines. The working group is chaired by a large U.S. regional, Mesaba Airlines. The Working Group is anticipating to complete its task in June 1991.

The result of the Working Group is also a list of Service Bulletins which will be mandated and a C.C.P.

The list of Service Bulletins is even smaller than with the F28.

- Four Bulletins to prevent fatigue or stress corrosion cracks; all four exist. Two of these are already 30 years old and incorporated in all aircraft except a handful. All mods, requiring very modest hardware, cost less than US $5,000.

- Additionally, five Bulletins will be made mandatory to introduce inspection holes, to facilitate corrosion inspection, or drain holes.

Three of these are more than 25 years old and incorporated in nearly all aircraft. One was introduced 20 years ago and needs accomplishment on approximately half the fleet (drainholes in fuselage bottom skin). One will be issued shortly to introduce a boroscope hole in the outerflaps to make internal inspection possible. Also in this case the hardware burden for the fleet is minimal.

The outcome of the corrosion control program is similar to the F28; however, even fewer tasks are required due to the smaller size and the absence of belly cargo compartments. The required inspection/prevention tasks need to be carried out at intervals of four or six years.

The first advantage Fokker had was that we had put a lot of research into metal bonding techniques in the 1950s and 1960s, which resulted in the production techniques for the F27 and F28. That at that time rather innovative process is of course no longer unique to Fokker, but we had and to the same extent still have an advantage over the other manufacturers. This comes to light especially if one compares the bond quality of older Fokker aircraft with those of other older aircraft from an era when this bonding process was not understood properly by the competition. The technicalities of the differences of these processes go beyond the scope of this presentation, but the differences with other bonding processes are the result of:

- The right choice of bonding adhesives, i.e., the ones not sensitive to moisture absorption.

- Proper quality control of the surfaces, before and during the treatment steps to eliminate surface contamination - the most overlooked secret to success!

- The fact that we use adhesive bonding primers which are sealed into the oxide layers, created during the anodizing process, during the autoclave curing.

All the above create not only a reliable and durable bond but also a good corrosion protection. This has been proved by virtually no bonding corrosion reported neither on the F27s nor on the F28s. It may be worthwhile to note that there are also no old or bad badges, but that all aircraft are to a good bonding standard.

The second advantage Fokker has, but it is shared with a few, mainly British manufacturers, is that its aircraft are designed for a high number of cycles, as stage lengths of one hour were projected. This resulted also in comparatively low stress levels.

The third advantage we had in the past was a good communication with some airlines namely those with Engineering Departments, of which we only had a few.

However, this had the advantage that lines of communication were strong. Examples of these airlines are: Braathens, Garuda, Malaysian Airline System (MAS), Ansett and Air New Zealand, who all have used our aircraft for more than 20 years.

Many of the smaller operators used the Fokker maintenance and overhaul facilities in Ypenburg and Woensdrecht, now combined into Fokker Aircraft Services, for C- and D-checks. This gave us first hand access to aircraft from all parts of the world. This input led to the introduction of the earlier mentioned drainhole mods.

Summarizing the results of the F27 and F28 aging aircraft programs we can say that:

- Both aircraft types have a sound structure that needs virtually no changes after 20 years and 30 years respectively.

- Our proposed CCP is aimed at saving maintenance cost in the future years and has a limited impact today.

- The fact that our structure is sound results in a smaller probability that defects exist, hence the number of cases where an important defect is missed, will be small.

We are convinced that the aging aircraft program and especially the corrosion control part of it will only enhance the long-term value of the Fokker fleet, without requiring a major initial financial burden from its current owners as is required for many other aircraft types.

Aging aircraft do not per definition create an airworthiness hazard as we have been led to believe by many politicians. A good design with properly described maintenance will result in aircraft that are safe from a structural point of view forever.

The Harmonization of Technical Requirements

Photo not available

CHRISTOPHER NORTH
Aviation Safety Section
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Commission of the European Communities

I have been asked to talk about the harmonization of technical requirements, but before I do, I would like to give you a little bit of background about the Directorate General for Transport (DG VII).

As its name implies, DG VII is responsible for Transport (road, rail, sea, inland waterways, as well as air). To cover the whole range of activities in these fields there is a mighty army of about 160 people (including secretarial support). In aviation there are approximately 15 people split between three divisions (Policy, Social Conditions, and Safety). Within my area (safety) there are three people.

DG VII is not the only DG with aviation interest, however.

The other active ones being :

DG III — Internal Market and Industrial Affairs

This DG is responsible for support to industry (e.g., the Airbus Consortium) and for establishing industrial standards through the CEN and CENELEC organizations. For industry standards in the field of aviation, I believe CEN relies on AECMA.

There is obviously some grayness between industry standards (to ease the working of industry) and regulatory/safety standards (to hinder the working of industry). But it is generally accepted that safety standards are the responsibility of DG VII.

DG XI — Environment

This DG is responsible for the noise and emissions policy of the commission with respect to aviation. The recently adopted legislation in this field could have a beneficial influence on the aging aircraft problem.

DG XII — Science, Research and Development

As its name implies, this DG is basically responsible for science and research and some of you may already be aware of activities in the Brite/Euram program in the areas of aerodynamics, acoustics, airborne system and propulsion such as aviation materials development, advanced computational techniques, helicopter health monitoring, icing etc. (There is a list of some 29 projects that are being supported under Area 5 (aeronautics).)

I should emphasize that the main objective of research funded by DG XII is not to improve aviation safety (although this may be a very significant spin-off in many cases). It is to enable European industry to compete with the rest of the world. The future of Europe is seen to be with high technology industry and European industry must be able to compete on equal terms notably with United States and Japan.

DG XIII — Telecommunications and Information Technology

This DG has strong similarities with DG XII but obviously with its area of interest on telecommunications, satellites, etc. Its interest in aviation is essentially on the future European air traffic management system. This program called ATLAS is looking at a high technology solution to the needs for communication, navigation, surveillance in "tomorrow's" aviation environment and to produce a blueprint for a single European ATM system for about the years 2010-2015 onwards.

I have given you a brief outline of the roles of the various DGs having an involvement in aviation. However, I should like to stress that DG VII is responsible for setting aviation policy but it can be a difficult task in keeping the overlapping and blurring to a minimum.

In the field of aviation, policy falls into two broad areas - competition and "other." "Other" being safety, social affairs, consumer protection, etc.

The Competition Policy within DG VII essentially hinges around the single Act, and the resulting single European market. It is basically intended to allow anybody to operate anywhere (or even everybody to operate everywhere) on equal terms; i.e., no bilateral route allocations, no discrimination between national and other EC operators, common rules, equal opportunities, etc.

It is both for reasons of competition as well as safety that the Commission considers that it is necessary to harmonize technical standards for aviation in the Member States.

Action in this field by the Commission was also called for by both the European Parliament and the Council. Both groups had basically the same objectives in making such a call — namely to ensure that aviation safety levels remained high following liberalization, that the maximum benefit of the single market was achieved by getting rid of internal barriers to trade (i.e., the transfer of aircraft between registers) and that everyone was competing on the same basis (i.e., the level playing field).)

In drafting its proposals in this area the Commission had to consider the two basic issues of safety and competition.

First, the issue of safety :

Europe has a very good aviation safety record. Whatever happens, this safety record must be maintained. Nobody would receive any prizes for reducing safety, particularly in an area with such high public awareness as aviation. While recognizing that the overall European safety level is good, some member states are better than others — and any European Community initiative should seek to raise the levels of all the member states to the best currently achieved in Europe.

Second, the issue of competition :

The single market in 1993, as I've already mentioned, and the liberalization process which is aimed at 'softening up' the aviation industry in preparation for the single market, has the objective of enabling free competition throughout the European Community without hindrance.

This competition does have to be fair, and it is the task of the Commission to ensure that everyone plays by the same rules. So, not only do we have to provide the means to achieve competition — i.e., the free transfer of aircraft between registers, for example — but we also have to make sure that everyone plays the game.

Before I go on to talk about the EC proposals, I would like to remind you how aviation safety is achieved. Essentially it is by the application of technical requirements at all stages :

- from the design of the aircraft by means of Type Certification;
- its manufacture by means of Certificate of Airworthiness issue;
- its operation by means of the Operations Manual;
- its maintenance by means of the approved maintenance program;
- the approval of the organizations and individuals involved with these tasks, through company approval, personnel licensing, etc;

In developing its proposals the Commission has been very fortunate in being able to draw on the work of the Joint Aviation Authorities (JAA).

As you are aware, a number of European civil aviation administrations have, since the 1970s worked together to develop Joint Airworthiness Requirements. In recent years there has been a growing recognition by the Authorities of the need to work even more closely together. This recognition stems in no small part from the pressures of the manufacturing industry — in particular Airbus Industrie.

This has resulted in the creation of a more formalized grouping of the Aviation Authorities into the JAA (currently 16 or 17 members) who have committed themselves, through an Arrangements Document, to cooperate in the development of a comprehensive set of the now renamed Joint Aviation Requirements (JARS) to cover the whole range of aviation activities, and to cooperate in the application of these JARS.

Important and far-reaching though this JAA grouping is, it does however suffer from the very serious limitation of being purely voluntary and having no legal basis.

The EC proposal on the harmonization of technical standards, which is now being considered by the Council of Ministers and the European Parliament, seeks to build on the good work of the JAA and, indeed, to strengthen it by giving it a firm legal basis within the European Community. The Commission recognizes that any attempt to create a new EEC organization to duplicate the work of the JAA would be impractical, inefficient and unwelcome. For this reason the Commission proposal seeks to make use of the JAA, not to recreate it.

How then does the Commission proposal intend to make use of the JAA ?

As the first step it will require all Member States to adopt JARS as their sole national codes (i.e., JARS will be the European Aviation Standards —backed by EC law).

These JAR codes will cover the full range of aviation safety requirements for :

- Certification: from gliders to large passenger transport aircraft;
- Maintenance;
- Operation: from private through to commercial;
- Personnel licensing: from maintenance engineers to pilots;
- Approval of organizations: from pilot schools through to Air Operators Certificates and manufacturers.

It is recognized that, currently, only a relatively small number of these JAR codes exist, and that, while the JAA is working very hard to develop the outstanding codes, it will be some time before this is completed.

As I have said, the JAR codes will cover the complete range of aviation activities including licensing and operations. Some of you may already be aware of other Commission initiatives in the field of mutual recognition of licenses and flight time limitations. I should like to point out that both of these initiatives were initiated prior to the current proposal on harmonization, and this is not a case of duplication of effort within the Commission. The harmonization proposal is essentially a framework which identifies in what areas common European requirements and procedures are necessary. If either of these other Commission initiatives result in Community legislation, any subsequent JAR will have to be consistent with it. The harmonization proposal should not be considered as a "backdoor" method of overturning "unpopular" EC legislation in other areas.

I will come back to the licensing proposal a little later.

As a result of the on-going work on JAR codes, the EC proposal therefore contains a mechanism to adopt new JARS into Community legislation as they are developed and to amend existing JARS, as quickly and efficiently as possible.

This mechanism is the delegated authority from the Council to the Commission to adopt new and/or amended JARS into Community legislation, as proposed by the JAA, with the assistance of a Committee.

The Committee would comprise representatives of the Member States and, in the views of the Commission, should be made up of the member states representatives of the JAA.

In the interim of course, and until such time as specific JAR codes are completed and adopted into Community legislation, Member States may continue to use their existing equivalent national code.

The second major thrust of the proposal requires the Member States to ensure their civil aviation authorities adhere to the JAA arrangements document.

The arrangements require the authorities to commit themselves to cooperate in all aspects related to the safety of aircraft, in particular their design, manufacture, continued airworthiness, maintenance and operation to ensure that a high consistent level of safety is achieved throughout the Member States; to avoid duplication of work between the authorities; and to facilitate exchange of products, services and persons not only between the parties but also between the parties and others. This is achieved by the Member States joining the JAA to develop, adopt and implement Joint Aviation Requirements.

This call for the adherence to the JAA is in recognition of the fact that the adoption of a single set of codes is not, in itself, sufficient to ensure a harmonization of safety standards, due to differences in interpretation of the requirements, and differences in the technical resources of the individual national civil aviation authorities.

This harmonization is best achieved, at this stage, through the creation, by the JAA, of technical teams, drawn from the authorities to carry out all the technical work on behalf of all the Member States. This will permit a more efficient use of the limited resources of the authorities of the Member States and enable the smaller authorities to be sure that an adequate technical assessment has been carried out, while at the same time minimizing the burden on the industry.

The pay-off for the Member States and the European aviation industry in adopting JARS and adhering to the JAA is that any product designed manufactured, operated and maintained in accordance with the JAR requirements and in accordance with JAA procedures, will be entitled to mutual recognition and will be able to transfer between EC registers without any additional technical work. This mutual recognition would also apply to the certification or approval of any organization or person involved in the design, manufacture and maintenance of products or operation of aircraft.

However, this mutual recognition only applies to new aircraft and while in the long term all aircraft will eventually be covered, there will be a significant number of aircraft operating on EC registers for a considerable length of time, that are not covered by this technical harmonization.

In recognition that there may well be a desire, if not an actual need, to incorporate some of these aircraft into the "JAA system" and hence benefit from "mutual recognition," the proposal makes provision to achieve this on request, through a technical assessment, carried out by the JAA, to determine that the level of safety of the product is broadly equivalent to that required by JARS.

I could well envisage that popular, pre-JAA, aircraft like Boeing 727, 737, Airbus A300, McDonnell Douglas DC9 may be candidates for such an assessment.

As I mentioned earlier, this proposal is currently being considered by the Council of Ministers, the European Parliament and the Economic and Social Committee. This may well result in some modifications to the proposal but, all being well, it is hoped that it will be adopted into Community law by the Council of Transport ministers at their meeting in June.

If I may come back briefly to the subject of personnel licensing, as mentioned before it is essentially seeking to simplify the recognition of licenses for air crews. As an initial step it is trying to ensure that discriminatory practices in favor of nationals are avoided, by introducing the concept that where the licensing requirements in one Member State are the same as in another, this shall be recognized and that any testing to issue a national license will be limited to those areas that are not covered by the original license, or where the requirements differ significantly. The proposal also identifies the need for a European Pilots License and calls for the establishment of a Committee of Experts to make suitable proposals in the future. This proposal obviously overlaps with the work of the JAA in the objectives of producing JAR 61 and with the proposal on the harmonization of technical requirements and procedures.

At this stage I would envisage that the JAA work in this area could be used in this proposition, either by the "Committee of Experts" being the JAA working group, or by the Committee delegating the work to the JAA. How this should be played obviously is a function of timescale. I don't know whether the JAA plan of campaign on JAR 61 is compatible with the EC proposal. Obviously if the Council has set a target date for the development of a European License, the Commission will be constrained by that.

Having given you a brief resumé on the Commission proposals on the harmonization of technical standards, I would like to touch on another issue which is of interest to this seminar, and that is the aging aircraft situation.

That a problem exists is recognized by everyone, that a lot of work aimed at resolving the problem is going on, primarily in the United States, is undisputed. That a satisfactory solution will be achieved is very probable. However, this work is very U.S. oriented (i.e., primarily of aircraft that are operated in large numbers in the United States). That this work applies equally well to a very large proportion of European-registered aircraft is recognized. However, there are some European products, which fall into the aging aircraft category, but which have not been included in the aging aircraft reviews. For example, the Caravelle, Mercure, Viscount, HS 748, Jetstream, NORD 262, BAe 125.

The question that arises is : "Are the European Authorities intending to do a similar exercise for these aircraft?" If the answer is 'yes' then when will this be done? If the answer is 'no' then why not? Are there special circumstances that make European aircraft less susceptible to this problem? For example, better corrosion/maintenance control? More conservative fatigue design assumptions?

I don't have the answers to these questions but answers would be useful and perhaps they could be addressed in the general discussion.

Terrorism — Dark Times Ahead?

Photo not available

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Almost a year ago, it was extremely quiet on the terrorist front. Hardly anyone predicted the sudden attention this subject was about to receive only a few months later.

Last spring, the inquest into the bombing of Pan Am Flight 103 over Lockerbie, Scotland, was still in the news, but did not make headlines anymore; the downing of a U.T.A. (Union de Transports Aeriens) airliner over Niger in 1989 seemed forgotten by the media; and the bomb that destroyed an Avianca plane near Bogota, Columbia in 1989 was but one atrocity in the Medellin cocaine cartel's violent war against the Columbian state. However, those quiet days have passed, and it is appropriate to consider a general assessment of the present terrorist situation in order to consider what kind of threat civil aviation can expect within the near future.

It is important to establish that the present situation is very dangerous indeed, not only because we are in the aftermath of a war, but first and foremost because of the violent nature and past behavior of Iraq's president, Saddam Hussein, the unpredictable kingpin of the catastrophe that unfolded during the past several months. Many things have been said about Hussein, but relatively few words have been spared about his knack for violence and conspiracy. Talking about that too loudly in the past decade would have been somewhat embarrassing for all those who actually knew what kind of person he was, but who nevertheless tolerated, and even supported him, for political and economical reasons. Many western governments, including the U.S. government, played down the violent acts of the Iraqi leader for quite some time, in the erroneous assumption that an enemy of their [western government] enemy had to be its friend.

So the West forgave and even silently applauded Hussein's assault on Iran, and subsequently felt obliged to provide him with the necessary military hardware to wage his eight-year-war with the ayatollahs in Teheran. In 1982, the U.S. government thought it was appropriate to strike Iraq off its list of terrorist sponsoring countries as a reward for Hussein's shrewd decision to remove the welcome mat for some of his oldest and most bloodthirsty guests and protegés, Abu Nidal and his Fatah Revolutionary Council, who were becoming an obstacle for profitable relations with the West. They were not arrested, but asked to leave Iraq [for Libya].

The use of chemical warfare, first against the Iranians and later against Iraq's own Kurdish population, was the first major crime that caused some Western doubt about Hussein. The super-cannon affair [during which Iraq tried to import specially designed pipes that were to become cannon barrels] and Iraqi efforts to get detonators for nuclear devices also made the headlines.

Hussein's past is riddled by killings, summary executions and public hangings — in fact, on several occasions he pulled the trigger himself. From 1968, which was the year his party took power, until 1979, Hussein as vice-president, was the architect of the Iraqi secret services, which he organized to great perfection and which apparently remain completely loyal to him. His conspiratorial skills changed Iraq into a society in which about 30 percent of the population informs and spies on the rest.

After he overthrew former president Ahmad Hasan al Bakr in 1979, Hussein took the presidency himself, becoming one of the very few, if not the only one, who dedicated his presidential task entirely to aggressive warfare. In 1980, he attacked Iran and waged war for eight years and later, made several attacks on his own Kurdish population. In 1990, he invaded Kuwait, an act of aggression that led to the recently ended war with several allied nations, that sought to enforce United Nations sanctions. Whatever the reasons for his dangerous behavior — territorial, nationalist, personal — his political career has excelled in the use of violence on a national and on an international level, and not as a victim but as the orchestrator.

Hussein is an able politician, at least in the framework of the Middle East. His claim that the annexation of Kuwait would bring closer a solution to the Palestine problem of self-determination garnered support, so much so that even the Palestine Liberation Organization (PLO) took his side in the conflict. The world has still to discover if Hussein's second claim, that he waged a religious war of Jihad against the infidels, will meet with success; there were signs of Moslem approval in other countries for this religious motive.

Unfortunately, both of these claims appealed to terrorist forces, as an effort to create some sort of an invisible, worldwide second front. This front did not win the war for him, but it certainly has created uneasiness among Hussein's adversaries.

This appeal to terrorist help is in accordance with Hussein's personality. He succeeded quite well in intimidating his own population, so why not try the same weapon of intimidation on his enemies abroad? It is possible that he has great expectation about its effects, and it has to be admitted that so far he has no reason to feel greatly disappointed.

Early in December 1990, the 12 European Community (EC) home affairs ministers gathered in Rome for a meeting of the so-called Trevi group, the international governmental security body we hear little about. This time, the public was merely informed of the concern expressed by minister-members about developments of the Middle East conflict, and about the possibility of terrorist acts in the event of a military showdown in the Persian Gulf region. The group even decided to call for a meeting of its anti-terrorist experts at an earlier date, in January 1991, instead of March as previously scheduled, in order to prepare for danger as soon as possible.

This seemed to be a good idea, assuming that the Iraqi dictator would unleash the agents of terrorist war he had assembled in Baghdad in 1990 in the event of a military conflict between Iraq and the West. Time seemed available to prepare effective countermeasures. But on the other hand, it was highly probable in those days of December that Hussein's fifth terrorist column was already in the field, and that the Trevi initiative had come too late. There were two reasons for this assumption. The first was that once war had started, it would become very difficult for terrorist agents to leave Iraqi territory for assigned targets in other countries, surrounded as Iraq was by enemies on almost any side, with Turkey on the north, Iran on the east, Syria on the west and Saudi Arabia on the south. Only Jordan offered a possible way out in that circumstance, a shaky ally at the time.

The second reason had to do with military effectiveness. Hussein had spent much money to acquire such an impressive force of underworld terrorists, and he had been expected to use them as a means of retaliation as soon as he was attacked. Because terrorist groups need preparation time for their actions, this would also imply that methods and targets had already been selected.

Therefore, it appeared crucial for the groups that back Hussein to get their active commandos out of his country well before war started, and to station them in the vicinity of the targets chosen to be attacked. These groups, by the way, can be trusted to find their way into Middle Eastern and European countries, because they had been there before. In the past, they spent time building networks of reliable moles and sleepers there who can be activated relatively easily.

Last year's marriage between Hussein's regime and the Palestinian terrorist groups was one of mutual convenience. It may now be assumed that Hussein's ambition to invade Kuwait ripened in 1989, immediately after the end of his disappointing war with Iran that denied him victory and substantial territorial gains. As a shrewd dictator, he must have guessed that an attack on Kuwait would leave him with few Western and Middle Eastern friends, although he must have been also taken by surprise by the widespread rejection of his enterprise. The support of terrorist groups balanced his isolated position somewhat.

The terrorist groups must have been pleased with Saddam's invitation to join forces with him, because of the decreasing market for terrorist actions. With Iran trying to gain more international legitimacy, Syria's president Hafez Al Assad posing as a responsible statesman and Libya's Col. Mu'ammar al-Qadhafi in one of his less deranged periods, the demand for terrorist mercenaries was deteriorating, so the call to arms from Baghdad was most welcome.

One of the first groups to accept Hussein's invitation was the Fatah Revolutionary Council, led by the notorious Sabri Al Banna, alias Abu Nidal, who made quite a name for himself as the most ruthless terrorist to fight for the liberation of Palestine and his own financial benefit. He and his group were responsible for a series of atrocities, including the airport massacres at Rome and Vienna in December 1985; the massacre at the synagogue in Istanbul in 1986; and the hijacking of an Egyptian plane in the same year, also with heavy losses of life. Before that time, Abu Nidal specialized in targeting and killing moderate PLO officials, a tactic he used again in 1982 when his group made an attempt on the life of the Israeli ambassador in London, thus provoking the Israeli invasion of Lebanon.

Abu Nidal's group, or what was left of it, was in fact saved from collapse by Hussein's invitation. In November 1989, two of Abu Nidal's closest aides, Atef Abu Bakr and Abdel Rahman Issa, had had enough of their leader and announced they and a rebel faction wanted a renewed alliance with Arafat's PLO. The reason for their desertion, as they told it, was the bloodthirstiness of their former leader, who according to them was "a perfect example of schizophrenia" and, who in an act of folly had more than 150 of his followers killed as Israeli spies. Even Qadhafi had shown his displeasure about this massacre, by taking Abu Nidal into custody and ordering his group to get out of Libya.

The whereabouts of Abu Nidal became unclear for a while. One source said that he was under Libyan house arrest, another located him in an Algerian hospital with terminal cancer, another source reported him dead and a fourth revealed that in April 1990 Abu Nidal had offered his services to Hussein. His troubles, however, were not over yet, because in June 1990, Arafat's PLO launched an attack on one of Abu Nidal's camps in the Lebanese Bekaa valley, and took some 40 of his followers prisoner.

With the remains of this group, Abu Nidal changed employers and moved from Libya to Baghdad, somewhere during May and June 1990. However, he did not break off relations with the Libyan leader. In fact, in January 1991 he did Qadhafi one more favor by setting free some Belgian hostages he had kept for several years, probably in an attempt to facilitate Libyan commercial relations with a Western country like Belgium. Belgium reciprocated Abu Nidal's kind gesture the same month, by not arresting Walid Khaled, one of Abu Nidal's henchmen, but by giving him the opportunity to leave Belgian territory without delay. And he pleased his new employer, Hussein, by having the PLO's number two man, Abu Iyad, murdered just two days before the military conflict started.

Abu Nidal's organization may be the most fearsome terrorist group at present, but in the late 1960s and early 1970s the most notorious group was the Popular Front for the Liberation of Palestine (PFLP), led by George Habash. While Arafat's Fatah movement engaged in guerrilla warfare against Israel during those days, the Marxist-Leninist Habash decided that more countries were to blame for Palestinian misery, especially the capitalist countries that sustained the Jewish state. In fact, Habash introduced Palestinian terrorism in western Europe by hijacking planes, bombing synagogues and attacking air terminals. Together with the Japanese Red Army, Habash's PFLP was responsible, on May 30, 1972, for the attack on Lod Airport in Tel Aviv, Israel, which resulted in the death of 25 people and the wounding of approximately 75 more.

Habash's organization and its pro-Soviet offspring, the Democratic Front for the Liberation of Palestine (DFLP) of Nayef Hawatmeh, continued their terrorist activities during the 1970s, after which they quieted down. In 1986, they made peace with Yasser Arafat and rejoined the PLO, which then announced that henceforth it would renounce terrorism as a means of fighting for a Palestinian state. Nevertheless, during a conference in Amman in September 1990, Habash and Hawatmeh opted for the Iraqi side in the Gulf conflict and promised to retaliate against any "imperialist-zionist" threat. Habash was quoted, "at this moment our fingers are touching the trigger. We will shoot the moment Iraq suffers aggression. War has its own logic. We are not terrorists. We are freedom fighters."

It did not seem to bother Habash that he was siding with a regime that, according to his own point of view, had committed the same crime against the Kuwaitis as he accused Israel of doing in 1948 against the Palestinians, by forcibly denying a people the right of independence. Habash turned the argument upside down, by asking why Iraq should withdraw from Kuwait if Israel had not been forced to withdraw from the occupied territories.

Threatening remarks were also made by Abu Abbas, leader of the Palestine Liberation Front, which in 1985 made news headlines with the hijack of the Achille Lauro cruise ship, and in

May 1990 torpedoed the United States-PLO dialogue by trying to invade a Tel Aviv beach using heavily armed personnel aboard speedboats. Two other groups, supposedly in Baghdad since August 1990, are Abu Salim's Popular Front for the Liberation of Palestine, Special Command, and the 15th of May group of Abu Ibrahim, a man known for his successful aircraft bombs during the 1970s. Another group, that according to rumors has moved to Baghdad, is Ahmed Jibril's Popular Front for the Liberation of Palestine-General Command, the primary suspect in the Lockerbie bombing.

The groups mentioned above are dangerous; they have proven that in the past. An additional danger has been Yassir Arafat's decision, just before the war started, for the PLO to take the Iraqi side. Why he made this apparently desperate move is not known. Perhaps he considered it his duty to follow the more radical factions of PFLP, DFLP and PLF; perhaps he was forced by his own Fatah followers to take a belligerent stand. Eventually, the move will cost him, politically and financially. But in the meantime, no one knows what to expect from all the PLO offices in so many countries, or from Palestinian immigrants worldwide or from the way the intifadah (the Palestinian uprising against the Israelis) might develop in the occupied territories.

All Palestinians, as far as they recognize the PLO as their representative organization, aligned with Hussein, and the consequences of this alliance could be dreaded. Another dangerous aspect is Hussein's effort to build an image as a holy warrior. If taken at face value, this could incite certain Moslem groups, like Hezbollah and Jihad Islami in Lebanon to join the terrorist force of Iraq, even in the aftermath of the war.

It is still unclear what all this means for civil aviation. However, the point to consider is that Hussein has surrounded himself with professional terrorists, some known because of their hijackings, aircraft bombings and attacks on airports in the past. In times past, these groups, although linked to some supportive regime, stressed the autonomy of their actions and claimed to be independent in their decision-making. Now, however, are they firmly embedded in Hussein's strategy to act as auxiliary forces?

Civil aviation has remained a favorite target for Middle East terrorist groups, and the reasons for it are still the same: high visibility, which means extensive coverage of any terrorist act by the news media, and the fear instilled into the traveling public just by threats of terrorist acts. The influence of fear has been dramatically demonstrated during the past several months, when corporations and individuals cancelled air travel because of potential terrorist attacks. Coupled with the world's generally poor economic conditions, made worse by high fuel costs during the past year, empty seats added to lost revenue. The effect on the airline industry has been devastating and echoed into other industries as well.

Hijacking, out of fashion for some years now, may become attractive again, as a tool to free prisoners of war, to coerce minor economic or territorial concessions, or to simply ridicule the coalition forces.

The hijacking of aircraft has been rendered more difficult in Western countries, but with Iraqi sympathizers within their borders, perhaps some of these difficulties might be overcome, like the smuggling of weapons aboard a plane. Outside the Western Hemisphere, the possibilities of getting an armed commando on board an aircraft are more likely because many people back Hussein, regardless of their governments' positions.

Hijacking is the least lethal way to attack an airline. Far more dangerous, are the use of bombs on aircraft and armed attacks on air terminals. Semtex, the favored terrorist explosive, has found its way to the Middle East by the ton, and detection technology, which has been developed to cope with this odorless and malleable explosive, is still imperfectly applied and distributed.

There has been evidence that some terrorist commandos are already on the move. In December 1990, two units were arrested in Spain, while in Italy an Iraqi was arrested on suspicion of terrorist activities. In January 1991, the Austrian security service arrested a group of Iranian terrorists belonging to the Majahedian el Khalk, the Iranian communist party which, out of revenge, sided with Iraq. In Yugoslavia, the Serbian government was accused of letting some 50 terrorists cross through the country into Western Europe; the accusation was never denied.

In this regard, it is an open question whether the United States, too, has been infiltrated by Middle Eastern terrorists. Experts have long expressed their amazement why it was that the United States, which in the view of so many Moslems personifies the Great Satan himself, has hardly been bothered by terrorist attacks. The explanations have not always been convincing, like the one that took for granted that it was the uniform outer frontier that protected the United States against terrorist infiltration, while in Europe a chaos of national borders facilitated easy entry.

It is difficult to understand why it would be difficult for terrorists to enter the United States, when tens of thousands of Latin Americans have already succeeded in illegally crossing the southern U.S. border.

I always suspected that the United States was spared terrorist action because of Soviet influence in radical Middle Eastern countries and their terrorist protegés, assuming that it has never been in the interest of the Soviet Union to heighten East-West tensions unnecessarily. If this theory has had any value, then now could be the time for terrorists to test it, because the Soviet Union has lost some of its grip on the Middle Eastern radicals, and this could mean that U.S. territory is no longer off-limits.

Safety Trends in Worldwide General Aviation Operations

by
Shung C. Huang
Statistical Consultant

The International Civil Aviation Organization (ICAO) defines general aviation as civil aviation other than scheduled and non-scheduled commercial air transport. The U.S. National Transportation Safety Board (NTSB) defines general aviation as operations of U.S. registered aircraft not conducting air carrier revenue operations under 14 CFR (Code of Federal Regulations — U.S.) 121, 14 CFR 125, 14 CFR 127, and 14 CFR 135. In other words, general aviation includes all civil operations other than those performed by certificated air carriers, supplemental air carriers, commuter air carriers and on-demand air taxis.

ICAO statistics showed that, in 1989, there were approximate 336,000 general aviation aircraft on register in ICAO contracting states (China and U.S.S.R. are not included). ICAO also reported that in recent years, there were few changes in the worldwide general aviation fleet. On an average, there were 322,100 fixed-wing and 13,500 rotary-wing aircraft. Of the fixed-wings, it includes 2.3 percent turboprop, 1.7 percent turbojet and 96 percent piston-engine aircraft. Table 1 shows the number of general aviation aircraft by types on register in ICAO contracting states (countries) for calendar years 1984-1989.

Of the worldwide total number of general aviation aircraft on register, it was estimated that, during an average 12-month period, only about 81 percent were used, flying an average of 45,500,000 hours a year. The use of aircraft by type of flying is presented in Table 2.

The number of general aviation aircraft was not broken down according to contracting state in the ICAO statistics. According to reports from other sources, there were about 26,000 general aviation aircraft on the Canadian register, and about 10,000 in Great Britain's register. In the United States, there were approximately 260,000 general aviation on register, about 210,000 of which were reported in operation in 1989 flying a total of 30 million hours.

Safety Statistics

Worldwide general aviation safety data are not available. Since the U.S. general aviation aircraft and annual flying hours account for more than about two-thirds of the world's totals, the accident statistics of U.S. general aviation reported by the U.S. National Transportation Safety Board (NTSB) are used for the following analyses on general aviation safety trend.

Table 1

Number of General Aviation Aircraft on Register in ICAO Contracting States as of January 1 Calendar Year 1984-1989

Aircraft Type	1984	1985	1986	1987	1988	1989
Fixed-wing Aircraft						
Turbo-jet						
Four engines	464	473	474	391	393	343
Three engines	238	272	251	248	276	330
Two engines	3,893	4,609	4,827	4,893	4,947	4,958
One engine	178	196	199	223	233	228
Propeller-driven (turbine)						
Four engines	102	126	139	131	131	131
Two engines	5,914	6,334	6,435	6,345	6,523	6,544
One engine	415	440	520	623	700	720
Propeller-driven (piston)						
Four engines	325	351	356	355	344	355
Three engines	60	57	57	45	42	48
Two engines	34,114	34,355	34,410	34,546	34,173	33,615
One engine	269,675	274,804	276,001	277,154	276,361	275,501
Total	315,378	322,017	323,579	325,044	324,123	322,773
Rotary-wing Aircraft						
Turbine-engine						
Two engines	1,430	1,586	1,636	1,678	1,823	1,934
One engine	4,815	4,400	4,150	4,200	4,350	4,370
Piston-engine						
Two engines	94	95	87	85	85	85
One engine	7,113	7,443	7,483	7,523	7,389	7,403
Total	13,452	13,524	13,356	13,486	13,647	13,792

Table 2

Estimated Number of Aircraft Hours Flown Worldwide General Aviation* 1988-1989

	Hours in millions		Two-year average
Type of Flying	1988	1989	in percent
Instructional	9.0	9.5	20.2
Business/Pleasure	26.9	26.5	58.4
Aerial work/other	9.6	10.0	21.4
Total	45.5	46.0	100.0

*Excluding U.S.S.R. and China

An overall statistical review of the safety records of U.S. general aviation during the past 16-year period (1975-1990) reveals that general aviation flying at the end of the period was much safer than at the beginning. Figure 1 displays the annual frequency distribution of total accidents and fatal accidents over the period. Figures 2A and 2B show the scatter diagrams of annual total and fatal accidents in relation to annual aircraft hours flown. The straight line delineates the linear regression between accidents and aircraft hours, illustrating that the number of accidents is a function of the observed values of aircraft flight hours. The curve is generated by the LOWESS method (Cleveland W.S.,1981, "LOWESS: A program for smoothing Scatterplots by Robust locally weighted regression," *The American Statistician)* in which it has a unique number of accidents according to aircraft hours flown.

Figure 1 — U.S. General Aviation Total Accidents and Fatal Accidents Calendar Year 1975-1990

Graphic not available

Over the years, the ratio between total accidents and fatal accidents has shrunk from six-to-one to five-to-one. Figure 3 displays the linear regression for total accidents and fatal accidents relating to aircraft hours flown in which the accidents are shown in base 10 logarithmic scale. Note that the distribution of total accidents and that of fatal accidents are shown very close to the straight line. It appears that the linear regression of total accidents onto aircraft hours flown is highly comparable to the linear regression of fatal accidents onto aircraft hours flown. Overall, the upward straight line indicates that the number of total accidents and fatal accidents is a positive function of aircraft hours. In other words, the number of total accidents or the number of fatal accidents increased if the gen-

Figure 2A — Scatterplot of Total Accidents in Relation to Aircraft Hours Flown Linear Smoothing vs Lowess Smoothing

Graphic not available

Figure 2B — Scatterplot of Fatal Accidents in Relation to Aircraft Hours Flown Linear Smoothing vs Lowess Smoothing

Graphic not available

Figure 3 — A Comparison of Scatterplot of U.S. General Aviation Total Accidents and Fatal Accidents Relating to Aircraft Hours Flown Calendar Year 1975-1990

Graphic not available

eral aviation aircraft hours flown increased and vice versa, although increases or decreases in rates of accidents may not be in proportion to increases or decreases in aircraft hours flown.

Findings

Over the 16-year period, from the period high to the period low, the number of total accidents reduced from 4,218 to 2,138, a decrease of 49 percent, the fatal accidents reduced from 721 to 423, a decrease of 41 percent. During the period, the aircraft hours flown fell from its high, 38,641,000 in 1979 to its low, 28,799,000 in 1987, a reduction of 24 percent. The statistics and analyses lead to the following conclusions:

1. The occurrence of an aircraft accident appears to be a random event because the frequency of occurrences fluctuates without a pattern. Over a period of time, i.e. in a three- to five-year period, U.S. general aviation accidents have been correlated with aircraft hours flown. In other words, the frequency of accident occurrences appear to be a positive function of aircraft hours flown although the increase or decrease are not in proportion of the increase or decrease of aircraft hours flown.

2. The safety improvement of U.S. general aviation over the past 16 years has been very encouraging. During the period, U.S. general aviation total accident rates declined 49 percent and fatal accident rates were down 37 percent. Since the difference of annual aircraft hours flown in its high and low points is only 25 percent, a part of the improvement of safety in U.S. general aviation flying appears attributable to the safety efforts contributed jointly by the federal and local governments, industries, and aviation safety organizations. ♦

Reports Received at FSF Jerry Lederer Aviation Safety Library

Reference

Advisory Circular 135-12A, 03/28/91, *Passenger Safety Information Briefing and Briefing Cards (FAR Part 135).* — Washington, D.C. : United States. Federal Aviation Administration, 1991, March 28. 7p.

AC 135-12, "Passenger Information, FAR Part 135: Passenger Safety Information Briefing and Briefing Cards, dated October 9, 1984, is cancelled.

Key Words
1. Aeronautics, Commercial — Safety Measures — United States.
2. Aircraft Cabins — Safety Measures — United States.

3. Airlines — Passenger Safety Information Briefing — United States.

Summary: This advisory circular (AC) provides information regarding items to be covered in oral passenger briefings and passenger briefing cards in air carrier operations conducted under Federal Aviation Regulations (FAR) Part 135. Items to be covered in the briefing include compliance with signs and placards, smoking, seatbelts, seat backs, exits, fire extinguishers, survival equipment, flotation equipment, passengers needing assistance, oxygen equipment, floor proximity emergency lighting, extended overwater operations, and supplemental information. [Purpose, contents]

Reports

Annual Review of Aircraft Accident Data, U.S. General Aviation, Calendar Year 1988. — Washington, D.C. : National Transportation Safety Board; Springfield, Va: Available from NTIS*, March 27, 1991. Report NTSB/ARG-91/01, NTIS Order Number PB91-156851. 86p.

Key Words
1. Aeronautics — Accidents — Statistics — United States — 1988.
2. Private Flying — Accidents — United States — 1988.
3. Corporate Flying — Accidents — United States — 1988.

Contents: Introduction — All accidents — Fatal accidents — Serious injury accidents — Property damage accidents — Midair Collision Accidents — Appendix A: Explanatory notes — Appendix B: Cause/factor assignments — Appendix C: NTSB Form 6120.4.

Summary: This report presents a statistical compilation and review of general aviation accidents which occurred in 1988 in the United States, its territories and possessions, and in international waters. The accidents reported are all those involving U.S. registered aircraft **not** conducting operations under 14 CFR 121, 14 CFR 125, 14 CFR 127, or 14 CFR 135. Several tables present accident parameters for 1988 accidents only, and each section includes tabulations which present comparative statistics for 1988 and for the five-year period 1983-1987. [Author abstract]

Response Capability During Civil Air Carrier Inflight Medical Emergencies. Final Report / J.R. Hordinsky and M.H. George (Civil Aeromedical Institute). — Washington, D.C. : United States. Federal Aviation Administration, Office of Aviation Medicine; Springfield, VA : Available through NTIS*, 1991, March. Report DOT/FAA/AM-91/3. 6p.

Key Words
1. Aeronautics, Commercial — Emergency Medical Care — United States.
2. Airlines — Emergency Medical Care — United States.
3. Airlines — Medical Kits — United States.

Summary: Expanded civil aircraft medical emergency kits have been mandated on U.S. carriers since August 1986. Airlines provided the Federal Aviation Agency reports on medical kit usage and outcomes of the associated medical emergencies; 1,016 inflight medical events during the period August 1, 1986, through July 31, 1987, were available for review. Physicians responded to the emergencies in over 63% of the occurrences; the two most prevalent presenting situations were chest pain and syncopal episodes. Since standardized report formats are not required, evaluation of response capability remains incomplete. ... The widest dissemination of this report is being effected to solicit individual citizen and industry feedback that can contribute to subsequent improvements in onboard medical emergency capability. [Author abstract, Foreword]

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Accident/ Incident Briefs

This information is intended to provide an awareness of problem areas through which such occurrences may be prevented in the future. Accident/ incident briefs are based upon preliminary information from government agencies, aviation organizations, press information and other sources. This information may not be accurate.

Air Carrier

A Dangerous Case of Mistaken Identity and False Assumptions

Boeing 737 and Beechcraft King Air 200: No Damage. No injuries.

The Boeing 737 had been cleared for a straight-in instrument landing system (ILS) approach to runway 11. The aircraft, completing a scheduled flight, was to the west of the airport on a long final approach leg at 1,500 feet in visual meteorological conditions (VMC). The King Air was on a local visual flight rules (VFR) flight at the same altitude as the 737 and was proceeding from north of the airport in a southwest direction, its intended track crossing the ILS course for runway 11 almost at a right angle. The crew of the King Air was dealing with a minor maintenance problem and was flying straight and level while waiting for advice from their ground maintenance personnel.

Both aircraft were in radio contact with the control tower, which had advised the King Air about the 737 and advised the 737 about two Piper Cherokee aircraft that had departed runway 16 and were making right turns to proceed northwest through the area of the 737's ILS approach to runway 11. However, the tower did not advise the 737 of the King Air.

The crew of the 737 saw the King Air and mistook it for a de Havilland Dash 8, a larger commuter aircraft with a similar configuration to a King Air, and consequently thought the King Air was farther away than it was. They also assumed that the Dash 8 would be landing on the active runway 16, and would not interfere with their approach to the other runway.

The stage was set.

The 737 was about 10 miles from the airport when the King Air crew saw the aircraft directly in front of them between one-quarter to one-half mile away on a collision course. The 737 crew spotted the King Air at about the same time and both crews immediately took evasive action. The 737 turned right and climbed and the King Air turned right and descended, passing beneath the 737 at a distance estimated at between 200 and 300 feet.

The cause of the near collision was attributed to the fact that the traffic information about the King Air had not been given to the 737 crew and that the King Air crew had not seen the 737 until the last minute. Contributing factors included possible distraction of the 737 crew because of the additional traffic of the two Cherokee aircraft. Also, the mistaken identification of the King Air led the 737 crew to assume that it was a larger aircraft that was farther away.

Parking Problem Plucks Pitots

Boeing 747: Minor damage. No injuries.

The jet transport was taxiing inbound to the terminal when a late change was made to its gate assignment, and sent to a gate that normally was not used by large widebody aircraft. The aircraft was held on the taxiway while a Boeing 767 was pushed back from the gate.

The ground marshaller, noting that there was servicing equipment between the gates to the right side of the arriving aircraft, proceeded to guide the pilot to the gate. The pilot taxied slowly into the gate parking area and reported that he observed the three green lights that indicated the aircraft was tracking along the proper ground path for alignment with the passenger jetway. He felt a light tapping sound on the left side of the aircraft and immediately applied the brakes, bringing the aircraft to a halt approximately two feet prior to the stop line.

The ground marshaller investigated and found that the jetway was pressing against the aircraft, so he retracted it. In doing so, however, he was not aware that the left-side pitot tubes of the aircraft had become imbedded in the edging material of the jetway. As the jetway retracted, the pitot tubes were bent away from the aircraft, putting it out of service until repairs could be made.

Air Taxi
Commuter

It's an Ill Wind That Crosses the Runway

BAe ATP: Moderate damage. No injuries.

The aircraft, with a crew of four and 69 passengers aboard, was approaching to land at the conclusion of a scheduled flight. It was already dark in the early winter evening. There was a strong crosswind that was close to the demonstrated limit for the aircraft type. During the landing, the aircraft made a firm ground contact in a nose-down attitude and bounced back into the air. While the pilot tried to complete the landing, the aircraft bounced two more times and each touchdown was on the nosewheel first.

The nose gear collapsed after the fourth oscillation resulted in another nose-first touchdown and the aircraft slid along the runway with the nose gear assembly folded back beneath the aircraft's belly. The propeller tips hit the runway surface and disintegrated, spraying the fuselage with debris that punctured the pressure hull.

No one was injured and there was no fire as the aircraft came to a stop to the side of the runway and the occupants departed the aircraft through the forward passenger door. The aircraft sustained damage that included detachment of the nose gear leg and damage to the propellers and the fuselage.

Lost Way In Snow

Fokker F27 Friendship: No damage. No injuries.

It was a dark winter night, the wind was from 030 degrees at 32 knots for runway 05, the temperature and dew point were equal at two degrees C and it was snowing. Snow, frost and gale warnings were in force in the area. The twin-turboprop aircraft taxied for takeoff with four crew members and 19 passengers.

The control tower operator asked the pilot to advise when the aircraft was approaching the holding point prior to the runway entrance because he could not see it "because of the snow." The pilot reported approaching the holding point in extremely poor visibility; the controller cleared him for takeoff. The pilot turned on the aircraft's landing lights to help see his way and followed the green taxiway centerline lights to enter the runway. He followed the lights that curved to the left and lined up on a line of lights that he assumed were the runway centerline lights.

The pilot applied power and started the takeoff roll — with the aircraft lined up on the left-hand runway edge lights. When the nosewheel, then the left main wheels, left the runway surface and began rumbling across the grass, the pilot felt the vibration and immediately aborted the takeoff. Realizing what had occurred, he taxied the aircraft back to the runway and returned to the ramp, where an inspection revealed no damage to the aircraft. No airfield lights had been damaged, either.

Another attempt to taxi into the proper takeoff position was successful. The pilot used only the aircraft taxi lights which gave him better visibility while looking for ground markings in the rain and snow, and he made a conscious effort to not be misled by the curve of the taxiway lights.

Corporate Executive

Where Did The Fuel Go?

Beechcraft Super King Air 200: Substantial damage. No injuries.

The aircraft departed with a pilot and one passenger to fly to another airport to pick up one more passenger. Fuel at departure was reported to be a total of 1,420 pounds, approximately evenly distributed. The aircraft had last been refueled a week earlier, when it was loaded to its full capacity of 2,580 pounds, before it had been flown on two flights totalling slightly less than two hours. Afterwards, it had been left for a week for inspection and renewal of its airworthiness certificate, during which the engines had been run on the ground.

After a low-altitude flight of slightly less than one hour the aircraft landed with an estimated 1,000 pounds of fuel remaining. Departing again, having added the second passenger, the aircraft was given radar vectors during an unrestricted climb to FL 240.

After leveling off and completing cruise checks, the pilot was surprised to notice that the fuel gauges indicated 120 pounds on the left tank and 100 pounds on the right. He reported a "fuel problem" to air traffic control (ATC) and requested a diversion to the nearest available airport immediately; however, he did not declare an emergency. He was cleared for an immediate descent toward an airport and, during hand-offs to two subsequent controllers he did not declare an emergency or report the aircraft's low fuel status.

Approaching the airport, the pilot was offered vectors and advised he was number two to land but he did not declare an emergency or report the aircraft's fuel status. As the aircraft turned on to the instrument landing system (ILS) final approach course at approximately eight nautical miles from the airport, the pilot saw that the fuel flow and torque on the right engine gauges were fluctuating, and he opened the fuel crossover. He realized he would not reach the airport and decided to make a forced landing under power. He then declared, "We are out of fuel."

The pilot told the passengers to sit in rear-facing seats and selected a plowed field in which to land because the proximity of power lines and buildings restricted his choices of landing sites. The field was frozen and firm, and the aircraft sustained substantial damage that included two collapsed landing gear, and damage to the nacelles and flaps, propellers and fuselage underside. There was no fire. The occupants all were able to leave the aircraft without injury.

An inspection of the fuel tanks revealed there was approximetely a quart in each wing fuel tank, with about half a gallon in each of the two nacelle collector tanks; the auxiliary tanks were empty.

No leaks or unusual fuel flows had been discovered during the recent inspection and engine runups. Flight time and number of takeoffs and landings were analyzed from the time the aircraft had last been refueled. Investigators established that the aircraft ran out of fuel close to the flight time predicted by calculations based on the aircraft manufacturer's performance data.

Air Loads Jam Landing Gear

Beechcraft Super King Air 200: Minor damage. No injuries.

The aircraft was being used for a training exercise to cover stalls and general aircraft handling. There were two pilots aboard, one an instructor.

A stall was accomplished in a gear-down, full-flap configuration. When the stall occurred, the instructor noted that the right wing dropped and the aircraft sideslipped to the right. At the same time, the student pilot applied full power and called for gear up and flaps to be retracted to the takeoff position.

The flaps retracted as expected but the gear unsafe warning light remained illuminated. Simultaneously, the crew noticed a burning smell and smoke poured from under the floor in the vicinity of the electric motor that operates the landing gear. The pilots put on their smoke goggles and oxygen masks, set the transponder on 7700 and carried out the fire checklist. The smoke in the cockpit was dispersed by opening the side windows and the cabin dump valve. After determining that the gear motor had failed and that there was no threat of fire, the instructor pilot decided to divert to a nearby airport where maintenance was available.

Another aircraft provided visual confirmation that the left gear was not fully retracted and that the right gear and nosewheel doors were open but that the wheels appeared to be fully retracted. The emergency landing gear system was jammed and would not operate. A diversion to another airport with yet more maintenance expertise available resulted in two flights past the control tower for engineers who offered advice to the crew that failed to solve the problem. The aircraft was diverted again, this time to a military airfield, and the crew tried again without success to lower the gear. With dusk approaching and fuel running low, the crew landed the aircraft on its belly with rescue equipment standing by. The aircraft came to a stop with damage to the gear, flaps and fuselage underside, but there was no fire and the crew deplaned without injury or further incident.

Investigation revealed the possibility that the gear was retracted after the practice stall while the aircraft was in a sideslip, and that the air loads imposed in the left inboard main landing gear door held it slightly retracted, positioning the door in the way of the retracting inboard wheel. As the gear retracted, it pulled the door into the gear bay causing damage to the mechanism and jamming it. The gear motor consequently overheated trying to move the jammed mechanism; the smoke was the result of heat and residual oil around the motor housing.

Other General Aviation

Engine Problem At Low Altitude

Cessna 404: Aircraft destroyed. No injuries.

The fisheries protection aircraft, modified by the addition of an externally mounted radar pod, was on a flight with its standard crew of two pilots and a radar observer. It was inspecting fishing trawlers to the northwest of Scotland.

At approximately 0900 hours in VFR conditions, the twin-engine aircraft arrived at its operational area and descended to its normal 200-foot height for ship inspection runs. A pass had been completed alongside one fishing trawler. The flaps were lowered to the takeoff position and airspeed reduced to approximately 130 knots as was the usual custom for ship inspection runs and the aircraft was being positioned for a pass alongside a second trawler. At this point the right-hand engine began running rough with a dull, banging sound according to the copilot, who also noticed a discrepancies between the manifold pressures and rpm readings between the engines. The crew decided to abort the mission and divert to a nearby airport, and reported their intentions on a flight watch frequency.

The pilot added full power to both engines and climbed rapidly to 300 feet while the airspeed reduced to the 109-knot maximum rate of climb speed. However, the aircraft began to descend and, suspecting that the right-hand engine was causing drag, the pilot ordered the copilot to shut it down. This was accomplished and all three crew members recalled seeing the right-hand propeller fully feathered. However, the aircraft did not accelerate and resume a climb as expected, but continued to descend.

Recognizing that a ditching was imminent, the pilot reduced airspeed to 80 knots, turned the aircraft into the wind and ditched it into a slight swell. The aircraft stopped rapidly and floated long enough for all three crew members, who were unhurt, to exit on to the left wing where they inflated their life jackets and a life raft. The aircraft began to sink before they boarded the raft and they were forced to board it from the water. None of them had been wearing immersion suits and all were beginning to suffer from hypothermia by the time they were rescued by helicopter 40 minutes later.

The aircraft was not recovered, so it could not be determined why the right engine had failed. The left engine was later brought up by a trawler but, because of long immersion in salt water, investigators could not determine whether it had been capable of producing full power prior to the ditching. The right engine had been new with only 40 hours of operation since its installation nine days before the accident. Fuel samples taken from the aircraft's last refuelling location were uncontaminated and up to specification.

Took Off on Empty Tank

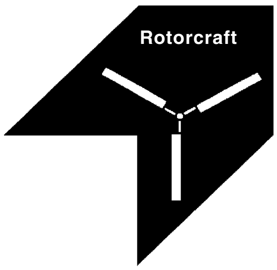
Jodel DR 1050: Substantial damage. Serious injuries to two.

The aircraft had been recently rebuilt and was to be ferried to a maintenance base preparatory to the reissuance of a certificate of airworthiness. The pilot, who rebuilt the aircraft, had made three test flights, totalling approximately three hours, to check out the aircraft before the ferry flight.

A friend who also was a pilot, agreed to accompany the rebuilder as an observer on a short flight prior to the ferry flight. The pilot taxied the aircraft, completed pre-takeoff checks and took off. The aircraft climbed straight ahead after a normal takeoff and had reached a height of approximately 150 feet when the engine suddenly lost power. The pilot immediately realized that he had taken off on the wrong fuel tank. He attempted to turn to the right over a valley to gain ground clearance while he switched tanks. Simultaneously, however, the other pilot had lowered the nose to maintain flying speed and the aircraft began to descend. The engine stopped completely although both occupants could hear the electric fuel pump operating.

There was not enough height left to restart the engine and the aircraft settled to the ground in a stalled condition and landed hard. The aircraft stopped in a tail-high attitude and the passenger was able to exit. The pilot was unconscious and had to be removed by rescuers. Both occupants had been wearing conventional safety belts with diagonal shoulder restraints but each suffered back injuries from vertical loads and facial injuries from impacts with the instrument panel and windshield.

The pilot admitted having mistakenly selected the nearly empty aft fuel tank for takeoff rather than the front one that had sufficient fuel for the intended flight. He stated that his failure to notice that the wrong fuel tank had been selected prior to takeoff could have been because of a heavy workload during the days prior to the accident and to distractions just before takeoff.



Helicopter Took in the Wash

Aerospatiale AS355 F1: Substantial damage. No injuries.

The rotorcraft, with two emergency medical technicians aboard, was responding to a call from a patient in a village. The pilot landed the aircraft on a large grassy parkland where the two paramedics deplaned and set off by foot to find the house where the patient was located. The pilot took off in the helicopter to find another landing site closer to the patient's house.

After examining the area, the pilot chose a landing site approximately 35 feet from the rear of the patient's single-story residence. There was a grassy area approximately 65 feet by 130 feet available, and he began a landing approach. At approximately 30 feet above the ground, the pilot suddenly became aware of decreased tail rotor control and the helicopter began a rapid yaw to the left that he could not arrest. He initiated an emergengy landing but the aircraft rotated almost four turns before it contacted the ground in a tail-low but otherwise normal attitude.

The pilot, unaware that the aircraft had landed hard enough to sustain damage, was unhurt and exited through the normal door. He discovered that, although there were no ground marks that indicated a hard landing, the tail pylon had collapsed downwards to the left and the tail rotor blades were dented.

Observers on the ground had seen a bed sheet drawn into the tail rotor and enmeshed in it as the helicopter approached the ground. The sheet had been hanging on a wash line parallel to the side of the building and approximately one foot away from it. Because the sheet was of a similar light color as the pale-colored walls of the residence, the pilot failed to notice it during his pre-landing survey of the site.

Disconnected Cyclic Leads to Loss of Control

Messerschmitt-Bolkow-Blohm, MBB-105: Substantial damage. Fatal injuries to one person.

The helicopter was about to depart on a VFR flight plan on company business. The pilot was the only occupant aboard.

The pilot lost control of the aircraft as it was lifting off and the rotorcraft collided with parked vehicles. The pilot was fatally injured and the aircraft was damaged substantially.

Investigation revealed that maintenance personnel had removed the cyclic interconnect for the dual controls the previous night following dual standardization training flights during that day. However, reconfiguration to single-pilot control was not completed. The result was that the aircraft had no lateral cyclic control. ♦