General Aviation
Aeronautical Decision-making

Joint Safety Analysis Team

Final Report

October 3, 2002

Table of Contents

Executive Summary

Poor decision-making by pilots has been identified as a major factor in the cause of general aviation accidents. Estimates of the proportion of accidents associated with poor decision-making range from 30% (Wiegmann & Shappell, 1997) to 50% (Jensen, 1995). . As an example, poor decisions result in pilots initiating flights under adverse conditions, continuing flights in the face of deteriorating conditions or operating aircraft beyond their limits. Thus, in contrast to other Joint Safety Analysis Teams (JSATs) which dealt with particular types of accident (ie., weather, CFIT), this Team was charged with investigating a more pervasive cause of accidents, which was believed to contribute to many types of General Aviation (GA) accidents.

The Aeronautical Decision-making (ADM) JSAT was chartered by the Joint Steering Committee (JSC) on August 5, 2001 and charged with identifying interventions that could reduce the number of fatal general aviation accidents associated with poor pilot decision-making.

The ADM JSAT was composed of representatives from the FAA, National Weather Service, Volpe National Transportation System Center and industry members representing HAI, GAMA, NBAA, AOPA and SAMA.

Accidents were selected based on a stratified sampling technique, using the results of a Human Factors Accident Classification System (HFACS) analysis of the entire GA accident database. From an initial pool of 120 accidents, 30 accidents that provided sufficient data for analysis and were representative of the various categories of decision errors were selected. The Team reviewed these accidents in detail, using a root cause analysis technique, to identify the specific decision errors that contributed to the accidents.

A panel of human factors experts was convened to develop a proposed set of interventions, based upon current knowledge in the fields of psychology and human factors. This expert panel produced 120 recommended interventions.

The recommended interventions from the human factors expert panel were then reviewed by the JSAT Team and evaluated for the effectiveness by which the interventions would resolve aeronautical decision errors and for the feasibility with which the intervention could be implemented. Each intervention was then ranked for its combined score for both effectiveness and feasibility.

The interventions that ranked high in both effectiveness and feasibility are:

- Develop and disseminate training that addresses the recognition of in-flight weather hazards, as well as countermeasures to these hazards.

- Encourage pilots to develop multiple options and decision points for flight, and to periodically reassess and revise their plans in flight.

- Encourage the appropriate use of checklists, and expand the use of these checklists into non-traditional roles, such as takeoff, landing, instrument approach and special maneuver checklists (not just for “switchology”.)

- During pre-flight planning, develop multiple options, check points and go/no-go criteria for use during the flight.

- Develop and implement training that would teach pilots to conduct periodic (i.e., every 15 minutes) evaluations of the status of their flight, to include aircraft controllability, fuel status, weather status, personal fatigue, stress, etc.

- From the initial flight onward, train pilots from the perspective of risk management and the effective utilization of all available resources.

- Develop training for pilots to manage unfamiliar situations. (e.g., Progressive Decision-Making.)

- Utilize the experiences (good and bad) of real pilots to teach decision-making skills. (e.g., use scenarios such as “I learned about flying from that” or those in FAA Trigger Tapes that provide concrete examples of the behaviors to be modeled or avoided.)

- Educate pilots of the potential consequences of flying in marginal weather in mountainous terrain.

- Produce a Personal Minimums Checklist training program expressly for the use of CFIs in setting their instructional practices, including training on risk assessment and management.

INTRODUCTION

For over 25 years, the importance of good pilot judgment, or aeronautical decision-making (ADM), has been recognized as critical to the safe operation of aircraft, as well as accident avoidance. (See Jensen, 1995, for a comprehensive review.) Interest in this area was precipitated by Jensen and Benel (1977), who reported that 51.6% of fatal GA accidents from 1970 through1974 were associated with decisional errors. More recent studies (e.g., Wiegmann and Shappell, 1997) have also found decision errors to be a major causal factor in accidents.

The early work in this area prompted the Federal Aviation Administration (FAA) to produce training directed at improving the decision-making of various pilot groups (e.g., Berlin & Holmes, 1981; Jensen & Adrion, 1987; 1988). Current FAA regulations require that decision-making be taught as part of the pilot training curriculum. Similar training was instituted in Canada and Australia (Buch & Diehl, 1984; Telfer, 1987).

In 1998 the Administrator of the FAA launched a Safer Skies Focused Safety Agenda (Safer Skies) in response to a White House initiative to improve aviation safety and security. One goal of Safer Skies was to achieve a marked reduction in the number of fatal general aviation accidents. To achieve that goal, six critical areas often associated with GA accidents were identified for action. Those areas were: Controlled Flight Into Terrain (CFIT), Weather, Aeronautical Decision-making, Survivability, Loss of Control, and Runway Incursion.

Industry/FAA teams were formed to study those areas and to develop interventions that would lead to a reduction in the numbers of fatal accidents associated with each of those causes. Reflecting the importance of Weather and CFIT as causes of accidents, these two areas were the first to be examined. Joint Safety Analysis Teams (JSATs) formed of industry and FAA personnel were chartered in 1998 to examine each of those areas. The reports of those teams were provided to the FAA/Industry Joint Steering Committee, and Joint Safety Implementation Teams (JSITs) were then formed to develop plans for the implementation of the JSATs' recommendations.

In developing their recommendations, the previous JSATs relied exclusively upon the expertise available within industry and the FAA. This approach reflected the nature of the tasks, which were to identify the underlying causes of accidents associated with CFIT and weather. For that task, industry and FAA personnel were clearly best qualified to evaluate the available data and make determinations of the probable underlying causes. In the area of aeronautical decision-making, however, the nature of the problem suggested that a different approach would be more productive. Discussions among FAA and industry personnel led to adoption of a unique approach in an attempt to gain a new perspective on the problem and capture interventions not considered by previous JSATs.

Under this approach, the operational expertise resident in the FAA and industry would be coupled with the scientific expertise available from the academic research community. Specifically, it was proposed that the ADM JSAT

make use of a panel of scientists who had expertise in the area of human factors and aeronautical decision-making among GA pilots. This expert panel would be used to develop proposed interventions, based upon their knowledge of the body of scientific research in this area. These interventions would then be evaluated and modified, as necessary, by the ADM JSAT using their knowledge of the operational realities of the GA environment to determine which interventions were most likely to be effective in reducing fatal accidents and most likely to be amenable to implementation.

This approach was briefed to FAA and industry and eventually to the Joint Steering Committee (JSC), who agreed to this modification of the usual JSAT process. The JSC further directed that, in view of this modification, it was appropriate for this team to perform both the analysis and implementation functions. Therefore, upon completion of the ADM JSAT process and approval by the JSC of a list of proposed interventions, the ADM JSAT would immediately continue operation as an ADM JSIT. Accordingly, a charter (Appendix A) reflecting those parameters was submitted and was approved by the JSC on August 5, 2001.

GOAL & SCOPE

The goal of the ADM JSAT is to reduce the number of fatal accidents among general aviation pilots attributable to poor aeronautical decision-making. The scope of the analysis was limited to pilots, with a conscious decision made not to include other groups that might affect flight operations, i.e. maintenance personnel, supervisors and management. Therefore, only those interventions that were directly relevant to pilots were considered.

METHOD

Selection of a Sample of Accidents for Analysis by the ADM JSAT

The accidents selected for analysis by the ADM JSAT were based upon a stratified random sample of the population of fatal general aviation accidents that occurred between approximately 1985 and 2000. Previously, Drs. Scott Shappell and Douglas Wiegmann had utilized the Human Factors Analysis and Classification System (HFACS; see Table 1) to classify the accidents that occurred during that time period. This analysis demonstrated that, within the overall category of Unsafe Acts, Violations and Decision-Errors (which together defined ADM accidents) accounted for 56% and 44% of the accidents, respectively. These proportions of the total accident population were used to select representative samples from the total population of accidents.

Specifically, the top five causes (listed in Table 2) from the list of Violation and Decision Errors were selected, as these all individually accounted for 5% or more of the accidents. As noted above, it has been shown that violations

constitute 56% and decision errors 44% of the causes of accidents (when all other non-ADM causes are eliminated). Therefore, the violation and decision categories were weighted .56 and .44, respectively. Then, each of the causes within a category (Decision Error or Violation) was weighted based on their contribution to the total of ADM accidents.

Previous JSATs had found that the majority of the NTSB reports did not contain sufficiently detailed information to conduct a thorough root cause analyses. Therefore, an arbitrary number of 120 accidents were selected as an initial body from which a smaller set of data-rich accidents could be selected for review. This allowed for the rejection of a large number of accidents due to insufficient information, while still providing a sufficient number of accidents for a reliable analysis.

Applying the stratified sampling proportions, as described above, to the NTSB database resulted in the selection of a weighted sampling of accidents, as shown in Table 2.

Table 1.
HFACS Categories

1. Organization
    - A. Resource Management
    - B. Organizational Climate
    - C. Organizational Process
    - D. Supervision

2. Inadequate Supervision
    - A. Planned Inappropriate Operations
    - B. Failed to Correct Problem
    - C. Supervisory Violations

3. Preconditions for Unsafe Acts
    - A. Adverse Mental States
    - B. Adverse Physiological States
    - C. Physical/Mental Limitations
    - D. Crew Resource Mismanagement
    - E. Personal Readiness
4. Unsafe Acts
    - A. Decision Errors
    - B. Skill-based Errors
    - C. Perceptual Errors
    - D. Violation

Table 2.
Numbers of accidents in sample by HFACS category

Violation Accidents	
VFR into IMC	29
Flight into Adverse Wx	16
Stress Limit Exceeded	9
IFR Procedure not followed	5
Weight & Balance Exceeded	6
Decision Accidents	
Poor in-flight planning	25
Wrong altitude selection	11
Over commitment to plan	7
Poor judgment	7
Poor flight planning	5
Total Accidents	120

This sample of accidents was randomized, and groups of 25 to 30 accidents were then drawn. The NTSB full factual file for each accident was obtained. The files were reviewed for content by the ADM JSAT. Files that were judged to contain sufficient information for analysis were retained. This process continued until an adequate number of accidents (approximately 30) with sufficient information for analysis were obtained.

The number of accidents to be analyzed (i.e., 30) is based upon several considerations. First, earlier guidance from the JSC had specified 30 as a suitable number. Additionally, previous JSATs (specifically, the Weather JSAT) had used approximately that number in their final analyses. Further, this number represented the largest workload that was feasible for the ADM JSAT and its expert panel to undertake within the timeframe and resource constraints. Finally, there was no scientific justification for selecting an alternative, and presumably, larger number.

It is important to note that the ADM JSAT was not tasked with evaluating accidents due to specific causes within the total accident population, as had been the case in evaluating weather and CFIT accidents. Had the JSAT been asked to analyze specific segments of ADM accidents that were caused by, for example, pilots electing to continue VFR flight into IMC conditions, then a more rigorous approach to sample selection and size specification might have been warranted. Instead, the ADM JSAT was tasked to produce interventions based on a comparatively more broad and general category of accident cause – poor decision-making by pilots. For the tasking assigned to the ADM JSAT, there is no sample size that can be arbitrarily or scientifically established, as the “next” case studied could include a specific decision error not previously addressed. The number of ADM accidents selected for review was simply a matter of judgment, to the extent that the various categories of ADM decision errors are adequately and proportionally represented.

Root Cause Analysis

Team members received a one-day course on root cause analysis, conducted by Apollo Associated Services, Inc.Root cause analysis was used to identify decision errors in each of the selected accidents. Analysis teams, consisting of two JSAT members each, were formed, and each analysis team was given the NTSB full factual files for four to six accidents. For those accidents wherein sufficient data were available to conduct an effective analysis, Team members independently created timelines that depicted the sequence of events in their assigned accidents and then identified decision errors that took place during that sequence. Each decision error was then classified into the appropriate HFACS category. (Appendix G).

Human Factors Expert Panel

A panel of human factors experts was formed, consisting of individuals drawn internationally. These panel members are well-known researchers and authorities, who have previously conducted and published extensive research in the area of aeronautical decision-making within the general aviation domain. (Appendix C)

This panel met in Alexandria, VA in February 2002 and was charged by the ADM JSAT to devise a comprehensive and detailed set of interventions that would, based on the current state of knowledge in psychology and human factors, improve the decision-making by general aviation pilots. To accomplish this goal, the panel used a variety of techniques. Prior to the meeting, the panel members reviewed current scientific literature on aeronautical decision-making and related topics. They were also provided a video depiction of a fictitious general aviation accident. Specific guidance to the panel members regarding their analysis of this video is contained in Appendix N. This video followed the decision-making processes of an inexperienced general aviation pilot as he prepared for and conducted a flight that presumably led to a crash. The video depiction provided a richness of information not present in the narrative, as well as factual descriptions provided by the NTSB, and served as a focus for discussion.

Each panel member provided a proposed list of interventions that would address the decision-making errors evident in the video. During the panel meeting, these initial interventions were elaborated upon, and additional interventions were identified. To further focus the panel's discussions and to ensure that interventions were related to actual (as opposed to fictitious) accidents, the panel members also reviewed the accidents analyzed by the JSAT. From this process, a list of approximately 120 potential interventions was produced. (Appendix H)

ADM JSAT members were then asked to match these interventions with the list of decision errors identified from the sample of accidents to identify those decision errors resolved by each intervention. (Appendix I)

Evaluation of Interventions

Effectiveness Rating – Following compilation by the Expert Panel of the Consolidated List of Interventions, each intervention was then evaluated by the Team for its effectiveness in preventing the decision errors that had led to an accident. Intervention effectiveness measures the relative ability of the intervention to influence a behavioral or attitudinal change by pilots toward proper aeronautical decision-making (ADM). Each Intervention was scored individually by Team members, receiving a "3" for high effectiveness, a "2" for moderate effectiveness or a "1" for low effectiveness. With thirteen members, scoring could range from a maximum of 39 to a minimum of 13. Actual scores for Effectiveness ranged from a high of 38 to a low of 16. A prioritized list of Interventions was

developed, based upon the Effectiveness scores assigned by the Team. (Appendix J) Areas of "High", "Moderate" and "Low" Effectiveness were calculated by dividing the total sum for all Interventions, compiled from individual Team member scores, and dividing them into thirds. The sum of all scores resulted in a total of 3558. The top third, or area of "High Effectiveness", includes those interventions whose scoring totals 1186, or Interventions that ranked #1 through #36. These Interventions scored individually from 38 to 32. The middle third, or area of "Moderate Effectiveness", extended from Interventions that scored 31 to partially through those Interventions that scored 28. So as not to differentiate between commonly scored Interventions, all of those scoring 28 were included in the "Moderate Effectiveness" range. These include Interventions ranked #37 through #83. The remaining Interventions fall into the lower third, or the area of "Low Effectiveness", and include Interventions that ranked #84 through #123.

Feasibility Rating - The Team was then tasked to rank each intervention based upon four categories: Technical Feasibility, Financial Feasibility, Regulatory Feasibility, and Operational Feasibility. Technical Feasibility rated an intervention based upon whether the technology needed to implement the Intervention already existed, was in development or required extensive further development to bring the technology to fruition. Financial Feasibility addressed the issue of whether an intervention would require little, some or significant dedication of financial, physical or personnel resources to implement the intervention. Regulatory Feasibility took into account whether the intervention would require some degree of FAA involvement or oversight, such as rulemaking, drafting of advisory circulars, certification, or regulatory change. Operational Feasibility addressed whether an intervention would be readily accepted or resisted by those entities involved with the conduct of flight operations: pilots and crew, supervisors, program management and/or corporate management.

If an intervention was easy to implement, used off-the-shelf technology, was inexpensive, did not require regulatory change and would be well accepted by the industry, it was considered highly feasible. If it required some further technological development, involved some level of funding, required some level or degree of FAA review or approval, or if the intervention might meet some resistance by the GA community, it was ranked as moderately feasible. If the intervention involved technology that was not well along in development, involved significant expenditures, required FAA rulemaking or regulatory change, or would meet significant resistance within the General Aviation community, it was given a Low Feasibility rating. Within each category, high feasibility was given a score of 2; moderate feasibility was scored a 1; and low feasibility was given a score of 0. Thus, the maximum score for each intervention by each team member was 8, and the lowest score was 0. Each intervention was ranked based upon its total score. Cumulatively, with ten members scoring, the maximum score possible was 80, and the lowest score possible was 0. The actual Feasibility scores ranged from 70 to 16. The aggregate score was divided into thirds to identify High, Moderate and Low Feasibility interventions. High feasibility interventions scored

from 70 to 61, moderate feasibility interventions scored from 60 to 54, and low feasibility interventions scored from 53 to 16. (Appendix K)

Priority Ranking

Matrix Development - With all interventions ranked by effectiveness and feasibility, they were charted accordingly and compared against each factor. It was decided not to combine effectiveness scores with feasibility scores, as an intervention might score extremely high in one field but extremely low in the other. That intervention's total score might indicate that it was a strong intervention, but in reality, it might be one that is totally infeasible or highly ineffective. Rather, the matrix was constructed to cross-match the criteria of the nine combined categories: highly effective and highly feasible, moderately effective and highly feasible, and so forth to those that were low in both effectiveness and feasibility. (Appendix L)

Recommendations

It is the recommendation of the Aeronautical Decision-making Joint Safety Analysis Team that the GA Coalition Joint Steering Committee reviews these findings and focus efforts within the General Aviation community on the development of implementation strategies for those interventions that are highly effective and highly feasible. The JSC should also consider interventions that are highly effective but moderately feasible, as well as interventions that are highly feasible but moderately effective. If time and resources permit, the JSC should also consider interventions that are moderately effective and moderately feasible, as some of these interventions may require only modest implementation but may have some impact upon the enhancement of safety. However, those interventions that are identified as low in effectiveness, low in feasibility, or both, should not be pursued. (Appendix M)

Appendix A.

Joint Safety Analysis Team (JSAT) Charter for General Aviation

Purpose: Develop interventions to reduce fatal general aviation accidents through improved aeronautical decision-making (ADM). For the purpose of this study, General Aviation (GA) is defined as "flight operations conducted under Parts 91, 125, 133, Nonscheduled 135 and 137." ADM refers to decisions made by aircrew regarding the planning and conduct of flights. It includes the information provided to these personnel upon which they base their decisions and the processes they use to evaluate that information.

Background: Industry (The General Aviation Coalition (GAC), NASA, NWS and FAA have agreed to work together to identify and implement a data driven, cost/benefit focused, safety enhancement program designed to reduce fatal general aviation accidents. The FAA, NASA, NWS and GAC have further agreed that cooperatively targeting a small number of critical and highly leveraged safety intervention strategies will maximize the safety benefit to the aviation community. To achieve this goal, the GA Joint Steering Committee (GAJSC) has chartered the Aeronautical Decision-making Joint Safety Analysis Team (JSAT).

This JSAT will differ from the previous JSATs in the following respects by:

- Examining a pervasive type of root cause, rather than a category of accidents.
- Addressing all "Safer Skies" categories of fatal GA accidents.
- Involving a panel of human factors experts to incorporate the latest human factors research findings.
- Seeking deeper insight into systemic ADM errors.
- Seeking to develop a range of intervention recommendations from entire decision support systems to specific situations.
- Incorporating state-of-the-art scientific knowledge of human decision-making.

Structure: The team will be co-chaired by an Industry and FAA representative who will recruit qualified representatives from industry, NASA, NWS and the FAA to serve as team members. The co-chairs will facilitate team meetings as necessary and will serve as the points-of-contact to the JSC. The team co-chairs will also maintain contact with the other JSAT co-chairs to take advantage of all the teams' collective experience. The Team will be assisted by a panel of human factors experts with experience in ADM.

Tasks:

- The Team will review summaries of accident and incident studies/reports containing GA ADM issues found in all Safer Skies accident categories to identify those most useful for the ADM analysis.
- These will include documents prepared by the CFIT and Weather JSATs, and limited analysis of accidents and incidents in other Safer Skies accident categories, including summaries and event sequences (but without root cause analysis).
- The Team will meet with an expert human factors panel (Panel), selected by FAA (AAM - 240), to brief them on these accidents and define the desired analysis activities and output of the Panel.
- Selected Team members will work with the Panel in its analysis activities.
- The Team will meet with the Panel again upon the conclusion of its deliberations to discuss the Panel's conclusions and recommendations.
- The Team will review the Panel's recommended interventions for effectiveness and feasibility, and where appropriate, modify them. When all interventions have been reviewed and prioritized, the Team will prepare a Report of its recommendations to submit to the JSC.

Product: The Team will provide the Joint Steering Committee (JSC) a report by the end of FY 2002, containing its recommended safety intervention strategies. The final report will include discussion on the process and assumptions used in the analysis. The Team will also provide periodic status reports on work in progress as may be requested from the JSC.

Resources: The JSC members who approve this JSAT charter agree to provide the people, necessary resources and organizational support to fulfill this charter. FAA will provide or budget for necessary support (e.g., Expert Panel, clerical support for dissemination of NTSB reports). FAA recognizes that the results of the ADM JSAT/JSIT process will likely result in multiple policy, procedural and programmatic enhancements that will require additional funding beginning in FY 2004 or 2005.

JSAT Members:

- Co-Chairs: FAA (AAM-240), HAI
- GA Associations: HAI, AOPA-ASF, GAMA, NBAA, SAMA.
- FAA: AAR-400, ARS-100, ACE-112, AFS-430, ATP-300, ARW-100, AAM-510.
- National Weather Service Aviation Services Branch.
- NASA

Appendix B.
Team Members

Name	Organization
Richard Wright, Co-Chair	HAI
David Hunter, Co-Chair	FAA
Jeff Brister	FAA
Vincent Carr	FAA
Brian Hancock	FAA
Joseph DeDonatis	FAA
Ken Knopp	FAA
Larry Randall	FAA
Dorothy Haldeman	NWS
Scott Shappell	FAA
Sherry Borener	Volpe National Transportation System Center
Richard Hiner	AOPA/ASF
Andrew Broom	GAMA
Glenn Rizner	HAI
Jay Evans	NBAA
Paul Fiduccia	SAMA

Appendix C.
Human Factors Expert Panel Members

David R. Hunter, Ph.D.	FAA Office of Aerospace Medicine
David O'Hare, Ph.D.	University of Otago, New Zealand
Monica Martinussen, Ph.D.	University of Tromso, Norway
Mark Wiggins, Ph.D.	University of Western Sydney, Australia
Richard Jensen, Ph.D.	Ohio State University
Robert Mauro, Ph.D.	University of Oregon
Douglas Wiegmann, Ph.D.	University of Illinois at Urbana-Champaign

Appendix D.

Acronyms

ATC	Air Traffic Control
CBT	Computer-Based Training
CFI	Certified Flight Instructor
CFIT	Controlled Flight Into Terrain
DUATS	Direct User Access Terminal System
FAA	Federal Aviation Administration
GA	General Aviation
HFACS	Human Factors Analysis and Classification System
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
JSAT	Joint Safety Analysis Team
JSC	Joint Steering Committee
JSIT	Joint Safety Implementation Team
METAR	Aviation Routine Weather Reports
OTC	Over The Counter
PCATD	Personal Computer Advanced Training Device
PIREPS	Pilot Reporting System
PPL	Private Pilot License
RCA	
TAF	Terminal Area Forecast
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

Appendix E.
Definitions

Aeronautical Decision-making (judgment) – Jensen (1995, pg 27) defines pilot judgment as "…the mental process that we use in making decisions…." and goes on to propose an eight-step judgment model which describes the judgment process as proceeding from problem vigil through action (see Jensen, 1995, Figure 2.1, pg 37). Jensen suggests that this eight-step model may be broken into two parts, consisting of rational judgment, which encompass the first five steps of the model, and motivational judgment, which encompasses the remaining three steps. Jensen (pg 53) defines these as:

> *"Rational judgment: The ability to discover and establish the relevance of all available information relating to problems of flight, to diagnose these problems, to specify alternative courses of action and to assess the risk associated with each alternative.*
> *Motivational judgment: The motivation to choose and execute a suitable course of action within the available time frame.*
> *Where:*
> *a. The choice could be either action or no action and,*
> *b. 'Suitable' is a choice consistent with 'societal' norms."*

From this definition, it is clear that judgment is a multidimensional construct, which incorporates the impact of both cognitive and personality constructs. Judgment reflects the bringing together of a large number of aspects of a person's skill repertoire, knowledge, and personality. It is not a single construct, in the sense of intelligence or locus of control, but rather a meta-construct. In addition, judgment contains an evaluative or outcome component. Judgment, by its name, implies a degree of correctness instead of error, of success as opposed to failure. This aspect is reflected in Jensen's definition through the inclusion of the "suitable" restriction.

Appendix F.

Listing of Accidents Analyzed

ATL86FA239
ATL92FA153
ATL95FA088
ATL97FA060
CHI00FA027
CHI86FA052
DEN00FA053
DEN88FA141
DEN99FA012
FTW95FA111
FTW99FA020
LAX87FA200
LAX90FA092
LAX91LA377
LAX94FA318
LAX94LA340
LAX99FA020
LAX99FA038
LAX99FA137
MIA00FA102
MIA99FA158
NYC94FA082
NYC95FA057
NYC99FA041
NYC99FA140
NYC99LA059
NYC99LA151
SEA91FA235
SEA98FA089
SEA99FA144

Appendix G.
SUMMARY OF DECISION ERROR ANALYSES WITH REGARD TO HFACS CLASSIFICATION

ORGANIZATIONAL INFLUENCES

Resource Management

This category refers to the management, allocation, and maintenance of organizational resources. For example, how does the company mange its pilots, staff, and maintenance personnel with regard to selection, background checks, training, and manning requirements. In addition, this category includes the manner in which the company manages its non-human resources. Issues such as cost cutting or lack of funding for proper equipment have adverse affects on operator performance and safety.

- Purchased wrong aircraft for mission

Organizational Climate

In general, organizational climate is the prevailing atmosphere within the organization and can be broken down into three over-arching categories: Structure, policies and culture. Structure - refers to the "form and shape" of an organization as reflected in the chain-of-command, delegation of authority and responsibility, communication channels, and accountability for actions. Organizations with maladaptive structures will be more prone to accidents. Policies - refers to hiring, promotion, retention, raises, sick leave, drugs and alcohol, overtime, accident investigations, use of safety equipment, etc. When these policies are ill defined, adversarial, or conflicting, safety may be reduced. Culture - refers to unspoken or unofficial rules, values, attitudes, beliefs, and customs of an organization that affect performance and safety.

- Rewarded results of risk taking (first on scene photo shots)

Organizational Process

This category refers to the formal process by which things get done in the organization. It has at least three components. Operations - refers to the characteristics or conditions of work that have been established by management. These characteristics included operational tempo, time pressures, production quotas, incentive systems, schedules, etc. Procedures - The official procedures as to how the job is to be done.

Examples include performance standards, objectives, documentation, instructions about procedures, etc. Oversight - refers to management's monitoring and checking of resources, climate, and processes to ensure a safe and productive work environment. Issues here relate to organizational self-study, risk management, and the establishment and use of safety programs. All of these organizational factors, if inadequate, can negatively impact employee supervision, performance, and safety.

- No provision in place to allow aircrew time to conduct adequate preflight

UNSAFE SUPERVISION

Inadequate Supervision

The role of any supervisor is to provide the opportunity to succeed. To do this, the supervisor, no matter at what level of operation, must provide guidance, training opportunities, leadership, and motivation, as well as the proper role model to be emulated.

- Flight dispatch failed to inform pilot of deteriorating weather
- Failed to ensure that crews adhered to CRM principles
- Allowed modification of control lock that jeopardized safety

Planned Inappropriate Operations

Occasionally, the operational tempo and/or the scheduling of aircrew are such that individuals are put at unacceptable risk, crew rest is jeopardized, and ultimately performance is adversely affected. Such operations, though arguably unavoidable during emergencies, are unacceptable during normal operations.

- Conducted external load operation with inappropriate aircraft and equipment
- Instructor elected to fly with student unprepared for flight
- Poor crew pairing (failed to match personnel qualifications to mission)
- Poor crew pairing (dominant PIC with acquiescent SIC)
- Failed to take corrective action when pilot routinely engaged in hazardous flight activities

Failed to Correct Problem

Failed to Correct a Known Problem, refers to those instances when deficiencies among individuals, equipment, training or other related safety areas are "known" to the supervisor, yet are allowed to continue unabated.

- SIC failed to alert supervisors to potential problems with PIC's IFR skills

- Pilot with demonstrated deficiencies allowed to retain PIC designation
- Management allows recheck without remedial training
- No corrective action taken to captain's rude demeanor

Supervisory Violation

Supervisory violations, on the other hand, are reserved for those instances when supervisors willfully disregard existing rules and regulations.

[None noted in set of 30 accidents reviewed by ADM JSAT.]

PRECONDITIONS FOR UNSAFE ACTS

SUBSTANDARD CONDITIONS OF OPERATOR

Adverse Mental States

The category of Adverse Mental States was created to account for those mental conditions that affect performance. Principal among these are the loss of situational awareness, task fixation, distraction, and mental fatigue due to sleep loss or other stressors. Also included in this category are personality traits and pernicious attitudes such as overconfidence, complacency, and misplaced motivation.

- Complacency
- Self-imposed pressure
- Pressure to reposition aircraft
- Overconfident
- Pilot in a hurry and not focusing on upcoming flight
- Mental fatigue
- Judgment impaired by antidepressant
- Focused on destination instead of overall weather situation
- Anti-authoritarian personality
- Invulnerable mental attitude
- Authoritarian attitude
- Anxious to depart before thunderstorms moved in
- Fixated on destination rather than overall weather
- Distracted by family emergency (death of father)
- Preoccupied with fuel state and system failure
- Perceived pressure from passenger (executive) to get underway
- Pilot determined to return to departure airport due to external pressure

Adverse Physiological States

Adverse physiological states refer to those medical or physiological conditions that preclude safe operations. Particularly important to aviation are such conditions as visual illusions and spatial disorientation as

described earlier, as well as physical fatigue, and the myriad of pharmacological and medical abnormalities known to affect performance.

[None noted in set of 30 accidents reviewed by ADM JSAT.]

Physical/Mental Limitations

This category refers to those instances when necessary visual or aural information is not available due to limitations inherent within the sensory system. For instance, in aviation, this most often includes not seeing other aircraft, power lines, or other obstacles due to the size or contrast of the object in the visual field. There may also be times when the individual's inherent aptitude, experience, and/or proficiency are incompatible with the characteristics or requirements of the task.

- Lack of proficiency/experience/training
- Unable to see runway for landing due to temporary light blindness at night
- Failed to recognize the importance of calculating density altitude
- Non-instrument rated pilot prepares for VFR flight in adverse weather

SUBSTANDARD PRACTICES OF OPERATOR

Crew Resource Mismanagement

Crew resource mismanagement was created to account for occurrences of poor coordination among personnel. Within the context of aviation, this includes coordination both within and between aircraft with air traffic control facilities and maintenance control, as well as with facility and other support personnel as necessary. But aircrew coordination does not stop with the aircrew in flight. It also includes coordination before and after the flight with the brief and debrief of the aircrew.

- Departs without weather update
- Failure to update weather in-flight
- Attempt to descend through IMC without ATC radar guidance
- Declines ATC flight following in adverse weather conditions.
- Fails to contact dispatch regarding flight progress
- PIC and SIC do not comment on weather below SOPs
- Failed to ensure that load was properly secured (planning error)
- Over-reliance on ATC to keep aircraft clear of weather
- Pilot and controller failed to obtain weather from alternate sources
- Failed to activate flight plan delaying search and rescue
- SIC fails to question urgency of 'repositioning' mission
- Crew did not coordinate on decision to launch into adverse weather

- Dominant PIC disregards input from acquiescent SIC

Personal Readiness

In aviation as in other professions, personal readiness failures occur when individuals fail to ensure that they are physically or mentally for duty. For instance, violations of crew rest requirements, bottle-to-brief rules, and self-medicating all will affect performance on the job and are particularly detrimental in the aircraft. This also includes those individuals that have not prepared mentally for the flight (e.g., students unprepared for the training flight).

- Student arrived unprepared for instructional flight
- Self-medicating with antidepressants
- Self-medicating with heart medication
- Came to flight tired
- Not medically certificated

UNSAFE ACTS OF OPERATORS

ERRORS

Errors are generally defined as mental or physical activities that fail to achieve their intended outcome. There are three basic error types - decision, skill-based, and perceptual.

Decision Errors

Decision errors represent intentional behavior that proceeds as intended, yet the plan proves inadequate or inappropriate for the situation. Often referred to as "honest mistakes," these unsafe acts represent the actions or inactions of individuals whose "hearts are in the right place," but they either did not have the appropriate knowledge or just simply chose poorly.

- Continued flight believing he could return to origination
- Did not believe PIREPS
- Underestimated the risk of flight
- Continued flight into deteriorating weather conditions
- Inadvertent/unintentional VFR flight into IMC
- Continued on planned flight route into adverse conditions
- Departed VFR in poor weather conditions
- Ignored warnings of "VFR not recommended"
- Opts to beat cold front in attempt to get to better weather
- Failure to recognize severity of weather conditions
- Attempted unpublished approach procedure at night during marginal weather

- Attempts to fly VFR-on-top of overcast
- Departs VFR despite active AIRMETs
- Continued flight rather than landing to wait for weather to improve
- Inappropriate response to emergency (flew low instead of doing 180 in IMC)
- Disregard for severity of weather
- Continued flight with known system failure (instructor)
- Although in demanding IMC, PIC assigns aircraft control to SIC
- PIC fails to take control when flight deviations begin
- Did not recognize implications of failure to achieve desired altitude (overloaded)
- Continued flight while in overloaded condition
- Misjudged aircraft's capabilities
- Failed to consider landing at more suitable alternate
- PIC fails to take stated action to execute go-around
- Overloaded aircraft
- Failed to confirm cause of low battery condition

Skill-based Errors

Skill-based behavior within the context of aviation is best described as "stick-and-rudder" and other basic flight skills that occur without significant conscious thought. As a result, these skill-based actions are particularly vulnerable to failures of attention and/or memory.

- Missed final opportunity to remove control lock before initiating takeoff
- Elected to perform maneuver with insufficient fuel
- Forgot item in checklist (prop de-ice and stall warning de-ice)
- Incorrectly positioned fuel switches in simulated engine shutdown procedure
- Incomplete preflight
- Not configured for best airspeed
- Did not lean mixture at high-density altitude

Perceptual Error

Perceptual errors occur when sensory input is degraded or "unusual," as is the case with visual illusions and spatial disorientation or when aircrew simply misjudges the aircraft's altitude, attitude, or airspeed.

[None noted in set of 30 accidents reviewed by ADM JSAT.]

VIOLATIONS

By definition, errors occur within the rules and regulations espoused by an organization. In contrast, violations represent a willful disregard for the rules and regulations that govern safe flight and, fortunately, occur much less frequently since they often involve fatalities.

Routine

Routine violations tend to be habitual by nature and often tolerated by governing authority. These violations are typically referred to as 'bending the rules (e.g., driving 65 mph in 55 mph zone).

- Unauthorized aerobatic maneuver
- "Show off" or "hot dog" for friend
- No pre-flight planning
- Failed to follow established safety procedures
- Did not compute weight and balance
- Intentionally did not load sufficient fuel for trip
- Used unpublished IFR procedure
- Violated Class B airspace
- Intentional VFR flight into IMC
- Unbriefed formation flight
- Failed to obtain any weather briefing
- Performance data not followed
- Disregarded emergency checklist for hydraulic failure
- PIC disregarded requirement to calculate landing distance
- Disregarded low fuel light and continued mission
- Departs with unworthy aircraft (unserviceable alternator)

Exceptional

Exceptional violations appear as isolated departures from authority, not necessarily indicative of individual's typical behavior pattern nor condoned by management (e.g., driving 105 mph in 55 mph zone).

- Continued VFR flight into IMC
- Ignores company SOPs by taking off below minimums

Appendix H.
Master Intervention List

Number	Category	Intervention
1	System: Weather	Create and disseminate to pilots a weather hazard index which incorporates the weather risks into a single graphic or number.
2	System: Weather	Reorganize weather briefings so as to present information related to potentially hazardous conditions as the first and last items given to the pilot.
3	System: Weather	Tailor weather briefings based upon pilot experience.
4	System: Weather	Organize weather information (particularly DUATS) by position along the proposed route.
5	System: Weather	Organize weather reports (e.g., TAFs) so as to facilitate the identification of trend information by pilots. (e.g., place all TAFs for a specified location together in the listing.)
6	System: Weather	Alert pilots to practical implications of weather conditions on aircraft performance and handling.
7	System: Testing	Require a minimum passing score on each major section of the written examination.
8	System: Testing	Decrease the reliance on multiple-choice questions in the written examination.
9	System: Testing	Increase the use of scenario-based questions in the written examination.
10	System: Testing	Increase the number of questions in the written examination.
11	System: Testing	Specify ADM competencies to be assessed during the practical test.
12	System: Testing	Require a minimum passing score on the ADM portion of the practical test, equivalent to the other major portions.
13	System: Testing	Develop and make available a large centralized bank of scenarios that examiners might use during the practical test to assess aeronautical decision-making skills.
14	System: Testing	Raise the minimum passing score on the written examination.
15	System: Testing	Utilize an item bank and adaptive testing system to reduce the influence of application memorization of questions and answers.
16	System: CFI Curriculum and Training	Establish one level of proficiency in training, such that training conducted under Part 61 is equivalent in structure and quality to that conducted under Part 141.
17	System: CFI Curriculum and Training	Expand the teaching of ADM, risk assessment, and risk management to be assessed as part of the written and practical tests for CFIs.
18	System: CFI Curriculum and Training	Include training for CFIs on risk assessment and management in instructional operations.
19	System: CFI Curriculum and Training	Produce a Personal Minimums Checklist training program expressly for use by CFIs in setting their instructional practices.
20	System: CFI Curriculum and Training	Incorporate additional training on human learning and teaching techniques in the CFI training curriculum and expand the assessment of these elements in the written and practical tests.

21	System: CFI Curriculum and Training	Institute a system for the periodic evaluation of CFIs (equivalent to the military standardization -evaluation programs) to ensure consistency in the quality of instruction given.
22	System: CFI Curriculum and Training	Institute a mentoring system for CFIs, so that they would have an identified source for guidance and counsel.
23	System: CFI Curriculum and Training	Provide guidance to CFIs on the ADM elements to be assessed during the flight review. Provide a bank of possible scenarios for use in assessing ADM.
24	System: CFI Curriculum and Training	Develop and disseminate guidance and techniques that CFIs could use to teach ADM, risk assessment, and risk management to their students.
25	System: CFI Curriculum and Training	Alert CFIs to notice behaviors indicative of invulnerability, over confidence, in their students, and modify their training to take those differences into account.
26	System: Flight Assistance Service	Establish a corps of experienced pilots advisers who could provide real-time advice to pilots.
27	System: Flight Assistance Service	Establish mechanisms (radio frequency and telephone numbers) by which pilots could access the adviser corps.
28	System: Flight Assistance Service	Establish a mechanism by which a pilot could transmit a short message to parties on the ground.
29	System: Flight Assistance Service	Establish a separate weather briefing and counseling line for low-time pilots.
30	System: Post-certificate training	Institute a system of voluntary graduated privileges for Private Pilot License holders.
31	System: Post-certificate training	Establish a formal continuing education program for private pilots, providing for the completion of a specified number of CEP credits that could be used in lieu of a flight review.
32	System: Post-certificate training	Establish a diagnostic pre-test which pilots would complete prior to the flight review, and which they would provide to their CFI prior to the review.
33	System: Post-certificate training	Develop a guide for completing a Personal Minimums Checklist.
34	System: Post-certificate training	Establish a post-certificate training program that would prepare newly certificated pilots for unusual or unfamiliar situations that they would not have experienced during their PPL training.
35	System: Integrated Flight Information Portal	Establish a single source from which pilots could obtain all information necessary for flight planning.
36	S: Integrated Flight Information Portal	Establish and promulgate standards and guidelines for the clear and effective communication of information, keyed to the skill and experience levels of the recipient.
37	System: Fail-Safe Design	Promulgate standards for the design of aircraft systems that require (1) fail-safe operation as a design standard; (2) graceful degradation; and, (3) error mitigation.
38	System: Fail-Safe Design	Require pitot heat to be applied automatically, whenever the aircraft is in flight.

39	System: Fail-Safe Design	Encourage the use of crash survivability equipment and new emergency technologies.
40	Equipment: Integrated Flight Display	Develop cockpit displays that integrate weather, navigation, aircraft performance, and control information.
41	Equipment: Integrated Flight Display	Develop an integrated weather hazard display.
42	Equipment: Integrated Flight Display	Develop equipment that relieves pilots of low-level tasks so that they may focus on high-level tasks.
43	Equipment: Integrated Flight Display	Establish human performance standards for the design of information displays.
44	Equipment: Improved Instrumentation	Incorporate visual and auditory warning devices into existing systems (such as fuel status).
45	Equipment: Improved Instrumentation	Develop fuel quantity indicators that are accurate throughout the range.
46	Equipment: Improved Instrumentation	Develop displays that depict critical operational variables in lieu of raw, unprocessed data. (E.g. Have fuel indicators that show remaining range or endurance, as well as remaining gallons of fuel.)
47	Equipment: Improved Instrumentation	Develop a mechanism to initiate a periodic in-flight system status and risk assessment by the pilot.
48	Equipment: Aircraft Performance Assistant	Develop user-friendly models that demonstrate to pilots the interaction of various flight conditions, such as temperature, weight and balance and fuel consumption throughout the course of a proposed flight.
49	Equipment: Aircraft Performance Assistant	Develop and publish functional standards for aircraft performance assistants.
50	Risk Management: Risk Assessment Procedures	Incorporate formal risk assessments into pre- and in-flight practices. (i.e., PCL and Risk Assessment Checklist)
51	Risk Management: Risk Assessment Procedures	Develop and test an expanded pre-flight risk assessment checklist
52	Risk Management: Risk Assessment Procedures	Develop and encourage the use of a cross-country card for low-time, inexperienced pilots.
53	Risk Management: Risk Assessment Procedures	Promote consultation between pilots and CFIs and safety counselors.
54	Risk Management: Risk Assessment Procedures	Develop measures of risk proclivity and encourage pilots to complete it as a means of developing self-awareness of risky habits.

55	Risk Management: Risk Assessment Procedures	Develop training and technology to assist pilots in recognizing and interpreting changes in the aircraft and/or environment that might signal increased risk.
56	Risk Management: Risk Assessment Procedures	Develop an FAA/Industry education program for pilots that identifies what assistance is available from ATC and explains what pilot actions might lead to FAA enforcement activities.
57	Risk Management: Risk Assessment Procedures	Develop and disseminate training that addresses the recognition of in-flight weather hazards, and countermeasures to these hazards.
58	Risk Management: Risk Assessment Procedures	Develop and disseminate quick tips for flying in specific regions (i.e., mountainous terrain, cross-country flights over water, etc.) or seasons (i.e., winter snow or ice, summer heat and humidity or low visibility due to summer haze.)
59	Risk Management: Risk Assessment Procedures	Develop and disseminate training that demonstrates the difficulty of maintaining situational awareness (i.e, navigating toward safety) while flying at very low levels over terrain of varying roughness.
60	Risk Management: Risk Assessment Procedures	Develop and disseminate training that would alert pilots to the need for an immediate life-saving decision in the face of: 1) loss of visibility; 2) loss of altitude; 3) loss of airspeed; and/or 4) CFIT alert.
61	Risk Management: Risk Assessment Procedures	Require/encourage new PPLs to obtain a CFI approval/review before each cross-country outside (some radius) until the PPL has ??? hours.
62	Risk Management: Risk Assessment Procedures	Encourage pilots to conduct a pre-flight risk assessment before each flight. (develop & disseminate training)
63	Risk Management: Risk Assessment Procedures	Develop self-awareness initiatives to ensure that pilots are aware of their limitations and the need to seek additional assistance when conduction operations outside their base of experience
64	Risk Management: Risk Assessment Procedures	Develop and disseminate easily-remembered Rules-of-Thumb that may be applied to weather forecasts to compensate for the lack of experience of low-time pilots.
65	Risk Management: Risk Management Procedures	Collect effective risk management procedures from the aviation community and disseminate them as "Rules of Thumb".
66	Risk Management: Risk Management Procedures	Encourage pilots to develop multiple options, decision points for flight, and to periodically reassess and revise their plans in flight.
67	Risk Management: Risk Management Procedures	Encourage appropriate use of checklists and crew briefings (self-brief), and expand use of checklists into non-traditional roles, such as takeoff, landing, instrument approach and special maneuver checklists (not just for "switchology).

68	Risk Management: Risk Management Procedures	Develop a "STUF" checklist (Social pressure, Time pressure, Unfamiliar situation, Feelings – emotional, physiological state.)
69	Risk Management: Risk Management Procedures	Encourage a sterile cockpit environment during "critical" phases of flight, such as takeoff, landing, instrument approaches, etc.
70	Risk Management: Risk Management Procedures	Establish pilot-passenger contracts that specify the conditions under which the pilot will operate and the conditions under which the passenger must notify the pilot of a problem or request a deviation or immediate landing.
71	Risk Management: Risk Management Procedures	Have pilots periodically complete a flying event history that would identify a history of doing hazardous things, which might build a belief that they can perform these activities with impunity.
72	Risk Management: Risk Management Procedures	During the pre-flight planning, develop alternative options, check points, and go/no-go criteria
73	Risk Management: Risk Management Procedures	Develop training that emphasizes the need to keep one problem from escalating into multiple problems. Periodic risk assessment should lead to early intervention.
74	Risk Management: Risk Management Procedures	Develop route plans that minimize the risks to survivability in the event of a crash (i.e., crash near a hospital, instead of in the desert)
75	Risk Management: Risk Management Procedures	Develop and implement training that would teach pilots to conduct periodic (i.e., every 15 minutes) evaluations of the status of their flight, to include aircraft controllability, fuel status, weather status, personal fatigue and stress.
76	Risk Management: Emergency Risk Management Procedures	Develop and disseminate information on the relative survivability of controlled precautionary or off-field landings versus uncontrolled landings.
77	RM: Emergency risk Management Procedures	Develop and disseminate training which explicitly addresses the issues involved in crash survivability; including crash technique, minimizing vertical loads, and planning for crashes (water, cell phone, matches, etc.) even on flights over hospitable terrain.
78	Decision Support: Automatic flight Planning Assistant	Develop an Automatic Flight Planning Assistant that: 1. Provides graphical flight planning with current and trend weather information in both cross-section and plan view. 2. Calculates and displays maximum likelihood, best case, and worst case weather states along route for proposed transit time. 3. Warns pilots of difficulties at specific points and provides suggested alternatives. 4. Calculates risks for flight based on aircraft, pilot, and environmental conditions. 5. Generates flight planning aids for routes. 6. Is capable of simulating alternative scenarios.
79	Decision Support: Automatic flight Planning Assistant	Publish standards for flight planning software.
80	Decision Support: Pilot Advisors	Develop a system whereby pilots may seek advice in a timely and convenient manner from a trusted and knowledgeable source. (for example, from the CFI at their FBO)

81	Decision Support: Pilot Advisors	Encourage pilots to make use of this system of advisers.
82	Decision Support: Automated Emergency Assistant	Develop an automated emergency assistant that provides direct instructions for emergency procedures.
83	Decision Support: Automated Emergency Assistant	Create computer software that illustrates various mechanical failures or conditions that could threaten safety of flight (e.g., leaning mixture, asymmetrical flaps, stuck elevator) and recommends appropriate pilot responses (e.g., gliding distances, animation that shows aircraft range as mixture is changed.)
84	Training: Principles of Instructional Design	Organize training around flight operations that the pilot will conduct upon award of their certificate.
85	Training: Principles of Instructional Design	Organize training such that the student is encouraged to be a proactive participant in making decisions and taking actions, rather than be a passive learner who simply does what the instructor directs.
86	Training: Principles of Instructional Design	From the initial flight onward, train pilots from the perspective of risk management and the effective utilization of all available resources.
87	Training: Principles of Instructional Design	Further develop within the general aviation community a culture of learning that utilizes peer pressure, leadership examples and perceived expectations to encourage participation and compliance.
88	Training: Principles of Instructional Design	Develop operations-based training curricula that integrate concepts and consequences (i.e., density altitude, mixture leaning, increased power).
89	Training: Weather	Develop and implement strategies for teaching: a) The dynamic characteristics of weather; b) the probabilistic nature of weather forecasts; c) how to make and interpret PIREPS; d) the correct interpretation of weather reports, so as to obtain the "big picture" and trends, during both pre-flight and in-flight.
90	Training: Weather	Develop a mechanism (probably PCATD) for route rehearsal to include weather information.
91	Training: Weather	Air traffic controllers and flight service specialists should receive more training in pilot operations and be given more information about the pilots and aircraft with which they are interacting.
92	Training: Unfamiliar Flight Conditions	Develop training for pilots to assist them in the recognition of unfamiliar situations.
93	Training: Unfamiliar Flight Conditions	Develop training for pilots to manage unfamiliar situations. (for example, Progressive Decision-Making)
94	Training: Unfamiliar Flight Conditions	Include assessments of the applicant's skill in dealing with unfamiliar situations in the written and practical test standards.
95	Training: Unfamiliar Flight Conditions	Train pilots to rehearse flights involving unfamiliar conditions.
96	Training: Human Performance	Expand training of pilots on the effect that human performance limitations have on flight operations. (e.g., fatigue, hypoxia, alcohol, tobacco, OTC drugs, self-medication, etc.)
97	Training: Human Performance	Develop training for pilots in metacognitive skills to enable them to continuously evaluate their own performance and compare it against an established standard.

98	Training: Human Performance	Train pilots to cope with stressful situations and to recognize and prepare for the effects of emotional interference on their performance.
99	Training: Human Performance	Develop training strategies for overcoming problematic beliefs. (e.g., invulnerability, anti-authoritarian and macho attitudes, resignation and passivity)
100	Training: Human Performance	Develop and implement expanded training in ADM, including training in the use of all available resources and the use of different decision strategies.
101	Training: Human Performance	Pilots should be encouraged and trained to develop and maintain a training log in which cognitive skills are examined on a reasonably regular basis, and this information is used to guide the subsequent training development of the individual.
102	Training: Cross-training	Pilots, controllers and flight service specialists should receive initial training in the operations performed by others outside their own specialty, including pilot and aircraft characteristics.
103	Training: Operations-based	Develop role-playing simulations in which pilots can observe modeled methods of resisting social pressures, and can then practice those methods.
104	Training: Operations-based	Develop software programs (both in-cockpit and simulated) that demonstrate the effects of aircraft and environmental conditions of performance and aircraft controllability (e.g., aerodynamic effects of ice: increased drag and weight, reduced power; reduction of power due to failure to lean mixture at high altitude, etc.)
105	Training: Mentoring	Improve the pilot mentoring (safety counselor) system, to explicitly link pilots (particularly new PPLs) with experienced role models.
106	TT: Scenario-based	Enhance training by utilizing scenarios that incorporate models of good behavior as well as problematic behavior. This training should be designed to develop cognitive skills, situational awareness, risk assessment, and decision-making. Develop simulator (and PCATD) scenarios for both normal and unfamiliar situations.
107	Training Technology: Scenario-based	Develop ground discussion and flight scenarios for use by CFIs
108	Training Technology: Scenario-based	Develop cue-based training to assist with diagnoses of changes in the aircraft, environment, and pilot states (e.g., fatigue). Develop interactive cue-based training scenarios, so that pilots learn to recognize the cues associated with deteriorating environmental or aircraft performance conditions.
109	Training Technology: Task-specific	Develop case-based training to assist in the retrieval of relevant information from memory.
110	Training Technology: Task-specific	Utilize simulation (and PCATD) technology to allow students to explore the effects of equipment states, environmental conditions, and pilot actions on flight, and to provide supplementary guidance and feedback.
111	Training Technology: Case-based	Capture best practices from experienced pilots and disseminate them in a readily accessible format to new or less experienced pilots.
112	Training Technology: Case-based	Utilize the experiences (good and bad) of real pilots to teach decision-making skills. (e.g., use scenarios such as “I learned about flying from that” or those in FAA Trigger Tapes that provide concrete examples of the behaviors to be modeled or avoided.)
113	Training Technology: Case-based	Teach problem solving and decision-making skills: a) Rule-based training should include instruction in the cues that trigger the rules. These rules should be clear and taught in an operational context; b) Training in analytical strategies should include training in the common "rules of thumb" and biases encountered when using analytical strategies, including operational suggestions on how to avoid some of the more common errors.
114	Training Technology: Case-based	Use typical pilots (with varying experience/skill levels) and show how their performance degrades after a few drinks, drugs, etc.
115	Training Technology: Case-based	Generate a large number of scenarios, in which the pilot, while demonstrating their typical behavior, crashes. Following some number, the good behavior is demonstrated so that they learn how to avoid the problems and the crash.

116	Training Technology: Case-based	Develop training to overcome the overgeneralization of infallibility from occupation into flying situation, where he/she is a novice.
117	Training Technology: Case-based	Educate pilots of the potential consequences of flying in marginal weather in mountainous terrain.
118	Training Technology: Case-based	Institute specific training aimed at helping students recognize and deal with unfamiliar conditions and events. Establish general rules of thumb for safe and immediate responses to changes in aircraft controllability or weather deterioration that avoids compounding errors. (i.e., turn toward lower terrain and clearer skies, and then work on the problem.)
119	Training Technology: Case-based	Develop and implement procedures to counter unrealistic optimism by GA pilots. (e.g., compare oneself to lists of characteristics of accident-involved pilots to counter the hazardous attitude of invulnerability).
120	Training Technology: Case-based	Develop a procedure or technique by which GA pilots may complete a personal critique (de-brief, self-evaluation, consolidation) of their performance following a flight. (This technique could be extended to training flights, in which the student and instructor independently complete the evaluations (for examples, see the Army PPDR, or the OSU research form) and then compare results.
121	Training Technology: Case-based	Develop a trainer (probably CBT) that demonstrates gliding or autorotational distance for various aircraft at different altitudes and wind conditions.
122	System: Testing	Enhance the written examination for pilot certification by: 1) Requiring a minimum passing score on each major section; 2) Decrease the reliance on multiple-choice questions; 3) Increase the use of scenario-based questions; 4) Increase the number of questions; and 5) Raise the minimum passing score.
123	System: CFI Curriculum and Training	Produce a Personal Minimums Checklist training program expressly for the use of CFIs in setting their instructional practices, including training on risk assessment and management.
124	System: CFI Curriculum and Training	FAA to rewrite the CFI curriculum to eliminate unnecessary maneuvers and stressing more of those that are necessary.
125	System: Flight Assistance Service	Establish a corps of experienced pilots who could provide real-time advice to pilots, and establish mechanisms (I.e., radio frequencies and telephone numbers) by which pilots could contact them.
126	Risk Management: Risk Management Procedures	Develop easily understood "rules of thumb" that can be applied to weather forecasts and risk management procedures to compensate for the lack of experience of low-time pilots.
127	Training: Unfamiliar Conditions	Develop training for pilots to assist them in recognition of unfamiliar situations and in the management of unfamiliar situations, as well as procedures to assess their skill in dealing with such unfamiliar conditions.
128	Training: Mentoring	Improve the pilot mentoring (safety counselor) system, explicitly to link pilots (particularly new PPLs) with an experienced role-model, such as CFIs and safety counselors.
129	Training Technology: Case-based	Create computer software that illustrates various mechanical failures or conditions that could threaten safety of flight (e.g., leaning mixture, asymmetrical flaps, stuck elevator) and recommends appropriate pilot responses (e.g., demonstrates gliding distances for various aircraft at various altitudes and wind conditions.)

Appendix I.

Intervention-Error Matrix

Number	Intervention	Decision Errors Resolved by Interventions (See Note 1 for codes)
1	Create and disseminate to pilots a weather hazard index which incorporates the weather risks into a single graphic or number.	3A8, 3C4, 3D1, 4A4, 4A5, 4A6, 4A7, 4A8, 4A10, 4A12, 4A13, 4A14, 4A16
2	Reorganize weather briefings so as to present information related to potentially hazardous conditions as the first and last items given to the pilot.	3A8, 3C4, 4A5, 4A7, 4A8, 4A10, 4A13
3	Tailor weather briefings based upon pilot experience.	3C1, 3C4, 4A6, 4A8
4	Organize the weather information (particularly DUATS) by position along the proposed route.	4A6
5	Organize weather reports (e.g., TAFs) so as to facilitate the identification of trend information by pilots. (e.g., place all TAFs for a specified location together in the listing.)	4A4, 4A5, 4A6, 4A9, 4A10, 4A14
6	Alert pilots to practical implications of weather conditions on aircraft performance and handling.	
7	Require a minimum passing score on each major section of the written examination.	3C1, 3C3, 4A10
8	Decrease the reliance on multiple-choice questions in the written examination.	
9	Increase the use of scenario-based questions in the written examination.	3C3
10	Increase the number of questions in the written examination.	
11	Specify ADM competencies to be assessed during the practical test.	
12	Require a minimum passing score on the ADM portion of the practical test, equivalent to the other major portions.	
13	Develop and make available a large centralized bank of scenarios which examiners might use during the practical test to assess aeronautical decision-making skills.	
14	Raise the minimum passing score on the written examination.	
15	Utilize an item bank and adaptive testing system to reduce the influence of application memorization of questions and answers.	
16	Establish one level of proficiency in training, such that training conducted under Part 61 is equivalent in structure and quality to that conducted under Part 141.	
17	Expand the teaching of ADM, risk assessment and risk management to be assessed as part of the written and practical tests for CFIs.	
18	Include training for CFIs on risk assessment and management in instructional operations.	4B4
19	Produce a Personal Minimums Checklist training program expressly for use by CFIs in setting their instructional practices.	2B2
20	Incorporate additional training on human learning and teaching techniques in the CFI training curriculum and expand the assessment of these elements in the written and practical tests.	
21	Institute a system for the periodic evaluation of CFIs (equivalent to the military standardization -evaluation programs) to ensure consistency in the quality of instruction given.	

22	Institute a mentoring system for CFIs, so that they would have an identified source for guidance and counsel.	
23	Provide guidance to CFIs on the ADM elements to be assessed during the flight review. Provide a bank of possible scenarios for use in assessing ADM.	
24	Develop and disseminate guidance and techniques that CFIs could use to teach ADM, risk assessment, and risk management to their students.	
25	Alert CFIs to notice behaviors indicative of invulnerability, over confidence, in their students, and modify their training to take those differences into account.	3A4, 3A9, 3A10, 3A11
26	Establish a corps of experienced pilots advisers who could provide real-time advice to pilots.	3C1
27	Establish mechanisms (radio frequency and telephone numbers) by which pilots could access the adviser corps.	3C1
28	Establish a mechanism by which a pilot could transmit a short message to parties on the ground.	
29	Establish a separate weather briefing and counseling line for low-time pilots.	3C1
30	Institute a system of voluntary graduated privileges for Private Pilot License holders.	3C1
31	Establish a formal continuing education program for private pilots, providing for the completion of a specified number of CEP credits that could be used in lieu of a flight review.	3C1, 3C3, 3E5, 4A2, 4A3, 4A4, 4A5, 4A6, 4A7, 4A8, 4A10, 4A12, 4A13, 4A14
32	Establish a diagnostic pre-test which pilots would complete prior to the flight review, and which they would provide to their CFI prior to the review.	3C1, 3E5, 4A10
33	Develop a guide for completing a Personal Minimums Checklist.	4A7
34	Establish a post-certificate training program that would prepare newly certificated pilots for unusual or unfamiliar situations that they would not have experienced during their PPL training.	3C1, 4A1, 4A4, 4A5, 4A8, 4A9, 4A12
35	Establish a single source from which pilots could obtain all information necessary for flight planning.	3D1
36	Establish and promulgate standards and guidelines for the clear and effective communication of information, keyed to the skill and experience levels of the recipient.	4A3, 4A4, 4A5, 4A8, 4A13
37	Promulgate standards for the design of aircraft systems that require (1) fail-safe operation as a design standard; (2) graceful degradation; and, (3) error mitigation.	4B1, 4B3, 4B7
38	Require pitot heat to be applied automatically, whenever the aircraft is in flight.	4B3
39	Encourage the use of crash survivability equipment and new emergency technologies.	
40	Develop cockpit displays that integrate weather, weather hazards, navigation, aircraft performance and control information.	3D2, 4A2, 4A4, 4A5, 4A6, 4A7, 4A8, 4A9, 4A10, 4A11, 4A12, 4A13, 4A14, 4A17
~~41~~	~~Develop an integrated weather hazard display.~~ –DELETED. Combined with Intervention #40.	
42	Develop equipment that relieves pilots of low-level tasks so that they may focus on high-level tasks.	
43	Establish human performance standards for the design of information displays.	
44	Incorporate visual and auditory warning devices into existing systems (such as fuel status).	4B6, 4D6

45	Develop fuel quantity indicators that are accurate throughout the range.	4D6, 4D15
46	Develop displays that depict critical operational variables in lieu of raw, unprocessed data. (E.g. Have fuel indicators that show remaining range or endurance, as well as remaining gallons of fuel.)	4B2, 4D6, 4D14
47	Develop a mechanism to initiate a periodic in-flight system status and risk assessment by the pilot.	
48	Develop user-friendly models that demonstrate to pilots the interaction of various flight conditions, such as temperature, weight and balance and fuel consumption throughout the course of a proposed flight.	4A20, 4A21, 4A22, 4A25, 4B7
49	Develop and publish functional standards for aircraft performance assistants.	
50	Incorporate formal risk assessments into pre- and in-flight practices. (i.e., PCL and Risk Assessment Checklist)	3A1, 3A2, 3A3, 3A12, 3A16, 3A17, 3D1, 3D12, 3E4, 4A3, 4A4, 4A6, 4A7, 4A8, 4A9, 4A12, 4A13, 4A16, 4A17, 4A25, 4A26, 4D5, 4D11
51	Develop and test an expanded pre-flight risk assessment checklist.	3A2, 3A3, 3A12, 3A16, 3D1, 3D12, 4A3, 4A6, 4A16, 4A17, 4A21, 4A25, 4A26
52	Develop and encourage the use of a cross-country card for low-time, inexperienced pilots.	3C1
53	Promote consultation between pilots and CFIs and safety counselors.	4A2
54	Develop measures of risk proclivity and encourage pilots to complete it as a means of developing self-awareness of risky habits.	
55	Develop training and technology to assist pilots in recognizing and interpreting changes in the aircraft and/or environment that might signal increased risk.	4A6, 4A10, 4A20, 4A26
56	Develop an FAA/Industry education program for pilots that identifies what assistance is available from ATC and explains what pilot actions might lead to FAA enforcement activities.	
57	Develop and disseminate training that addresses the recognition of in-flight weather hazards, and countermeasures to these hazards.	3A13, 3C4, 3D1, 3D2, 3D4, 3D8, 4A2, 4A4, 4A5, 4A6, 4A7, 4A8, 4A9, 4A10, 4A13, 4A14, 4A16
58	Develop and disseminate quick tips for flying in specific regions (i.e., mountainous terrain, cross-country flights over water, etc.) or seasons (i.e., winter snow or ice, summer heat and humidity or low visibility due to summer haze.)	
59	Develop and disseminate training that demonstrates the difficulty of maintaining situational awareness (i.e, navigating toward safety) while flying at very low levels over terrain of varying roughness.	4A11, 4A15
60	Develop and disseminate training that would alert pilots to the need for an immediate life-saving decision in the face of: 1) loss of visibility; 2) loss of altitude; 3) loss of airspeed; and/or 4) CFIT alert.	3C4, 4A4, 4A5, 4A6, 4A10, 4A20, 4D17
~~61~~	~~Require/encourage new PPLs to obtain a CFI approval/review before each cross-country outside (soe radius) until the PPL has ??? Hours.~~ DELETED. Duplication of Intervention #52.	
~~62~~	~~Encourage pilots to conduct a pre-flight risk assessment before each flight. (Develop and disseminate training.)~~ DELETED. Duplication of Intervention #50.	
63	Develop self-awareness initiatives to ensure that pilots are aware of their limitations and the need to seek additional assistance when conduction operations outside their base of experience	3A4, 3A6, 3A9, 3A10, 3A11, 3C1, 4A8
64	Develop and disseminate easily remembered Rules-of-Thumb which may be applied to weather forecasts to compensate for the lack of experience of low-time pilots.	3C1, 3C4, 4A4, 4A7, 4A8
65	Collect effective risk management procedures from the aviation community and disseminate them as "Rules of Thumb".	

66	Encourage pilots to develop multiple options, decision points for flight, and to periodically reassess and revise their plans in flight.	3A13, 3A17, 3D4, 4A4, 4A6, 4A7, 4A8, 4A9, 4A12, 4A14, 4A15, 4A23
67	Encourage appropriate use of checklists and crew briefings (self-brief), and expand use of checklists into non-traditional roles, such as takeoff, landing, instrument approach and special maneuver checklists (not just for "switchology).	3C3, 4B1
68	Develop a "STUF" checklist (Social pressure, Time pressure, Unfamiliar situation, Feelings – emotional, physiological state.)	3A1, 3A2, 3A3, 3A5, 3A6, 3A7, 3A12, 3A14, 3A16, 3A17, 3E2, 3A3, 3A4
69	Encourage a sterile cockpit environment during "critical" phases of flight, such as takeoff, landing, instrument approaches, etc.	
70	Establish pilot-passenger contracts that specify the conditions under which the pilot will operate and the conditions under which the passenger must notify the pilot of a problem or request a deviation or immediate landing.	3A16
71	Have pilots periodically complete a flying event history that would identify a history of doing hazardous things, which might build a belief that they can perform these activities with impunity.	4D1, 4D2, 4D9
72	During pre-flight planning, develop alternative options, check points and go/no-go criteria.	3A5, 3D1, 4A4, 4A6, 4A7, 4A8
73	Develop training that emphasizes the need to keep one problem from escalating into multiple problems. Periodic risk assessment should lead to early intervention.	
74	Develop route plans that minimize the risks to survivability in the event of a crash (i.e., crash near a hospital, instead of in the desert)	
75	Develop and implement training that would teach pilots to conduct periodic (i.e., every 15 minutes) evaluations of the status of their flight, to include aircraft controllability, fuel status, weather status, personal fatigue and stress.	3A13, 4A4, 4A6, 4A15, 4B2
76	Develop and disseminate information on the relative survivability of controlled precautionary or off-field landings versus uncontrolled landings.	
77	Develop and disseminate training which explicitly addresses the issues involved in crash survivability; including crash technique, minimizing vertical loads, and planning for crashes (water, cell phone, matches, etc.) even on flights over hospitable terrain.	
78	Publish standards for flight planning software, and with that software develop an Automatic Flight Planning Assistant that: 1) Provides graphical flight planning with current and trend weather information in both cross-section and plan view; 2) Calculates and displays maximum likelihood, best case and worst case weather states along the route for the proposed transit period; 3) Warns pilots of difficulties at specific points and provides suggested alternatives; 4) Calculates risks for flight based on aircraft, pilot and environmental conditions; 5) Generates flight planning aids for routes; and 6) Is capable of simulating alternative scenarios.	3A8, 3C1, 3C3, 3D1, 3D2, 4A4, 4A5, 4A6, 4A10, 4A14, 4A16
~~79~~	~~Publish standards for flight planning software~~. DELETED. Combined with Intervention #78.	
80	Develop a system whereby pilots may seek advice in a timely and convenient manner from a trusted and knowledgeable source. (for example, from the CFI at their FBO)	3C1, 4A2, 4A3, 4A10
81	Encourage pilots to make use of this system of advisers.	3C1, 4A2, 4A3, 4A10
82	Develop an automated emergency assistant that provides direct instructions for emergency procedures.	4A5, 4A15
83	Create computer software that illustrates various mechanical failures or conditions that could threaten safety of flight (e.g., leaning mixture, asymmetrical flaps, stuck elevator) and recommends appropriate pilot responses (e.g., gliding distances, animation that shows aircraft range as mixture is changed.)	4A20, 4A21, 4A22, 4A25, 4A26, 4B3, 4B6, 4B7

84	Organize training around flight operations that the pilot will conduct upon award of their certificate.	
85	Organize training such that the student is encouraged to be a proactive participant in making decisions and taking actions, rather than be a passive learner who simply does what the instructor directs.	
86	From the initial flight onward, train pilots from the perspective of risk management and the effective utilization of all available resources.	
87	Further develop within the general aviation community a culture of learning that utilizes peer pressure, leadership examples and perceived expectations to encourage participation and compliance.	4A6, 4A8
88	Develop operations-based training curricula that integrate concepts and consequences (i.e., density altitude, mixture leaning, increased power).	4A22, 4B6, 4B7
89	Develop and implement strategies for teaching: a) The dynamic characteristics of weather; b) the probabilistic nature of weather forecasts; c) how to make and interpret PIREPS; d) the correct interpretation of weather reports, so as to obtain the "big picture" and trends, during both pre-flight and in-flight.	3A8, 3A12, 3A13, 3D1, 3D2, 3D4, 4A2, 4A4, 4A5, 4A6, 4A7, 4A8, 4A9, 4A10, 4A12, 4A13, 4A14, 4A16
90	Develop a mechanism (probably PCATD) for route rehearsal to include weather information.	
~~91~~	~~Air traffic controllers and flight service specialists should receive more training in pilot operations and be given more information about the pilots and aircraft with which they are interacting~~. DELETED. Duplication of Intervention #102.	
92	Develop training for pilots to assist them in the recognition of unfamiliar situations.	4A5, 4A15
93	Develop training for pilots to manage unfamiliar situations. (e.g., Progressive Decision-Making.)	4A5, 4A20
94	Include assessments of the applicant's skill in dealing with unfamiliar situations in the written and practical test standards.	
95	Train pilots to rehearse flights involving unfamiliar conditions.	4A5, 4A20
96	Expand training of pilots on the effect that human performance limitations have on flight operations. (e.g., fatigue, hypoxia, alcohol, tobacco, OTC drugs, self-medication, etc.)	3A6, 3A7, 3E2, 3E3, 3E4, 3E5
97	Develop training for pilots in metacognitive skills to enable them to continuously evaluate their own performance and compare it against an established standard.	3A1, 3A4, 3E2, 3E5
98	Train pilots to cope with stressful situations and to recognize and prepare for the effects of emotional interference on their performance.	3A2, 3A3, 3A12, 3A14, 3A16, 3A17
99	Develop training strategies for overcoming problematic beliefs. (e.g., invulnerability, anti-authoritarian and macho attitudes, resignation and passivity)	3A1, 3A4, 3A9, 3A10, 3A11
100	Develop and implement expanded training in ADM, including training in the use of all available resources and the use of different decision strategies.	4A8, 4A13
101	Pilots should be encouraged and trained to develop and maintain a training log in which cognitive skills are examined on a reasonably regular basis, and this information is used to guide the subsequent training development of the individual.	2A2, 2C3
102	Pilots, controllers and flight service specialists should receive initial training in the operations performed by others outside their own specialty, including pilot and aircraft characteristics.	3D4, 3D8, 3D9
103	Develop role-playing simulations in which pilots can observe modeled methods of resisting social pressures, and can then practice those methods.	3A5, 3A14, 3A16, 3A17

104	Develop software programs (both in-cockpit and simulated) that demonstrate the effects of aircraft and environmental conditions of performance and aircraft controllability (e.g., aerodynamic effects of ice: increased drag and weight, reduced power; reduction of power due to failure to lean mixture at high altitude, etc.)	1A1, 3C3, 4A5, 4A6, 4A7, 4A15, 4A17, 4A20, 4A21, 4A22, 4A25, 4B3, 4B6, 4B7, 4D5, 4D12
105	Improve the pilot mentoring (safety counselor) system, to explicitly link pilots (particularly new PPLs) with experienced role models.	3C1
106	Enhance training by utilizing scenarios that incorporate models of good behavior as well as problematic behavior. This training should be designed to develop cognitive skills, situational awareness, risk assessment, and decision-making. Develop simulator (and PCATD) scenarios for both normal and unfamiliar situations.	3C1, 4A3, 4A4, 4A6, 4A7, 4A8, 4A16
107	Develop ground discussion and flight scenarios for use by CFIs	4A4, 4A6, 4A8
108	Develop cue-based training to assist with diagnoses of changes in the aircraft, environment, and pilot states (e.g., fatigue). Develop interactive cue-based training scenarios, so that pilots learn to recognize the cues associated with deteriorating environmental or aircraft performance conditions.	3E4, 4A4, 4A6, 4A9, 4A10, 4A15
109	Develop case-based training to assist in the retrieval of relevant information from memory.	
~~110~~	~~Utilize simulation (and PCATD) technology to allow students to explore the effects of equipment states, environmental conditions and pilot actions on flight, and to provide supplementary guidance and feedback~~. DELETED. Duplicates Intervention #104.	
111	Capture best practices from experienced pilots and disseminate them in a readily accessible format to new or less experienced pilots.	3C1, 4A4, 4A6, 4A8
112	Utilize the experiences (good and bad) of real pilots to teach decision-making skills. (e.g., use scenarios such as “I learned about flying from that” or those in FAA Trigger Tapes that provide concrete examples of the behaviors to be modeled or avoided.)	3C1, 4A13
113	Teach problem solving and decision-making skills: a) Rule-based training should include instruction in the cues that trigger the rules. These rules should be clear and taught in an operational context; b) Training in analytical strategies should include training in the common "rules of thumb" and biases encountered when using analytical strategies, including operational suggestions on how to avoid some of the more common errors.	3C1, 3C3, 4A15, 4A17
114	Use typical pilots (with varying experience/skill levels) and show how their performance degrades after a few drinks, drugs, etc.	3A6, 3A7, 3E2, 3E3, 3E4, 3E5
115	Generate a large number of scenarios, in which the pilot, while demonstrating their typical behavior, crashes. Following some number, the good behavior is demonstrated so that they learn how to avoid the problems and the crash.	3A4, 3A13
116	Develop training to overcome the overgeneralization of infallibility from occupation into flying situation, where he/she is a novice.	3A4
117	Educate pilots of the potential consequences of flying in marginal weather in mountainous terrain.	4A3, 4A4, 4A6, 4A7
118	Institute specific training aimed at helping students recognize and deal with unfamiliar conditions and events. Establish general rules of thumb for safe and immediate responses to changes in aircraft controllability or weather deterioration that avoids compounding errors. (i.e., turn toward lower terrain and clearer skies, and then work on the problem.)	3C1, 4A5
119	Develop and implement procedures to counter unrealistic optimism by GA pilots. (e.g., compare oneself to lists of characteristics of accident-involved pilots to counter the hazardous attitude of invulnerability).	3A4, 3A10, 4A3, 4A8, 4A16

120	Develop a procedure or technique by which GA pilots may complete a personal critique (de-brief, self-evaluation, consolidation) of their performance following a flight. (This technique could be extended to training flights, in which the student and instructor independently complete the evaluations (for examples, see the Army PPDR, or the OSU research form) and then compare results.	
121	Develop a trainer (probably CBT) that demonstrates gliding or autorotational distance for various aircraft at different altitudes and wind conditions.	
122	Enhance the written examination for pilot certification by: 1) Requiring a minimum passing score on each major section; 2) Decrease the reliance on multiple-choice questions; 3) Increase the use of scenario-based questions; 4) Increase the number of questions; and 5) Raise the minimum passing score.	3C3, 4A10, 4A15, 4A16, 4D5
123	Produce a Personal Minimums Checklist training program expressly for the use of CFIs in setting their instructional practices, including training on risk assessment and management.	2B2, 4A17, 4B4
124	FAA to rewrite the CFI curriculum to eliminate unnecessary maneuvers and stressing more of those that are necessary.	
125	Establish a corps of experienced pilots who could provide real-time advice to pilots, and establish mechanisms (I.e., radio frequencies and telephone numbers) by which pilots could contact them.	4A1, 4A3, 4A6, 4A7, 4A8, 4A10, 4A12, 4A13, 4A16, 4A26
126	Develop easily understood "rules of thumb" that can be applied to weather forecasts and risk management procedures to compensate for the lack of experience of low-time pilots.	4A2, 4A3, 4A4, 4A7, 4A8, 4A9, 4A10, 4A13, 4A14, 4A16
127	Develop training for pilots to assist them in recognition of unfamiliar situations and in the management of unfamiliar situations, as well as procedures to assess their skill in dealing with such unfamiliar conditions.	4A2, 4A4, 4A5, 4A6, 4A7, 4A9, 4A10, 4A14, 4A17
128	Improve the pilot mentoring (safety counselor) system, explicitly to link pilots (particularly new PPLs) with an experienced role model, such as CFIs and safety counselors.	3C1, 3C3, 3C4, 4A2, 4A3, 4A4, 4A6, 4A7, 4A8, 4A9, 4A10, 4A13, 4A15, 4A16, 4A22, 4A25, 4B5
129	Create computer software that illustrates various mechanical failures or conditions that could threaten safety of flight (e.g., leaning mixture, asymmetrical flaps, stuck elevator) and recommends appropriate pilot responses (e.g., demonstrates gliding distances for various aircraft at various altitudes and wind conditions.)	4A17, 4A20, 4A21, 4A22, 4A25, 4A26, 4B1, 4B2, 4B3, 4B4, 4B6, 4B7, 4D12, 4D14, 4D15, 4D16

Note1: The first digit and letter in the codes refer to the HFACS coding scheme given in Table 1. The final two digits are unique identifiers for a particular decision error identified by the ADM JSAT. For example, 4A17, refers to an Unsafe Act (4) Decision Error (A).

Appendix J.
Combined Effectiveness Ranking

ADM JSAT Intervention Ranking	ADM JSAT Intervention Number	Intervention	Combined Effectiveness Score
		High Effectiveness	
1	66	Encourage pilots to develop multiple options, decision points for flight, and to periodically reassess and revise their plans in flight.	**38**
2	86	From the initial flight onward, train pilots from the perspective of risk management and the effective utilization of all available resources.	**38**
3	40	Develop cockpit displays that integrate weather, weather hazards, navigation, aircraft performance and control information.	**37**
4	78	Publish standards for flight planning software, and with that software develop an Automatic Flight Planning Assistant that: 1) Provides graphical flight planning with current and trend weather information in both cross-section and plan view; 2) Calculates and displays maximum likelihood, best case and worst case weather states along the route for the proposed transit period; 3) Warns pilots of difficulties at specific points and provides suggested alternatives; 4) Calculates risks for flight based on aircraft, pilot and environmental conditions; 5) Generates flight planning aids for routes; and 6) Is capable of simulating alternative scenarios.	**37**
5	6	Alert pilots to practical implications of weather conditions on aircraft performance and handling.	**36**
6	46	Develop displays that depict critical operational variables in lieu of raw, unprocessed data. (E.g. Have fuel indicators that show remaining range or endurance, as well as remaining gallons of fuel.)	**36**
7	89	Develop and implement strategies for teaching: a) The dynamic characteristics of weather; b) the probabilistic nature of weather forecasts; c) how to make and interpret PIREPS; d) the correct interpretation of weather reports, so as to obtain the "big picture" and trends, during both pre-flight and in-flight.	**36**
8	1	Create and disseminate to pilots a weather hazard index that incorporates the weather risks into a single graphic or number.	**35**
9	56	Develop an FAA/Industry education program for pilots that identifies what assistance is available from ATC and explains what pilot actions might lead to FAA enforcement activities.	**35**
10	104	Develop software programs (both in-cockpit and simulated) that demonstrate the effects of aircraft and environmental conditions of performance and aircraft controllability (e.g., aerodynamic effects of ice: increased drag and weight, reduced power; reduction of power due to failure to lean mixture at high altitude, etc.)	**35**
11	35	Establish a single source from which pilots could obtain all information necessary for flight planning.	**34**
12	45	Develop fuel quantity indicators that are accurate throughout the range.	**34**
13	48	Develop user-friendly models that demonstrate to pilots the interaction of various flight conditions, such as temperature, weight and balance and fuel consumption throughout the course of a proposed flight.	**34**
14	55	Develop training and technology to assist pilots in recognizing and interpreting changes in the aircraft and/or environment that might signal increased risk.	**34**
15	67	Encourage appropriate use of checklists and crew briefings (self-brief), and expand use of checklists into non-traditional roles, such as takeoff, landing, instrument approach and special maneuver checklists (not just for "switchology).	**34**
16	72	During pre-flight planning, develop alternative options, check points and go/no go criteria.	**34**

17	75	Develop and implement training that would teach pilots to conduct periodic (i.e., every 15 minutes) evaluations of the status of their flight, to include aircraft controllability, fuel status, weather status, personal fatigue and stress.	**34**
18	88	Develop operations-based training curricula that integrate concepts and consequences (i.e., density altitude, mixture leaning, increased power).	**34**
19	117	Educate pilots of the potential consequences of flying in marginal weather in mountainous terrain.	**34**
20	127	Develop training for pilots to assist them in recognition of unfamiliar situations and in the management of unfamiliar situations, as well as procedures to assess their skill in dealing with such unfamiliar conditions.	**34**
21	23	Provide guidance to CFIs on the ADM elements to be assessed during the flight review. Provide a bank of possible scenarios for use in assessing ADM.	**33**
22	31	Establish a formal continuing education program for private pilots, providing for the completion of a specified number of CEP credits that could be used in lieu of a flight review.	**33**
23	47	Develop a mechanism to initiate a periodic in-flight system status and risk assessment by the pilot.	**33**
24	77	Develop and disseminate training which explicitly addresses the issues involved in crash survivability; including crash technique, minimizing vertical loads, and planning for crashes (water, cell phone, matches, etc.) even on flights over hospitable terrain.	**33**
25	102	Pilots, controllers and flight service specialists should receive initial training in the operations performed by others outside their own specialty, including pilot and aircraft characteristics.	**33**
26	112	Utilize the experiences (good and bad) of real pilots to teach decision-making skills. (e.g., use scenarios such as “I learned about flying from that” or those in FAA Trigger Tapes that provide concrete examples of the behaviors to be modeled or avoided.)	**33**
27	118	Institute specific training aimed at helping students recognize and deal with unfamiliar conditions and events. Establish general rules of thumb for safe and immediate responses to changes in aircraft controllability or weather deterioration that avoids compounding errors. (i.e., turn toward lower terrain and clearer skies, and then work on the problem.)	**33**
28	128	Improve the pilot mentoring (safety counselor) system, explicitly to link pilots (particularly new PPLs) with an experienced role model, such as CFIs and safety counselors.	**33**
28	24	Develop and disseminate guidance and techniques that CFIs could use to teach ADM, risk assessment, and risk management to their students.	**32**
30	34	Establish a post-certificate training program that would prepare newly certificated pilots for unusual or unfamiliar situations that they would not have experienced during their PPL training.	**32**
31	42	Develop equipment that relieves pilots of low-level tasks so that they may focus on high-level tasks.	**32**
32	44	Incorporate visual and auditory warning devices into existing systems (such as fuel status).	**32**
33	50	Incorporate formal risk assessments into pre- and in-flight practices. (i.e., PCL and Risk Assessment Checklist)	**32**
34	57	Develop and disseminate training that addresses the recognition of in-flight weather hazards, and countermeasures to these hazards.	**32**
35	93	Develop training for pilots to manage unfamiliar situations. (e.g., Progressive Decision-Making.)	**32**
36	123	Produce a Personal Minimums Checklist training program expressly for the use of CFIs in setting their instructional practices, including training on risk assessment and management.	**32**

		Moderate Effectiveness	
37	5	Organize weather reports (e.g., TAFs) so as to facilitate the identification of trend information by pilots. (e.g., place all TAFs for a specified location together in the listing.)	**31**
38	51	Develop and test an expanded pre-flight risk assessment checklist.	**31**
39	53	Promote consultation between pilots and CFIs and safety counselors.	**31**
40	59	Develop and disseminate training that demonstrates the difficulty of maintaining situational awareness (i.e, navigating toward safety) while flying at very low levels over terrain of varying roughness.	**31**
41	60	Develop and disseminate training that would alert pilots to the need for an immediate life-saving decision in the face of: 1) loss of visibility; 2) loss of altitude; 3) loss of airspeed; and/or 4) CFIT alert.	**31**
42	68	Develop a "STUF" checklist (Social pressure, Time pressure, Unfamiliar situation, Feelings – emotional, physiological state.)	**31**
43	90	Develop a mechanism (probably PCATD) for route rehearsal to include weather information.	**31**
44	92	Develop training for pilots to assist them in the recognition of unfamiliar situations.	**31**
45	2	Reorganize weather briefings so as to present information related to potentially hazardous conditions as the first and last items given to the pilot.	**30**
46	11	Specify ADM competencies to be assessed during the practical test.	**30**
47	13	Develop and make available a large centralized bank of scenarios that examiners might use during the practical test to assess aeronautical decision-making skills.	**30**
48	33	Develop a guide for completing a Personal Minimums Checklist.	**30**
49	65	Collect effective risk management procedures from the aviation community and disseminate them as "Rules of Thumb".	**30**
50	76	Develop and disseminate information on the relative survivability of controlled precautionary or off-field landings versus uncontrolled landings.	**30**
51	100	Develop and implement expanded training in ADM, including training in the use of all available resources and the use of different decision strategies.	**30**
52	105	Improve the pilot mentoring (safety counselor) system, to explicitly link pilots (particularly new PPLs) with experienced role models.	**30**
53	109	Develop case-based training to assist in the retrieval of relevant information from memory.	**30**
54	113	Teach problem solving and decision-making skills: a) Rule-based training should include instruction in the cues that trigger the rules. These rules should be clear and taught in an operational context; b) Training in analytical strategies should include training in the common "rules of thumb" and biases encountered when using analytical strategies, including operational suggestions on how to avoid some of the more common errors.	**30**
55	126	Develop easily understood "rules of thumb" that can be applied to weather forecasts and risk management procedures to compensate for the lack of experience of low-time pilots.	**30**
56	4	Organize weather information (particularly DUATS) by position along the proposed route.	**29**
57	17	Expand the teaching of ADM, risk assessment and risk management to be assessed as part of the written and practical tests for CFIs.	**29**
58	21	Institute a system for the periodic evaluation of CFIs (equivalent to the military standardization -evaluation programs) to ensure consistency in the quality of instruction given.	**29**
59	52	Develop and encourage the use of a cross-country card for low-time, inexperienced pilots.	**29**

60	58	Develop and disseminate quick tips for flying in specific regions (i.e., mountainous terrain, cross-country flights over water, etc.) or seasons (i.e., winter snow or ice, summer heat and humidity or low visibility due to summer haze.)	**29**
61	85	Organize training such that the student is encouraged to be a proactive participant in making decisions and taking actions, rather than be a passive learner who simply does what the instructor directs.	**29**
62	95	Train pilots to rehearse flights involving unfamiliar conditions.	**29**
63	96	Expand training of pilots on the effect that human performance limitations have on flight operations. (e.g., fatigue, hypoxia, alcohol, tobacco, OTC drugs, self-medication, etc.)	**29**
64	106	Enhance training by utilizing scenarios that incorporate models of good behavior as well as problematic behavior. This training should be designed to develop cognitive skills, situational awareness, risk assessment, and decision-making. Develop simulator (and PCATD) scenarios for both normal and unfamiliar situations.	**29**
65	111	Capture best practices from experienced pilots and disseminate them in a readily accessible format to new or less experienced pilots.	**29**
66	119	Develop and implement procedures to counter unrealistic optimism by GA pilots. (e.g., compare oneself to lists of characteristics of accident-involved pilots to counter the hazardous attitude of invulnerability).	**29**
67	121	Develop a trainer (probably CBT) that demonstrates gliding or autorotational distance for various aircraft at different altitudes and wind conditions.	**29**
68	129	Create computer software that illustrates various mechanical failures or conditions that could threaten safety of flight (e.g., leaning mixture, asymmetrical flaps, stuck elevator) and recommends appropriate pilot responses (e.g., demonstrates gliding distances for various aircraft at various altitudes and wind conditions.)	**29**
69	3	Tailor weather briefings based upon pilot experience.	**28**
70	9	Increase the use of scenario-based questions in the written examination.	**28**
71	18	Include training for CFIs on risk assessment and management in instructional operations.	**28**
72	19	Produce a Personal Minimums Checklist training program expressly for use by CFIs in setting their instructional practices.	**28**
73	26	Establish a corps of experienced pilots advisers who could provide real-time advice to pilots.	**28**
74	27	Establish mechanisms (radio frequency and telephone numbers) by which pilots could access the adviser corps.	**28**
75	32	Establish a diagnostic pre-test which pilots would complete prior to the flight review, and which they would provide to their CFI prior to the review.	**28**
76	39	Encourage the use of crash survivability equipment and new emergency technologies.	**28**
77	63	Develop self-awareness initiatives to ensure that pilots are aware of their limitations and the need to seek additional assistance when conduction operations outside their base of experience	**28**
78	69	Encourage a sterile cockpit environment during "critical" phases of flight, such as takeoff, landing, instrument approaches, etc.	**28**
79	94	Include assessments of the applicant's skill in dealing with unfamiliar situations in the written and practical test standards.	**28**
80	99	Develop training strategies for overcoming problematic beliefs. (e.g., invulnerability, anti-authoritarian and macho attitudes, resignation and passivity)	**28**
81	103	Develop role-playing simulations in which pilots can observe modeled methods of resisting social pressures, and can then practice those methods.	**28**

82	124	FAA to rewrite the CFI curriculum to eliminate unnecessary maneuvers and stressing more of those that are necessary.	**28**
83	125	Establish a corps of experienced pilots who could provide real-time advice to pilots, and establish mechanisms (I.e., radio frequencies and telephone numbers) by which pilots could contact them.	**28**
		Low Effectivness	
84	37	Promulgate standards for the design of aircraft systems that require (1) fail-safe operation as a design standard; (2) graceful degradation; and, (3) error mitigation.	**27**
85	43	Establish human performance standards for the design of information displays.	**27**
86	54	Develop measures of risk proclivity and encourage pilots to complete it as a means of developing self-awareness of risky habits.	**27**
87	73	Develop training that emphasizes the need to keep one problem from escalating into multiple problems. Periodic risk assessment should lead to early intervention.	**27**
88	80	Develop a system whereby pilots may seek advice in a timely and convenient manner from a trusted and knowledgeable source. (for example, from the CFI at their FBO)	**27**
89	81	Encourage pilots to make use of this system of advisers.	**27**
90	82	Develop an automated emergency assistant that provides direct instructions for emergency procedures.	**27**
91	83	Create computer software that illustrates various mechanical failures or conditions that could threaten safety of flight (e.g., leaning mixture, asymmetrical flaps, stuck elevator) and recommends appropriate pilot responses (e.g., gliding distances, animation that shows aircraft range as mixture is changed.)	**27**
92	108	Develop cue-based training to assist with diagnoses of changes in the aircraft, environment, and pilot states (e.g., fatigue). Develop interactive cue-based training scenarios, so that pilots learn to recognize the cues associated with deteriorating environmental or aircraft performance conditions.	**27**
93	120	Develop a procedure or technique by which GA pilots may complete a personal critique (de-brief, self-evaluation, consolidation) of their performance following a flight. (This technique could be extended to training flights, in which the student and instructor independently complete the evaluations (for examples, see the Army PPDR, or the OSU research form) and then compare results.	**27**
94	12	Require a minimum passing score on the ADM portion of the practical test, equivalent to the other major portions.	**26**
95	15	Utilize an item bank and adaptive testing system to reduce the influence of application memorization of questions and answers.	**26**
96	64	Develop and disseminate easily remembered Rules-of-Thumb which may be applied to weather forecasts to compensate for the lack of experience of low-time pilots.	**26**
97	70	Establish pilot-passenger contracts that specify the conditions under which the pilot will operate and the conditions under which the passenger must notify the pilot of a problem or request a deviation or immediate landing.	**26**
98	98	Train pilots to cope with stressful situations and to recognize and prepare for the effects of emotional interference on their performance.	**26**
99	49	Develop and publish functional standards for aircraft performance assistants.	**25**
100	74	Develop route plans that minimize the risks to survivability in the event of a crash (i.e., crash near a hospital, instead of in the desert)	**25**

101	101	Pilots should be encouraged and trained to develop and maintain a training log in which cognitive skills are examined on a reasonably regular basis, and this information is used to guide the subsequent training development of the individual.	**25**
102	107	Develop ground discussion and flight scenarios for use by CFIs	**25**
103	114	Use typical pilots (with varying experience/skill levels) and show how their performance degrades after a few drinks, drugs, etc.	**25**
104	116	Develop training to overcome the overgeneralization of infallibility from occupation into flying situation, where he/she is a novice.	**25**
105	122	Enhance the written examination for pilot certification by: 1) Requiring a minimum passing score on each major section; 2) Decrease the reliance on multiple-choice questions; 3) Increase the use of scenario-based questions; 4) Increase the number of questions; and 5) Raise the minimum passing score.	**25**
106	25	Alert CFIs to notice behaviors indicative of invulnerability, over confidence, in their students, and modify their training to take those differences into account.	**24**
107	29	Establish a separate weather briefing and counseling line for low-time pilots.	**24**
108	36	Establish and promulgate standards and guidelines for the clear and effective communication of information, keyed to the skill and experience levels of the recipient.	**24**
109	84	Organize training around flight operations that the pilot will conduct upon award of their certificate.	**24**
110	87	Further develop within the general aviation community a culture of learning that utilizes peer pressure, leadership examples and perceived expectations to encourage participation and compliance.	**24**
111	97	Develop training for pilots in metacognitive skills to enable them to continuously evaluate their own performance and compare it against an established standard.	**24**
112	115	Generate a large number of scenarios, in which the pilot, while demonstrating their typical behavior, crashes. Following some number, the good behavior is demonstrated so that they learn how to avoid the problems and the crash.	**24**
113	20	Incorporate additional training on human learning and teaching techniques in the CFI training curriculum and expand the assessment of these elements in the written and practical tests.	**23**
114	7	Require a minimum passing score on each major section of the written examination.	**22**
115	30	Institute a system of voluntary graduated privileges for Private Pilot License holders.	**22**
116	22	Institute a mentoring system for CFIs, so that they would have an identified source for guidance and counsel.	**21**
117	8	Decrease the reliance on multiple-choice questions in the written examination.	**20**
118	10	Increase the number of questions in the written examination.	**20**
119	14	Raise the minimum passing score on the written examination.	**20**
120	38	Require pitot heat to be applied automatically, whenever the aircraft is in flight.	**18**
121	71	Have pilots periodically complete a flying event history that would identify a history of doing hazardous things, which might build a belief that they can perform these activities with impunity.	**18**
122	16	Establish one level of proficiency in training, such that training conducted under Part 61 is equivalent in structure and quality to that conducted under Part 141.	**17**
123	28	Establish a mechanism by which a pilot could transmit a short message to parties on the ground.	**16**

Appendix K.
Combined Feasibility Ranking

ADM JSAT Intervention Ranking	ADM JSAT Intervention Number	Intervention	Combined Feasibility Score
		High Feasibility	
1	72	During pre-flight planning, develop alternative options, check points and go/no go criteria.	**70**
2	53	Promote the consultation of pilots with CFIs and safety counselors.	**68**
2	68	Develop a "STUF" checklist (Social pressure, Time pressure, Unfamiliar situation, Feelings – emotional, physiological state.)	**68**
3	2	Reorganize weather briefings so as to present information related to potentially hazardous conditions as the first and last items given to the pilot.	**67**
3	64	Develop and disseminate easily remembered Rules-of-Thumbs which may be applied to weather forecasts to compensate for the lack of experience of low-time pilots.	**67**
3	69	Encourage a sterile cockpit environment during "critical" phases of flight, such as takeoff, landing, instrument approaches, etc.	**67**
4	66	Encourage pilots to develop multiple options, decision points for flight, and to periodically reassess and revise their plans in flight.	**66**
4	67	Encourage appropriate use of checklists and crew briefings (self-brief). Expand use of checklists into non-traditional roles (not just for "switchology).	**66**
4	96	Expand training of pilots on the effect that human performance limitations have on flight operations. (e.g., fatigue, hypoxia, alcohol, tobacco, OTC drugs, self-medication, etc.)	**66**
5	76	Develop and disseminate information on the relative survivability of controlled precautionary or off-field landings versus uncontrolled landings.	**65**
6	33	Develop a guide for completing a Personal Minimums Checklist.	**64**
6	58	Develop and disseminate quick tips for flying in specific regions (i.e., mountainous, cross-water, Florida summer time, etc.) and specific times (i.e., low visibility due to haze in Ohio in the Summer).	**64**
6	75	Develop and implement training that would teach pilots to conduct period (i.e., every 15 minutes) evaluations of the status of their flight, to include aircraft controllability, fuel status, weather status, personal fatigue and stress.	**64**
6	86	From the initial flight onward, train pilots from the perspective of risk management and effective utilization of all available resources.	**64**
6	107	Develop ground discussion and flight scenarios for use by CFIs	**64**
6	117	Demonstrate the potential consequences of flying in marginal weather in mountainous terrain.	**64**
7	57	Develop and disseminate training that addresses the recognition of in-flight weather hazards, and countermeasures to these hazards.	**63**
7	74	Develop route plans that minimize the risks to survivability in the event of a crash (i.e., crash near a hospital, instead of in the desert)	**63**
7	92	Develop training for pilots to assist them in the recognition of unfamiliar situations.	**63**
7	111	Capture best practices from experienced pilots and disseminate them in a readily accessible format to new or less experienced pilots.	**63**
8	13	Develop and make available a large centralized bank of scenarios which examiners might use during the practical test to assess ADM.	**62**
8	81	Encourage pilots to make use of this system of advisers.	**62**
8	90	Develop a mechanism (probably PCATD) for route rehearsal to include weather information.	**62**

8	93	Develop training for pilots to manage unfamiliar situations. (e.g., Progressive Decision-Making.)	**62**
8	99	Develop training strategies for overcoming problematic beliefs. (e.g., invulnerability, anti-authoritarian and macho attitudes, resignation and passivity)	**62**
8	113	Teach problem solving and decision-making skills: a) Rule-based training should include instruction in the cues that trigger the rules. These rules should be clear and taught in an operational context; b) Training in analytical strategies should include training in the common "rules of thumb" and biases encountered when using analytical strategies, including operational suggestions on how to avoid some of the more common errors.	**62**
8	123	Produce a Personal Minimums Checklist training program expressly for use by CFIs in setting their instructional practices, including training on risk assessment and management.	**62**
9	5	Organize weather reports (for example, TAFs) so as to facilitate the identification of trend information by pilots. For example, place all TAFs for a specified location together in the listing.	**61**
9	19	Produce a Personal Minimums Checklist training program expressly for use by CFIs in setting their instructional practices.	**61**
9	65	Collect effective risk management procedures from the aviation community and disseminate them as "Rules of Thumb".	**61**
9	70	Establish pilot-passenger contracts that specify the conditions under which the pilot will operate and the conditions under which the passenger must notify the pilot of a problem or request a deviation or immediate landing.	**61**
9	98	Train pilots to cope with stressful situations and to recognize and prepare for the effects of emotional interference on their performance.	**61**
9	109	Develop case-based training to assist in the retrieval of relevant information from memory.	**61**
9	112	Utilize the experiences (good and bad) of real pilots to teach decision-making skills. (for example, use scenarios such as “I learned about flying from that” or the FAA Trigger Tapes to provide concrete examples of the behaviors to be modeled or avoided.)	**61**
9	126	Develop easily understood "rules of thumb" that can be applied to weather forecasts and risk management procedures to compensate for the lack of experience of low-time pilots.	**61**
		Moderate Feasibility	
10	52	Develop and encourage the use of a cross-country card for low-time, inexperienced pilots.	**60**
10	77	Develop and disseminate training which explicitly addresses the issues involved in crash survivability; including crash technique, minimizing vertical loads, and planning for crashes (water, cell phone, matches, etc.) even on flights over hospitable terrain.	**60**
10	87	Further develop within the general aviation community a culture of learning that utilizes peer pressure, leadership examples and perceived expectations to encourage participation and compliance.	**60**
10	100	Develop and implement expanded training in ADM, including training in the use of all available resources and the use of different decision strategies.	**60**
10	127	Develop training for pilots to assist them in recognition of unfamiliar situations, in the management of unfamiliar situations and develop procedures to assess their skill in dealing with unfamiliar conditions.	**60**
11	4	Organize the weather information (particularly DUATS) by position along the proposed route.	**59**
11	54	Develop measures of risk proclivity and encourage pilots to complete it as a means of developing self-awareness of risky habits.	**59**
11	89	Develop and implement strategies for teaching: (a) The dynamic characteristics of weather, (b) the probabilistic nature of weather forecasts, (c) how to make and interpret PIREPS, (d) the interpretation of weather reports so as to obtain the "big picture" and trends, both during pre-flight and in-flight.	**59**

11	95	Train pilots to rehearse flights involving unfamiliar conditions.	**59**
11	105	Improve the pilot mentoring (safety counselor) system, to explicitly link pilots (particularly new PPLs) with experienced role-models.	**59**
12	10	Increase the number of questions in the written examination.	**58**
12	14	Raise the minimum passing score on the written examination.	**58**
12	23	Provide guidance to CFIs on the ADM elements to be assessed during the flight review. Provide a bank of possible scenarios for use in assessing ADM.	**58**
12	51	Develop and test an expanded pre-flight risk assessment checklist.	**58**
12	56	Develop an FAA/Industry education program for pilots that identifies what assistance is available from ATC and explains what pilot actions might lead to FAA enforcement activities.	**58**
12	101	Pilots should be encouraged and trained to develop and maintain a training log in which cognitive skills are examined on a reasonably regular basis, and this information is used to guide the subsequent training development of the individual.	**58**
13	3	Tailor weather briefings based upon pilot experience.	**57**
13	18	Include training for CFIs on risk assessment and management in instructional operations.	**57**
13	63	Develop self-awareness initiatives to ensure that pilots are aware of their limitations and the need to seek additional assistance when conduction operations outside their base of experience	**57**
13	88	Develop operations-based training curricula that integrate concepts and consequences (i.e., density altitude, mixture leaning, increased power).	**57**
13	114	Use typical pilots (with varying experience/skill levels) and show how their performance degrades after a few drinks, drugs, etc.	**57**
13	116	Develop training to overcome the overgeneralization of infallibility from occupation into flying situation, where he/she is a novice.	**57**
13	120	Develop a procedure or technique by which GA pilots may complete a personal critique (de-brief, self-evaluation, consolidation) of their performance following a flight. (This technique could be extended to training flights, in which the student and instructor independently complete the evaluations (for examples, see the Army PPDR, or the OSU research form) and then compare results.	**57**
13	121	Develop a trainer (probably CBT) that demonstrates gliding or autorotational distance for various aircraft at different altitudes and wind conditions.	**57**
14	12	Require a minimum passing score on the ADM portion of the practical test, equivalent to the other major portions.	**56**
14	24	Develop and disseminate guidance and techniques which CFIs could use to teach ADM, risk assessment, and risk management to their students.	**56**
14	59	Develop and disseminate training that demonstrates the difficulty of maintaining situational awareness (i.e, navigating toward safety) while flying at very low levels over terrain of varying roughness.	**56**
14	60	Develop and disseminate training that would alert pilots to the need for an immediate life-saving decision in the face of: 1) loss of visibility; 2) loss of altitude; 3) loss of airspeed; and/or 4) CFIT alert.	**56**
14	73	Develop training that emphasizes the need to keep one problem from escalating into multiple problems. Periodic risk assessment should lead to early intervention.	**56**
14	115	Generate a large number of scenarios, in which the pilot, while demonstrating their typical behavior, crashes. Following some number, the good behavior is demonstrated so that they learn how to avoid the problems and the crash.	**56**
14	119	Develop and implement procedures to counter unrealistic optimism by GA pilots. (e.g., compare oneself to lists of characteristics of accident-involved pilots to counter the hazardous attitude of invulnerability).	**56**
14	128	Improve the pilot mentoring (safety counselor) system, explicitly to link pilots (particularly new PPLs) with an experienced role model, such as CFIs and safety counselors.	**56**

15	25	Alert CFIs to notice behaviors indicative of invulnerability, over confidence, in their students, and modify their training to take those differences into account.	**55**
15	97	Develop training for pilots in metacognitive skills to enable them to continuously evaluate their own performance and compare it against an established standard.	**55**
15	103	Develop role-playing simulations in which pilots can observe modeled methods of resisting social pressures, and can then practice those methods.	**55**
16	11	Specify ADM competencies to be assessed during the practical test.	**54**
16	84	Organize training around flight operations that the pilot will conduct upon award of their certificate.	**54**
16	85	Organize training such that the student is encouraged to be a proactive participant in making decisions and taking actions, rather than be a passive learner who simply does what the instructor directs.	**54**
16	118	Institute specific training aimed at helping students recognize and deal with unfamiliar conditions and events. Establish general rules of thumb for safe and immediate responses to changes in aircraft controllability or weather deterioration that circumvents additional errors. (i.e., turn toward lower terrain and clearer skies, and then work on the problem.)	**54**
		Low Feasibility	
17	39	Encourage the use of crash survivability equipment and new emergency technologies.	**53**
17	71	Have pilots periodically complete a flying event history which would identify a history of doing hazardous things, which might build a belief that they can perform these activities with impunity.	**53**
17	80	Develop a system whereby pilots may seek advice in a timely and convenient manner from a trusted and knowledgeable source. (for example, from the CFI at their FBO)	**53**
18	15	Utilize an item bank and adaptive testing system to reduce the influence of application memorization of questions and answers.	**52**
18	47	Develop a mechanism to initiate a periodic in-flight system status and risk assessment by the pilot.	**52**
18	94	Include assessments of the applicant's skill in dealing with unfamiliar situations in the written and practical test standards.	**52**
18	108	Develop cue-based training to assist with diagnoses of changes in the aircraft, environment, and pilot states (e.g., fatigue). Develop interactive cue-based training scenarios, so that pilots learn to recognize the cues associated with deteriorating environmental or aircraft performance conditions.	**52**
19	7	Require a minimum passing score on each major section of the written examination.	**51**
19	22	Institute a mentoring system for CFIs, so that they would have an identified source for guidance and counsel.	**51**
19	34	Establish a post-certificate training program that would prepare newly certificated pilots for unusual or unfamiliar situations that they would not have experienced during their PPL training.	**51**
19	49	Develop and publish functional standards for aircraft performance assistants.	**51**
19	50	Incorporate formal risk assessments into pre- and in-flight practices. (i.e., PCL and Risk Assessment Checklist)	**51**
20	17	Expand the teaching of ADM, risk assessment and risk management to be assessed as part of the written and practical tests for CFIs.	**50**
20	83	Create computer software that illustrates various mechanical failures or conditions that could threaten safety of flight (e.g., leaning mixture, asymmetrical flaps, stuck elevator) and recommends appropriate pilot responses (e.g., gliding distances, animation that shows aircraft range as mixture is changed.)	**50**
20	104	Develop software programs (both in-cockpit and simulated) that demonstrate the effects of aircraft and environmental conditions of performance and aircraft controllability (e.g., aerodynamic effects of ice: increased drag and weight, reduced power; reduction of power due to failure to lean mixture at high altitude, etc.)	**50**
21	9	Increase the use of scenario-based questions in the written examination.	**49**

21	26	Establish a corps of experienced pilots advisers who could provide real-time advice to pilots.	**49**
21	32	Establish a diagnostic pre-test which pilots would complete prior to the flight review, and which they would provide to their CFI prior to the review.	**49**
21	46	Develop displays that depict critical operational variables in lieu of raw, unprocessed data. (E.g. Have fuel indicators that show remaining range or endurance, as well as remaining gallons of fuel.)	**49**
21	106	Enhance training by utilizing scenarios that incorporate models of good behavior as well as problematic behavior. This training should be designed to develop cognitive skills, situational awareness, risk assessment, and decision-making. Develop simulator (and PCATD) scenarios for both normal and unfamiliar situations.	**49**
22	20	Incorporate additional training on human learning and teaching techniques in the CFI training curriculum and expand the assessment of these elements in the written and practical tests.	**48**
22	48	Develop user-friendly models that demonstrate to pilots the interaction of various flight conditions, such as temperature, weight and balance and fuel consumption throughout the course of a proposed flight.	**48**
22	129	Create computer software that illustrates various mechanical failures or conditions that could threaten safety of flight (e.g., leaning mixture, asymmetrical flaps, stuck elevator) and recommends appropriate pilot responses (e.g., demonstrates gliding distances for various aircraft at various altitudes and wind conditions.)	**48**
23	8	Decrease the reliance on multiple-choice questions in the written examination.	**47**
23	31	Establish a formal continuing education program for private pilots, providing for the completion of a specified number of CEP credits that could be used in lieu of a flight review.	**47**
23	45	Develop fuel quantity indicators that are accurate throughout the range.	**47**
23	55	Develop training and technology to assist pilots in recognizing and interpreting changes in the aircraft and/or environment that might signal increased risk.	**47**
23	102	Pilots, controllers and flight service specialists should receive initial training in the operations performed by others outside their own specialty, including pilot and aircraft characteristics.	**47**
24	82	Develop an automated emergency assistant that provides direct instructions for emergency procedures.	**46**
24	125	Establish a corps of experienced pilots who could provide real-time advice to pilots, and establish mechanisms (I.e., radio frequencies and telephone numbers) by which pilots could contact them.	**46**
25	1	Create and disseminate to pilots a weather hazard index that incorporates the weather risks into a single graphic or number.	**45**
25	35	Establish a single source from which pilots could obtain all information necessary for flight planning.	**45**
26	44	Incorporate visual and auditory warning devices into existing systems (such as fuel status).	**44**
26	122	Enhance the written examination for pilot certification by: 1) Requiring a minimum passing score on each major section; 2) Decrease the reliance on multiple-choice questions; 3) Increase the use of scenario-based questions; 4) Increase the number of questions; and 5) Raise the minimum passing score.	**44**
27	29	Establish a separate weather briefing and counseling line for low-time pilots.	**41**
28	43	Establish human performance standards for the design of information displays.	**40**
29	30	Institute a system of voluntary graduated privileges for Private Pilot License holders.	**39**
29	38	Require pitot heat to be applied automatically, whenever the aircraft is in flight.	**39**
30	6	Alert pilots to practical implications of weather conditions on aircraft performance and handling.	**38**
31	124	FAA to rewrite the CFI curriculum to eliminate unnecessary maneuvers and stressing more of those that are necessary.	**37**

32	42	Develop equipment that relieves pilots of low-level tasks so that they may focus on high-level tasks.	**35**
33	16	Establish one level of proficiency in training, such that training conducted under Part 61 is equivalent in structure and quality to that conducted under Part 141.	**34**
33	27	Establish mechanisms (radio frequency and telephone numbers) by which pilots could access the adviser corps.	**34**
33	28	Establish a mechanism by which a pilot could transmit a short message to parties on the ground.	**34**
33	36	Establish and promulgate standards and guidelines for the clear and effective communication of information, keyed to the skill and experience levels of the recipient.	**34**
33	40	Develop cockpit displays that integrate weather, weather hazards, navigation, aircraft performance and control information.	**34**
34	78	Publish standards for flight planning software, and with that software develop an Automatic Flight Planning Assistant that: 1) Provides graphical flight planning with current and trend weather information in both cross-section and plan view; 2) Calculates and displays maximum likelihood, best case and worst case weather states along the route for the proposed transit period; 3) Warns pilots of difficulties at specific points and provides suggested alternatives; 4) Calculates risks for flight based on aircraft, pilot and environmental conditions; 5) Generates flight planning aids for routes; and 6) Is capable of simulating alternative scenarios.	**33**
35	21	Institute a system for the periodic evaluation of CFIs (equivalent to the military standardization -evaluation programs) to ensure consistency in the quality of instruction given.	**27**
36	37	Promulgate standards for the design of aircraft systems that require (1) fail-safe operation as a design standard; (2) graceful degradation; and, (3) error mitigation.	**16**

Appendix L.
Effectiveness-Feasibility Matrix

Aeronautical Decision-Making
Joint Safety Analysis Team (JSAT)
Intervention
Effectiveness and Feasibility Matrix

Effectiveness	Feasibility: High	Feasibility: Moderate	Feasibility: Low
High	**57**, **66**, **67**, **72**, **75**, 86, **93**, **112**, **117**, **123**	23, 24, 56, 77, **88**, **89**, **118**, **127**, **128**	**1**, 6, **31**, **34**, **35**, **40**, 42, **44**, **45**, **46**, 47, **48**, **50**, **55**, **78**, **102**, **104**
Moderate	**2**, **5**, 13, **33**, **53**, 58, 65, **68**, 69, 76, 90, **92**, **96**, **99**, 109, **111**, **113**, **126**	**3**, **4**, 11, **18**, **51**, **52**, **59**, **60**, **63**, 85, **95**, **100**, **103**, **105**, **119**, 121	**9**, 17, 21, **26**, **27**, **32**, 39, 94, **106**, 124, **125**, **129**
Low	**64**, **70**, 74, **81**, **98**, **107**	10, 12, 14, **25**, 54, 73, 84, **87**, **97**, **101**, **114**, **115**, **116**, 120	**7**, 8, 15, 16, 20, 22, 28, **29**, **30**, **36**, **37**, **38**, 43, 49, **71**, **80**, **82**, **83**, **108**, **122**

(Intervention Numbers highlighted in bold have been determined by Team consensus to apply to decision errors identified in the root cause analysis of aeronautical decision-making accidents.)

Appendix M.

Aeronautical Decision-making
Joint Safety Analysis Team (JSAT)
Recommended Interventions

High Effectiveness and High Feasibility:

- Develop and disseminate training that addresses the recognition of in-flight weather hazards, as well as countermeasures to these hazards.

- Encourage pilots to develop multiple options and decision points for flight, and to periodically reassess and revise their plans in flight.

- Encourage the appropriate use of checklists, and expand the use of these checklists into non-traditional roles, such as takeoff, landing, instrument approach and special maneuver checklists (not just for “switchology”.)

- During pre-flight planning, develop multiple options, check points and go/no-go criteria for use during the flight.

- Develop and implement training that would teach pilots to conduct periodic (i.e., every 15 minutes) evaluations of the status of their flight, to include aircraft controllability, fuel status, weather status, personal fatigue, stress, etc.

- From the initial flight onward, train pilots from the perspective of risk management and the effective utilization of all available resources.

- Develop training for pilots to manage unfamiliar situations. (e.g., Progressive Decision-Making.)

- Utilize the experiences (good and bad) of real pilots to teach decision-making skills. (e.g., use scenarios such as “I learned about flying from that” or those in FAA Trigger Tapes that provide concrete examples of the behaviors to be modeled or avoided.)

- Educate pilots of the potential consequences of flying in marginal weather in mountainous terrain.

- Produce a Personal Minimums Checklist training program expressly for the use of CFIs in setting their instructional practices, including training on risk assessment and management.

High Effectiveness and Moderate Feasibility:

- Provide guidance to CFIs on the ADM elements to be assessed during the flight review. Provide a bank of possible scenarios for use in assessing Aeronautical Decision-making.

- Develop and disseminate guidance and techniques that CFIs could use to teach aeronautical decision-making, risk assessment and risk management to their students.

- Develop an FAA/Industry education program for pilots that identifies what assistance is available from ATC and explains what pilot actions might lead to FAA enforcement activities.

- Develop and disseminate training that explicitly addresses the issues involved in crash survivability, including crash techniques, minimizing vertical loads and planning for crashes (survival equipment, such as water, cell phone, matches, etc.), even on flights over hospitable terrain.

- Develop operations-based training curricula that integrate concepts and consequences (i.e., density altitude, mixture leaning, increased power).

- Develop and implement strategies for teaching: a) the dynamic characteristics of weather; b) the probabilistic nature of weather forecasts; c) how to make and interpret PIREPS; d) the correct interpretation of weather reports, so as to obtain the "big picture" and trends, during both pre-flight and in-flight.

- Institute specific training aimed at helping students recognize and deal with unfamiliar conditions and events. Establish general rules of thumb for safe, immediate responses to changes in aircraft controllability or weather deterioration that avoids compounding errors. (i.e., turn toward lower terrain and clearer skies, and then work on the problem.)

- Develop training for pilots to assist them in recognition of unfamiliar situations and in the management of unfamiliar situations, as well as procedures to assess their skill in dealing with such unfamiliar conditions.

- Improve the pilot mentoring (safety counselor) system, explicitly to link pilots (particularly new PPLs) with an experienced role model, such as CFIs and safety counselors.

High Feasibility and Moderate Effectiveness:

- Reorganize weather briefings so as to present information related to potentially hazardous conditions as the first and last items given to the pilot.

- Organize weather reports (e.g., TAFs) so as to facilitate the identification of trend information by pilots. (e.g., place all TAFs for a specified location together in the listing.)

- Develop and make available a large centralized bank of scenarios that examiners might use during the practical test to assess aeronautical decision-making skills.

- Develop a guide for completing a Personal Minimums Checklist.

- Promote consultation between pilots and CFIs and safety counselors.

- Develop and disseminate quick tips for flying in specific regions (i.e., mountainous terrain, cross-country flights over water, etc.) or seasons (i.e., winter snow and ice, summer heat and humidity or low visibility due to summer haze).

- Collect effective risk management procedures from the aviation community and disseminate them as “Rules of Thumb”.

- Develop a “STUF” checklist (Social pressure, Time pressure, Unfamiliar situation, Feelings – emotional, physiological state.

- Encourage a sterile cockpit environment during "critical" phases of flight, such as takeoff, landing, instrument approaches, etc.

- Develop and disseminate information on the relative survivability of controlled precautionary or off-field landings versus uncontrolled landings.

- Develop a mechanism (probably PCATD) for route rehearsal, to include weather information.

- Develop training for pilots to assist them in the recognition of unusual situations.

- Train pilots on the effects of human performance limitations on flight operations. (e.g., fatigue, hypoxia, alcohol, OTC drugs, etc.)

- Develop training strategies for overcoming problematic beliefs. (e.g., invulnerability, anti-authoritarian and macho attitudes, resignation and passivity)

- Develop case-based training to assist in the retrieval of relevant information from memory.

- Capture best practices from experienced pilots and disseminate them in a readily accessible format to new or less experienced pilots.

- Teach problem solving and decision-making skills: a) Rule-based training should include instruction in the cues that trigger the rules, and these cues should be clear and taught in the operational context; b) Training in analytical strategies should include training in the common heuristics and biases encountered when using analytical strategies and include operational suggestions on how to avoid some of the common mistakes.

- Develop easily understood "rules of thumb" that can be applied to weather forecasts and risk management procedures to compensate for the lack of experience of low-time pilots.

Moderate Effectiveness and Moderate Feasibility:

- Tailor weather briefings based upon pilot experience.

- Organize weather information (particularly DUATS) by position along the proposed route.

- Specify ADM competencies to be assessed during the practical test.

- Include training for CFIs on risk assessment and management in instructional operations.

- Develop and test an expanded pre-flight risk assessment checklist.

- Develop and encourage the use of a cross-country card for low-time, inexperienced pilots.

- Develop and disseminate training that demonstrates the difficulty of maintaining situational awareness (i.e., navigating toward safety) while flying at very low levels over terrain of varying roughness.

- Develop and disseminate training that would alert pilots to the need for immediate life-saving decisions when faced with: (1) loss of visibility, (2) loss of altitude, (3) loss of airspeed, and/or CFIT alert.

- Develop self-awareness initiatives to ensure that pilots are aware of their limitations and the need to seek additional assistance when conducting operations outside their base of experience.

- Organize training such that the student is an active learner, who make decisions and takes actions, rather than a passive learner who simply does what the instructor directs.

- Train pilots to rehearse flights that involve unfamiliar conditions.

- Develop and implement expanded training in aeronautical decision-making, to include training in the use of all available resources and the use of different decision strategies.

- Develop role-playing simulations in which pilots can observe modeled methods of resisting social pressures, and can then practice those methods.

- Improve the pilot mentoring (safety counselor) system, to explicitly link pilots (particularly new PPLs) with experienced role models.

- Develop and implement procedures to counter unrealistic optimism by GA pilots. (e.g., compare oneself to lists of characteristics of accident-involved pilots to counter the hazardous attitude of invulnerability).

- Develop a trainer (probably CBT) that demonstrates gliding or autorotational distance for various aircraft at different altitudes and wind conditions.

Appendix N

Instruction to the Human Factors Expert Panel

Identifying Possible Interventions from the Model Accident Scenario

The objective of this exercise is to identify as many interventions as possible that could improve pilot decision-making. The model accident scenario serves as a common basis of reference for this activity and will let us combine everyone's suggested interventions.

The video depicts a fairly low-time pilot who encounters conditions beyond his capabilities, resulting in a crash. Review this video and try to pick out points at which some change in the pilot, the information he is working with, how the information is presented, or the way in which the decisions are presented to him, would have improved his decisions and, presumably, prevented the crash.

Do not feel constrained by cost or feasibility.

You can look at the attached list for some possible topic areas for interventions, but do not feel limited by that list. You can be as original and wide-ranging in your suggested interventions as you wish.

As much as possible, try to link your proposed intervention with a particular point on the video. You can use the frame numbers that appear at the bottom of the screen to identify the point at which you think each of your interventions would be most appropriate. Make a list of the interventions and the corresponding frame numbers.

You can also include broader interventions that don't apply necessarily to a specific frame. If you do, then try to indicate how those interventions would have affected the outcome.

Be specific. Don't just say, "The pilot needs more training." As much as you can, tell us, for example, what kind of training he needs and what content it should include. Also, explain why you think your intervention would change the outcome.

When you are finished, email your list to: david.hunter@faa.gov

If you have a question about this exercise, or you would like to know how it works out, you can send me an email or call me at (202) 267-8345. If you don't have email, you can also send your list by regular mail to: David R. Hunter, AAM-240, 800 Independence Ave., Washington, DC 20591.

Suggested Areas for Interventions

Pilot-centered - interventions that focus on the knowledge, skills, and attitudes of individual GA pilots. For example, this could include initial training, recurrent training, or self-assessment. Be specific about what knowledge, skill, or attitude you think needs to be trained.

Information transfer-centered - interventions that focus on the information that pilots use to make strategic and tactical decisions. You could consider both the information format and content. You might also consider the processes that take place during pre-flight planning, and in-flight planning. For example, you might consider how pre-flight weather briefings or in-flight availability of weather information affect decisions.

Organization-centered - interventions that focus on the organizations that support, control, or influence the decision-making of GA pilots. For example, how do organizations such as clubs and schools affect the decisions of pilots. Do the policies of the insurers influence decisions? Do the procedures and rules of the regulatory agencies influence decisions (For example, does fear of enforcement lead pilots to decide not to seek help?)

Culture-centered -- interventions that focus on the culture of GA pilots as a group. Consider, for example, how peer expectations may influence decisions. Do pilots press-on into deteriorating weather because they do not want to appear incompetent to their fellow pilots or passengers?

Mitigation-centered - interventions that focus on mitigating the effects of poor decisions. This could include developing and training effective emergency procedures, that would address aircraft control, getting help, or egress strategy & tactics. You might also consider aspects of crash survival, such as planning for crashes (wearing shoulder harness, carrying a survival pack, etc.), along with crash techniques (how do you crash a plane as safety as possible), and post-crash survival.

Appendix O.

A Brief History of ADM

Classic, Mainstream ADM

In 1977 Jensen & Benel examined accident records and show that 50% of fatalities are related to poor flying judgment.
They proposed a two-part definition of pilot judgment:

(a) How well can you think?
(b) *How cautious or risky are you?*

They concluded that judgment can be taught and evaluated.

In 1982 Berlin and his associates at Embry-Riddle produced a pilot judgment training and evaluation program. They defined pilot judgment as:

The mental process by which the pilot recognizes, analyzes, and evaluates information regarding himself, the aircraft, and the outside environment. The final step in the process is to make a decision pertaining to the safe operation of the aircraft and to implement the decision in a timely manner.

Their training program addressed:

(a) The six action ways (i.e., Do-No Do; Under Do – Over Do; Early Do – Late Do)
(b) Pilot Judgment Behavior Chain
(c) Three mental processes of safe flight (Automatic reaction; problem resolving; repeated reviewing)
(d) Five Hazardous Thought Patterns (anti-authority; impulsive; invulnerable; macho; resigned) with Self-assessment inventory & antidotes.
(e) Identifying and reducing stress.

From 1982 to 1990 the FAA sponsored the development of manuals for ADM training for various pilot groups. (i.e., Student and Private Pilots, Helicopter Pilots, Air Ambulance Pilots, Instrument Pilots, Instructor Pilots, Commercial Pilots)

Several evaluation studies were conducted early during this period, which generally showed that this training produced beneficial effects, at least among student pilots. The effect was generally greater when conducted as part of a more structured training program. (It worked best at Part 141 schools, least among non-affiliated instructors) No long-term studies were conducted and no data are available to demonstrate a change in accident or incident rate.

In a national survey of pilots conducted in 1995, 57% of the private pilots indicated that hazardous thoughts (the most recognizable part of the classic ADM training) were not discussed in any of their training.

Post-Classical ADM

Beginning in 1991 the FAA initiated a long-term research effort to develop a better understanding of pilot decision-making and to develop new interventions to improve decision-making. These studies have focused on how pilots acquire and use information to make decisions and, more recently, on how the personality attributes of pilots affect their decision-making.

Some of the research findings related to ADM are:

(a) When evaluating weather, pilots tend to let one good aspect of the weather compensate for bad aspects. For example, pilots let a high ceiling compensate for low visibility, when rating weather risk. Particularly for novice pilots, this is a potentially dangerous practice.

(b) Low-time pilots, in particular, seem not to take into account either dangers or resources outside a very narrow corridor along their planned route of flight. For example, they seem to exhibit “tunnel vision” and don’t consider the potential for weather to move across their route, nor do they consider using alternative airports located a short distance from their route of flight.

(c) Pilots allow their proximity to their destination to overrule caution when faced with deteriorating weather conditions. Pilots will press-on through conditions near their destination, while the same conditions when encountered early in the flight will result in a diversion.

(d) Some pilots, particularly those will low time, will make a decision when faced with a problem, and will then make no further efforts to diagnose the problem, seek help, consider alternatives, or evaluate the effectiveness of their decision.

(e) Many pilots are unable to judge when conditions have deteriorated to near or below VFR minima, and are unaware of the environmental cues that would alert them to this deterioration.

(f) Pilots differ in their perceptions of the degree of risk of flying activities, and those who perceive the lowest risk (usually of weather) tend to be more at risk for accident involvement. However, differences in risk tolerance are not related to accident risk.

(g) Pilots who believe themselves to be more in control tend to be at lower accident risk than those who believe that what happens to them is the result of outside factors (i.e., fate, luck, other people and organizations).

(h) Overconfidence in personal abilities and an inability to accurately assess visibility are associated with continued VFR flight into IMC in simulation studies.

(i) In tests of situational judgment, half of the time pilots will choose a course of action not recommended as best (i.e., safest) by a panel of instructors.

(j) Approximately 35% of private and commercial pilots have not attended a Safety Seminar in the last two years; 20% have attended 1 seminar. The predominant reason for not attending is “too busy”.

Specific products have resulted from this effort:

(a) “Making Your Own Rules: Creating a Personal Minimums Checklist” – teaches pilots to use a systematic procedure for identifying hazards and assessing risks before flights. Risk management is achieved by establishing a pre-determined set of operating minima and procedures, and recording them in a checklist format. It is available both as a videotape for seminars and as a CD-ROM for self-study. An experimental web-enabled version is also available on the website http://FlySafe.faa.gov.
(b) “Progressive Decision-making” -- a CD-ROM program that teaches pilots to use a structured problem resolution and decision-making process. It focuses on: Situation Awareness, Diagnosis, Resolution, and Vigilance.
(c) “WeatherWise” – a CD-ROM program that addresses the environmental cues pilots should look for that alert them to the need to make a weather-related decision.
(d) Self-awareness exercises (internality, situational judgment, hazardous attitudes) are also implemented and are being evaluated on the FlySafe website.

Appendix P
References

Berlin, J. & Holmes, C. (1981). Developing a civil aviation pilot judgment training and evaluation manual. In R. S. Jensen (Ed.), *Proceedings of the First International Symposium on Aviation Psychology* (p 166-170). Columbus, OH: Ohio State University.

Buch, G. & Diehl, A. (1984). An Investigation of The Effectiveness of Pilot Judgment Training. *Human Factors*, 26, 557 – 564.

Jensen, R. S. & Adrion, J. (1987). *Aeronautical decision making for instrument pilots.* Report DOT/FAA/PM-86/43. Washington, DC: Federal Aviation Administration.

Jensen, R. S. & Adrion, J. (1988). *Aeronautical decision making for commercial pilots.* Report DOT/FAA/PM-86/42. Washington, DC: Federal Aviation Administration.

Jensen, R. S. & Benel, R. A. (1977) *Judgment evaluation and instruction in civil pilot training.* Report FAA-RD-78-24. Washington, DC: Federal Aviation Administration.

Jensen, R.S. (1995) *Pilot judgment and crew resource management*. Brookfield, VT: Ashgate.

Telfer, R. & Ashman, A.F. (1986) *Pilot judgment training: An Australian validation study* University of Newcastle

Wiegmann, D.A. & Shappell, S.A. (1997) Human factors analysis of postaccident data. *International Journal of Aviation Psychology*, 7, 67-82.