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The Use of Weather Information in Aeronautical Decision-Making: II

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16. Abstract

An investigation was conducted of the values, or worth functions, pilots attribute to weather and terrain variables in making decisions about flight in a single-engine aircraft under visual flight rules. This study replicated earlier exploratory research (Driskill, Weissmuller, Quebe, Hand, Dittmar, and Hunter, 1997) that used data from a single geographic area. The present study obtained data from pilots in six geographic regions of the United States. The results of this study confirm the three tentative hypotheses suggested by the data from the initial study: (1) Cognitive processes that pilots utilize in making aeronautical decisions can be modeled using regression methods; (2) The values pilots associate with varying levels of ceiling, visibility, and precipitation are a function of the terrain over which the flight is made; and (3) While values differ among pilots, specific policies can be found to describe how they assign weights in making decisions about beginning or continuing a flight. Generally, pilots use a compensatory decision strategy, combining the weather variables in making judgments about flight by compensating for poor conditions in one variable with better conditions in other variables. However, under some circumstances, pilots also tend to employ a worst-factor strategy; that is, pilots appear to have personal standards for either ceiling, visibility, or precipitation, below which they become reluctant to make a flight.

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THE USE OF WEATHER INFORMATION IN AERONAUTICAL DECISION MAKING: II

I. INTRODUCTION

This report describes research which assessed worth functions that a nationwide sample of pilots assign to weather information when making aeronautical decisions about flight over varying terrain. It replicates exploratory research (Driskill, Weissmuller, Quebe, Hand, Dittmar, and Hunter, 1997), which was based on data from a single geographic area, that provided data tentatively confirming three hypotheses: First, cognitive processes pilots utilize in making aeronautical decisions can be modeled using regression methods; second, the values pilots associate with varying levels of ceiling, visibility, and precipitation are a function of the terrain over which the flight is made; and third, while values differ among pilots, specific policies can be found to describe how they assign weights in making decisions about a flight.

Reported are results from data collected from pilots from six geographical regions. The report includes the following: identification of worth functions pilots attribute to weather variables, description of differences of policy decisions with respect to the worth functions, assessment of regional differences in use of weather information, analysis of the relationship of pilot demographic information and pilot decision-making with regard to weather and terrain information, comparison of results with the exploratory research findings, assessment of pilot decision strategies, and a summary of findings and conclusions.

II. BACKGROUND

The importance of understanding the cognitive processing of flight information in preparing for and during flight is evident from research reported by Jensen and the National Transportation Safety Board (NTSB). According to Jensen (1982), 80 to 85 percent of aircraft accidents can be assigned to pilot error and, further, over 50 percent of the fatal accidents result from faulty decision-making. The NTSB, in a study of 361 small aircraft accidents in which 583 fatalities were reported for 276 of them (NTSB/SR-89/01, July 14, 1989, p.1), reported that flight under visual meteorological rules (VFR) into instrument meteorological conditions (IMC), and pilot error are two of the most important factors in small aircraft fatal accidents.

While considerable research is reported about the potential effects of Five Hazardous Thought Patterns on decision-making (see, for example, Jensen, Adrion, & Lawton, 1987) in aviation accidents, very little is reported on the cognitive aspects of aeronautical decision-making, i. e., on how pilots assess adverse conditions and assign and integrate appropriate weights to such flight data elements as weather and terrain in making their judgments. Two studies are reported by Curry (1976) and Flathers, Giffin, and Rockwell (1982), who noted differences in worth functions or values pilots assigned to various flight data elements in the landing and en route phases of flight. In addition, studies at the University of Illinois (Barnett, 1989; Stokes, Kemper, & Marsh, 1992; Wickens, Stokes, Barnett, & Davis, 1987) have examined the relationship of pilot biographical and demographic information, along with knowledge and ability measures, to pilot performance and information processing during simulated flight performance.

Whether or not worth functions can be modeled using regression methods was the focus of research reported in Driskill *et al.*, (1997). The approach involved collection of pilot judgments of scenarios describing flight over non-mountainous, over mountainous, and over-water terrain under various visibility, ceiling, and precipitation conditions. Each scenario consisted of a proposed cross-country VFR flight of approximately one-hour duration in a single-engine aircraft with an inoperative navigation radio and without a transponder over each of the three kinds of terrain under differing VFR into IMC weather conditions. The procedure and findings from that study are summarized below, however readers are directed to the original report (Driskill et al., 1997) for a complete description.

A set of 27 scenarios was developed for each terrain type. Specific routes were drawn on route maps for flight from Hereford airport to Dalhart airport in the Texas Panhandle (non-mountainous), from Las Vegas airport to San Juan airport in New Mexico (mountainous), and from City County airport over Lake Michigan to Delta County airport (over water). Scenarios were described on 5 x 7 cards. Each card in a set described different combinations of visibility, ceiling, and precipitation conditions, developed with the assistance of National Oceanographic and Atmospheric Agency (NOAA) and U. S. Air Force weather experts to assure realistic weather combinations, i. e., that combinations could be observed in nature. Maps denoting the routes pilots were to follow and other information pertinent to flight over each terrain were provided for reference.

Pilot judgments of their level of comfort in flying under each of the scenario conditions were the basis for assessing worth functions. The judgment task required two actions on the part of the subject. First, each pilot rank ordered the scenarios in a set in descending order based on how comfortable he or she would feel in flying over the specified terrain under the weather conditions described. Second, using the set of rank-ordered scenarios, each pilot then assigned a "comfort" rating to each scenario, using the accompanying comfort rating scale. This scale ranged from 0, least comfortable, to 100, most comfortable. Pilots were not constrained (nor were they expected) to rate their most comfortable scenario 100. Instead, they could assign any lesser level of rating that described their comfort level. Many of the subjects, in fact, used a rating lower than 100 to indicate their "most comfortable" scenario. Each pilot completed three decks of scenario cards, one deck for each of the terrain conditions.

Most of the data collected from 131 male and 19 female pilots came from group administration during meetings of the FAA Safety Seminar Program held in the South Texas area (roughly from San Antonio, Austin, and Killeen, south to Victoria, and west to Rockport). After distributing the three decks of scenario cards (one deck for each kind of terrain), the experimenter presented a motivational introduction, and then briefed and walked the pilots through the rating process, using sample scenarios. The experimenter remained through the data collection process to provide further instruction or clarification that may have been required.

Analysis was based on computation of a multiple correlation for each subject for each terrain condition. The comfort ratings a pilot assigned to the scenarios within a terrain condition comprised the dependent variable. Independent variables were ratings from 22 experienced pilots on 16 ceiling levels ranging from 600 to 5,000 feet, 12 visibility levels ranging from 1 1/2 NM to more than 8 NM, and eight precipitation levels ranging from freezing rain to no precipitation. Using a 0-100 point scale, the experts rated how safe it would be for an inexperienced pilot to fly under each of the levels (Driskill *et al.*, 1997). Multiple correlations for the each of the 150 pilots comprising the sample met at least the .05 level of statistical significance.

Regression weights (from the individual multiple correlations) associated with the visibility, ceiling, and precipitation variables, which represent the value or worth pilots associated with each of the variables, were hierarchically clustered. The analysis package used was HIER-GRP (Appendix A), which is part of an Armstrong Laboratory mathematical-statistical package. This analytical process formed clusters of pilots with similar within-cluster regression weights; between cluster weights (within terrain type), however, differed significantly with respect to the value or worth functions assigned to visibility, ceiling, and precipitation information.

Hierarchical clustering produced four significantly different non-mountainous terrain policy clusters or groups; four groups for flight over the mountainous route; and two groups for the over-water route. Within terrain group policy differences seemed to vary according to how conservative the subjects comprising each of the groups were in making their ratings. Some policy groups were formed by pilots who provided relatively low overall comfort levels even when flight was under the best weather conditions while some other policy groups exhibited considerably higher comfort levels for flight under all conditions, including the most adverse.

Some significant differences of demographic data for clusters within a terrain condition were found, mostly based on kinds of flying experience, age, and aircraft ownership. Such differences, however, were not consistent across clusters within a terrain condition. Age of pilots comprising each of the four clusters for the non-mountainous clusters, for example, did not differ, but age in one or more of the clusters in the other two terrain types differed significantly from other clusters. Further analysis of the background information revealed that pilots changed group policy membership from one terrain to another, i. e., some pilots who were members of a policy group reporting overall low, conservative comfort levels changed group membership to policy groups under other terrain conditions having overall higher comfort levels.

Analysis also addressed the decision strategies pilots employed in making their comfort level ratings. This analysis was undertaken because of decision theory research which suggests that judges may employ different decision-making strategies in judgment tasks such as those employed in the exploratory research (Payne, Bettman, & Johnson, 1992). Further, it is important to determine whether some pilots may employ inappropriate strategies when assessing flight information, so that training or interventions could be used to redirect their decision-making. In general, pilots tended to use a compensatory strategy (as opposed to multiplicative or non-compensatory) whereby good conditions in one weather variable compensate for poorer conditions in other variables.

The fact that the sample of pilots in the exploratory research was drawn from pilots in the South Texas area limits the generalization of results to other geographical regions. Subsequent sections of this report describe use of the scenario-based judgment task to collect judgments from pilots from six other geographical regions of the United States.

III. METHOD AND DATA COLLECTION

The logistics of data collection from a pilot sample nationwide required a change from a proctored-group to a mail-out-and-return protocol. In turn, mail administration necessitated modification of the format of the data collection instruments.

Format Modifications

For efficient mail administration, the scenario descriptions were transcribed from cards to answer sheets. Only the format of the scenario information was changed. The same route maps were provided. Some minor modification of the Pilot Background Data form on which pilots provided demographic information was made. Gender, for example, was omitted and a few additional informational items were added. Instructions, demographic information forms, and answer sheets containing scenario information and places for respondent rankings and ratings (Appendix B) were packaged for mailing.

Modifications of the scale used and instructions for making ratings were made based upon comments received from pilots during a pre-test of the instrument. In the original study, the scale ranged from 100 for the most comfortable scenario to 0 for the least comfortable. This scale was reversed for mail administration with 100 to be used for the *least comfortable* and 0 for the *most comfortable*. For analysis of the data, pilot responses were transposed to match the original scale.

Instructions for making comfort level ratings differed also. In the exploratory study, respondents were instructed that the maximum rating, e. g., 100, did not have to be used for the terrain scenario for which they felt most comfortable. In this study, such instructions were not provided and, as shown in Section IV, respondents appeared to anchor their ratings on the extreme ratings, e. g., at 0 and 100.

Pilot Sample Selection and Description

The sample was randomly selected from FAA records. Only pilots who were actively flying as determined by the presence of a current flight physical record in their FAA records file were considered for selection. Pilots from the South Texas area were excluded. Data collection packages were mailed to 1,200 pilots in the Alaskan, Western Pacific, Southern, Northwest Mountain, Eastern, and New England regions. Packages contained a pre-addressed and post-paid envelope for the raters to return their responses to the FAA in Washington, DC.

Responses from 326 respondents were received and submitted for analysis. Answer sheets were transcribed into EXCEL and a floppy disk containing the data was prepared by the FAA for analysis.

Demographic statistics describing the sample of 326 respondents are shown in Table 1. Since not all pilots completed all the scenarios, there were 319 respondents for over-water, 315 for over non-mountainous, and 303 over mountainous terrain. The most noteworthy demographic characteristic is the 52-year average age. This average is almost 10 years higher than the average in data compiled by the FAA (see Table 13, U.S. Civil Airmen Statistics, 1993). In this report, the average ages for private, commercial, and air transport pilots were 42.7, 41.9, and 44.1, respectively. Because of the 10-year difference, demographics of the present sample were compared with a mail-administered nationwide sample reported in Hunter (1995). As Table 1 shows, the demographics of the two mail-administered samples are quite similar, including the ages of the respondents.

The distribution of pilots among six geographical regions is shown in Table 2 while Table 3 shows the background variables for which regions differ significantly ($p < .05$)[1] from the Total Sample. As shown, the sample of Alaskan pilots was considerably smaller than were the samples from other regions.

Mean comfort level ratings were also computed, using GRPREL from the Comprehensive Occupational Data Analysis Programs (CODAP) (see Appendix A), for the total sample and for each terrain type. The grand mean (total sample) was 39.52, over-water 39.80, over non-mountainous, 42.27, and over mountains, 36.38. The comfort rating for over-water terrain is slightly higher than the grand mean. Non-Mountainous average comfort level is about three points higher than the overall mean; and, the mountainous mean is over three points lower.

IV. ANALYSIS OF REGIONAL DATA

Data analysis replicated the method used in the exploratory research: interrater agreement, policy stability, computation of multiple correlations for each pilot respondent, identification of within-terrain policy groups based on hierarchical clustering of regression weights associated with the weather variables for each terrain type, testing of significance of differences of demographic variables among policy groups, and identification of decision strategy pilots employed when they made their judgments. Other analyses include the effect terrain exerts on comfort level, comparisons of regional comfort level, identification of the scenarios for each terrain for which pilots indicated the most and least comfort, and determination of relationships of demographic information to comfort level.

Interrater Agreement and Stability

Interrater agreement and stability of ratings for the total group and for each regional group by terrain type (Table 4) was computed, using GRPREL (See Appendix A for a description of this analysis package). Interrater agreement is indicated by r_{11} and r_{kk} indicates the stability of the policies represented by the ratings. An r_{11} of .20 is considered an acceptable level of interrater agreement and any r_{kk} above .90 represents high stability. (The authors recognize that these analysis procedures are little utilized outside military occupational analysis settings. For more detailed information on the procedures and their application,

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[1] In Table 3, and Tables 14, 15, and 17 which will follow later, caution is needed in interpreting the results. Because a large number of comparisons are being made in each of these tables, it is likely that some of the observed differences reached statistical significance purely by chance. We have chosen, in order not to inflate the Type II error rate, not to make an adjustment to the individual comparisons so as to restrict the experimentwise error rate to the nominal 0.05 level. The impact of this decision is to place slightly more burden on the reader, who must keep in mind, for example, that of the 174 comparisons made in Table 3, approximately 9 (.05 x 174) would reach statistical significance even if there were absolutely no differences among the regions on any of the demographic items. Clearly, since there were 37 comparisons that were found to be statistically significant in that table, there are some underlying differences among the regions. However, which of the 37 comparisons truly reflect real differences and which are spurious statistical artifacts, we cannot say. Since our interest is observing the general pattern of differences (examine, for example, the flying experience of pilots in the Northwest Region), we do not find this to be a serious restriction. Rather, adopting more stringent significance levels for each individual comparison, so as to maintain the experimentwise error rate, would mask much of the underlying richness of the data by inflating the Type II error rate. On balance, the current approach which reports individual comparisons somewhat liberally seems the most prudent course, keeping in mind that any particular individual comparison should be regarded skeptically.

the reader may consult Albert, et al., 1994; Christal & Weissmuller, 1976, 1988; Phalen & Mitchell, 1993; Staley & Weissmuller, 1981; and Weissmuller, Phalen, & Tartell, 1997.) Interrater agreement across the total group of pilots and within each geographical region (r_{11}) ranged from .31 to .58. Stability was high, r_{kk} ranging from .82 to .99. In the table, k shows the average number of raters per scenario. Fractional entries for the number of raters are given because the software computes an overall or grand mean number of raters per scenario. For the Western region overwater route, for example, inspection of the number of raters for each scenario shows that 46 of the pilots rated 14 scenarios and 47 pilots rated 13 scenarios; thus the average number of raters per scenario was 46.48, rounded to 46.5. The actual number of pilots rating a scenario was used to compute the scenario mean comfort level. The means of the comfort level for the 27 scenarios were the basis for computing the regional grand mean comfort rating over all scenarios.

Policy Group Identification and Description

The high interrater agreement found for pilot comfort level judgments for each terrain type indicates that the judgments were based on a single, homogeneous, and common terrain-specific policy with respect to a terrain type. The pilots, in effect, defined three policies, one for each terrain type by their agreement about the ordering of the comfort level they would experience in making flights under the terrain-weather variable scenarios. Subpolicies within an overall terrain policy, if any, would be characterized by subtle differences among weather-variable worth functions from which comfort level ratings derived. Further analyses were required to determine if there were any such differences of weights for the weather variables sufficient to define one or more subpolicies within a terrain policy. To this objective, a multiple regression equation for each pilot was computed and the worth functions (regression weights) for each variable were hierarchically clustered, using HIER-GRP. This clustering methodology has the power to detect subtle differences of the kind anticipated when there is such high interrater agreement and to cluster the pilots attributing similar weights to the weather variables.

Worth Function Computation. To identify the worth functions (i. e., the relative emphasis) pilots attributed to the ceiling, visibility, and precipitation variables, coefficients for each variable were computed for each pilot by terrain type using the following regression equation:

$$CF = A + B + C + AB + AC + BC + ABC$$

where CF was a vector of a pilot's 27 weather scenario "comfort" ratings for a given type of terrain; and A, B, and C and their interactions were vectors of benchmark values for ceiling, visibility, and precipitation, respectively. The regression equations represent a pilot's worth function with respect to the given terrain type. A total of 937 regression equations were computed (one for each pilot for each terrain type), 319 equations for over water, 315 for non-mountainous, and 303 for mountainous (not all 326 respondents completed each terrain set).

Individual R values were high and all statistically significant ($p < 0.05$; null hypothesis R = zero). Overwater values were lowest; only 47 percent exceeded .70. Seventy-three percent, however, exceeded .60. For non-mountainous terrain, 70 percent were .70 or higher, and for mountainous terrain, 84 percent exceeded .70. Average R^2s were .66, .73, and .77, respectively. A large part of the variance associated with the pilots' ratings is explained by their worth functions and scenario benchmark values. Average R^2s and regression weights for the weather variables are shown for each terrain in Table 5.

Subpolicy Group Specification. Hierarchical clustering revealed that each terrain policy was composed of four subpolicies differing with respect to weather-variable worth function emphasis (i. e., differences of regression weights). Tables 6, 7, and 8 display descriptive data for each of the subpolicies, showing number of pilots in each group, average comfort level, average R^2, and highest regression weights (only weights $> +0.20$ or < -0.20 are shown in the Tables).

Comparison of the **numbers of pilots** in the policy groups reveals that terrain type differentially affects group membership size. For the over-water route, the largest N is 139 for the policy group (W-2) having the second lowest comfort level and a relatively small number (24 for Group W-1) constitutes the group with the lowest mean comfort level. For the non-mountainous route, the Ns decrease in order from the group (NM-4) with the highest comfort level to the group (NM-1) with the lowest. This pattern changes for the over-mountains route where the largest number is found in the group (M-1) with the lowest average comfort level. In terms of terrain effect, the pilots tended to be more conservative in their ratings of comfort level for over mountains flight. They became less conservative for over-water and over non-mountainous routes, respectively.

Between subpolicy group comparisons of **mean comfort level** differences were all significant ($p < .05$ or less). For the over-water route, mean ratings range from 13.70 to 55.29, non-mountainous from 20.85 to 54.53, and mountainous from 21.61 to 53.72. The mean levels by policy groups within each terrain type are illustrated in Figure 1 in terms of deviation from the grand mean (39.52).

Average R^2 indicates the degree to which a policy group seems to make use of the experts' benchmarked attribute values and combine them in a consistent and rational manner. Even though weights differ significantly from policy group to policy group with respect to ceiling, visibility, and precipitation variables, these factors were very important determinants for pilots when they rated their comfort levels, accounting for most of the variance (60 to 74 percent) associated with comfort level ratings.

Regression weights in Tables 5, 6, 7, and 8 are displayed to demonstrate how groups differed with respect to the weighting of the weather variables. As the tables show, some type of interaction (i.e., A*B*C, A*B, A*C, B*C) accounts for the larger regression weights. For six of the nine subpolicy groups having the lowest comfort level means (the more cautious), for example, comfort level is primarily accounted for by the three-way interaction of ceiling, visibility, and precipitation (A*B*C). The three subpolicy groups having the highest comfort-level means (W-4, NM-4, M-4) have a slightly different pattern of weights. The largest over-water subpolicy weights are for the two-way interaction of ceiling and precipitation (A*C) and visibility and precipitation (B*C); for non-mountainous, two-way interaction of ceiling and precipitation (A*C) and visibility; and for over mountains, precipitation (C) and ceiling and visibility (B*C) interaction.

The ceiling-visibility-precipitation interactions can be discerned, though not easily, in a careful inspection of the scenarios and associated mean comfort levels displayed in Tables 9, 10, and 11. Some insight about the weather-condition interactions may be gained from Figure 2, showing ceiling-precipitation interaction for each terrain when visibility is held constant at 8 nautical miles (NM). Two features should be noted. First, the dramatic decrease in over-water comfort level from 5000 feet ceiling and no rain to freezing rain at the same ceiling. Second, the shapes representing the ceiling-precipitation interactions for over-water and non-mountainous routes are essentially alike. It also seems likely that the shape for the mountainous route would be more similar if the scenarios for that route had contained precipitation conditions for ceiling levels between 1000-5000 feet.

Policy Group Demographic Information

Demographic information (from the Pilot Background Data form) for policy groups is summarized in Tables 12, 14, and 16. Demographic information about the total terrain group is included with each of the three tables under the headings TOTALW (for over-water), TOTALNM (for non-mountainous), and TOTALM (for mountainous) for reference purposes. Means for terrain, precipitation, visibility, and ceiling are based on the 5-point scale shown on the Pilot Background Data form (Appendix B). The scale was 1, "Never;" 2, "Once or Twice;' 3, "Several Times;" 4, "Many Times;" 5, "Numerous Times."

Significant differences among groups, computed from t-tests (.05 level)[2] of policy-group to policy-group comparisons, are detailed in Tables 13, 15, and 17. Across the various comparisons, the most consistent differences seem to be associated with experience in flying over the terrain types and personal ceiling. In general, as group comfort level increases, terrain

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[2] Readers are reminded of the earlier caution regarding interpretation of these comparisons. Some of the individual comparisons which attained statistical significance may be spurious simply as a matter of chance. Patterns of relationships, rather than individual comparisons, should therefore be the principal focus.

experience tends to increase and personal ceiling tends to decrease.

Multiple regression methodology was used for two purposes. First, we examined the degree to which pilot comfort level was predicted from demographic variables. The R^2 obtained was 0.156. Secondly, we assessed the degree to which pilots used weather information consistent with the ratings by the expert pilots. Two regression equations were computed; one which used demographic variables ***and*** pilot comfort ratings to predict individual R^2s, and one which used ***only*** demographic variables as predictors. The R^2s were 0.176 and 0.149, respectively. Results of the regression analyses are displayed in Appendix C, which shows that zero-order correlations (ZOC) and unique contribution of each of the variables to the separate criteria are small. These results indicate that age, certification and flying experience have little influence on pilots' ratings of comfort level. Further, in view of the high individual multiple Rs reported in an earlier section, the worth functions pilots attributed to the weather variables (1) accounted for most of the variance in the pilots' comfort ratings and (2) were consistent with expert pilot ordering of the importance of the weather variables.

Regional Comparisons

Analyses addressed differences of mean comfort level among regions by terrain type, regional worth function comparisons, demographic characteristics, and the proportionality of regional membership among subpolicy groups. In reviewing these analyses, readers should bear in mind the limited sample of Alaskan pilots (N = 13), which makes interpretation of results for that region problematic.

Mean Comfort Levels. The mean comfort levels for each region by terrain type are given in Table 18. Significant ($p < .05$) differences in the mean comfort levels among the regions for each terrain type are summarized below:

Over-Water Terrain

- Northwest Mountain region is significantly lower than Total Group, Southern region, Western Pacific region means
- Southern region is significantly higher than Total Group mean

Non-Mountainous Terrain

- Alaska region mean is significantly higher than the Total Group and all other regional means
- Northwest Mountain region is significantly lower than Total Group mean

Mountainous Terrain

- Alaska region mean is significantly higher than Total Group and all other regional means

Worth Functions. Average R^2 and regression weights for the geographical regions by terrain type have been previously shown in Table 5. Overall, the amount of comfort-level variance accounted for by the expert ratings of the weather variables was not only higher for the Alaskan pilots than the total sample (all terrains) but was higher than the other regions for both the non-mountainous and mountainous terrains.

For over-water terrain, the R^2s were similar among regions, accounting for 62 to 70 percent of the variance in comfort levels. Except for Alaska, worth functions are similar with the highest weight attributed to the interaction of ceiling, visibility, and precipitation (A*B*C). The Alaskan weights are somewhat different; the largest weight is attributed to an interaction of ceiling and precipitation (A*C) followed by the A*B*C interaction.

Non-mountainous terrain R^2s are larger than those for over water, ranging from .71 to .82. R^2 are the product of ceiling-visibility (A*B) and ceiling-precipitation (A*C) interactions for all regional groups.

Average R^2s for the mountainous terrain are the highest of all. Expert ratings contribute from 74 to 79 percent of the variance in comfort levels. Generally, pilots attribute most weight to the ceiling-visibility-precipitation interaction.

Regional Group Membership Proportionality. The issue of proportionality of policy group membership was addressed by determining if membership in any given subpolicy group was comprised of a larger or smaller number of pilots than should be expected from the proportion of pilots for the region comprising the total sample. As shown in Table 20, 6 of the 72 comparisons were found to be statistically different from the mean proportions ($p < .05$). Since we would have expected 4 comparisons to attain statistical significance simply because of chance, the results do not present strong evidence of differences in the proportionality of policy group membership. However, since 4 of the 6 significant differences were found for Alaskan pilots, the data are suggestive (though certainly not definitive) of a real difference in proportionality for that group. More Alaskan pilots than should be expected were members of the terrain groups (W-4, NM-4, and M-4) having the highest comfort levels (55.29 for over water, 54.53 for non-mountainous, and 53.72 for mountainous) for each terrain type.

Given the results of the analysis of regional membership in subpolicy groups, comparisons of the regional groups against the Total Group were made (see Table 3). Differences were noted for 19 of the 30 experience items in the Pilot Background Data form. Many of the differences are in the direction to be anticipated. That is, Alaskan pilots reported more experience with heavy snow; the Western Pacific and Northwest Mountains pilots have more experience in flight over mountains. While Table 3 provides some insight for the differences of Northwest Mountains membership, there is nothing to support the Alaskan proportionality findings. Northwest Mountain pilots, although reporting more experience over water and in the mountains, have significantly less experience in all the ceiling and visibility conditions. With respect to the Alaskan region, it may very well be that pilots there represent a different sample with respect to comfort level than found elsewhere in the United States. Such an assumption, however, can only be tentative, because of the small Alaskan sample size.

Worst Flight Scenario

Pilots were asked to choose from among the scenarios (i. e., the 27 combinations of weather variables) the one scenario that represented the worst flight scenario under which they would consider continuing the flight described for each terrain type. Data for this item, however, were not usable, since some pilots followed the instructions, while others simply listed the scenario they had ranked worst for a particular terrain type.

V. COMPARISON WITH SOUTH TEXAS SAMPLE RESULTS

There is a striking similarity between the hierarchical clustering results from the regional and South Texas samples for flight over non-mountainous and mountainous routes. Subpolicies for each terrain condition were alike with respect to how pilots viewed flight under the ceiling, visibility, and precipitation conditions. By route type, both samples were comprised of groups of pilots who made uniquely conservative ratings of comfort level, even for the best combinations of conditions, as well as other groups making progressively less conservative ratings. Over-water route results differed with respect to number of subpolicy groups identified. Where there were four subpolicies for the regional sample, there were only two for the South Texas sample. The policies from both samples, however, are characterized by progressively less conservative comfort ratings.

Less similarity is noted for other factors. Comparisons of the South Texas and regional samples for demographic information, average comfort level, and for average R^2 and weather variable average regression weights are described in the following paragraphs.

Demographic Information

Comparison of the data from the 326 pilots in six geographical regions with the 150 pilots from South Texas revealed, first, the South Texas sample was 10 years younger and more nearly matches the 1993 national average age of 42.7 years (Table 21). Second, the South Texas pilots had fewer total flying hours (1694 to 3845 hours logged) and were less experienced in flight over the three terrains. In addition, for a large number of the remaining variables, the South Texas pilots had less experience in flying under the different ceiling, visibility, and precipitation levels. The variables for which South Texas pilots reported higher means are for flying hours logged in the past 90 days, use of the FAA/FSS weather source, and for larger number holding private pilot licenses. A variable-by-variable comparison of the two samples is shown in Tables 22, 23, and 24. Subpolicy alignment follows for the groups having the lowest comfort level means to a comparison of groups with the highest means. The South Texas sample data are shown under the columns labeled GP.

Comfort Level

For all subpolicy groups, the South Texas pilots reported much lower mean comfort level ratings. The lower ratings, however, may, in part, be attributable to the differences in instructions for providing the ratings (see Methodology and Data Collection, Section III).

Average R^2 and Average Regression Weights

Regional average R^2 and regression weights for subpolicy groups are displayed in Tables 6, 7, and 8. Comparable information for the South Texas subpolicy groups are shown in Driskill *et al.*, 1997. While average R^2s are fairly similar (that is, the amount of total variance in comfort ratings ranges from approximately 60 to 80 percent), inspection of the two sets of tables reveals different patterns in the average weights the pilots assign to ceiling, visibility, and precipitation and their interactions.

VI. DECISION STRATEGY

To determine the extent to which pilots used compensatory or noncompensatory strategies when assigning weather scenario comfort ratings, the correlations between comfort ratings and sets of compensatory and noncompensatory models were examined and compared. Specifically, the standardized scenario benchmark ratings (which were standardized to a mean of 5.0 and a standard deviation of 1.0 for all scenarios) were transformed (using sets of transformations designed to simulate compensatory and noncompensatory policies) and then correlated with the pilots' scenario mean comfort ratings for each terrain type. The models consisted of additive, multiplicative, worst-factor cut-off, single-factor, continuous, and cut-off models, one each for ceiling, visibility, and precipitation.

Within the compensatory model set, the additive model summed the three benchmark factors and implied equal weights for the three factors. The multiplicative model, both two and three factor models, cross-multiplied benchmark values. This model implies a policy in which one or more factors may introduce a dampening effect which can overpower the level of the other factors.

The worst-factor cutoff models used the lowest of the three benchmark values. This model implies a policy in which the poorest of the three factors became the focus.

Noncompensatory models were represented by continuous single factors (A, B, or C) as the decision variable and single-factor cut-offs. A pilot using a single continuous factor to establish a cut-off value would represent a policy in which the focus was on either ceiling, visibility, or precipitation (A, B, or C) or some established cut-off value (e. g., $X > 4.5$) as a single judgment factor.

Table 25 lists the compensatory, worst-factor, and noncompensatory models and their respective correlations with the pilot comfort ratings. This Table shows, just as in the case of the South Texas sample, the multiplicative and additive models consistently showed the strongest relationships with assigned comfort ratings.

It should be noted, however, that the worst-factor model where $X > 4.5$ also had relatively strong relationships with comfort ratings. These data suggest that values less than one-half (.5) standard deviation below the mean of the expert (benchmark) rating for any one of the three variables were used as the determining judgment factor when the pilots made their comfort ratings. That is, individual pilots tend to have a self-defined level, a personal standard, for ceiling, visibility, or precipitation that establishes the point at which they become very uncomfortable and, most probably, would be reluctant to make a flight under that condition.

VII. FINDINGS AND CONCLUSIONS

Although the six geographical region and South Texas samples are markedly different samples of the continental United States pilot population, there is high substantive agreement of results. To the degree that these samples are representative of the general pilot population, therefore, this agreement strongly suggests that the findings and conclusions can be generalized to the national pilot population.

In summary, this study found:

1. Pilot-unique worth functions or regression weights attributed to ceiling, visibility, and precipitation conditions for differing terrain in aeronautical decision-making can be modeled using regression methods.
2. In the context of the scenarios used in this study, weather variable regression weights accounted for a large proportion (66 to 77 percent) of the variance associated with pilot decisions to make a flight, as reflected in their comfort levels.
3. These worth functions consistently parallel the emphasis experts assign to flight under the various levels of ceiling, visibility, and precipitation over the three terrain types.
4. Although there appears to be a common ordering of the weather variables in terrain policy, each pilot attributes uniquely different weights to weather conditions for each terrain type. Hierarchical clustering of these pilot-unique regression weights, with respect to the worth functions attributed to the weather variables, produced four statistically different policy groups of pilots for each terrain route.
5. Mean policy group comfort levels, the product of the regression weights for the weather variables, differ markedly among terrain subpolicy groups and range from conservative to progressively higher levels.
6. Demographic characteristics of pilots forming the subpolicy groups account for 15-17 percent of policy variance at most. From a training perspective, this result is disappointing, because it is not possible to identify pilots for whom targeting training interventions might be most useful.
7. The interactive effect of variation in ceiling, visibility, and precipitation in decision-making is complex and, except for freezing precipitation where pilots are reluctant to make a flight, generalization about any one of the variables is inappropriate. In combining the weather variables, pilots tend to trade-off a poor value for one variable for good values in others.
8. While pilots tend to use compensatory (multiplicative and additive) decision strategies in considering the weather variables, there is evidence that a worst-factor strategy operates for some weather scenarios. That is, pilots appear to have personal standards for either ceiling, visibility, or precipitation below which they become reluctant to make a flight.
9. Since neither weather condition nor demographic variable weights individually nor cumulatively account for the total variance associated with pilot comfort levels, other factors that can affect pilot decision-making warrant investigation. Other personal characteristics and the willingness of pilots to take risks may be potential sources of some of the variance. In addition, the current study attempted to hold constant motivational factors — the urgency of making a given flight — through the specification of the flight scenarios. Had motivational factors been allowed to vary, different weighting and integration of the weather information may have occurred.

Given these findings, how then does one make use of the results. First, let us note that, on average, the pilots agree with the risk assessments given by experts of the various weather combinations. This replicates the previous finding (Driskill, et al., 1997) and the findings of a study using a considerably different assessment instrument (Driskill, et al., in press). Given that accidents are relatively rare events, it should not be too surprising that experts and the general population of pilots share a common view of what constitute safe and hazardous weather conditions. Still, there is some variability in risk assessments, as indicated by differences in comfort levels among the hierarchical groups for each terrain. If, as this and other studies have found, demographic variables do not predict differential comfort level (which may equate to risk tolerance), then the present instrument may be one way to assess those differences.

The next question, of course, is whether or not those differences in comfort level or group membership have any real utility. For example, are they associated with differential involvement in accidents, incidents, or critical flying events? If these measures are found to be valid predictors of those criteria, then using them to make pilots aware of their risk tolerance might be worthwhile. Similarly, pilot awareness of their preferred decision model (i.e., compensatory, cut-off levels) might also prove worthwhile if it led to a change of behavior toward safer operations. One might also speculate that low-time, VFR pilots should use a non-compensatory model to reduce the risk of weather accidents. All of these issues are open to study, and may be addressed in future studies.

Additionally, a reviewer (K. Joseph, personal communication, July 2, 1997) suggested that the findings relating to decision strategy types may be useful to designers of flight planning software. For example, knowledge about pilot decision strategies when considering weather information could be used to enhance weather-related decisions made by pilots during flight planning. Flight planning software could be designed to include weather-related decision aids that reduce and possibly eliminate poor decision strategies.

While the present study has shown that weather-related decision making may be modeled successfully using linear modeling techniques, much remains to be done to determine whether this approach can make a significant contribution to improving aviation safety. Future studies will address the relationships of measures derived from this modeling technique with criteria of interest and how best to apply the results to achieve a safety benefit.

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FIGURES

Figure 1.

Group Comfort Levels By Route

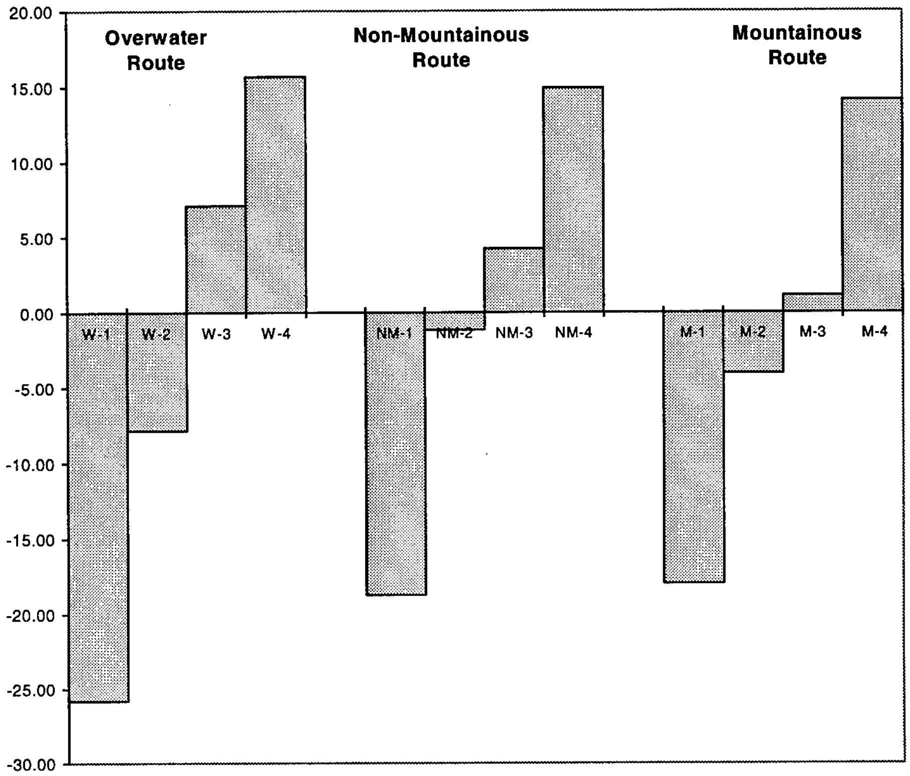
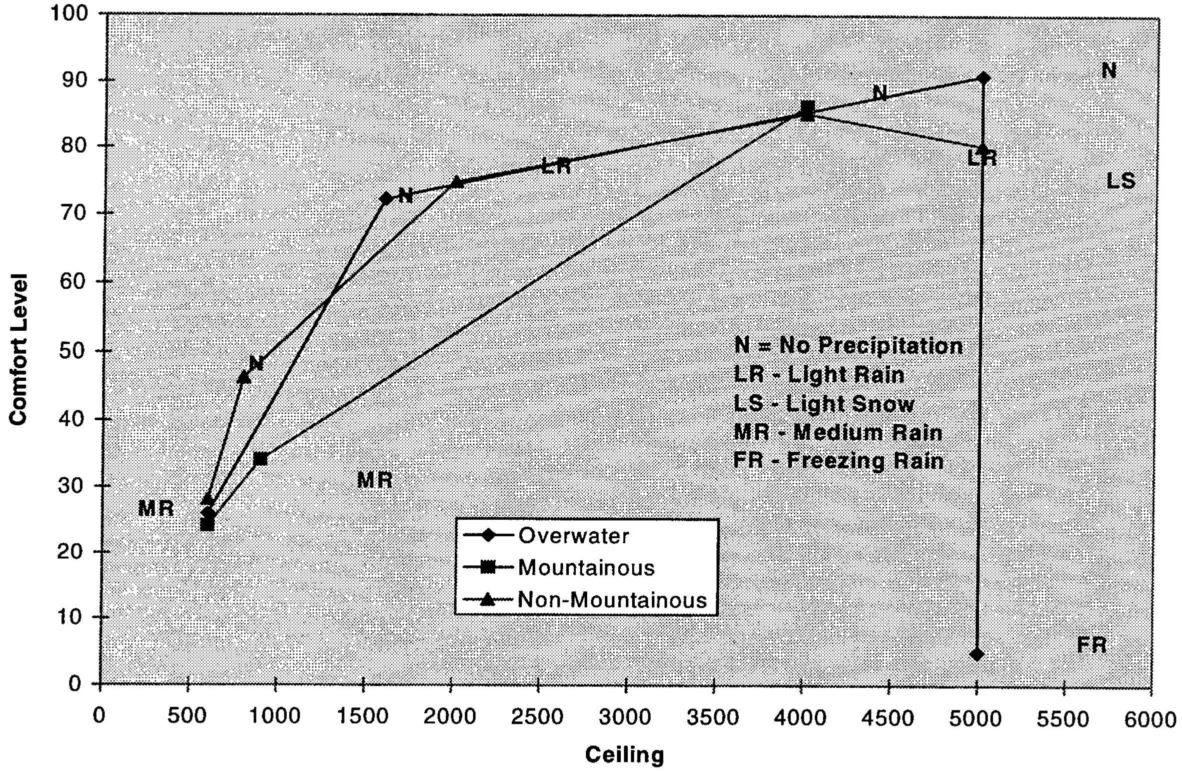


Figure 2.


Pilot Comfort Levels at 8NM Visibility
Comfort Level
Ceiling
100
90
80
70
60
50
40
30
20
10
0
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
N
N
N
LR
N
LR
LS
N = No Precipitation
LR - Light Rain
LS - Light Snow
MR - Medium Rain
FR - Freezing Rain
MR
MR
Overwater
Mountainous
Non-Mountainous
FR

TABLES

Table 1. 1997 Sample Demographics Compared with Demographics in 1995 Study

Item	1997	1995[1]
Mean Age	52 yrs.	50 yrs.
CFI or CFII certificate	34%	34%
Private pilot license	33%	38%
Commercial license	44%	43%
Airline transport license	20%	18%
Multi-engine rated	49%	49%
Instrument rated	77%	71%
Employed as pilot	19%	34%
Flying hours 90 days	36	29
Total flying hours logged	3845	3465
Mean comfort level - total group	39.52	-----
Mean over-water comfort level	39.80	-----
Mean non-mountain comfort level	42.27	-----
Mean mountain comfort level	36.38	-----

[1] From Hunter (1995)

Table 2. Sample Distribution by Terrain Type and Geographic Region

Terrain	N	Alaska	Northwest	Western	Southern	Eastern	New England
Water	319	12	56	49	50	57	82
Non-Mountain	315	13	57	48	50	55	81
Mountain	303	13	54	47	48	52	79

Table 3. Mean Differences Comparisons for Total and Geographic Region Samples[1]

Demographic Item	Total	AK	NW	WP	SO	EA	NE
Age	52 yrs.	-	-	**H**[2]	-	-	-
CFI or CFII certificate	34%	-	-	-	-	-	-
Private pilot license	33%	-	-	-	-	-	-
Commercial license	44%	-	-	-	-	-	-
Airline Transport license	20%	-	-	-	-	-	-
Multi-engine rated	49%	-	-	-	-	-	-
Instrument rated	77%	-	-	-	-	-	-
Employed as pilot	19%	-	**H**	-	**H**	-	L
Own aircraft	52%	-	-	-	-	-	-
Hours logged last 90 days	36	-	-	-	**H**	L	-
Total hours logged	3845	-	-	-	-	L	-
Number FAA Seminars attended	1.69	-	L	-	-	-	-
% Time weather from FAA/FSS	58	-	-	-	-	-	-
% Time weather from radio/TV	41	-	-	L	-	**H**	-
% Time weather from DUAT	26	-	-	-	-	-	-
% Tune weather other sources	16	-	-	-	-	-	L
Lowest ceiling day VFR	2184 ft.	L	**H**	-	L	-	-
Flying experience[3]							
Terrain							
over water	2.84	**H**	**H**	L	**H**	**H**	L
over non-mountain	4.42	-	-	-	-	-	-
over mountains	3.48	-	-	-	-	-	-
Precipitation conditions							
light rain	3.94	-	-	-	**H**	**H**	L
moderate rain	3.36	-	-	-	**H**	L	-
heavy snow	2.14	**H**	-	-	-	-	-
Visibility conditions							
1 mile	3.15	-	L	**H**	-	L	-
4 miles	4.18	-	L	-	-	-	-
8 miles	4.72	-	L	**H**	-	-	-
Ceiling conditions							
800 feet	3.14	-	L	-	**H**	-	-
1800 feet	4.05	-	L	-	-	-	L
4000 feet	4.78	-	L	-	-	-	-

[1] Significance of differences computed by *t-tests* at 0.05 level for individual comparisons

[2] **H** indicates significantly higher mean than Total Group, L significantly lower than Total Group, - no difference

[3] Rating scale used: *1, Never: 2, Once or twice; 3, Several times; 4, Many times; 5, Numerous times*

Table 4. Interrater Agreement and Stability for Regional and Total Samples by Terrain Type

Over Water

Region	R11	Rkk	k
Alaska	0.3450	0.8528	11.0
Western	0.4772	0.9770	46.5
Southern	0.5177	0.9810	48.2
Northwest	0.4944	0.9818	55.3
Eastern	0.5778	0.9873	56.8
New England	0.5219	0.9888	80.9
Total	0.5130	0.9968	300.0

Non-Mountainous

Region	R11	Rkk	k
Alaska	0.4948	0.9112	10.5
Western	0.5264	0.9811	46.9
Southern	0.5314	0.9815	46.7
Northwest	0.5265	0.9840	55.3
Eastern	0.5506	0.9851	53.9
New England	0.4938	0.9870	77.8
Total	0.5214	0.9968	286.9

Mountainous

Region	R11	Rkk	k
Alaska	0.3082	0.8200	10.2
Western	0.5028	0.9794	46.9
Southern	0.5369	0.9811	44.7
Northwest	0.5866	0.9867	52.3
Eastern	0.5521	0.9837	49.0
New England	0.5529	0.9895	76.5
Total	0.5430	0.9970	275.9

Table 5. Average Regression Weights for Terrain Policies

	Over Water	Non-Mountain	Mountains
Number of Members	319	315	303
Average Comfort Level*	39.80	42.27	36.38
Average R^2	0.66	0.73	0.77
Regression Weights			
Ceiling (A)		-0.41	-0.38
Visibility (B)			
Precipitation (C)	-0.31		
(MULT A*B*C)	1.48		0.99
(MULT A*B)	-0.54	0.75	0.23
(MULT A*C)		0.40	
(MULT B*C)			-0.33

*Comfort level means are significantly different (p<.05)

Table 6. Over-Water Subpolicy Group Mean Regression Weights

	Total TOTALW	Group W-1	Group W-2	Group W-3	Group W-4
Number of Members	319	24	139	72	84
Mean Comfort Level*	39.80	13.79	31.76	46.73	55.29
Mean R^2	0.66	0.67	0.70	0.61	0.65
Regression Weights					
Ceiling (A)			-0.24		
Visibility (B)		0.20			
Precipitation (C)	-0.31	-0.38	-0.33		-0.38
(MULT A*B*C)	1.48	1.41	2.05	1.84	0.26
(MULT A*B)	-0.54	-0.82	-0.58	-0.76	-0.21
(MULT A*C)					0.60
(MULT B*C)			-0.38	-0.41	0.47

*Comfort level means are significantly different (*t-test*, p<0.05)

Table 7. Non-Mountainous Subpolicy Group Mean Regression Weights

	Total TOTALNM	Group NM-1	Group NM-2	Group NM-3	Group NM-4
Number of Members	315	49	72	93	101
Average Comfort Level*	42.27	20.85	38.45	43.82	54.53
Average R^2	0.73	0.71	0.73	0.74	0.74
Regression Weights					
Ceiling (A)	-0.41	-0.63		-0.78	
Visibility (B)		-0.20		-0.28	0.39
Precipitation (C)				0.20	
(MULT A*B*C)		-0.29	1.62	-0.84	
(MULT A*B)	0.75	1.18	-0.41	1.93	0.27
(MULT A*C)	0.40	0.56		0.57	0.47
(MULT B*C)			-0.23		

*Comfort level means are significantly different (*t-test,* $p<0.05$)

Table 8. Mountainous Subpolicy Group Mean Regression Weights

	Total TOTALM	Group M-1	Group M-2	Group M-3	Group M-4
Number of Members	303	94	78	63	68
Average Comfort Level*	36.38	21.61	35.57	40.71	53.72
Average R^2	0.77	0.69	0.62	0.67	0.63
Regression Weights					
Ceiling (A)	-0.38	-0.48		-0.86	
Visibility (B)					
Precipitation (C)					0.48
(MULT A*B*C)	0.99	1.53	1.96		
(MULT A*B)	0.23	0.20	0.34	0.75	0.46
(MULT A*C)			-0.35	1.38	
(MULT B*C)	-0.33	-0.47	-0.44	-0.30	

*Comfort level means are significantly different (*t-test,* $p<.05$)

Table 9. Over-Water Scenario Mean Comfort Ratings

No.	Ceiling (in feet)	Visibility (in NM)	Precipitation	N	Mean
104	5000	>8	none	318	90.94
103	4000	4	none	318	83.51
101	4000	7	moderate rain	318	72.93
112	1600	8	none	317	72.22
105	2000	3	none	316	70.28
114	4000	5	light snow	316	63.90
110	1800	7	moderate rain	317	57.02
107	1800	7	light snow	317	54.80
125	1800	5	moderate rain	314	51.34
102	5000	1 ½	light rain	315	43.45
122	900	5	none	314	40.06
106	1800	3	heavy rain	313	37.80
124	1600	4	moderate snow	313	37.41
119	600	7	none	313	32.99
123	800	4	moderate rain	312	27.66
118	600	8	moderate rain	313	25.98
111	800	1 ½	none	313	25.80
108	3500	1	heavy rain	314	25.63
113	1600	3	heavy snow	315	25.02
127	900	4	heavy rain	309	21.08
120	1600	1 ½	moderate snow	313	20.83
116	1600	1 ½	heavy rain	312	20.29
109	900	1 ½	moderate rain	314	20.09
126	1800	1 ½	none	314	18.45
117	5000	1 ½	moderate rain	312	17.50
115	700	1 ½	heavy snow	312	5.69
121	5000	8	freezing rain	313	4.95

Table 10. Non-Mountainous Scenario Mean Comfort Ratings

No.	Ceiling (in feet)	Visibility (in NM)	Precipitation	N	Mean
206	4000	8	light rain	313	85.18
201	5000	8	light snow	312	80.27
226	2000	>8	light rain	310	74.83
227	4000	5	light snow	308	70.89
210	1800	4	none	311	70.27
204	4000	3	light rain	311	66.76
205	2000	7	light snow	310	65.92
217	1800	7	moderate rain	309	59.86
213	1800	5	moderate rain	311	57.68
212	800	8	none	308	46.31
223	1600	4	moderate snow	309	41.21
220	2000	1 ½	none	305	40.34
211	8000	>8	light snow	308	38.19
202	4000	1	light rain	306	37.5
224	800	3	none	308	36.61
221	1800	3	heavy rain	308	35.141
216	5000	1 ½	moderate rain	304	34.84
218	900	5	light snow	306	32
203	1600	3	heavy snow	309	29.29
214	600	8	moderate rain	303	28.17
215	900	4	heavy rain	302	23.16
225	900	1 ½	light rain	305	20.87
207	3500	½	heavy rain	306	14.75
208	1800	½	moderate snow	306	11.83
209	600	½	light snow	307	9.38
219	900	½	light rain	306	8.08
222	2000	½	freezing rain	304	3.92

Table 11. Mountainous Scenario Mean Comfort Ratings

No.	Ceiling (in feet)	Visibility (in NM)	Precipitation	N	Mean
307	4000	8	none	298	86.31
301	5000	5	none	298	84.83
316	2000	>8	light rain	295	67.19
303	3500	>8	moderate rain	295	66.00
325	2000	4	none	295	64.55
313	4000	4	light snow	293	60.63
321	2000	5	light snow	293	52.39
309	1800	7	moderate rain	294	49.95
327	1800	5	moderate rain	292	46.54
326	5000	1 ½	light rain	292	39.99
317	2000	1 ½	none	291	38.03
323	900	8	light rain	292	34.13
315	1600	3	heavy rain	290	32.20
322	900	5	light rain	292	31.60
314	3500	1	light snow	291	31.28
324	1699	3	heavy snow	288	25.52
319	600	8	moderate rain	290	24.17
310	800	1	none	290	23.17
306	900	4	heavy rain	288	22.84
308	600	3	moderate snow	291	16.74
305	2000	½	moderate rain	291	15.87
311	4000	½	heavy snow	289	12.49
312	600	1	moderate snow	289	11.94
304	900	1	heavy snow	290	11.24
320	3500	3	freezing rain	291	7.39
318	1600	1	freezing rain	291	4.39
302	600	5	freezing rain	291	4.29

Table 12. Overwater Policy Group Comparison

GROUP	Total	W-1	W-2	W-3	W-4
Number of Cases	319	24	139	72	84
Mean Comfort Level	39.98	13.79	31.76	46.73	55.29
BACKGROUND VARIABLE					
Flying History					
Total Hours Mean	3845 hrs	2711 hrs	3174 hrs	3950 hrs	3771 hrs
Last 90 Days Mean	36 hrs	32 hrs	38 hrs	32 hrs	38 hrs
Mean Age	52	56	52	51	52
Percent Owning Aircraft	52	67	50	50	52
Mean Terrain Experience					
Route 1 - Overwater	2.84	2.29	2.80	3.17	2.77
Route 2 - Flatland	4.42	4.29	4.38	4.46	4.47
Route 3 - Mountain	3.48	3.70	3.57	3.30	3.44
Mean Precipitation Experience					
Light Rain	3.94	3.65	3.93	4.04	3.95
Moderate Rain	3.36	3.00	3.31	3.44	3.46
Heavy Snow	2.14	1.83	2..08	2.43	2.07
Mean Visibility Experience					
1 NM	3.15	2.88	3.03	3.46	3.18
4 NM	4.18	3.91	4.14	4.33	4.20
8 NM	4.72	4.52	4.72	4.81	4.70
Mean Ceiling Experience					
800 ft.	3.14	2.92	3.04	3.39	3.16
1800 ft.	4.05	3.75	3.98	4.23	4.09
4000 ft.	4.78	4.71	4.78	4.81	4.76
Percent Using Weather Source					
FAA/FSS	58%	57%	54%	57%	66%
DUAT	26%	32%	26%	27%	25%
TV/Radio	41%	36%	43%	38%	40%
Other	16%	12%	20%	13%	14%
Percent Certificates Held					
Private	33%	29%	32%	33%	35%
Commercial	44%	54%	45%	38%	45%
Airline Transport	20%	13%	21%	26%	15%
Other	3%	4%	2%	3%	5%
Multi-Engine Rating	49%	33%	50%	44%	55%
CFI/CFII	34%	33%	37%	28%	32%
Instrument Rating	77%	71%	78%	78%	77%
Percent Flying Job					
Employed as a Pilot	19%	17%	17%	29%	15%
Mean Number of FAA Safety Seminars	1.69	1.75	1.40	2.08	1.81
Mean Lowest Ceiling for Day VFR Trip	2148 ft	2775 ft	2312 ft	2093 ft	1882 ft

Table 13. Highlights of Group Characteristics (Overwater Route)

Highlights of Group Characteristics (Overwater Route)					
Probability	**W-1**	**W-2**	**W-3**	**W-4**	**Compared to W-3, W-2 has:**
0.00	13.79	31.76	46.73	55.29	a lower comfort level for overwater route
0.02	17%	17%	29%	15%	a lower percentage employed as a pilot
0.02	1.75	1.40	2.08	1.81	less attendance at FAA Safety Seminars
0.04	2.29	2.80	3.17	2.77	less experience flying overwater
0.04	1.83	2.08	2.43	2.07	less experience flying on heavy snow
0.02	2.88	3.03	3.46	3.18	less experience flying in 1 NM visibility
0.05	2.92	3.04	3.39	3.16	less experience flying in 800ft ceilings
0.05	3.75	3.98	4.23	4.09	less experience flying in 1800ft ceilings
Probability	**W-1**	**W-2**	**W-3**	**W-4**	**Compared to W-1, W-2 has:**
0.00	13.79	31.76	46.73	55.29	a higher comfort level for overwater route
0.05	2775ft	2312ft	2093ft	1882ft	a lower personal ceiling for a day VFR trip
Probability	**W-1**	**W-2**	**W-3**	**W-4**	**Compared to W-4, W-2 has:**
0.00	13.79	31.76	46.73	55.29	a lower comfort level for overwater route
0.00	2775ft	2312ft	2093ft	1882ft	a higher personal ceiling for a day VFR trip
0.01	57%	54%	56%	66%	a lower percentage obtain weather from FAA/FSS
Probability	**W-1**	**W-2**	**W-3**	**W-4**	**Compared to W-1, W-3 has:**
0.00	13.79	31.76	46.73	55.29	a higher comfort level for overwater route
0.02	2775ft	2312ft	2093ft	1882ft	a lower personal ceiling for a day VFR trip
0.01	2.29	2.80	3.17	2.77	more experience flying overwater
0.05	3.65	3.93	4.04	3.95	more experience flying in light rain
0.03	1.83	2.08	2.43	2.07	more experience flying in heavy snow
0.02	2.88	3.03	3.46	3.18	more experience flying in 1 NM visibility
0.04	3.91	4.14	4.33	4.20	more experience flying in 4 NM visibility
0.03	4.76	4.69	4.86	4.38	more experience flying with visibility at 8NM
0.03	3.75	3.98	4.23	4.09	more experience flying in 1800ft ceilings
Probability	**W-1**	**W-2**	**W-3**	**W-4**	**Compared to W-4, W-3 has:**
0.00	13.79	31.76	46.73	55.29	a lower comfort level for overwater route
0.05	13%	21%	26%	15%	a higher percentage of ATP rated pilots
0.02	17%	17%	29%	15%	a higher percentage employed as a pilot
0.04	2.29	2.80	3.17	2.77	more experience flying overwater
0.05	1.83	2.08	2.43	2.07	more experience flying in heavy snow
Probability	**W-1**	**W-2**	**W-3**	**W-4**	**Compared to W-4, W-1 has:**
0.00	13.79	31.76	46.73	55.29	a lower comfort level for overwater route
0.03	33%	50%	44%	55%	a lower percentage of multi-engine rated pilots
0.00	2775ft	2312ft	2093ft	1882ft	a higher personal ceiling for a day VFR trip

Table 14. Non-Mountainous Policy Group Comparison

GROUP	Total	NM-1	NM-2	NM-3	NM-4
Number of Cases	315	49	72	93	101
Mean Comfort Level	42.45	20.85	38.43	43.82	54.53
BACKGROUND VARIABLE					
Flying History					
Total Hours Mean	3835 hrs	1849 hrs	3950 hrs	3372 hrs	3955 hrs
Last 90 Days Mean	35 hrs	18 hrs	37 hrs	41 hrs	37 hrs
Mean Age	52 yrs	53 yrs	52 yrs	50 yrs	53 yrs
Percent Owning Aircraft	52%	59%	51%	47%	53%
Mean Terrain Experience					
Route 1 - Overwater	2.82	2.29	2.93	2.80	3.01
Route 2 - Flatland	4.41	4.26	4.26	4.49	4.53
Route 3 - Mountain	3.47	3.43	3.61	3.27	3.59
Mean Precipitation Experience					
Light Rain	3.95	3.65	3.99	4.01	4.00
Moderate Rain	3.36	3.00	3.32	3.44	3.49
Heavy Snow	2.13	1.83	1.96	2.21	2.32
Mean Visibility Experience					
1 NM	3.15	2.83	3.17	3.18	3.26
4 NM	4.18	3.67	4.14	4.34	4.31
8 NM	4.72	4.38	4.69	4.76	4.86
Mean Ceiling Experience					
800 ft.	3.13	2.73	3.18	3.17	3.25
1800 ft.	4.05	3.63	4.10	4.10	4.16
4000 ft.	4.77	4.52	4.74	4.85	4.86
Percent Using Weather Source					
FAA/FSS	58%	56%	53%	61%	60%
DUAT	26%	32%	28%	26%	23%
TV/Radio	41%	50%	34%	45%	37%
Other	16%	17%	14%	18%	13%
Percent Certificates Held					
Private	33%	43%	33%	30%	30%
Commercial	45%	39%	38%	47%	50%
Airline Transport	19%	10%	28%	19%	18%
Other	3%	8%	1%	3%	2%
Multi-Engine Rating	49%	33%	51%	49%	53%
CFI/CFII	34%	27%	33%	34%	37%
Instrument Rating	77%	67%	81%	83%	73%
Percent Flying Job					
Employed as a Pilot	19%	6%	21%	24%	19%
Mean Number of FAA Safety Seminars	1.74	1.49	2.11	1.66	1.66
Mean Lowest Ceiling for Day VFR Trip	2174 ft	2718 ft	2490 ft	1979 ft	1863 ft

Table 15. Highlights of Group Characteristics (Non-Mountainous)

Highlights of Group Characteristics (Non-Mountainous Route)					
Probability	**NM-1**	**NM-2**	**NM-3**	**NM-4**	**Compared to NM-4, NM-2 has:**
0.00	20.85	38.43	43.82	54.53	a lower comfort level
					for non-mountainous route
0.00	2718ft	2490ft	1979ft	1836ft	a higher personal ceiling for a day VFR trip
0.02	4.26	4.26	4.49	4.53	less experience over non-mountainous terrain
0.04	1.83	1.96	2.21	2.32	less experience flying in heavy snow
0.02	4.38	4.69	4.76	4.86	less experience flying with visibility at 8NM
0.05	39%	38%	47%	50%	a lower percentage of commercial pilots
Probability	**NM-1**	**NM-2**	**NM-3**	**NM-4**	**Compared to NM-3, NM-2 has:**
0.00	20.85	38.43	43.82	54.53	a lower comfort level
					for non-mountainous route
0.00	2718ft	2490ft	1979ft	1863ft	a higher personal ceiling for a day VFR trip
0.03	50%	34%	45%	37%	a lower percentage obtain weather
					from TV/Radio sources
Probability	**NM-1**	**NM-2**	**NM-3**	**NM-4**	**Compared to NM-1, NM-2 has:**
0.00	20.85	38.43	43.82	54.53	a higher comfort level
					for non-mountainous route
0.01	18%	10%	19%	28%	a lower percentage of ATP rated pilots
0.05	67%	81%	83%	73%	a higher percentage of instrument rated pilots
0.02	33%	51%	49%	53%	a higher percentage of multi-engine rated pilots
0.01	6%	21%	24%	19%	a higher percentage employed as a pilot
0.01	18hrs	37hrs	41hrs	37hrs	more flying hours in the last 90 days
0.01	1849hrs	3950hrs	3372hrs	3955hrs	a higher number of total flying hours
0.01	50%	34%	45%	37%	a lower percentage obtain weather
					from TV/Radio sources
0.01	2.29	2.93	2.80	3.01	more experience flying overwater
0.04	3.65	3.99	4.01	4.00	more experience flying in light rain
0.01	3.67	4.14	4.34	4.31	more experience flying with 4NM visibility
0.02	4.38	4.69	4.76	4.86	more experience flying with 8NM visibility
0.04	2.73	3.18	3.17	3.25	more experience flying in 800ft ceilings
0.01	3.62	4.10	4.10	4.16	more experience flying in 1800ft ceilings
Probability	**NM-1**	**NM-2**	**NM-3**	**NM-4**	**Compared to NM-3, NM-4 has:**
0.00	20.85	38.43	43.82	54.53	a higher comfort level
					for non-mountainous route
0.05	3.43	3.61	3.27	3.59	more experience over mountainous terrain

Table 15. Highlights of Group Characteristics (Non-Mountainous) (Continued)

Probability	NM-1	NM-2	NM-3	NM-4	Compared to NM-1, NM-4 has:
0.00	20.85	38.43	43.82	54.53	a higher comfort level
					for non-mountainous route
0.03	39%	38%	47%	50%	a higher percentage of commercial pilots
0.01	33%	51%	49%	53%	a higher percentage of multi-engine rated pilots
0.02	6%	21%	24%	19%	a higher percentage employed as a pilot
0.00	2718ft	2490ft	1979ft	1863ft	a lower personal ceiling for a day VFR trip
0.01	18hrs	37hrs	41hrs	37hrs	more flying hours in the last 90 days
0.00	1849hrs	3950hrs	3372hrs	3955hrs	a higher number of total flying hours
0.02	50%	34%	45%	37%	a lower percentage obtain weather from TV/Radio sources
0.00	2.29	2.93	2.80	3.01	more experience flying overwater
0.03	4.26	4.26	4.49	4.53	more experience over non-mountainous terrain
0.02	3.65	3.99	4.01	4.00	more experience flying in light rain
0.01	3.00	3.32	3.44	3.49	more experience flying in moderate rain
0.02	1.83	1.96	2.21	2.32	more experience flying in heavy snow
0.03	2.83	3.17	3.18	3.26	more experience flying with 1NM visibility
0.00	3.67	4.14	4.34	4.31	more experience flying with 4NM visibility
0.00	4.38	4.69	4.76	4.86	more experience flying with 8NM visibility
0.01	2.73	3.18	3.17	3.25	more experience flying in 800ft ceilings
0.00	3.62	4.10	4.10	4.16	more experience flying in 1800ft ceilings
0.00	4.52	4.74	4.85	4.86	more experience flying in 4000ft ceilings
Probability	**NM-1**	**NM-2**	**NM-3**	**NM-4**	**Compared to NM-1, NM-3 has:**
0.00	20.85	38.43	43.82	54.53	a higher comfort level
					for non-mountainous route
0.02	67%	81%	83%	73%	a higher percentage of instrument rated pilots
0.03	33%	51%	49%	53%	a higher percentage of multi-engine rated pilots
0.00	6%	21%	24%	19%	a higher percentage employed as a pilot
0.00	2718ft	2490ft	1979ft	1863ft	a lower personal ceiling for a day VFR trip
0.01	18hrs	37hrs	41hrs	37hrs	more flying hours in the last 90 days
0.02	1849hrs	3950hrs	3372hrs	3955hrs	a higher number of total flying hours
0.02	2.29	2.93	2.80	3.01	more experience flying overwater
0.03	3.65	3.99	4.01	4.00	more experience flying in light rain
0.03	3.00	3.32	3.44	3.49	more experience flying in moderate rain
0.04	1.83	1.96	2.21	2.32	more experience flying in heavy snow
0.00	3.67	4.14	4.34	4.31	more experience flying with 4NM visibility
0.00	4.38	4.69	4.76	4.86	more experience flying with 8NM visibility
0.04	2.73	3.18	3.17	3.25	more experience flying in 800ft ceilings
0.01	3.62	4.10	4.10	4.16	more experience flying in 1800ft ceilings
0.00	4.52	4.74	4.85	4.86	more experience flying in 4000ft ceilings

Table 16. Mountainous Policy Group Comparisons

GROUP	Total	M-1	M-2	M-3	M-4
Number of Cases	303	94	78	63	68
Mean Comfort Level	36.38	31.61	35.57	40.71	53.72
BACKGROUND VARIABLE					
Flying History					
Total Hours Mean	3775 hrs	3013 hrs	3605 hrs	3246 hrs	3801 hrs
Last 90 Days Mean	36 hrs	30 hrs	47 hrs	33 hrs	32 hrs
Mean Age	52 yrs	53 yrs	51 yrs	51 yrs	53 yrs
Percent Owning Aircraft	52%	56%	60%	46%	43%
Mean Terrain Experience					
Route 1 - Overwater	2.81	2.68	2.94	2.97	2.68
Route 2 - Flatland	4.41	4.40	4.45	4.45	4.36
Route 3 - Mountain	3.46	3.46	3.46	3.37	3.55
Mean Precipitation Experience					
Light Rain	3.94	3.83	4.04	3.97	3.95
Moderate Rain	3.35	3.24	3.39	3.35	3.47
Heavy Snow	2.12	2.09	2.01	2.06	2.32
Mean Visibility Experience					
1 NM	3.13	2.94	3.20	3.34	3.14
4 NM	4.19	3.99	4.22	4.32	4.29
8 NM	4.72	4.58	4.68	4.86	4.83
Mean Ceiling Experience					
800 ft.	3.11	2.99	3.20	3.11	3.18
1800 ft.	4.04	3.96	1.01	4.03	4.20
4000 ft.	4.78	4.70	4.74	4.87	4.83
Percent Using Weather Source					
FAA/FSS	58%	54%	61%	53%	62%
DUAT	26%	31%	29%	24%	19%
TV/Radio	40%	45%	39%	42%	32%
Other	15%	16%	13%	18%	13%
Percent Certificates Held					
Private	33%	37%	27%	37%	31%
Commercial	45%	43%	50%	44%	41%
Airline Transport	19%	19%	18%	19%	22%
Other	3%	1%	5%	0%	6%
Multi-Engine Rating	49%	41%	47%	49%	59%
CFI/CFII	34%	29%	38%	33%	38%
Instrument Rating	77%	76	83%	79%	69%
Percent Flying Job					
Employed as a Pilot	19%	14%	22%	21%	21%
Mean Number of FAA Safety Seminars	1.69	1.62	1.9	1.86	1.41
Mean Lowest Ceiling for Day VFR Trip	2167 ft.	2323 ft.	2164 ft	2051 ft.	2063 ft.

Table 17. Highlights of Group Characteristics (Mountainous)

Highlights of Group Characteristics (Mountainous Route)					
Probability	**M-1**	**M-2**	**M-3**	**M-4**	**Compared to M-2, M-1 has:**
0.00	21.61	35.57	40.71	53.72	a lower comfort level for mountainous route
0.03	30hrs	47hrs	33hrs	32hrs	less flying hours in the last 90 days
Probability	**M-1**	**M-2**	**M-3**	**M-4**	**Compared to M-4, M-1 has:**
0.00	21.61	35.57	40.71	53.72	a lower comfort level for mountainous route
0.01	41%	47%	49%	59%	a lower percentage of multi-engine rated pilots
0.02	76%	83%	79%	69%	a higher percentage of instrument rated pilots
0.02	56%	60%	46%	43%	a higher percentage own their own airplane
0.02	31%	29%	24%	19%	a higher percentage obtain weather from DUAT
0.02	45%	39%	42%	32%	a higher percentage obtain
					weather from TV/Radio sources
0.03	3.99	4.22	4.32	4.29	less experience flying with 4NM visibility
0.01	4.58	4.68	4.86	4.83	less experience flying with 8NM visibility
Probability	**M-1**	**M-2**	**M-3**	**M-4**	**Compared to M-3, M-1 has:**
0.00	21.61	35.57	40.71	53.72	a lower comfort level for mountainous route
0.04	2.94	3.20	3.34	3.14	less experience flying with 1NM visibility
0.02	3.99	4.22	4.32	4.29	less experience flying with 4NM visibility
0.01	4.58	4.68	4.86	4.83	less experience flying with 8NM visibility
Probability	**M-1**	**M-2**	**M-3**	**M-4**	**Compared to M-4, M-2 has:**
0.00	21.61	35.57	40.71	53.72	a lower comfort level for mountainous route
0.02	76%	83%	79%	69%	a higher percentage of instrument rated pilots
0.02	56%	60%	46%	43%	a higher percentage own their own airplane
0.05	4.58	4.68	4.86	4.83	less experience flying with 8NM visibility
Probability	**M-1**	**M-2**	**M-3**	**M-4**	**Compared to M-3, M-2 has:**
0.00	21.61	35.57	40.71	53.72	a lower comfort level for mountainous route
0.05	56%	60%	46%	43%	a higher percentage own their own airplane
0.03	4.58	4.68	4.86	4.83	less experience flying with 8NM visibility
0.05	4.70	4.74	4.87	4.83	less experience flying in 4000ft ceilings
Probability	**M-1**	**M-2**	**M-3**	**M-4**	**Compared to M-3, M-4 has:**
0.00	21.61	35.57	40.71	53.72	a higher comfort level for mountainous route

Table 18. Mean Regional Comfort Ratings by Terrain

	Terrain Type		
Region	Water	Non-Mountainous	Mountainous
Alaska	42.69	56.43	48.23
Northwest	36.23	38.14	34.29
Western	41.95	45.09	37.09
Southern	42.76	45.49	37.50
New England	39.48	40.08	35.25
Eastern	38.99	40.07	34.44
Total Sample	39.98	42.45	36.38

Table 19. Mean Regression Weights for Geographical Regions by Terrain

Over Water

Variable	AK	NW	WP	SO	NE	EA
Average R^2	0.69	0.68	0.63	0.62	0.67	0.70
Ceiling (A)	-0.44					
Visibility (B)						
Precipitation (C)	-0.63	-0.33	-0.25		-0.38	-0.33
A*B*C	0.65	1.60	1.30	1.17	1.75	1.60
A*B	-0.26	-0.43	-0.34	-0.23	-0.89	-0.67
A*C	0.79					
B*C	0.27				-0.22	-0.25

Non-Mountainous

Variable	AK	NW	WP	SO	NE	EA
Average R^2	0.82	0.73	0.75	0.72	0.71	0.76
Ceiling (A)	-0.29	-0.47	-0.43	-0.41	-0.33	-0.52
Visibility (B)	0.23					
Precipitation (C)						
A*B*C		0.25				
A*B	0.57	0.70	0.85	0.72	0.72	0.82
A*C	0.31	0.22	0.32	0.32	0.21	
B*C		-0.25	-0.23	-0.43	-0.33	-0.40

Mountainous

Variable	AK	NW	WP	SO	NE	East
Average R^2	0.79	0.76	0.79	0.76	0.74	0.78
Ceiling (A)	-0.39	-0.32	-0.49	-0.39	-0.32	-0.42
Visibility (B)						
Precipitation (C)						
A*B*C	0.47	1.00	0.74	0.91	1.03	1.34
A*B	0.38	0.22	0.32	0.32	0.21	
A*C	0.31		0.40			
B*C		-0.25	-0.23	-0.43	-0.33	-0.40

Table 20. Proportionality of Group Membership by Region

			OVERWATER ROUTE		
TOTAL CASES	319	24	139	72	84
	TotalW	W-1	W-2	W-3	W-4
Alaskan Region	12	2	2	1	7**
Southern Region	50	2	23	9	16
New England Region	82	7	36	22	17
Western Pacific Region	49	5	19	11	14
Northwest Mountains Region	56	5	33	9	9
Eastern Region	57	2	22	16	17
			NON-MOUNTAINOUS ROUTE		
TOTAL CASES	315	49	72	93	101
	TotalNM	NM-1	NM-2	NM-3	NM-4
Alaskan Region	13	1	0*	2	10**
Southern Region	50	5	10	14	21
New England Region	81	19**	18	24	20
Western Pacific Region	48	5	10	14	19
Northwest Mountains Region	57	12	19	15	11**
Eastern Region	55	6	13	21	15
			MOUNTAINOUS ROUTE		
TOTAL CASES	315	49	72	93	101
	TotalM	M-1	M-2	M-3	M-4
Alaskan Region	13	4	1	1	7**
Southern Region	48	15	14	10	9
New England Region	79	27	22	15	15
Western Pacific Region	47	14	10	11	12
Northwest Mountains Region	54	15	17	9	13
Eastern Region	52	18	11	13	10
Legend * = Statistically significant t-test, (.05) below the mean					
** = Statistically significant t-test, (.05) above the mean					

Table 21. Comparison of Total Sample Demographic Data with South Texas Sample

Variable	Current Sample	South Texas
N	326	150
Average Age	52 years	42
Mean Total Flying Hours	3845	1694
Mean Comfort Level		
Mean Over-Water Comfort Level	39.80	30.29
Mean Non-mountain Comfort Level	42.27	30.15
Mean Mountain Comfort Level	36.38	30.29

Table 22. Regional and South Texas Demographics

ROUTE 1 OVERWATER						
MEAN COMFORT LEVEL	13.79	27	31.76	40	46.73	55.29
NUMBER OF CASES (319/150)	24	112	139	38	72	84
BACKGROUND VARIABLE	W-1	GP A	W-2	GP B	W-3	W-4
Flying History						
Total Hours	2711hrs	1896hrs	3174hrs	1187hrs	3950hrs	3771hrs
Last 90 Days	32hrs	39hrs	38hrs	39hrs	32hrs	38hrs
Mean Age	56 yrs	43yrs	52 yrs	40yrs	51 yrs	52 yrs
Percent Owing Aircraft	67%	39%	50%	26%	50%	52%
Percent Female	n/a	12%	n/a	16%	n/a	n/a
Mean Terrain Experience						
Route 1 - Overwater	2.29	1.04	2.80	0.89	3.17	2.77
Route 2 - Flatland	4.29	n/a	4.38	n/a	4.46	4.47
Route 3 - Mountainous	3.70	n/a	3.57	n/a	3.30	3.44
Mean Precipitation Experience						
Light Rain	3.65	2.49	3.93	2.18	4.04	3.95
Moderate Rain	3.00	1.71	3.31	1.29	3.44	3.46
Heavy Snow	1.83	0.43	2.08	0.37	2.43	2.07
Mean Visibility Experience						
1 NM	2.88	1.74	3.03	1.42	3.46	3.18
4 NM	3.91	2.80	4.14	2.50	4.33	4.20
8 NM	4.52	3.62	4.72	3.37	4.81	4.70
Mean Ceiling Experience						
800 ft	2.92	1.77	3.04	1.50	3.39	3.16
1800 ft	3.75	2.94	3.98	2.68	4.23	4.09
4000 ft	4.71	3.65	4.78	3.53	4.81	4.76
Percent Using Weather Source						
FAA/FSS	57%	67%	54%	65%	57%	66%
DUAT	32%	n/a	26%	n/a	27%	25%
TV/Radio	36%	33%	43%	24%	38%	40%
Other	12%	12%	20%	7%	13%	14%
Percent Certificates Held						
PP	29%	58%	32%	63%	33%	35%
COM	54%	33%	45%	21%	38%	45%
ATP	13%	n/a	21%	n/a	26%	15%
Other	4%	n/a	2%	n/a	3%	5%
Multi-Engine Rating	33%	n/a	50%	n/a	44%	55%
CFI/CFII	33%	21%	37%	18%	28%	32%
Instrument Rating	71%	46%	78%	39%	78%	77%
Percent Flying						
Job-employed as a pilot	17%	14%	17%	19%	29%	15%
Average Number	1.75	n/a	1.40	n/a	2.08	1.81
FAA Safety Seminars Attended						
Lowest Ceiling for Day VFR Trip	2775ft	n/a	2312ft	n/a	2093ft	1882ft
Average R^2		0.69		0.67		

Table 23. Regional and South Texas Demographics

ROUTE 2 NON-MOUNTAINOUS								
MEAN COMFORT LEVEL	**20.85**	*17*	**38.43**	*28*	**43.82**	*32*	**54.53**	*50*
NUMBER OF CASES (315/150)	**49**	*37*	**72**	*52*	**93**	*34*	**101**	*27*
BACKGROUND VARIABLE	**NM-1**	***GP 4***	**NM-2**	***GP 2***	**NM-3**	***GP 1***	**NM-4**	***GP 3***
Flying History								
Total Hours	**1849hrs**	*1679hrs*	**3950hrs**	*1516hrs*	**3372hrs**	*1942hrs*	**3955hrs**	*1869hrs*
Last 90 Days	**18hrs**	*25hrs*	**37hrs**	*37hrs*	**41hrs**	*51hrs*	**37hrs**	*47hrs*
Average Age	**53yrs**	*46yrs*	**52yrs**	*41yrs*	**50yrs**	*44yrs*	**53yrs**	*38yrs*
Percent Owing Aircraft	**59%**	*41%*	**51%**	*44%*	**47%**	*32%*	**53%**	*19%*
Percent Female	**n/a**	*14%*	**n/a**	*17%*	**n/a**	*12%*	**n/a**	*4%*
Mean Terrain Experience								
Route 1 - Overwater	**2.29**	*n/a*	**2.93**	*n/a*	**2.80**	*n/a*	**3.01**	*n/a*
Route 2 - Flatland	**4.26**	*3.49*	**4.26**	*3.65*	**4.49**	*3.50*	**4.53**	*3.41*
Route 3 - Mountainous	**3.43**	*n/a*	**3.61**	*n/a*	**3.27**	*n/a*	**3.59**	*n/a*
Mean Precipitation Experience								
Light Rain	**3.65**	*2.11*	**3.99**	*2.50*	**4.01**	*2.62*	**4.00**	*2.41*
Moderate Rain	**3.00**	*1.27*	**3.32**	*1.71*	**3.44**	*1.79*	**3.49**	*1.63*
Heavy Snow	**1.83**	*0.38*	**1.96**	*0.33*	**2.21**	*0.38*	**2.32**	*0.67*
Mean Visibility Experience								
1 NM	**2.83**	*1.38*	**3.17**	*1.79*	**3.18**	*1.62*	**3.26**	*1.85*
4 NM	**3.67**	*2.24*	**4.14**	*2.92*	**4.34**	*2.74*	**4.31**	*3.00*
8 NM	**4.38**	*3.30*	**4.69**	*3.77*	**4.76**	*3.38*	**4.86**	*3.70*
Mean Ceiling Experience								
800 ft	**2.73**	*1.62*	**3.18**	*1.75*	**3.17**	*1.65*	**3.25**	*1.78*
1800 ft	**3.63**	*2.46*	**4.10**	*3.13*	**4.10**	*2.88*	**4.16**	*2.93*
4000 ft	**4.52**	*3.38*	**4.74**	*3.81*	**4.85**	*3.56*	**4.86**	*3.67*
Percent Using Weather Source								
FAA/FSS	**56%**	*68%*	**53%**	*66%*	**61%**	*74%*	**60%**	*56%*
DUAT	**32%**	*n/a*	**28%**	*n/a*	**26%**	*n/a*	**23%**	*n/a*
TV/Radio	**50%**	*26%*	**34%**	*32%*	**45%**	*33%*	**37%**	*35%*
Other	**17%**	*13%*	**14%**	*12%*	**18%**	*10%*	**13%**	*7%*
Percent Certificates Held								
PP	**43%**	*70%*	**33%**	*58%*	**30%**	*53%*	**30%**	*56%*
COM	**39%**	*24%*	**38%**	*37%*	**47%**	*32%*	**50%**	*22%*
ATP	**10%**	*n/a*	**28%**	*n/a*	**19%**	*n/a*	**18%**	*n/a*
Other	**8%**	*n/a*	**1%**	*n/a*	**3%**	*n/a*	**2%**	*n/a*
Multi-Engine Rating	**33%**	*n/a*	**51%**	*n/a*	**49%**	*n/a*	**53%**	*n/a*
CFI/CFII	**27%**	*16%*	**33%**	*21%*	**34%**	*21%*	**37%**	*26%*
Instrument Rating	**67%**	*n/a*	**81%**	*38%*	**83%**	*n/a*	**73%**	*n/a*
Percent Flying								
Job-employed as a pilot	**6%**	*3%*	**21%**	*17%*	**24%**	*21%*	**19%**	*23%*
Average Number FAA Safety Seminars Attended	**1.49**	*n/a*	**2.11**	*n/a*	**1.66**	*n/a*	**1.66**	*n/a*
Lowest Ceiling for Day VFR Trip	**2718ft**	*n/a*	**2490ft**	*n/a*	**1979ft**	*n/a*	**1863ft**	*n/a*
Average R^2		*0.58*		*0.77*		*0.79*		*0.50*

Table 24. Regional and South Texas Demographics

ROUTE 3 MOUNTAINOUS								
MEAN COMFORT LEVEL	**21.61**	*17*	**35.57**	*29*	**40.71**	*36*	**53.72**	*46*
NUMBER OF CASES (303/136)	**94**	*36*	**78**	*69*	**63**	*14*	**68**	*31*
BACKGROUND VARIABLE	**M-1**	***GP 4***	**M-2**	***GP 2***	**M-3**	***GP 1***	**M-4**	***GP 3***
Flying History								
Total Hours	**3013hrs**	*2140hrs*	**3605hrs**	*1963hrs*	**3246hrs**	*1969hrs*	**3801hrs**	*561hrs*
Last 90 Days	**30hrs**	*21hrs*	**47hrs**	*49hrs*	**33hrs**	*47hrs*	**32hrs**	*34hrs*
Average Age	**53 yrs**	*48yrs*	**51 yrs**	*41yrs*	**51 yrs**	*51yrs*	**53 yrs**	*34yrs*
Percent Owing Aircraft	**56%**	*44%*	**60%**	*39%*	**46%**	*43%*	**43%**	*16%*
Percent Female	**n/a**	*25%*	**n/a**	*10%*	**n/a**	*7%*	**n/a**	*6%*
Mean Terrain Experience								
Route 1 - Overwater	**2.68**	*n/a*	**2.94**	*n/a*	**2.97**	*n/a*	**2.68**	*n/a*
Route 2 - Flatland	**4.40**	*n/a*	**4.45**	*n/a*	**4.45**	*n/a*	**4.36**	*n/a*
Route 3 - Mountainous	**3.46**	*1.36*	**3.46**	*1.58*	**3.37**	*1.57*	**3.55**	*1.10*
Mean Precipitation Experience								
Light Rain	**3.83**	*2.31*	**4.04**	*2.59*	**3.97**	*2.50*	**3.95**	*2.10*
Moderate Rain	**3.24**	*1.42*	**3.39**	*1.81*	**3.35**	*2.00*	**3.47**	*1.19*
Heavy Snow	**2.09**	*0.58*	**2.01**	*0.43*	**2.06**	*0.36*	**2.32**	*0.19*
Mean Visibility Experience								
4 NM	**2.94**	*1.39*	**3.20**	*1.90*	**3.34**	*1.86*	**3.14**	*1.35*
1 NM	**3.99**	*2.25*	**4.22**	*2.94*	**4.32**	*3.14*	**4.29**	*2.61*
8 NM	**4.58**	*3.28*	**4.68**	*3.72*	**4.86**	*3.57*	**4.83**	*3.55*
Mean Ceiling Experience								
800 ft	**2.99**	*1.58*	**3.20**	*1.84*	**3.11**	*2.43*	**3.18**	*1.19*
1800 ft	**3.96**	*2.50*	**4.01**	*3.10*	**4.03**	*3.50*	**4.20**	*2.52*
4000 ft	**4.70**	*3.28*	**4.74**	*3.77*	**4.87**	*3.86*	**4.83**	*3.58*
Percent Using Weather Source								
FAA/FSS	**54%**	*64%*	**61%**	*68%*	**53%**	*58%*	**62%**	*69%*
DUAT	**31%**	*n/a*	**29%**	*n/a*	**24%**	*n/a*	**19%**	*n/a*
TV/Radio	**45%**	*35%*	**39%**	*32%*	**42%**	*24%*	**32%**	*28%*
Other	**16%**	*17%*	**13%**	*1%*	**18%**	*7%*	**13%**	*5%*
Percent Certificates Held								
PP	**37%**	*61%*	**27%**	*59%*	**37%**	*36%*	**31%**	*68%*
COM	**43%**	*33%*	**50%**	*33%*	**44%**	*36%*	**41%**	*16%*
ATP	**19%**	*n/a*	**18%**	*n/a*	**19%**	*n/a*	**22%**	*n/a*
Other	**1%**	*n/a*	**5%**	*n/a*	**0%**	*n/a*	**6%**	*n/a*
Multi-Engine Rating	**41%**	*n/a*	**47%**	*n/a*	**49%**	*n/a*	**59%**	*n/a*
CFI/CFII	**29%**	*19%*	**38%**	*22%*	**33%**	*29%*	**38%**	*16%*
Instrument Rating	**76%**	*n/a*	**83%**	*36%*	**79%**	*n/a*	**69%**	*50%*
Percent Flying								
Job-employed as a pilot	**14%**	*5%*	**22%**	*22%*	**21%**	*18%*	**21%**	*12%*
Average Number	**1.62**	*n/a*	**1.90**	*n/a*	**1.86**	*n/a*	**1.41**	*n/a*
FAA Safety Seminars Attended								
Lowest Ceiling for Day VFR Trip	**2323ft**	*n/a*	**2164ft**	*n/a*	**2051ft**	*n/a*	**2063ft**	*n/a*
Average R^2		*0.60*		*0.80*		*0.83*		*0.75*

Table 25. Comparison of Compensatory and Non-Compensatory Models

Model	**Correlation**					
	Over-water		Non-Mountainous		Mountainous	
	S. Tex.	Regions	S. Texas	Regions	S. Tex.	Regions
Compensatory Models						
A+B+C (Additive)	0.83	0.80	0.94	0.92	0.93	0.92
A*B*C (Multiplicative)	0.89	0.86	0.96	0.94	0.96	0.95
A*B (Multiplicative)	0.65	0.62	0.86	0.89	0.84	0.85
A*C (Multiplicative)	0.79	0.74	0.76	0.73	0.82	0.83
B*C (Multiplicative)	0.73	0.72	0.79	0.76	0.86	0.83
Worst Factor Models						
Worst Factor (X>5.0)	0.54	0.59	0.69	0.74	0.71	0.73
Worst Factor (X>4.5)	0.78	0.85	0.80	0.85	0.82	0.86
Worst Factor (X>4.0)	0.74	0.83	0.76	0.82	0.79	0.83
Non-Compensatory Models						
A	0.46	0.43	0.48	0.50	0.53	0.56
A (X>5.0)	0.46	0.44	0.44	0.47	0.55	0.60
A (X>4.5)	0.35	0.41	0.38	0.45	0.42	0.48
A (X>4.0)	0.35	0.41	0.38	0.45	0.42	0.48
B	0.48	0.50	0.67	0.69	0.62	0.59
B (X>5.0)	0.41	0.43	0.56	0.59	0.53	0.50
B (X>4.5)	0.46	0.53	0.62	0.66	0.46	0.45
B (X>4.0)	0.46	0.53	0.62	0.66	0.46	0.45
C	0.62	0.58	0.60	0.52	0.73	0.72
C (X>5.0)	0.57	0.53	0.60	0.57	0.67	0.68
C (X>4.5)	0.50	0.49	0.53	0.52	0.56	0.58
C (X>4.0)	0.41	0.42	0.35	0.30	0.56	0.57

APPENDIX A

Software and Analysis

Data analysis for this project was accomplished on a Unisys 1100 series mainframe computer at the Human Resources Directorate of the USAF Armstrong Laboratory (AL/HR) and on the IBM RS-6000 RISC model 530 machine at the Metrica facility. All software used was developed by and is the property of the USAF Armstrong Laboratory, Brooks AFB, San Antonio, Texas. More specifically, in addition to utility and custom software required to reformat input files, data analysis was carried out using software packages described in the Mathematical and Statistical Library of the Armstrong Laboratory. This library is reviewed in Albert, W. G. & Whitehead, L. K., MATHEMATICAL AND STATISTICAL SOFTWARE INDEX: SECOND EDITION (AFHRL-TP-85-47, August 1986). This index provides a brief description of each package and external references when available. Detailed program documentation is only available on the Unisys under their "@DA*DA.ADOC" retrieval system.

(AL/HR internet address: "http://www.brooks.af.mil/HSC/AL/HR/hr-home.html")

The Unisys 1100 is scheduled for shut-down and replacement in October 1997 by an IBM RISC machine at AL/HR which is already in operation, but not yet accessible to outside users. It is unknown to this contractor as to which Unisys-resident programs are being converted for operation on the RISC platform and which will be "lost". Metrica has already produced the RISC-based version of ASCII CODAP.

This project used the following packages in this order: TRICOR (Correlation and Regression Package, Albert & Whitehead, 1986, p 23), GEN-HIER-GRP (Generate HIER-GRP input data, Albert & Whitehead, 1986, p 10), HIER-GRP (Regression Equation Grouping, Albert & Whitehead, 1986, p 11), GRPREL (Group Reliability, Staley & Weissmuller, 1981), and the ASCII CODAP system (the Comprehensive Occupational Data Analysis Programs, Albert & Whitehead, 1986, p 53). A description of each package and its applicability to this project is provided below.

TRICOR

The first package used was TRICOR which stands for Triangular Correlation & Regression system. This system was developed by the United States Air Force Human Resources Laboratory (AFHRL) which is now known as the Human Resource Directorate of the USAF Armstrong Laboratory. This system can handle up to 400 variables in correlation matrices and regression analysis problems. Its matrix-inversion (exact solution) method accounts for its speed in processing hundreds of queued regression problems while screening-out linear dependencies while could lead to spuriously high results. In addition to hard-copy reports, TRICOR produces a Regression Master File which tracks every problem submitted to the system. This Regression Master File is input to the following program which extracts all the required statistics without error-prone human transcription.

In this research stream, "rater policy" is defined in terms of "level of comfort" associated with flying into a given weather scenario and the "worth functions" the pilot gives to the weather attributes being varied in this study which are ceiling, visibility, and precipitation. In statistical terms, the "level of comfort" is the criterion being predicted in the regression equation and the "worth functions" are the regression weights being computed for each of the predictors of ceiling, visibility, and precipitation.

In judging their own personal comfort level, some people may evaluate the weather factors in the proposed scenarios in different ways. Some people may look at each of the weather variables in turn, one at a time, like ceiling, then visibility, then precipitation. Other pilots may consider those factors in pairs, or all three simultaneously. For example, a given pilot may view ceiling AND visibility as a single factor which means if either is bad, he or she will not fly, regardless of the other value. These interaction forms introduce a non-compensatory notion into normal linear forms which permit multiple "high" variables to overwhelm a lone "low" variable. The regression model used in this project had to be expanded to include all "likely interactions." This means that the regression model used was robust enough to capture not only simple (compensatory), one-factor policies, but also, two-, three- (non-compensatory), or hybrid policies. The individual pilot's data is evaluated in terms of all possible models and the "best fit" becomes the policy ascribed to that pilot.

Because the goal was to determine pilot policy under each of three terrains, the TRICOR correlations and regressions were run for each of the three terrain scenarios, each with about three hundred cases. Each of the TRICOR Master Regression Files was submitted separately to the following GEN-HIER-GRP, HIER-GRP, and CODAP analyses.

GRPREL

GRPREL is the standard interrater reliability in the CODAP system. For a given list of items rated by a set of Subject Matter Experts (SMEs), this program reports two measures of interrater agreement (R_{11} and R_{kk}). The R_{11} value indicates the reliability of the observed set of ratings — while 0.10 is considered a minimum for usable rater agreement (lower values or negative values indicate the presence of deviant raters — typically those who are using a reversed rating scale), a value of 0.20 or greater is desired. The R_{kk} value is driven by the number of raters actually used. Although an R_{kk} of 0.90 is usually desired, it may not be practical in a particular study because of a small number of raters (SMEs) that may be subdivided even further into smaller groups based on policy differences. The GRPREL program also computes means and standard deviations for each item in the list. Item-level reports are printed in three orders: original sequence, ordered descending y-mean value, and ordered descending on standard deviation. GRPREL computes each rater's correlation with the full-group mean vector and uses a probability evaluation to recommend the removal of deviant (non-cooperative or reversed scale) raters. The program can automatically iterate and remove flagged raters until either a sufficienct level of agreement ($R_{kk} = 0.90$) is reached or no raters can be found with a probability (of deviant rating) above 0.95.

GEN-HIER-GRP

Because of the complexity and magnitude of the data required by the HIER-GRP program below, another program, GEN-HIER-GRP was created to mechanicaly reformat data from regression packages into the form required by HIER-GRP. While the Albert et al reference indicates that GEN-HIER-GRP only accepts a TRICOR Regression Master File as input, personal communication with Janice Buchhorn of AL/HR indicates the program MAY have been modified to accept matrix information as output by SPSS. Note that the documentation indicates the software is limited to 200 cases. Metrica provided Ms. Buchhorn the source code updates to increase this limit to 400 cases to accommodate this project.

HIER-GRP

Given the regression analysis conducted above (determination of regression weights and "constant"), HIER-GRP performs a hierarchical clustering which begins with individuals (i.e., their policy/regression equation) and iteratively forms larger and larger policy groups until a single group remains. At each stage of the process, the two most similar people (or groups) are combined into a single, group policy equation. Two people are considered "most similar" if the mathematics shows that (at that stage of the process) combining those two people loses the least amount of predictive efficiency, i.e., losses are minimized compared to all other alternative pairings. By studying diagrams of the clustering stages, it can clearly be seen when fairly large groups are being "forced" together by the precipitous drop in the amount of variance accounted for (i.e., the R^2 value.) Note that the documentation indicates the software is limited to 200 cases. Metrica provided the source code updates to increase this limit to 400 cases to accommodate this project.

HIER-GRP was run once for each terrain scenario. While HIER-GRP provided a text-output report identifying "significantly different" branches within each terrain, the cluster solution data for each terrain was reformatted for display in CODAP below.

CODAP

CODAP stands for the Comprehensive Occupational Data Analysis Programs and represents over 100 programs designed to input, process, organize and report job-related data. CODAP includes procedures for clustering jobs into structured job families, performing interrater reliability assessments on expert raters, comparing and reporting job descriptions for selected groups, reporting within-group frequency distributions for selected variables as well as statistical comparisons between groups. Note that the reference, Albert & Whitehead is outdated and program names have changed. For current program names and information, access the internet URL "http://metricanet.com/groups/codap".

For the remainder of this project, the primary data processing was moved to the RISC machine for processing with the RISC version of CODAP. Only the experimental versions of VARSUM and CONHGP (explained below) were run on the Unisys after this point. Data were loaded into a CODAP data base using AUDITR, INPSTD, and AUDITD (one for each terrain). The interrater reliability program (GRPREL) was run on each of the terrain samples. The reliability levels were very high indicating a strong consensus in prioritizing the 27 weather scenarios from "good" to "bad". Note that while pilots agreed on how to prioritize the weather scenarios, they still could have arrived at those decisions along different lines and have different personal comfort level about entering those conditions.

To address the components of their personal policies, the cluster solution from HIER-GRP was converted to a CODAP cluster solution file using CONHGP (not documented on the internet). For each cluster solution the CODAP DIAGRM program was run to display a summary of the clustering. Analyzing the DIAGRM lead to the identification of four policy groups for each of the three terrains. Summary variables such as "average comfort level" and "group membership" were computed and added to the data base using VARGEN. The people in "stages of interest" on the DIAGRM were identified using the STGJOB program while demographic groups (based on FAA region) were identified using the MEMSEL program. Once identified by either method, the interrater reliability program (GRPREL) was run to assess agreement as well as to produce a mean vector of ratings from the group. Each mean vector was shown in graphic form using PLTTSK (a derivative of PLTVAL). These mean vectors were input to FACMAT to produce an intercorrelation matrix showing how close the results of the policies are in prioritizing the weather scenarios. In addition, for each group identified, demographics were reported and cross-compared using the VARSUM (experimental version with t-tests) program.

Availability Notes

TRICOR:

While the TRICOR system may be replaced by any reasonable correlation and regression package (1 criterion, 7 predictors), reformatting outputs for HIER-GRP may be tedious.

GEN-HIER-GRP & HIER-GRP:

No known substitute is available for the (GEN-HIER-GRP & HIER-GRP) programs. Much of the underlying math and all known references are contained in Ward, J. H. Jr, Treat, B. R., & Albert, W. G. GENERAL APPLICATIONS OF HIERARCHICAL GROUPING USING THE HIER-GRP COMPUTER PROGRAM. (AFHRL-TP-84-42).

CODAP:

While Metrica maintains ASCII CODAP for the Air Force, all release authorizations must go through the Air Force. Coordinating the release of ASCII CODAP from the Air Force should start by contacting the USAF AETC Occupational Measurement Squadron at Randolph AFB (OMSq). OMSq personnel are the operational users of CODAP in the Air Force and underwrote the conversion from the Unisys to the RISC platform. Their home page is "http://www.omsq.af.mil/omy_pl.htm".

Other versions of the CODAP system have been programmed over the years and include versions known as IBM 7040, IBM 360/370, Univac/Sperry/Unisys 1100, CDC 6600, CODAP 80, IBM MVS, IBM VM, IBM RISC and atCODAP. The only systems known to be available at the present time include the government-owned ASCII CODAP family (Unisys 1100, IBM MVS, and RISC CODAP) and the commercial, pc-based product atCODAP from Sensible Systems, Inc., also in San Antonio, Texas.

APPENDIX B

PILOT INFORMATION FORM

The aeronautical charts used in this study were identical to those used in the previous study (Driskill et al., 1997); therefore, they have not been reproduced here.

U.S. Department
of Transportation

**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

Dear Airman:

I need your help. I am conducting a study of how pilots like you use weather information in making decisions. As you probably know, weather is a significant factor in a very large number of aviation accidents every year. The results of this study will help us develop new and more effective training programs to improve safety.

This study examines how pilots use information on ceiling, visibility, and precipitation in their flight planning. It also examines how terrain influences the pilot's use of those weather data. Briefly, the study asks you to rank order various combinations of these weather factors from most to least comfortable and to then assign specific numerical ratings to each weather scenario. This process is repeated for three routes over widely different terrain. When we ran this study with some local pilots it took them about an hour to complete the exercise.

This is not an easy exercise. You will really have to think about just what conditions you would rather fly under, and what factors are most important to you in making weather decisions. However, the more we learn about this decision making process, the safer we can make flying for everyone, so I hope you will take the time to complete the materials and send them back to me. If you have any questions you can reach me at (202) 366-6935.

Sincerely,

David R. Hunter, Ph.D.
Program Scientist

YOUR PARTICIPATION IS VOLUNTARY. If you do not wish to participate, simply discard these materials. If you decide to participate, your responses will remain anonymous. There are no codes or other identifying marks on the materials you are asked to complete and return to us that would identify you personally.

This data collection is covered under OMB Approval Number 2120-0587

INSTRUCTIONS

First. let me make it clear that we are not asking whether or not you would actually make the flights described in these scenarios. Some pilots, for example, would never fly a single-engine aircraft across Lake Michigan, regardless of the weather conditions. For this study, it does not matter whether or not you would make a particular flight. What is important is how you think the various scenarios compare against each other. In other words, if you were flying along the routes shown, which weather combination would you most like to fly in and which would be your last choice. (By the way, those are usually the easy combinations to pick out. The going gets much tougher when deciding on all the in-between combinations.)

Since you may never have flown over water long distances or through high mountain areas or through some of the weather conditions, you may have to use your imagination and think about what flying those routes under those conditions might be like. For a few of the weather combinations (such as heavy snow and five miles visibility), you may also have to use your imagination, since such a combination may be somewhat unlikely.

Remember, there are no right or wrong answers. We are not trying to trick you into admitting you would fly under illegal conditions. We just want to know how you think these combinations of weather rate, and how comfortable you would be flying through them.

1. Look at the Map for Route 1. It shows a flight from the City County Airport across Lake Michigan to the Delta County Airport in Escanaba, Michigan. Familiarize yourself with this route of flight and read the information about your aircraft and the departure and destination weather printed in the insert box on the map.

2. Look at the response sheet for Route 1 which shows the Enroute Weather. You will see that a weak cold front is across your route of flight and that several combinations of reported ceilings, visibility and precipitation are given. For example, in the row for Scenario 101, the ceiling is reported to be 4,000 feet, the visibility is 7 miles, and moderate rain has been reported.

3.1 **Your first task** is to decide under which set of conditions you would be **most comfortable** flying this particular route. Look carefully over all the combinations of ceiling, visibility, and precipitation and find the combination under which you would be most comfortable flying. When you have found that combination, **write the number 1 in the box headed Rank Order** for that combination.

INSTRUCTIONS - Page 2

3.2 As you fill in the boxes on the forms, please print the numbers clearly. If there are two boxes for a particular answer (like there are for the Rank Order responses) and you want to enter a single number (for instance, you want to enter the number 1 for your most comfortable set of conditions) be sure to put that number in the box on the right.

Example: Your entry for Rank Order 1 would be: ☐☐

Your entry for Rank Order 15 would be: ☐☐

Note that you **do not** need to fill in the leading boxes with zeros.

3.3 Now look over the remaining combinations of ceiling, visibility and precipitation and find the combination under which you would be most comfortable flying from those remaining. Once you have found it, write the number 2 in the box headed Rank Order for that combination.

3.4 Then just keep on narrowing the list of combinations down by finding the combination from among those remaining under which you are most comfortable and marking that combination with the next number. Finally, you will end up with only one combination left, and that will be the combination under which you would be least comfortable flying. If you have done the numbering properly, that combination will get numbered 27.

3.5 At this point you should have gone through all the combinations and rank ordered them in terms of your comfort so that the combination you are **most comfortable** with is numbered **1** and the combination you are **least comfortable** with is numbered **27**. All the other combinations will have some number between those two values, and no value will appear more than once. That is, you can't use the same rank number on more than one combination.

3.6 Now, look back at the various weather combinations and decide which combination is the **WORST COMBINATION** under which you would continue the flight. That is, if any of the three factors (ceiling, visibility, or precipitation) got any worse, then you would not continue the flight and would divert. Once you have decided which is the worst combination in which you would still fly, write the **SCENARIO NUMBER** of that combination in the box marked **WORST FLYABLE SCENARIO**. If you would not make this flight under any of the combinations we have given, then enter "**0 0 0**" in the box marked **WORST FLYABLE SCENARIO**.

INSTRUCTIONS -- Page 3

4.1 **Your second task** is to assign a **level of comfort** to each individual scenario using a scale from 1 to 100, where:

1 = **Most Comfortable** about completing the flight VFR under these enroute weather and terrain conditions.

100 = **Least Comfortable** about completing the flight VFR under the enroute weather and terrain conditions.

4.2 Use any numbers in the range from 1 to 100 to indicate your level of comfort, but you **May Not** use the same number more than once. If, for instance, you feel that two choices are both "least comfortable" then rate one as "99" and the other as "100".

5.1 After you have rank ordered all the weather scenarios for Route 1 and have assigned a comfort rating to each scenario for that route, **do the same thing for Route 2 and Route 3.**

5.2 Beginning with Route 2, review the map and read the information on the map. Then rank order each of the combinations of weather conditions. After you have completed the rank ordering, decide on the worst flyable scenario, then assign a comfort rating to each combination, again using the 1 to 100 scale.

5.3 After you have completed Route 2, go on to Route 3 and repeat the rank ordering and comfort rating process for that route.

6.1 To help in the analysis of the weather ratings, we need some information about you (for example, your age), your aviation ratings and experiences, and what area of the country you live in (we get that from the Zip code), so please **complete the sheet labeled Pilot Background Data**. Do not put your name or other identifying information on the sheet.

6.2 If you have any comments or suggestions, please feel free to write them on a separate sheet of paper and send it back to us.

7.1 **Put the three Weather Information Study sheets** on which you have written your rank order and comfort ratings and the **Pilot Background Data Sheet** in the **self-addressed business reply envelope** and drop it in the mail. No postage is required.

That's all.

Thank you for taking the time to help me on this project. If you would like information on the results of this study, just send me a note with your name and address (don't put them on your answer sheets) and I will send you a copy of the report.

Weather Information Study
Route 1 - City County to Delta County

Scenario Number	Ceiling (feet)	Visibility (miles)	Precipitation	Rank Order	Comfort Level
101	4,000	7	moderate rain		
102	5,000	1.5	light rain		
103	4,000	4	none		
104	5,000	8+	none		
105	2,000	3	none		
106	1,800	3	heavy rain		
107	1,800	7	light snow		
108	3,500	1	heavy rain		
109	900	1.5	moderate rain		
110	1,800	7	moderate rain		
111	800	1.5	none		
112	1,600	8	none		
113	1,600	3	heavy snow		

ENROUTE WEATHER: A weak cold front has stalled along a line from Sturgeon Bay to Namistique. The reported ceilings, visibility, and precipitation are given above.

Draft

Scenario Number	Ceiling (feet)	Visibility (miles)	Precipitation	Rank Order	Comfort Level
114	4,000	5	light snow		
115	900	0.5	heavy snow		
116	1,600	1.5	heavy rain		
117	5,000	0.5	moderate rain		
118	600	8	moderate rain		
119	600	7	none		
120	1,600	1.5	moderate snow		
121	5,000	8+	freezing rain		
122	900	5	none		
123	800	4	moderate rain		
124	1,600	4	moderate snow		
125	1,800	5	moderate rain		
126	1,800	0.5	none		
127	900	4	heavy rain		

WORST FLYABLE SCENARIO ☐☐☐

For office use only

Scan Code: ☐☐☐☐☐ 1

Weather Information Study
Route 2 - Hereford Airport to Dalhart Airport

Scenario Number	Ceiling (feet)	Visibility (miles)	Precipitation	Rank Order	Comfort Level
201	5,000	8	light snow		
202	4,000	1	light rain		
203	1,600	3	heavy snow		
204	4,000	3	light rain		
205	2,000	7	light snow		
206	4,000	8+	light rain		
207	3,500	0.5	heavy rain		
208	1,800	0.5	moderate snow		
209	600	0.5	light snow		
210	1,800	4	none		
211	800	8+	light snow		
212	800	8	none		
213	1,800	5	moderate rain		

ENROUTE WEATHER: A weak cold front has stalled along a line running west from Amarillo into New Mexico. The reported ceilings, visibility, and precipitation are given above.

Draft

Scenario Number	Ceiling (feet)	Visibility (miles)	Precipitation	Rank Order	Comfort Level
214	600	8	moderate rain		
215	900	4	heavy rain		
216	5,000	1.5	moderate rain		
217	1,800	7	moderate rain		
218	900	5	light snow		
219	900	0.5	heavy rain		
220	2,000	1.5	none		
221	1,800	3	heavy rain		
222	2,000	0.5	freezing rain		
223	1,600	4	moderate snow		
224	800	3	none		
225	900	1.5	light rain		
226	2,000	8+	light rain		
227	4,000	5	light snow		

WORST FLYABLE SCENARIO ☐☐☐

For office use only

Scan Code: ☐☐☐☐☐ 2

OMB Approval Number 2120-0587

Weather Information Study
Route 3 - Las Vegas Airport to San Juan Pueblo Airport

Scenario Number	Ceiling (feet)	Visibility (miles)	Precipitation	Rank Order	Comfort Level
301	5,000	5	none	☐☐	☐☐☐
302	600	5	freezing rain	☐☐	☐☐☐
303	3,500	8	moderat rain	☐☐	☐☐☐
304	900	1	heavy snow	☐☐	☐☐☐
305	2,000	0.5	moderate rain	☐☐	☐☐☐
306	900	4	heavy rain	☐☐	☐☐☐
307	4,000	8+	none	☐☐	☐☐☐
308	600	3	moderate snow	☐☐	☐☐☐
309	1,800	7	moderate rain	☐☐	☐☐☐
310	800	1	none	☐☐	☐☐☐
311	4,000	0.5	heavy snow	☐☐	☐☐☐
312	600	1	moderate snow	☐☐	☐☐☐
313	4,000	4	light snow	☐☐	☐☐☐

Draft

ENROUTE WEATHER: A weak cold front has stalled along a line running from Santa Fe northest into Colorado. The reported ceilings, visibility, and precipitation are given above.

Scenario Number	Ceiling (feet)	Visibility (miles)	Precipitation	Rank Order	Comfort Level
314	3,500	1	light snow	☐☐	☐☐☐
315	1,600	3	heavy rain	☐☐	☐☐☐
316	2,000	8+	light rain	☐☐	☐☐☐
317	2,000	1.5	none	☐☐	☐☐☐
318	1,600	1	freezing rain	☐☐	☐☐☐
319	600	8	moderate rain	☐☐	☐☐☐
320	3,500	3	freezing rain	☐☐	☐☐☐
321	2,000	5	light snow	☐☐	☐☐☐
322	900	5	light rain	☐☐	☐☐☐
323	900	8	light rain	☐☐	☐☐☐
324	1,600	3	heavy snow	☐☐	☐☐☐
325	2,000	4	none	☐☐	☐☐☐
326	5,000	1.5	light rain	☐☐	☐☐☐
327	1,800	5	moderate rain	☐☐	☐☐☐

WORST FLYABLE SCENARIO ☐☐☐

For office use only

Scan Code: ☐☐☐☐☐ 3

OMB Approval Number 2120-0587

Weather Information Study
Pilot Background Data

What is your highest pilot certificate

○ Private ○ Commercial ○ Airline Transport

Do you have an instrument rating?	○ No	○ Yes
Do you have a multi-engine rating?	○ No	○ Yes
Are you primarily employed as a pilot?	○ No	○ Yes
Do you hold a CFI or CFII certificate?	○ No	○ Yes
Do you own your own aircraft, either by yourself or as a member of a partnership?	○ No	○ Yes

How many FAA-sponsored Safety Seminars have you attended in the last 24 months?

What is the lowest ceiling under which you would start a cross-country day VFR trip from your local airport? feet

What is your age?

What is your home zip code?

How many hours have you logged in the last 90 days?

How many Total Hours have you logged?

What percent of the time do you obtain weather information for flight planning from each of these sources?

FAA/FSS % DUAT %

TV/Radio % Other %

Draft

Please indicate how often during your flying experiences you have flown under these or highly similar circumstances?

NEVER	ONCE or TWICE	SEVERAL TIMES	MANY TIMES	NUMEROUS TIMES	
○	○	○	○	○	Over a large body of water similar to that in ROUTE 1
○	○	○	○	○	Over non-mountainous terrain similar to that in ROUTE 2
○	○	○	○	○	Over mountainous terrain similar to that in ROUTE 3
○	○	○	○	○	Light Rain
○	○	○	○	○	Moderate Rain
○	○	○	○	○	Heavy Snow
○	○	○	○	○	Visibility 1 mile
○	○	○	○	○	Visibility 4 miles
○	○	○	○	○	Visibility 8 miles
○	○	○	○	○	Ceiling 800 feet
○	○	○	○	○	Ceiling 1,800 feet
○	○	○	○	○	Ceiling 4,000 feet

Thank you for your help.

Please return these four answer sheets in the self-addressed business reply envelope.

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Scan Code: 4

OMB Approval Number 2120-0587

APPENDIX C

Regression Models

Predicting Policy-Related Metrics from Demographics

Regression Model 1:
Predicting (C0011) Average Comfort Level

```
 r = 0.39471
RSq = 0.15580
```

Note: "ZOC" stands for Zero-Order Correlation with ...

```
Variable ID (Predictor)
|    ZOC with Comfort Level
|    |    ZOC with Person's RSq - Degree Expert Info was used)
|    |    |    Unique Variance Accounted for by this Variable
|    |    |    |    Variable Description (Predictor)
|    |    |    |    |
VAR  w/C0011 w/RSQ1  Unique |
|    |    |    |    |
V0025  .1905      .020353 EXPERIENCE - VISIBILITY 4 MILES
V0009 -.1848      .017303 LOWEST CEILING FOR DAY VFR TRIP
C0023 -.1409      .023269 ROUTE 3 (MOUNTAIN)
V0026  .1250      .001216 EXPERIENCE - VISIBILITY 8 MILES
C0015  .1235      .016317 ALASKA REGION
V0004  .1144      .017114 MULTI-ENGINE RATING (1=YES, 0=NO)
V0014  .1141      .003797 PCT TIME OBTAIN WEATHER INFO - FAA/FSS
V0028  .0949      .004001 EXPERIENCE - CEILING 1800 FEET
V0017 -.0884      .004344 PCT TIME OBTAIN WEATHER INFO - OTHER
V0005  .0701      .002925 EMPLOYED AS A PILOT (1=YES, 0=NO)
C0018  .0612      .007541 WESTERN PACIFIC REGION
C0016  .0609      .001354 SOUTHERN REGION
C0020 -.0557      .001034 EASTERN REGION
V0027  .0524      .002153 EXPERIENCE - CEILING 800 FEET
C0013  .0487      .000873 HIGHEST CERTIFICATE - COMMERCIAL
V0007 -.0399      .001431 OWN AIRCRAFT (1=YES, 0=NO)
C0021  .0210      .002777 ROUTE 1 (WATER)
V0003  .0202      .001264 INSTRUMENT RATING (1=YES, 0=NO)
V0008  .0174      .000893 NUMBER OF FAA SAFETY SEMINARS
V0020 -.0163      .003723 EXPERIENCE - ROUTE 3
```

```
C0014 -.0070        .005119 HIGHEST CERTIFICATE - AIRLINE TRANSPORT
```

Regression Model 2:
Predicting (RSQ1) Person's RSq - Degree Expert Info was used.
(Model without using Comfort Level as a predictor.)

```
 r = 0.38716
RSq = 0.14989
```

Note: "ZOC" stands for Zero-Order Correlation with ...

```
Variable ID (Predictor)
|    ZOC with Comfort Level
|    |    ZOC with Person's RSq - Degree Expert Info was used)
|    |    |    Unique Variance Accounted for by this Variable
|    |    |    |    Variable Description (Predictor)
|    |    |    |    |
VAR  w/C0011 w/RSQ1  Unique |
|    |    |    |    |
C0021       -.2612  .069710 ROUTE 1 (WATER)
V0010       -.0994  .001646 AGE
V0014       -.0988  .006845 PCT TIME OBTAIN WEATHER INFO - FAA/FSS
V0019        .0930  .007995 EXPERIENCE - ROUTE 2
V0026        .0790  .005269 EXPERIENCE - VISIBILITY 8 MILES
C0020        .0759  .000958 EASTERN REGION
C0016       -.0686  .002257 SOUTHERN REGION
C0022        .0659  .005700 ROUTE 2 (FLAT)
C0015        .0624  .003744 ALASKA REGION
C0014        .0618  .009200 HIGHEST CERTIFICATE - AIRLINE TRANSPORT
V0022       -.0612  .006049 EXPERIENCE - MODERATE RAIN
V0024       -.0580  .001329 EXPERIENCE - VISIBILITY 1 MILE
C0013       -.0579  .001243 HIGHEST CERTIFICATE - COMMERCIAL
V0013       -.0525  .003875 TOTAL HOURS LOGGED
C0017       -.0445  .001455 NEW ENGLAND REGION
V0006       -.0429  .004380 CFI OR CFII CERTIFICATE (1=YES, 0=NO)
V0023       -.0416  .000503 EXPERIENCE - HEAVY SNOW
V0012        .0390  .001357 HOURS LOGGED IN LAST 90 DAYS
V0028        .0319  .000603 EXPERIENCE - CEILING 1800 FEET
V0016        .0158  .002992 PCT TIME OBTAIN WEATHER INFO - TV/RADIO
V0021       -.0083  .001260 EXPERIENCE - LIGHT RAIN
```

Regression Model 3:
Predicting (RSQ1) Person's RSq - Degree Expert Info was used.
(Model using Comfort Level as a predictor.)

```
 r = 0.41940
RSq = 0.17590
```

Note: "ZOC" stands for Zero-Order Correlation with ...

```
Variable ID (Predictor)
|   ZOC with Comfort Level
|   |   ZOC with Person's RSq - Degree Expert Info was used)
|   |   |   Unique Variance Accounted for by this Variable
|   |   |   |   Variable Description (Predictor)
|   |   |   |   |
VAR  w/C0011 w/RSQ1   Unique |
|   |   |   |   |
C0021 .0205 -.2612 .060171 ROUTE 1 (WATER)
C0011 1.0000 -.1640 .026108 AVERAGE COMFORT RATING
V0010 -.0103 -.0994 .001723 AGE
V0014 .1038 -.0988 .005004 PCT TIME OBTAIN WEATHER INFO - FAA/FSS
V0019 .0480 .0930 .008659 EXPERIENCE - ROUTE 2
V0026 .1742 .0790 .010557 EXPERIENCE - VISIBILITY 8 MILES
C0020 -.0468 .0759 .004221 EASTERN REGION
C0022 .1189 .0659 .002370 ROUTE 2 (FLAT)
C0015 .1124 .0624 .010397 ALASKA REGION
C0014 -.0175 .0618 .005369 HIGHEST CERTIFICATE - AIRLINE TRANSPORT
V0022 .0899 -.0612 .005670 EXPERIENCE - MODERATE RAIN
C0013 .0635 -.0579 .000598 HIGHEST CERTIFICATE - COMMERCIAL
V0013 .0378 -.0525 .003143 TOTAL HOURS LOGGED
V0006 .0481 -.0429 .005361 CFI OR CFII CERTIFICATE (1=YES, 0=NO)
V0023 .0610 -.0416 .000997 EXPERIENCE - HEAVY SNOW
V0012 .0070 .0390 .001398 HOURS LOGGED IN LAST 90 DAYS
V0027 .0474 -.0341 .001608 EXPERIENCE - CEILING 800 FEET
V0009 -.1898 -.0273 .002502 LOWEST CEILING FOR DAY VFR TRIP
V0016 -.0527 .0158 .002957 PCT TIME OBTAIN WEATHER INFO - TV/RADIO
V0021 .0766 -.0083 .001507 EXPERIENCE - LIGHT RAIN
V0004 .0974 .0058 .001805 MULTI-ENGINE RATING (1=YES, 0=NO)
C0018 .0722 .0045 .003173 WESTERN PACIFIC REGION
C0019 -.0828 -.0009 .001111 NORTHWEST MOUNTAINS REGION
V0020 -.0149 -.0003 .000836 EXPERIENCE - ROUTE 3
```

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