Continued VFR Flight Into IMC: Situational Awareness or Risky Decision Making?

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Introduction

In general aviation (GA) crashes associated with VFR flight into deteriorating weather have been one of the major sources of fatal injury for many years. Latest figures (NTSB, 2002) for U.S general aviation showed 1,714 GA crashes (343 of them fatal) with 576 fatalities. During the same period there were no fatalities aboard scheduled U.S air carriers who flew over 17.5 million flight hours. Maneuvering flight crashes accounted for nearly a third of all fatal pilot-related crashes, with weather-related crashes accounting for 12.4% (AOPA, 2001).

Much has been written about the possible causes and contributing factors for these weather-related fatal crashes and numerous post-hoc ‘explanations’ have been advanced. One such is the popular notion that many of these crashes are due to pilots “pressing-on”. Whilst not a scientific explanation in itself, the “pressing-on” concept contains several empirically testable propositions. The first is the implication that pilots recognize the potentially hazardous nature of the weather conditions but deliberately choose to continue the flight for some reason or other. This is a non-trivial assertion since a perfectly reasonable a-priori alternative would be that pilots fail to recognize and properly identify the nature of the conditions that they are encountering and thus continue the flight without proper awareness of their situation.

Distinguishing between these alternative explanations (risky decision making versus situational awareness) is important not only for scientific reasons but because the appropriate interventions to modify pilot behavior would be quite different in one case than the other. The second implication of the “pressing-on” concept is that there is a relationship between the extent and duration of the flight and the pilot’s decision making process. The lure of “pressing-on” is considered greater when the pilot is in proximity to their goal (i.e. intended destination) and/or has already flown some distance (i.e. has already invested considerable resources of time and money in the flight). The influence of such factors on decision making has been previously described in a body of scientific literature investigating the role of ‘sunk costs’ in decision making.
Sunk costs:

In the original proposal we discussed the substantial body of behavioural decision making research that indicates that people’s decisions can be affected by normatively irrelevant considerations such as the investment of time and/or effort already undertaken. The analysis of air crash data (Study 1) showed that weather-related crashes occurred further away from the departure point, and closer to the intended destination than other types of crashes. This is consistent with the ‘sunk cost’ theory (Arkes & Blumer, 1985). Study 3 was designed to test this hypothesis experimentally by systematically varying the investment of time and effort in the two flights used in Study 2.

The same scud-running (SR) and VFR-on-Top (VOT) flights were used in this study. In Study 2, the critical weather changes occurred after 42nm (SR) and 86nm (VOT). In the revised flights (SR* and VOT*) the critical weather changes were introduced after 86nm (SR*) and 42nm (VOT*). In order to avoid confounding the effects of distance before the critical weather change with distance remaining to the original destination, it was necessary to alter the flights in a second way. The length of the SR flight was increased from 110nm to 156nm so that the distance to destination after the critical weather change remained the same (68 nm in SR and 70 nm in SR*). The length of the VOT flight was reduced from 135nm to 96nm so that the distance to destination after the critical weather change remained the same (53 nm in VOT and 54 nm in SR*). These changes are summarised in Table 1.

<table>
<thead>
<tr>
<th>Scud Running</th>
<th>Study 2</th>
<th>Study 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dep-Weather Change: 42</td>
<td>Dep-Weather Change: 86</td>
</tr>
<tr>
<td></td>
<td>Weather Change-Dest: 68</td>
<td>Weather Change-Dest: 70</td>
</tr>
<tr>
<td>VFR-on-Top</td>
<td>Dep-Weather Change: 82</td>
<td>Dep-Weather Change: 42</td>
</tr>
<tr>
<td></td>
<td>Weather Change-Dest: 53</td>
<td>Weather Change-Dest: 54</td>
</tr>
</tbody>
</table>

Table 1. Summary of distances (in nautical miles) between the departure airport, critical weather change, and original intended destination in the two flight simulator studies.
Figure 1: Profile sketch of the two versions of the VFR-on-Top flight.
Figure 2: Profile sketch of the two versions of the Scud-Running flight
Study 3: Method

Participants:
Qualified pilots were recruited from advertisements placed at two local flight training organizations and in local newspapers. Participants were reimbursed NZ$40 after completing both experimental sessions. Eighteen pilots (15 males, 3 females) were recruited. Fifteen participants held private pilot licences. There were two commercial pilot licence holders and one student pilot. Ages ranged from 19 to 69 years (M = 32.9 yrs, sd = 12.9 yrs). Total flight hours ranged from 27 to 986 (M = 259.5 hrs, sd = 211.6 hrs). Participants were randomly allocated to the GPS or non-GPS group for their flights. There were no significant differences between the groups in terms of age, total flight hours, total cross-country flight hours, hours flown in the last 90 days or cross-country hours flown in the last 90 days.

Although the pilots in Study 3 had more than twice the number of flight hours as pilot in command (164 hrs v 83 hrs) and as pilot-in-command of cross-country flights (71 hrs v 38 hrs) there were no statistically significant differences between the participants in Study 2 and Study 3 in terms of any of the demographic or pilot experience variables.

Simulator:
The same PC-based flight simulator used in Study 2 (Fly!2K, by Terminal Reality, incorporating GroundControl and Sky! by Howintheworld (www.howintheworld.com) and the Flyscripts! v1.2 flight data recorder) was used in Study 3. Additions were made to the flight simulator airport database to ensure the sectional chart and simulator were as similar as possible. The program was enhanced with a scenery generation program called Terrascene2.1 by Todd Klaus. This program uses current USGS DEM (Digital Elevation Map) and LULC (Land Use Land Class) data, and the set of generic scenery textures from the Terminal Reality simulator Fly!II, to make a highly accurate representation of terrain elevation, land use, and major geographical features of any specified area within the continental United States. The fidelity of this scenery allows for VFR navigation with relative ease using standard
aeronautical sectional charts. The aircraft modelled was a Cessna 172 SP built by Rob Young (www.lineone.net/~r.young/) as part of his V88 series of flight model refinements. The performance of the simulated aircraft is very close to the specifications published by Cessna for this aircraft.

The computer was based around an Athlon Thunderbird 1.4Ghz processor with 512 MB DDR266 RAM, NVIDIA GeForce3 64Mb Graphics card, Maxtor 80 GigaByte hard drive and a Soundblaster Live! Sound card. The monitor used was a Philips Brilliance 201B 21” CRT. Pilots interacted with the simulator through a Precision Flight Controls ‘Cirrus’ flight yoke, Hoffman Simped-Vario rudder pedals, a Precision Flight Controls programmable active link (PAL) console and a mouse. The keyboard was used for only two radio functions. The computer was set up in a cubicle to minimise distraction to the pilot.

Since these studies were completed the flight simulation laboratory at the University of Otago has been considerably upgraded (see Appendix A).

Other Materials:

Several questionnaires were used in this study and these can be split into three broad categories: pre-flight, flight, and post-flight.

Pre-flight: Two questionnaires were presented pre-flight comprising of a demographics, flight experience, and opinions questionnaire, and two trait mood measures [the “general” form of the PANAS (Positive and Negative Affect Scales, Watson & Tellegen, 1985), and the Trait form of the STAI (State Trait Anxiety Inventory, Spielberger, 1983)]. The demographics questionnaire was a development of that used in the first flight simulator study (Study 2). The present version also incorporated relevant sections of other questionnaires found to be useful in aviation research.

In-flight: The flight questionnaires were presented at pre-defined points during the experimental flights. The questionnaire used here was a development of that used in the previous flight simulator study. This questionnaire required pilots to answer detailed questions on the current state of the aircraft, location of airfields, terrain, weather, planning,
and option and risk assessment. The current version also incorporated three measures of mood and arousal, the “state” forms of the PANAS and STAI, and the AD-ACL (Activation-Deactivation Adjective Check List, Thayer, 1967, 1989).

*Post-flight:* The post-flight questionnaire was given on the completion of both experimental flights. This questionnaire covered the pilots experiences in using (or not using) the Bendix King KLN89 GPS system modelled on the simulator for navigation. This questionnaire was adapted from the original used by the CAA (NZ) to survey GPS use in New Zealand. Copies of the questionnaire measures used can be found in Appendix B.

*Physiological Measures:*

Heart rates were recorded as a continual trace during flight time from the participant’s right earlobe using an ADInstruments MLT1020 IR Plethysmograph transducer in an ear-clip configuration. The transducer was connected to an ADInstruments Powerlab/4SP, which was controlled by a 128mb Pentium II-based PC running Chart v4.12 software. Time codes were added to the trace by the experimenter using a keyboard. The participant was separated from the physiological measuring equipment by a floor-to-ceiling curtain, and could not see their recording or the interactions of the experimenter.

*Flight Data Recording:*

Flight data were extracted using an add-on utility for Fly! called *Fly!Scripts v1.2.1*, by Anthony Merton. Fly!Scripts allows for the writing of module ‘scripts’ which can enable external programs to control aspects of the flight simulator. It also, for our purposes, allows for these modules to export variables from the simulator into text-based files. For the current study, a script was written which exported the latitude, longitude, altitude fAGL, IAS, and VVI of the aircraft every two seconds.
Summary of Measured Variables

The primary dependent variables are shown in grouped tabular form below.

**Demographics and Flight Experience:**

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>Total Flight Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours as Pilot in Command</td>
<td>Hours as Pilot in Command (Cross Country)</td>
<td>Hours as Pilot in Command (Last 90 Days)</td>
</tr>
<tr>
<td>No of Cross Country flights (Last 90 Days)</td>
<td>Pilot Certification</td>
<td>Time held Certification</td>
</tr>
<tr>
<td>Instrument Rating (Y/N)</td>
<td>Instructors Rating (Y/N)</td>
<td>Ever Diverted due to Weather? (Y/N)</td>
</tr>
</tbody>
</table>

**GPS Experience and Opinions:**

<table>
<thead>
<tr>
<th>Ever Used GPS (Y/N)</th>
<th>Use as Main Navigation aid for VFR</th>
<th>Use as Secondary Navigation aid for VFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes Physical workload</td>
<td>Changes Mental Workload</td>
<td>Changes use of Maps and Charts</td>
</tr>
<tr>
<td>Changes ‘Head-Down’ time</td>
<td>Changes Lookout</td>
<td>Changes Instrument Scan</td>
</tr>
<tr>
<td>Changes Position Awareness</td>
<td>Changes Airspace Awareness</td>
<td>Changes Terrain Awareness</td>
</tr>
<tr>
<td>Changes Situational Awareness</td>
<td>Changes Tracking Accuracy</td>
<td>Changes Frequency of Flying in Marginal Conditions</td>
</tr>
<tr>
<td>GPS Changes (TOTAL)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Usual Aeronautical Practices:**

<table>
<thead>
<tr>
<th>Weather Briefing</th>
<th>Weight &amp; Balance</th>
<th>Expected Fuel Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use a Checklist</td>
<td>File a Flight Plan</td>
<td>Request Weather Updates In-Flight</td>
</tr>
<tr>
<td>Fly VFR above Cloud</td>
<td>Fly at Less than 1000ft agl</td>
<td>Verify Fuel Consumption In-Flight</td>
</tr>
<tr>
<td>UAP (TOTAL)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Personal Minima:**

<table>
<thead>
<tr>
<th>Visibility for Local Flight</th>
<th>Visibility for Cross-Country Flight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling for Local Flight</td>
<td>Ceiling for Cross-Country Flight</td>
</tr>
</tbody>
</table>
**Hazardous Events Scale** (From Hunter, 1995):  
(Study 3 Only)

<table>
<thead>
<tr>
<th>Event</th>
<th>Precautionary Landing on Airfield</th>
<th>Precautionary Landing Off Airfield</th>
<th>Mechanical Failure In-Flight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run Low on Fuel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unintentional Stall</td>
<td>Geographically Disoriented</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine Quit due to Fuel Management</td>
<td>Flown into IMC</td>
<td></td>
<td>Disoriented in IMC</td>
</tr>
<tr>
<td>Turned Back due to Weather</td>
<td>Made Bad Decision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazardous Events Scale (TOTAL)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Opinions about Self**

<table>
<thead>
<tr>
<th>Skill</th>
<th>Judgment</th>
<th>Willingness to Take Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Careful</td>
<td>Cautious</td>
<td>Proficient</td>
</tr>
<tr>
<td>Frequency of Taking Risks</td>
<td>TOTSELF</td>
<td></td>
</tr>
</tbody>
</table>

**Aeronautical Risk Judgment Questionnaire (ARJQ)** (From O’Hare, 1990).

<table>
<thead>
<tr>
<th>Causes of GA Accidents (%)</th>
<th>Phases of Flight (Rank)</th>
<th>Pilot Causal Factors – Self (Rank)</th>
<th>Accident Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Causal Factors</td>
<td>Pilot Causal Factors</td>
<td></td>
<td>Accident Likelihood</td>
</tr>
<tr>
<td>(Rank)</td>
<td>– Self (Rank)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**In-Flight Post Critical Weather Change (Awareness of Current Status)**

<table>
<thead>
<tr>
<th>Flight Time Actual-Estimated-Accuracy</th>
<th>Airspeed Actual-Estimated-Accuracy</th>
<th>Heading Actual-Estimated-Accuracy</th>
<th>Rate of Climb/Descent Actual-Estimated-Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude (AMSL) Actual-Estimated-Accuracy</td>
<td>Altitude (AGL) Actual-Estimated-Accuracy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Remaining Actual-Estimated-Accuracy</td>
<td>Cloud Base (AGL) Actual-Estimated-Accuracy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cloud Tops Actual-Estimated-Accuracy</td>
<td>Visibility Actual-Estimated-Accuracy</td>
<td></td>
<td>OVERALL SA (TOTAL)</td>
</tr>
</tbody>
</table>
### In-Flight Post Critical Weather Change (Importance of Cues)

<table>
<thead>
<tr>
<th></th>
<th>Cloud Base</th>
<th>Horizontal Visibility</th>
<th>Darkened Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud Concentration</td>
<td>Rain Showers</td>
<td>Distance between Cloud Base &amp; Horizon</td>
<td></td>
</tr>
<tr>
<td>Cloud Type</td>
<td>Wind Direction</td>
<td>Wind Velocity</td>
<td></td>
</tr>
<tr>
<td>Proximity of Cloud</td>
<td>Visibility of Surface</td>
<td>Prediction of Change</td>
<td></td>
</tr>
<tr>
<td>Fuel</td>
<td>Terrain</td>
<td>Distance from Departure/Destination</td>
<td></td>
</tr>
<tr>
<td>All Cues (TOTAL)</td>
<td>Weather Cues (TOTAL)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### In-Flight Post Critical Weather Change (Affect)

<table>
<thead>
<tr>
<th></th>
<th>Comfortable (COMF) (Study 3 only)</th>
<th>General Anxiety (CUE16) (Study 3 only)</th>
<th>Specific Anxiety (CUE17) (Study 3 only)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PANAS (Study 3 only)</td>
<td>STAI (State) (Study 3 only)</td>
<td>STAI (Trait) (Study 3 only)</td>
</tr>
<tr>
<td></td>
<td>AD-ACL (Study 3 only)</td>
<td>Heart Rate (Study 3 only)</td>
<td></td>
</tr>
</tbody>
</table>

### In-Flight Post Critical Weather Change (Evaluation of Options)

<table>
<thead>
<tr>
<th></th>
<th>Choice of Option (MPCOA)</th>
<th>Desirability: Continue</th>
<th>Desirability: Precautionary Landing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desirability: Divert</td>
<td></td>
<td>Desirability: Return to Departure</td>
<td>Desirability: Orbit</td>
</tr>
<tr>
<td>Confidence (OCCONF)’</td>
<td></td>
<td>Certainty (COACRT)</td>
<td>Violate VFR? (Y/N)</td>
</tr>
<tr>
<td>Consider Other Options? (Y/N)</td>
<td></td>
<td>Modify Plan? (Y/N)</td>
<td>Other Information? (Y/N)</td>
</tr>
</tbody>
</table>

### In-Flight Post Critical Weather Change (Costs, Benefits & Risks)

<table>
<thead>
<tr>
<th></th>
<th>Continue Benefits</th>
<th>Continue Costs</th>
<th>Continue Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return Benefits</td>
<td>Return Benefits</td>
<td>Return Costs</td>
<td>Return Risks</td>
</tr>
<tr>
<td>Precautionary Lndg Benefits</td>
<td>Precautionary Lndg Benefits</td>
<td>Precautionary Lndg Costs</td>
<td>Precautionary Lndg Risks</td>
</tr>
<tr>
<td>Divert Benefits</td>
<td>Divert Benefits</td>
<td>Divert Costs</td>
<td>Divert Risks</td>
</tr>
<tr>
<td>Orbit Benefits</td>
<td>Orbit Benefits</td>
<td>Orbit Costs</td>
<td>Orbit Risks</td>
</tr>
<tr>
<td>Actual Choice Benefits</td>
<td>Actual Choice Benefits</td>
<td>Actual Choice Costs</td>
<td>Actual Choice Risks</td>
</tr>
</tbody>
</table>
Procedure:

This experiment was run over two sessions. During the first session the pilot was required to sign an informed consent form, complete the demographic questionnaire, and finally undertake a short training flight.

The aim of the training flight was threefold: to familiarise the pilot with the flight characteristics of the Cessna 172 modelled in the simulator, to familiarise the pilot with navigation using the Bendix King KLN 89 GPS system, and to ensure the pilot was comfortable navigating by the sectional charts provided. The flight was approximately 25 n.m. in length and required the pilot to fly between three airports using both the GPS and traditional VFR navigation in clear weather. All controls were described and demonstrated to the pilot before they took over the simulator for the flight. Pilots were encouraged to familiarise themselves with all the aircraft and GPS functions available to them over the course of this flight.

The second session began with the pilot being reminded of the procedure for the experimental flights. Written instructions, a weather report, NOTAMS, a laminated sectional chart, aircraft specifications, and all navigation equipment including a nav computer were provided at the outset. The experimenter verbally went through the all information provided for the flight and assisted the pilot in orienting themselves with the map. The pilot was informed that s/he would be flying with or without GPS depending on group allocation, and it was reiterated that the pilot was the pilot-in-command and free to conduct the flight in any way they wished.

Non-GPS Group: The non-GPS participants simply planned the flight, requested how much fuel they wanted for the flight and then took their seat at the simulator. The pilot was free to take whatever materials provided for the session over to the simulator for the flight. During the time the pilot was planning the flight the simulator was set up with appropriate weather and aircraft settings confirmed.
Once the pilot was ready the experimenter started the simulator. The flight data recorder was activated and the GPS was turned off. For the first of the two flights the experimenter reiterated the control functions for the pilot. The plethysmograph transducer was attached to the pilot’s right earlobe, which was prepared by scrubbing with a disposable alcohol swab. The pilot was then free to begin the flight. The experimenter left the cubicle and took a seat behind the pilot to monitor progress.

At the pre-determined decision points or if the pilot indicated they no longer wished to continue with the flight the experimenter paused the simulation and turned off the monitor and disconnected the transducer. The pilot was then invited to take a seat at a table and presented with the appropriate questionnaire. The experimenter verbally instructed the pilot to answer the questions as accurately as possible from memory, but if s/he really did not know an answer to a question to leave it blank. The pilot was also instructed that they could ask for clarification for any of the questions. While the pilot filled out the questionnaire the experimenter manually recorded the aircraft status values (airspeed, heading, etc.).

Once the pilot had completed the questionnaire the experimenter checked what decision the pilot had made regarding the continuation of the flight. If the pilot chose to continue then they were instructed to take a seat at the simulator for the flight to be continued. The pilot was reattached to the transducer and allowed a little time to re-orientate him/herself then the simulator was un-paused for flight on to the second decision point. If the pilot chose to do anything other than continue to the original destination of the flight the pilot was informed that the flight would be terminated at that point. The flight recorder data were saved and the simulator restarted. After a short break this procedure was repeated for the second flight.

**GPS Group:** The procedure for the GPS group was identical to that described except for the selection and loading of waypoints into the GPS. When the pilot had finished planning the flight the experimenter asked what waypoints the pilot would like loaded into the GPS which then constituted the flightplan. The pilot could select VORs, NDBs, or airports as waypoints.
Due to some limitations of the simulator airport database not all waypoints requested by pilots could be loaded into the GPS. If pilot selected such a waypoint then a new waypoint was identified as close as possible to the original selection to be loaded into the GPS. The pilot approved the selection of the new waypoint before it was loaded into the GPS.

Once the simulator was started the experimenter ran the GPS through the set-up screens and ensured it was fully operational. Once the flight recorder was activated the pilot was free to begin the flight.

Flights

Pilots were required to plan and fly two cross-country flights. The order of the flights was counter-balanced across the two experimental groups (GPS/Non-GPS) and across the participant type (GPS experience/No GPS experience).

Scud-Running Flight:

This flight was approximately 156 n.m. in length running north to south down the Pacific coast of Washington State in the United States. The departure airport was Quillayute (UIL) and the destination was Tillamook (S47). The weather forecast was for an overcast cloud base at 2000 ft AMSL with light westerly winds. The simulated weather was a cloud base of 2500 ft at Quillayute, dropping to 1500 ft after about 20 n.m. into the flight. A further weather change reduced visibility and lowered the cloud base to 800 ft 86 n.m. into the flight. If the pilot chose to continue on from this point s/he would experience further reducing visibility until about 10 n.m. from the destination. The visibility at this point was below VFR minima.
Figure. 3. Route of the Scud-Running Flight
VFR-On-Top Flight:

This flight was approximately 96 n.m. long from Chico (CIC) to Little River (O48) across the Sacramento Valley to the Pacific Coast. The weather forecast predicted fine weather over the valley but 5000-6000 ft overcast toward the coast with some lowering visibility. The weather experienced was as expected over the valley but the cloud came in further inland than expected and was sitting on top of the mountains to the west of the valley. The weather was set such that climbing high out of the valley to clear the western mountains would put the pilot VFR on-top of broken cloud with limited ground visibility by Decision Point 1 (42 n.m into the flight). If the pilot chose to drop down beneath the cloud immediately s/he had to navigate very carefully through the mountains to avoid flying into cloud. If the pilot continued the flight from this point then a further weather change was experienced about 15 n.m. from the destination of Little River. At this point the 6000 ft cloud layer turned solid overcast with light rain and visibility reducing to VFR minima by the time the destination was reached. Had a pilot not dropped below the broken cloud prior to the final weather change then s/he would find him/herself above a solid overcast layer.

Figure 4. Route of the VFR-On-Top Flight
Results and Discussion of Study 3

Decision to Continue or Discontinue at first Decision Point:

In the VFR-on-top (VOT*) flight, ten participants continued past the first decision point and 8 discontinued the flight. For the scud-running (SR*) flight exactly half the participants (9) continued and half (9) discontinued the flight. A more detailed breakdown of the options chosen by each participant at both the first and second decision points is shown in Table 2.

<table>
<thead>
<tr>
<th>Flight Options</th>
<th>Scud-Running* Flight</th>
<th>VFR On-Top* Flight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GPS</td>
<td>No GPS</td>
</tr>
<tr>
<td></td>
<td>DP1</td>
<td>DP2</td>
</tr>
<tr>
<td>Continued</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Precautionary</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Divert</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Return</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Orbit</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Crashed</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 2. Flight options chosen at the two decision points for participants in the GPS and non-GPS groups.

There appear to be few differences in option choice between the GPS and non-GPS groups. More detailed comparisons of the responses of these two groups will be outlined below.
Figure 5. Flow-chart representation of decisions made by participants during each flight.
Differences between the flight scenarios

The two flights presented quite different challenges to the pilots (see Figures 1 & 2). In the scud-running flights the cloudbase lowered to a solid overcast. The further deterioration in cloudbase to 800 ft agl required the pilot to descend and was therefore difficult to miss. In contrast, the VFR-on-Top scenario presented pilots with a developing cloud layer beneath the aircraft as it passed over high ground *en route* to the destination airport. The cloud layer was somewhat scattered and broken at first, only developing into a solid overcast much closer to the destination. In this case, there seems to have been a division between those pilots who immediately perceived this as a potential hazard and those who did not.

Demographics and Flight Experience:

For the VFR-on-Top flight, pilots who continued were younger (27.1yrs v 40.1yrs) than those who discontinued the flight (F (1,16) = 5.8, p = .028). They had held their highest level of pilot certification for significantly less time (9mths vs 7yrs 10mths) than those who discontinued the flight (F (1,16) = 5.5, p = .032). There were no significant differences between the continuers and non-continuers on any of the demographic or flight experience variables for the scud-running flight. Although not statistically significant, it may be of interest to note that in both flights, the proportion of instrument-rated pilots who continued (40% in the VFR-on-Top flight; 20% in the scud-running flight) was less than the proportion of non-instrument rated pilots (62% in both flights).

For the VFR-on-Top flight, pilots who discontinued the flight had previously discontinued more flights due to weather (3.25 vs 1.7) than those who continued (F (1,16) = 4.5, p = .049).

GPS Experiences and Opinions:

There was no association between previous experience using GPS and decisions to continue or abandon the flights. Of the pilots with previous GPS experience (n=10), those who continued the flights at the first decision points expressed a general opinion that GPS
systems increased workload (comprising physical and mental workload, use of maps and charts, ‘head down’ time, lookout, and instrument scan opinions) and decreased situational awareness (comprising position, airspace and terrain awareness, overall situation awareness, tracking accuracy and frequency of flight in marginal conditions) relative to the pilots who discontinued the flights. Only the difference on the VOT* flight (continuers average 3.8 vs non-continuers 2.78 on a 7 point scale ranging from “Decreases Greatly” to “Increases Greatly”) was significant, F(1)=56.281, p<.001. (The questions regarding workload and awareness used the same scale, so the awareness questions were reverse scored when averaging, thus placing “Increased Workload” and “Decreased Awareness” at the same ends of the scale).

Usual Aeronautical Practices:

The practice of filing a flight plan was significantly associated with the decision to continue in both flights. In the VFR-on-Top flight, those who continued indicated a greater propensity to file a flight plan (F (1,16) = 6.8, p = .019) whereas in the scud-running flight those who continued were less likely to file flight plans (F (1,16) = 4.6, p = .047).

The majority of pilots (72%) claimed that they would never fly VFR-on-Top, whereas in the simulated flight 56% actually continued the flight above an increasingly dense cloud layer. In contrast, only 11% of pilots claimed that they never flew below 1000ft agl to maintain cloud clearance, although the majority (72%) claimed to do so only rarely (i.e. less than 25% of the time). Once again, in the simulated flight 50% chose to continue the flight at 800ft agl below cloud.

Personal Minima:

There were no differences between those who continued in either flight and the other pilots in terms of their personal minima for flight visibilities or for their personal minimum ceiling for local or cross-country flights.
**Hazardous Events Scale:**

There were no significant differences between the continuers and non-continuers in either flight in terms of their scores on the Hunter (1995) Hazardous Events Scale.

**Opinions about Self:**

There were no significant differences between the continuers and non-continuers in either flight in terms of their opinions about their own skills, judgment etc.

**Aeronautical Risk Judgment Questionnaire:**

There were no significant differences between the continuers and non-continuers in either flight in terms of their responses to any of the items on the Aeronautical Risk Judgment Questionnaire.

**In-Flight Post Critical Weather Change (Awareness of Current Status):**

The pilots who continued the VFR-on-Top flight were generally more accurate in their estimates of aircraft status (airspeed, heading etc) than those who discontinued the flight. A multivariate analysis of variance (MANOVA) on seven questions covering awareness of aircraft status showed that those who continued the flight were more accurate in their estimates than other pilots. Using Roy’s Largest Root criterion the combined awareness accuracy variables were significantly affected by the continuation variable (F(7,8) = 3.4, p = .05). There were significant differences between the continuing pilots and the non-continuing pilots on accuracy of estimated airspeed (F(1,15) = 9.8, p = .007) and heading (F(1,15) = 8.9, p = .009)

**In-Flight Post Critical Weather Change (Importance of Cues):**

For the VFR-on-Top flight the five most important cues (on a scale of 1-10) were horizontal visibility (8.7), increasing cloud concentration (8.6), visibility of ground (7.8), cloud base (7.6) and cloud type (6.3). The two least important cues were wind direction (2.4)
and wind velocity (3.2). For the scud-running flight the five most important cues were visibility of ground (8.8), horizontal visibility (8.3), increasing cloud concentration (8), cloud base (7) proximity of cloud to aircraft (5.8). Once again, the two least important cues were wind direction (2.1) and wind velocity (3).

There were no differences in the rated importance of any of the cues between those who continued the flights past the first decision point and those who did not.

*In-Flight Post Critical Weather Change (Affect):*

In both flights there was a consistent, although only marginally significant, tendency for the pilots who elected to discontinue the flight to exhibit higher levels of negative affect on the PANAS measure (VOT* - F(1,15) = 3.3, p = .09: SR* - F(1,16) = 3.7, p = .07). There was also a marginally significant difference in comfort levels on the VFR-on-Top flight with those who discontinued the flight feeling more uncomfortable (F(1,15) = 3.3, p = .09).

The heart-rate data in the VFR-on-Top flight showed an interesting interaction. For those who discontinued the flight there was a significant rise in heart rate following the weather-change at decision point 1. Those who continued showed no change in heart-rate from that obtained five minutes into the flight (averaging 76.5 bpm) whereas the heart-rate of the non-continuers jumped to 85.3 bpm (F (1,14) = 8.9, p = .01).
In-Flight Post-Critical Weather Change (Evaluation of Options):

Plan adherence: In both flights, every single participant who continued the flight indicated that they made no modifications to their plan once chosen. In contrast, 29% of non-continuing participants in the VFR-on-Top flight ($\chi^2 (1) = 3.2$, $p = .07$) and 33% in the scud-running flight ($\chi^2 (1) = 3.6$, $p = .058$) indicated post-choice modification of their plans. In terms of the Janis and Mann (1977) model, the participants who continued the flights may have been displaying ‘unconflicted adherence’ to their original course of action. In the ‘ARTFUL’ model of aeronautical decision making proposed by O’Hare (1992), the risk assessment process provided the trigger to begin the search for alternative courses of action. As noted below, the continuing pilots in the present study did not perceive the same level of risk in this course of action as did the non-continuing pilots and may therefore have remained in a state of ‘unconflicted adherence’.

In-Flight Post-Critical Weather Change (Costs, Benefits & Risks):

Perceptions of Risk: In both flights, those pilots who chose to continue the flight past the first decision point rated the risk of this course of action as significantly lower than did those who turned away at this point. For the VOT* flight, $F (1,14) = 48.7$, $p < .0001$, and for
the SR* flight, $F(1,14) = 24.7, p < .0001$. For the VOT* flight the continuers rated the risks of all the remaining courses of action as lower than did the non-continuers: Precautionary landing, $F(1,13) = 12.1, p < .004$; divert, $F(1,13) = 13.2, p < .003$; return, $F(1,12) = 6.8, p < .025$ and orbit, $F(1,13) = 18.9, p < .001$. In the SR* flight, those who chose to discontinue the flight were significantly more confident that the outcome of their choice would be successful ($F(1,16) = 5.4, p < .04$) and more certain that they had made the correct choice ($F(1,16) = 6.8, p < .02$).

In both the SR* and VOT* flights, pilots who chose to continue rated the risks of the alternatives (precautionary landing, diversion etc) as lower than that of continuing. The only exception was in the SR* flight where the option of ‘orbiting’ was rated as extremely risky by both the continuing and non-continuing pilots. These data suggest that the continuing pilots are willing to accept a greater degree of risk by ‘pressing-on’ than by choosing one of the other alternatives. The results suggest that this may be a combination of risk perception (pilots who continue rate the risks of continuing as significantly lower than do the non-continuing pilots) and risk tolerance (pilots who continue do so despite rating other options as less risky) (Hunter, 2002).

**Perceived Costs and Benefits:** In both flights, as would be expected, perceived benefits outweighed perceived costs for the chosen course of action and perceived costs outweighed perceived benefits for the non-chosen options (VOT* flight: $F(1,13) = 12.1, p = .004$; SR* flight: $F(1,14) = 24.1, p < .0001$). In the VFR-on-Top flight, those who discontinued the flight put more emphasis on perceived benefits and less emphasis on perceived costs than did the continuing pilots ($F(1,13) = 5.7, p = .032$). One strategy proposed by O’Hare and Smitheram (1995) to encourage greater caution in in-flight decision making was to encourage pilots to focus on the benefits rather than the costs of alternative courses of action. This was based on prospect theory research (Kahneman & Tversky 1979) where people are typically found to be less risk taking when prospects are framed in terms of potential gains or benefits.
In the scud-running flight there was evidence that those pilots who discontinued the flight engaged in more reasoning (both pros and cons) about their actual choice ($F(1,14) = 5.5, p = .035$). There were no differences in reasoning about the non-chosen options.


**Effects of Using GPS for Navigation:**

*Demographics and Flight Experience:* There were no statistically significant differences between participants in the GPS and non-GPS conditions on any of the measures of flight experience although the non-GPS pilots did have a higher mean total flight hours (332 hrs vs 168 hrs).

*In-Flight Post Critical Weather Change (Awareness of Current Status):* There were no differences between the GPS and non-GPS groups in terms of the accuracy of their estimates of aircraft status (airspeed, heading etc).

*In-Flight Post Critical Weather Change (Importance of Cues):* The GPS group rated the weather cue “visibility of ground or water” as more important in their decision making in the VFR-on-Top flight than the non-GPS group (F(1,15) = 5.6, p = .03) and the weather cue “distance between cloud base and horizon” as less important in their decision making in the scud-running flight (F(1, 16) = 6.7, p = .02). The GPS group also rated the cue “distance from departure/destination” as much more important in the scud-running flight (F(1, 16) = 5.0, p = .04).

*In-Flight Post Critical Weather Change (Affect):* In both flights the GPS group showed higher levels of positive affect on the PANAS measure (Scud-running flight: F(1,16) = 3.9, p = .06; VFR-on-Top flight: F(1,15) = 4.9, p = .04) and lower levels of state anxiety on the STAI measure (Scud-running flight: F(1,16) = 4.0, p = .06; VFR-on-Top flight: F(1,15) = 9.7, p = .007). The GPS group also showed lower levels of tense arousal on the AD-ACL measure in the scud-running flight (F(1,11) = 5.2, p = .04).

*In-Flight Post-Critical Weather Change (Evaluation of Options):* There were no differences between the groups on any of the measures.

*In-Flight Post-Critical Weather Change (Costs, Benefits & Risks):* Pilots in the GPS condition consistently listed a greater number of “thoughts” (both pros and cons) in relation to the available courses of action. This was the case in 16 out of 20 comparisons. The difference was marginally significant for the scud-running flight (F(1,14) = 4.2, p = .06) and for the two flights combined (F(1,14) = 3.2, p = .097). On an individual basis, the GPS group listed
significantly more benefits for the precautionary landing option in the VFR-on-Top flight
(F(1,13) = 4.5, p = .05) and the continuing option in the scud-running flight (F(1,16) = 4.7, p
= .047).

Participants assigned to the GPS condition consistently saw less risk in the courses of
action than did the non-GPS participants. This was the case in 9 out of 10 comparisons across
the 2 flights (Sign test, p = .01). On an individual basis, the GPS group rated the riskiness of
diverting in the scud-running flight as significantly lower (F(1,12) = 7.4, p = .018).
Results and Discussion of Studies 2 and 3 Combined

A combined database of measures used in Study 2 and Study 3 was generated. The two independent variables of interest were time/distance to critical weather change (short/long) and decision at critical weather change (continue as planned/other action). The dependent variables were the various demographic and past experience measures as well as the in-flight situational awareness and risk assessment measures. Some measures of actual flight performance (e.g. distance flown, fuel remaining etc) were also included. Where appropriate a 2x2 ANOVA was conducted on each dependent variable. In other cases chi-square or other non-parametric tests were conducted. The two flights (VFR-on-Top and Scud-Running) were analyzed separately.

Effects of Prior Commitment (Sunk Cost) on Decision Making:

The effects of length of flight prior to the first significant weather encounter on decision making are shown in Tables 3 and 4. For the VFR-on-Top flights there was no difference in choice of continuing or not continuing the flight between the group who flew for 82nm prior to the first decision point compared to those who only flew 42nm.

<table>
<thead>
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<th>Not Continue</th>
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<tbody>
<tr>
<td>Short (42nm)</td>
<td>10 (55%)</td>
<td>8 (45%)</td>
</tr>
<tr>
<td>Long (82nm)</td>
<td>8 (45%)</td>
<td>10 (55%)</td>
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</tbody>
</table>

Table 3. Number and percentage of participants choosing to continue the VFR-on-Top flights past the first decision point.

However, for the scud-running flight there was a significant difference between those who covered the longer and shorter distance before the critical weather change, with those who had covered the greater distance being much more likely to continue with the flight than those who had only come half as far ($\chi^2 (1) = 4.1$, $p < .05$).
<table>
<thead>
<tr>
<th></th>
<th>Continue</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Short (42nm)</td>
<td>3 (18%)</td>
<td>14 (82%)</td>
</tr>
<tr>
<td>Long (86 nm)</td>
<td>9 (50%)</td>
<td>9 (50%)</td>
</tr>
</tbody>
</table>

Table 4. Number and percentage of participants choosing to continue the Scud-Running flights past the first decision point.

**Effects of Time/Distance to Weather Change (VFR-on-Top flight):**

There were no main effects on any of the risk assessment or situational awareness measures. Actual fuel remaining was lower in the long flight as would be expected ($F(1,26) = 9.9, p = .004$). There was a main effect ($F(1,21) = 4.7, p = .042$) and an interaction effect ($F(1,21) = 4.9, p = .04$) for intended cruise altitude after the weather change. This was due to those who turned back after the short flight being at a much lower altitude (2700 ft agl) than those who turned back after the longer flight (6417 ft agl).

**Effects of Time/Distance to Weather Change (Scud-Running flight):**

For those pilots who had covered a shorter distance to the critical weather change a precautionary landing seemed far less ideal than for those who had travelled much further ($F(1,31) = 10.9, p = .002$). Diversion to another airport was also less attractive to the pilots who had covered less ground ($F(1,31) = 4.4, p = .044$). Returning to the departure airport was considered far more unsatisfactory by those who had flown further ($F(1,31) = 10.4, p = .003$).

Pilots who had flown a shorter distance were at a significantly lower altitude (757ft vs 895ft amsl) than those who had flown further ($F(1,30) = 4.3, p = .046$). Actual fuel remaining was lower in the long flight as would be expected ($F(1,27) = 5.7, p = .024$).

There were marginally significant differences in the perceived importance of two weather cues in deciding what to do. These were darkened cloud ($F(1,31) = 3.5, p = .07$) and
cloud type (F (1,31) = 3.3, p = .08) which were both seen as more important by those who had flown the shorter distance.

**Characteristics of Continuers versus Non-Continuers:**

In the previous analyses we have taken a situational perspective – looking at the correlates of the decision to continue within each particular flight. In this section, we take a more person-based perspective by looking across the flights and looking at the characteristics of those who consistently continue compared to those who consistently abandon their planned flights. The proportions fitting into these categories (plus those who continue in one but abandon the other) are shown below.

<table>
<thead>
<tr>
<th></th>
<th>STUDY 2</th>
<th>STUDY 3</th>
<th>TOTAL</th>
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<tbody>
<tr>
<td>Continued Both Flights</td>
<td>2</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Abandoned Both Flights</td>
<td>9</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Mixed</td>
<td>7</td>
<td>5</td>
<td>12</td>
</tr>
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</table>

**Demographics and Flight Experience:**

Exactly one-quarter (n = 9) of our participants across the two studies were habitual continuers. Examination of their flight experience levels show that they had virtually the same total flight hours, hours as PIC and cross-country hours as PIC as the other pilots. However, they had significantly more cross-country hours in the previous 90 days (14.3 vs 3.3) than other pilots (F (2, 29) = 10.3, p < .0001) and were more likely to hold an instructors rating ($\chi^2 (2) = 6.3, p = .043$). The Continuers had held their highest level of qualification for significantly less time (7mths vs 6yrs 6mths) than the pilots who abandoned both flights ($t (31) = -2.1, p = .048$).
GPS Experience and Opinions:

The continuers were more sceptical about the benefits of GPS as a navigational tool. They saw it as generally increasing workload and reducing awareness. Scoring items so that higher scores equal greater belief that GPS increases workload and decreases awareness showed that the continuers were more negative about GPS (F(2, 11) = 4.3, p = .04). In particular, the continuers thought that GPS had more adverse effects on airspace awareness (F(2,13) = 4.5, p = .037) than either the discontinuers or the mixed group. Compared to the pilots who discontinued both flights, those who continued both felt that GPS decreased overall situational awareness (t(11) = -2.4, p = .035).

A multivariate analysis of variance (MANOVA) on six questions covering pilot awareness showed that those who consistently continued flights viewed GPS as having a more negative impact on performance than did other pilots. Using Roy’s Largest Root criterion the combined GPS opinion variables were significantly affected by the continuation variable (F(6,6) = 5.2, p = .032).

Usual Aeronautical Practices:

No differences.

Personal Minima:

Compared to the consistent non-continuers, the continuers had lower personal minima for ceilings for both local flights (t(33) = -1.8, p = .08) and cross-country flights (t(33) = -1.82, p = .079). These differences were only marginally significant however. Looked at another way, 89% of the continuers had a personal minimum ceiling of 1500 ft or less for local flights and 67% had the same for cross-country flights. For the other pilots the proportions were 63% and 19% respectively. The difference for cross-country flights was significant ($\chi^2(2) = 7.8, p = .02$). The same trend was evident for personal minimum visibilities but the differences were not statistically significant.
Opinions about Self:

The continuers agreed more strongly with the statement: “I fly enough to maintain proficiency” than the pilots who abandoned both flights \( t(21.9) = 2, p = .058 \). This difference approached statistical significance. This opinion is consistent with the objective data on cross-country flight hours in the previous 90 days.

Aeronautical Risk Judgment Questionnaire (ARJQ):

Causes of GA Accidents: Pilots who consistently continued flights attributed less likelihood in GA accidents to “Pilot Error” (52% vs 61.64% for non-continue and 73.75% for pilots who continued only one flight). The difference between the continuing pilots and the others was marginally significant, \( t(32)=-1.831, p=.076 \).

Phases of Flight: Pilots who consistently continued ranked accidents as being far more likely during “Cruise” (continue 2.75 vs non-continue 5.33 and continue only once 4.17, on a 7 point scale ranging from 1–Most Likely to 7–Least Likely) than did the other pilots, \( F(2)=4.338, p=.02 \). Conversely, continuing pilots saw “touchdown” as a far safer phase of flight (continue 5.13 vs non-continue 2.07 and continue once 2.42) \( F(2)=10.735, p<.001 \) than the other pilots.

Pilot Causal Factors Of a set of accident factors related to pilot attributes, decisions and actions, continuing pilots ranked “Violation of Rules” as less likely to cause accidents (continue 5.67 vs non-continue 4.53 and continue only once 4.42), \( t(33)=2.002, p=.054 \). When pilots were asked to rate the same set of factors in terms of their likely contribution to an accident that they themselves were involved in, the “Violation of Rules” was consistently seen to be a less likely cause (5.56, 5.07, 5.5 for each of the three groups).

In-Flight Post Critical Weather Change (Importance of Cues):

There were no differences in the perceived importance of any of the cues in either flight.
In-Flight Post Critical Weather Change (Affect):

The only measure common to both studies was the rating of comfort with the situation. Those who abandoned both flights had significantly higher ratings of discomfort than the others (F(2,32) = 4.0, p = .028) in the VFR-on-Top flight.

In terms of the new measures used in Study 3 those who continued both flights had significantly lower scores on the positive affect scale of the PANAS than the pilots who abandoned one or both flights (t(15) = -2.23, p = .038). Similarly, those pilots who continued with both flights showed significantly less change in heart rate after encountering the weather change in the VFR-on-Top flight than the other pilots (t(13) = -2.2, p = .044). The same trend was found in the scud-running flight but the difference was not statistically different. The mean change in heart rate was 5 bpm for the continuers compared to 9.65 for those who abandoned both flights. This interesting interaction between pilot inclination and heart rate at different phases of flight, whilst not reaching statistical significance, is evident in the figures below (particularly for the VOT* flight, or when the mean is taken across both flights).
In-Flight Post Critical Weather Change  (Evaluation of Options):

The continuers were significantly less confident than other pilots that their decision would have a successful outcome in the scud-running flight (F(2,32) = 7.1, p = .003). The same trend was present in the VFR-on-Top flight but was not significant. In both flights the continuers rated the continue to destination option as more desirable than did the other pilots.
The continuers rated the option of a precautionary landing as significantly more unsatisfactory than the other pilots (for the VFR-on-Top flight F(2,32) = 9.6, p = .001 and for the scud-running flight F(2,32) = 4.6, p = .018). The continuers also rated the option of returning to the departure airfield as more unsatisfactory than did the other pilots (for the VFR-on-Top flight F(2,32) = 10.8, p < .0001 and for the scud-running flight F(2,32) = 6.9, p = .003). The only options that were not rated differently by the continuing pilots were that of diverting to another airport and orbiting at current position.

*In-Flight Post Critical Weather Change (Awareness of Current Status):*

A multivariate analysis of variance (MANOVA) on seven measures of accuracy of current aircraft status (airspeed, heading, flight time etc) showed that those who consistently continued flights were more accurate in estimating these parameters for the VFR-on-Top flight than the other pilots. Using Pillai’s Trace criterion the combined accuracy measures were significantly affected by the continuation variable (F(14,26) = 2.4, p = .028). There was no difference on the scud-running flight

On an individual variable basis the continuing pilots were significantly more accurate on estimating their airspeed (F(2,18) = 5.4, p = .015) and vertical velocity (F(2,18) = 3.9, p = .038).

*In-Flight Post Critical Weather Change (Costs, Benefits & Risks):*

The continuing pilots rated the risks of continuing on to the original destination as significantly less than the other pilots (for the VFR-on-Top flight F(2,32) = 14.5, p < .0001 and for the scud-running flight F(2,30) = 8.2, p = .001). The continuing pilots’ average perception of risk across all five options was significantly lower than the other pilots (for the VFR-on-Top flight F(2,32) = 9.4, p < .0001 and for the scud-running flight F(2,32) = 3.9, p = .03).
For the VFR-on-Top flight the continuing pilots perceived less risk in the options of returning to departure airport (F(2,29) = 4.0, p = .029) and orbiting in current position (F(2,29) = 9.6, p = .001). For the scud-running flight, there was a marginally significant overall difference between the groups (F(2,29) = 3.1, p = .059) for their perception of risk associated with a precautionary landing. Individual t tests showed that those who abandoned both flights saw significantly greater risk than those who continued both flights (t(29) = -2.3, p = .022) or than those who continued only one of the flights (t(29) = 1.75, p = .023).

Those who continued the flights saw fewer benefits to the option of diverting to another airport in the VFR-on-Top flight (x = .57) than either the mixed group (x = 1.0) or those who abandoned both flights (x = 1.64) (F(2,28) = 4.4, p =.022). Pilots who abandoned both flights saw more benefits to their own choice of action than other pilots in the scud-running flight (F(2,32) = 5.3, p = .01). The same trend was found in the VFR-on-Top flight but was not statistically significant.

Summing up the reasons offered for and against each option into “Pros” (benefits of chosen option and costs of non-chosen options) and “Cons” shows that each group showed a preponderance of “pros” over “cons” for their chosen options. Those who abandoned both flights listed significantly greater numbers of “pros” for their chosen options in both the “VFR-on-Top” flight (t(29) = 2.0, p = .055) and the scud-running flight (t(29) = 2.5, p = .02) as well as consistently greater numbers of “cons” than pilots who continued one or both flights in the VFR-on-Top flight (F(2,29) = 3.5, p = .043) and more than other pilots in the scud-running flight (t(29) = 2.4, p = .025).

Pilots who consistently abandon flights appear to engage in more reasoning about their decisions than other pilots. Those pilots who abandoned both flights had considered a greater number of overall “pros” and “cons” (x = 11.5) than the other pilots (x = 9.1) (t(30) = 2.0, p = .052).
A multitude of horrors concealed in just 14 words. This brief account of an aviation disaster provides a classic example of the principle questions that motivated the current studies. Did the pilots underestimate the magnitude of the risks associated with thunderstorm activity or were they foolish enough to take on a known risk in the pursuit of other goals such as maintaining their schedules? This explanation focuses on pilots’ perceptions of risk as well as their willingness to accept or tolerate risks in the pursuit of other goals. An alternative approach would ask whether the cues were sufficiently clear or hard to discern. Did the flight take place at night? Was the aircraft equipped with radar or Stormscope™? Did the pilots lack familiarity or experience with this kind of weather? These are more complex, yet potentially far more useful questions to pursue than to simply file the case away under the heading of ‘Pilot Error’.

**Summary of Substantive Findings:**

These can be discussed in terms of the following four key questions that motivated the present research:

- Does the investment of time/effort in a flight affect the decisions made in-flight?
Is the use of GPS for VFR en-route navigation associated with differences in decision making?

Are there measurable pre-existing differences in pilot experience, attitudes or behaviours that affect in-flight decision making?

Are the critical differences in decision making (continue – discontinue) associated with differences in situational awareness?

Are the critical differences in decision making (continue – discontinue) associated with differences in option evaluation, risk perception, risk tolerance and reasoning?

Effects of Investing Time/Effort on In-Flight Decision Making:

The study of archival aircrash data (Study 1) provided evidence that weather-related crashes tended to occur further into flight than other types of crashes. Experimental data from the simulated flights (Studies 2 & 3) showed that the distance travelled prior to the critical weather encounter did affect decision making outcomes in one of the flights (Scud-Running). The only measurable differences in the decision making process lay in the perceived desirability of the available courses of action. Although it would be expected that those who had flown further would find the option of returning to the departure airport as less desirable, there is no logical reason why the options of diverting elsewhere or precautionary landing should also be seen as less desirable. Distance flown did not affect the decision making of pilots in the VFR-on-Top flight.

Recommendations: Pilots should be aware that investment of time in a flight can lead to a greater likelihood of self-imposed pressure to continue on towards deteriorating weather. It would be possible to design computer-based training simulations to demonstrate this effect and its effect on option evaluation. The perceived value of the precautionary landing needs to be further emphasized in training. It should be promoted as a safe (Study 1 found no fatalities associated with precautionary landings) and desirable option. Work on the framing of choices (O’Hare & Smitheram, 1995) in terms of potential gains could be used to promote the
selection of the precautionary landing as a desirable alternative. Interactive exercises on framing and option evaluation could be implemented in classroom or CD-ROM instruction.

**GPS and Decision Making in VFR Flight:**

The first flight simulation study (Study 2) showed marginally significant effects of GPS use on the options chosen at the first decision point in the scud-running flight. No such differences were found in the second flight simulation study (Study 3). The other effects of using GPS for en-route VFR navigation can be summarised as “less anxiety – more thinking”. The results of Study 3 indicated a clear trend for increased levels of positive affect and decreased levels of anxiety and tension amongst the GPS group accompanied by increased numbers of thoughts (pros and cons) about the options. If anxiety and arousal have a negative effect on decision making by taking up information processing capacity, then lowering anxiety and arousal should lead to more capacity for conscious reasoning. This is exactly the pattern of results observed here.

**Recommendations:** The initial concern with the use of GPS by general aviation pilots for en route navigation has been with the possibility that GPS would induce higher levels of confidence and complacency and encourage greater levels of risk-taking in marginal weather (Heron & Nendick, 1999). Our studies have shown a slightly increased tendency for GPS-equipped pilots to remain airborne rather than seek out a diversion or precautionary landing and reduced levels of risk perception across all the available course of action. At the same time, our data suggests a positive benefit to GPS use in terms of freeing up cognitive capacity for reasoning about courses of action. This hypothesis deserves further empirical investigation before definitive recommendations about GPS use in VFR flight are advanced. The evidence from the present study is that GPS use can have both positive and negative effects on pilot performance and decision making.
Effects of Pre-Existing Differences on In-Flight Decision Making:

The study of archival aircrash data (Study 1) found that pilots who were involved in ‘controllable exposure to risk’ crashes were significantly younger and had a higher number of recent (last 90 days) flight hours than other pilots. In both flight simulation studies the pilots who chose to continue the flights tended to be younger, more recently qualified, and with more recent (last 90 days) cross-country flight hours than other pilots.

This same pattern has shown up repeatedly in analyses of archival aircrash data (O’Hare, 1999) as well as in data obtained from experimental flight simulations (e.g. O’Hare, 1990). This consistent pattern of findings between laboratory studies and archival data tends to support the validity of the flight simulation studies.

These younger, more current pilots did not rate themselves as any more skilled or more prone to risk-taking than other pilots although they did see themselves as having greater currency to maintain proficiency. These pilots did however set a lower personal minimum for cross-country ceilings compared to other pilots. Presumably, they see this as reasonable in view of their current high levels of activity.

Recommendations: There can be little doubt that younger, currently highly active pilots represent a special group in terms of aviation safety. Such pilots are typically newly employed in flight instruction or in entry-level positions in tourism, charter operations etc. They are undoubtedly keen to progress up the career ladder which can only be done by successfully completing as many flight missions as possible. This group of pilots needs to be the target of greater efforts in supervision and mentoring. More specifically, the findings suggest that such pilots would benefit from more conservative settings for personal minima, especially for cross-country ceilings. Both written and video material could be used to actively promote more conservative strategies. However, this will likely conflict with the motivation of such pilots to demonstrate their ability to ‘get the job done’. The question therefore becomes entangled with wider social, organizational and regulatory issues.

Interactive exercises on the setting and evaluation of personal minima could be implemented on video or CD-ROM. Pilots could be challenged to recognize when weather
conditions have actually fallen below their minima using similar technology to that used in the Weatherwise I and Weatherwise II CD-ROMs on weather decision making (Wiggins & O’Hare, In Press). It should be noted however, that efforts targeted exclusively at individual pilots may fail to result in meaningful change due to the influence of other factors (social, organizational, and regulatory) on pilot behavior.

Effects of Situational Awareness on In-Flight Decision Making:

Somewhat surprisingly there was no evidence that differential evaluation of weather cues played a role in the pilots’ decisions to continue their VFR flight in either scenario. The only significant finding in regard to situational awareness was that pilots who continued the flights were more accurate in their perceptions of the aircraft’s status (airspeed, altitude, heading etc) in the VFR-on-Top flight. This may not have emerged in the scud-running flight due to both a literal and metaphorical ‘ceiling’ effect constraining the possible data values by virtue of the conditions encountered.

The lack of any evidence that differences in cue assessment played a role in decision making in our simulations is somewhat surprising at first. This may be explained in several ways. Firstly, that after early attempts at cross-country flying pilots acquire sufficient knowledge about weather cues that decisions come to be driven largely by other factors. For example, in our scud-running flight it was easily apparent to every pilot that they were in a situation of lowering cloudbase and visibility. The decision to continue the flight would have to be taken on the basis of other factors – perceived risks and utilities, feelings of comfort etc.

An alternative possibility is that the visual fidelity of our PC-based simulations was simply not high enough to allow pilots to evaluate visual weather cues as they would normally do in the real flight environment. This would partly arise from hardware limitations, as all information was presented on a 21” CRT monitor directly in front of the pilot, as well as software limitations on the modelling of clouds and visibility. We have now made significant improvements in the hardware aspects (see Appendix A) and expect further improvements in software with each new flight simulator release.
**Effects of Option Evaluation, Risk Perception, Risk Tolerance and Reasoning on In-Flight Decision Making:**

The majority of the significant findings in the flight simulator studies were in relation to how pilots viewed the available course of action and their associated risks and benefits. Clearly, the pilots who continued flights viewed that option as markedly less risky than did pilots who elected not to continue. Thus differences in risk perception were associated with differences in choice of action. However, the pilots who continued viewed other options as less risky than continuing but chose to continue anyway. Thus differences in risk utility or risk tolerance were also associated with choice of action.

Hunter (2002) has highlighted the differences between risk perception and risk tolerance and has attempted to develop psychometrically valid measures of each construct in the aviation domain. Data collected from over 400 participants showed that the two constructs were only slightly related. Risk perception was also found to be related to involvement in hazardous events using the Hazardous Events Scale (Hunter, 1995) which was also incorporated in the second flight simulator study (Study 3). The combined evidence shows that pilots who perceive lower levels of risk in courses of action are more likely to choose to continue flights into deteriorating weather (present study) and have a slightly greater involvement in previous hazardous flight events (Hunter, 2002).

Our data also show that non-continuing pilots engage in more reasoning about costs and benefits than do those pilots who continue. This might either reflect some pre-existing individual difference associated with the propensity to continue or else it might reflect something about the pilots’ state of mind at the time of making the choice between potential courses of action. It is possible to view these data as consistent with the view that the pilots who ultimately discontinued the flights were more highly engaged in deliberative decision making than those who continued. As suggested earlier, this is compatible with Janis and Mann’s (1977) theory of the vigilant decision maker. The discontinuers appear to be operating in a more vigilant mode having perceived greater risk and showing less tolerance for the action of continuing the flight. In Janis and Mann’s (1977) terms, these decision makers are
more conflicted about their choices. The continuers show less concern overall, commensurate with their lower risk perception and greater risk tolerance for the situation.

Unfortunately, as in all research of this kind it is impossible to determine any causal pathways or directions from the present data. Heightened risk perception might be the driver for greater deliberation about courses of action, as suggested by O’Hare (1992), or greater deliberation might result in increased risk perception.

**Recommendations:** The paucity of good research on pilot risk perceptions and risk tolerance in aviation make it difficult to prescribe educational or training approaches with any degree of confidence. It is tempting to deduce that activities that increase pilots’ perception of the risks associated with pushing-on into deteriorating weather would have the effect of inducing greater caution in decision making. As we have shown, making a precautionary landing is a much safer option in terms of mortality although there may be increased costs and inconveniences as well as increased likelihood of aircraft damage. This greater likelihood of sustaining minor damage and inconvenience may induce pilots to frame the problem in terms of certain loss (precautionary landing) versus the less likely prospect of much greater losses (‘pressing on’). There is ample evidence that people are extremely reluctant to accept a more-or-less certain loss when there is the possibility of avoiding loss altogether (Kahneman & Tversky, 1979).

There is certainly plenty of aviation safety material already available that has been designed to impress upon pilots the risks associated with ‘pressing-on’. However, it is known from research on self-protective behaviors (e.g. Weinstein, 1984) that people will not protect themselves from a risk unless they see a direct connection between their own behaviours and likely harm. In aviation, as in driving, it is easy to develop and maintain risky styles that do not cause any immediate harm to the individual due to the probabilistic nature of the environment within which people operate. For example, an habitual ‘tailgater’ may drive for years without experiencing a crash.

Knowing that a series of actions (e.g. cigarette smoking) is risky in the long-term is not the same thing as believing that an individual action will have any immediate detrimental
effects (Slovic, 2000). Simulator training could be used to demonstrate that individual risky actions are likely to lead to unfavorable outcomes in the long term. However, the simulation training would have to be carefully engineered to ensure that negative outcomes were experienced within the training period and that these outcomes were seen as caused by the pilot’s actions. Otherwise, it is possible that such training could have the unwanted effect of increasing confidence and further reducing risk perception after a series of successful encounters with adverse weather thus further reinforcing the lessons of natural experience.

An alternative approach would be to develop direct representations (Vicente, 1999) of the safe boundaries of aircraft operation. At present, risk is an abstract concept based on long-term averages with no one-to-one correspondence with individual actions. In recent years an alternative to cognitivist approaches in human factors has been actively promoted under the rubric of ecological interface design (Vicente & Rasmussen, 1992) and cognitive work analysis (Vicente, 1999). These approaches involve the analysis of intrinsic task constraints rather than an analysis of operators’ mental strategies. They are descended from James Gibson’s work in visual perception which included driving and aviation (e.g. Gibson & Crooks, 1938). Various tools are available for domain analysis which can be used to develop direct representations (e.g cockpit displays) of the variables which shape behavior.

The results of the present study clearly indicate that appraisals of risk and determination of risk acceptability (risk tolerance) are significant in the decision to continue VFR flight into deteriorating weather conditions. It is recommended that this problem be analysed from a fresh perspective as outlined above. The outcomes of this approach might include cockpit representations of the safe boundaries of aircraft operation, decision support assistance, and augmented simulation training along the lines of the adaptively augmented ‘highway-in-the-sky’ approach to flight path control (Roscoe & Jensen, 1981).

Effects of Affect on In-Flight Decision Making:

The results of the first flight simulation study (Study 2) highlighted the potential role of affective processes in triggering/driving the decision making process. This led us to obtain
additional measures of affect, both subjective and psychophysiological, in the second flight simulation study (Study 3). The heart rate (HR) data showed that the pilots who continued both flights were less physiologically reactive to the weather event (at least in the VFR-on-Top flight) than the other pilots. Of course, issues of cause and consequence cannot be untangled from these data, but in conjunction with the data on reasoning and risk perception, it is tempting to conclude that there is converging evidence to indicate that the continuing pilots are less conflicted about their course of action than the others. They react less to the weather change in physiological terms, show less sign of general anxiety in their overall risk ratings, and engage in less reasoning about the situation. Taken together, this pattern is highly consistent with the profile of the unconflicted decision maker in Janis and Mann’s (1977) theory of vigilant decision making.

In contrast, the other pilots exhibit greater emotional reactivity to the weather change, show heightened anxiety in elevated risk ratings for every course of action, and engage in more reasoning about their choices. In short, these decision makers correspond to the pattern of conflicted decision making described by Janis and Mann (1977).

Conclusions:

We have successfully completed the program of research as proposed (O’Hare & Wiegmann, 1999). We analyzed over 1,000 aircrashes from archival data obtained from the New Zealand accident investigation authorities. We conducted two flight simulator studies involving 36 qualified general aviation pilots who conducted a total of 72 VFR flights. Each flight involved between 2 and 5 hours in planning and preparation and flight time. We manipulated the nature of the flights (two different VFR scenarios), the use of a simulated GPS system for in-flight navigation (GPS and non-GPS conditions), and the pilots’ investment in each flight prior to the first critical decision point. This was operationalized as the distance flown prior to the weather change (short or long).

We measured a range of objective flight performance variables (altitude, airspeed, position etc) as well as subjective estimates of the same variables. We obtained ratings of the
importance of weather cues, the desirability, costs, benefits and risks of various courses of action. We measured opinions about GPS use, personal minima, usual aeronautical practices and involvement in hazardous events. In the third study we added standard psychological measures of anxiety and mood and psychophysiological measures of heart rate.

The specific conclusions and recommendations regarding the effects of each of the manipulated variables on the measured variables have been presented above. Some findings confirm previous suggestions (e.g. that GPS can affect decision making and reduce the perception of risk) whilst at the same time revealing additional perspectives (e.g. GPS use may reduce anxiety and increase cognitive capacity). We partially confirmed the generalizability of psychological theory on investments and sunk costs by showing that sunk cost can affect flight decision making. However, the effect is not overwhelming and manifests itself only under particular flight conditions.

We found clearcut differences between the pilots who chose to continue with the flights and those who did not in terms of their perceptions of risk, tolerance of risk and reasoning about costs and benefits. The findings confirm the importance of these constructs for understanding aeronautical decision making (Hunter, 2002). These differences appear to be associated with underlying feelings of anxiety and psychophysiological responsiveness to flight events. No satisfactory all-encompassing theoretical model has been developed although the findings are compatible with the decision making framework proposed by Janis and Mann (1977) and elaborated on by O’Hare (1992).
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National Transportation Safety Board (2002). Aviation accident statistics. [http://www.ntsb.gov/Aviation/Table1.htm](http://www.ntsb.gov/Aviation/Table1.htm).


Spielberger, C.D. (1983). *State-Trait Anxiety Inventory: STAI (Form Y)*. Mindgarden: Redwood City, CA


Acknowledgements

We are grateful to the Office of Aerospace Medicine at the Federal Aviation Administration for supporting this work and to Dr David Hunter for continued support and encouragement. We are grateful for the technical support and assistance of the Department of Psychology at the University of Otago. We are also grateful for the contribution of Mr Billy Jorgensen in setting up the flight simulations, testing participants in Study 3 and in data analyses and preparing the figures used in this report.

Most of all, we acknowledge the contribution of the pilots who took part in the two simulation studies for their commitment of time and energy in the interests of aviation safety.
Appendix A: Current Flight Simulation Facilities at the University of Otago

Since the completion of the two flight simulation studies reported here the flight simulation laboratory has been considerably upgraded. The major change has been the introduction of a triple-LCD screen display system with high-fidelity analog flight controls (see below).

The system is run by an Athlon Thunderbird 1Ghz based computer with 512mb RAM, with a Matrox Parhelia 256Mb 3D card driving three 17” Philips LCD panels. A Precision Flight Controls Cirrus II flight console with an aluminium cast yoke with electric pitch trim and a series of realistic rocker switches and rotary controls allows pilots to interact with the simulation. The console has three and six lever interchangeable throttle quadrants. Rudder input is provided by CH Products Pro Pedals. The displays and flight controls are mounted in a modified computer desk with a fully adjustable pilot seat (see below).
The system has been used for a follow-up study investigating sense-of-presence induced by PC-based flight simulations with subjective and psychophysiological measures. Initial pilot response to the simulator has been extremely positive.

We intend to standardize our flight simulator software on two commercially available systems: Microsoft™ Flight Simulator™ and X-Plane™. These are fully compatible with the triple-screen display setup and the analog flight control console.
The screen-shot (see below) taken from a Microsoft™ Flight Simulator™ scenario shows the detail now possible in terrain mapping (screenshots reproduced by permission from Microsoft™ Corporation)

At the time of release (during the planning of Study 3), Microsoft™ Flight Simulator™ did not offer the level of detail and control over weather scenarios as we were experiencing with the older Terminal Reality Fly!2K™ simulator. Since then, however, several 3rd party enhancement programs have become available. Some of these promise to allow the kind of fine control needed for planning realistic yet controlled and consistent flight scenarios (with particular emphasis on realistic transitions when flying between areas of differing weather coverage which on all extant simulator packages tends to happen with a bit of a ‘snap’). We are currently obtaining and evaluating some of these 3rd party enhancements. The newest release of Laminar Research’s X-Plane™ package has just been installed in the lab, and it also
promises to deliver the ‘state-of-the-art’ in terms of presenting realistic cloud and weather patterns, as well as improved support for the efforts of 3rd party programmers who might be expected to release enhancements of their own in the near future. If these weather control programs deliver, on either platform, they will increase the immersion in the situation experienced by pilots in the University of Otago Flight Simulator. In conjunction with the heightened terrain fidelity and the surround-screen presentation, this increased immersion should help us gain deeper insight into the experiences, feelings, and decision processes of pilots engaging in our increasingly realistic decision making scenarios. 3rd party scenery designers are also making wider areas of New Zealand available to the flight-simming community. In our lab we also have the capacity to generate photo-realistic scenery for New Zealand (and other parts of the world) given that we can access high quality aerial photography. The development and use of such ‘local’ terrain will enable us to investigate the effect of factors such as local expertise (whether ‘perceived’ or ‘real’), confidence and familiarity.
Appendix B – Pre- and In- and Post-Flight Questionnaires

Cognitive Ergonomics and Human Decision-Making Laboratory

Aeronautical Decision-Making Questionnaire
(Pre Flight)

Demographics, Practices & Opinions

No.
DEMOGRAPHIC INFORMATION (DEMOG)

Name: ____________________  (01)Age: ________  (02)Gender: M  F

The following questions relate to your flying experience. Please answer the questions as accurately as possible.

(03) Total number of hours: ______ hours
(04) Number of hours as pilot-in-command: ______ hours
(05) Number of hours as pilot-in-command on cross country flights: ______ hours
(06) Number of hours as pilot-in-command over the last 90 days: ______ hours
(07) Number of hours cross-country flights in the last 90 days: ______ hours
(08) What is the highest level of certification you currently hold? (Circle) PPL  CPL  ATPL
(09) How long have you held this certification? ______ years
(10) Do you hold, or have you ever held, an instrument rating? Yes  No
(11) Do you hold, or have you ever held, a flight instructors rating? Yes  No
(12) Have you ever been forced to land at an airport other than your destination due to a weather situation?

Yes ☐

No ☐

If YES, please recount the most memorable event giving as much detail as possible – include information under the following headings.

Hours in prior 90 days:

Departure:

Destination:

Diverted to …

Weather expected:

Weather experienced:

Fuel status:

Mechanical/Electrical/Structural difficulties:

Additional Information:
ACQ (ACQ)
Listed below are a number of statements describing a set of beliefs. Please read each statement carefully and, on the 0-5 scale below, indicate how much you think each statement is typical of you.

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Disagree</td>
<td>Moderately Disagree</td>
<td>Slightly Disagree</td>
<td>Slightly Agree</td>
<td>Moderately Agree</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>

____ 01: I am usually able to avoid threat quite easily.
____ 02: How well I cope with difficult situations depends on whether I have outside help.
____ 03: When I am put under stress, I am likely to lose control.
____ 04: I can usually stop my anxiety from showing.
____ 05: When I am frightened by something, there is generally nothing I can do.
____ 06: My emotions seem to have a life of their own.
____ 07: There is little I can do to influence people’s judgements of me.
____ 08: Whether I can successfully escape a frightening situation is always a matter of chance with me.
____ 09: I often shake uncontrollably.
____ 10: I can usually put worrisome thoughts out of my mind easily.
____ 11: When I am in a stressful situation, I am able to stop myself from breathing too hard.
____ 12: I can usually influence the degree to which a situation is potentially threatening to me.
____ 13: I am able to control my level of anxiety.
____ 14: There is little I can do to change frightening events.
____ 15: The extent to which a difficult situation resolves itself has nothing to do with my actions.
____ 16: If something is going to hurt me, it will happen no matter what I do.
____ 17: I can usually relax when I want.
____ 18: When I am under stress, I am not always sure how I will react.
____ 19: I can usually make people like me if I work at it.
____ 20: Most events that make me anxious are outside my control.
____ 21: I always know exactly how I will react to difficult situations.
____ 22: I am unconcerned if I become anxious in a difficult situation, because I am confident in my ability to cope with my symptoms.
____ 23: What people think of me is largely outside of my control.
____ 24: I usually find it hard to deal with difficult problems.
____ 25: When I hear someone has a serious illness, I worry that I am next.
____ 26: When I am anxious, I find it hard to focus on anything other than my anxiety.
____ 27: I am able to cope as effectively with unexpected anxiety as I am with anxiety that I expect to occur.
____ 28: I sometimes think, “Why even bother to try coping with my anxiety when nothing I do seems to affect how frequently or intensely I experience it?”
____ 29: I often have the ability to get along with “difficult” people.
____ 30: I will often avoid conflict due to my inability to successfully resolve it.
These scales consist of a number of words that describe different feelings and emotions. Read each item, and then circle the appropriate number next to that word. Indicate to what extent you generally feel this way, that is, how you feel on the average. Use the following scale to record your answers.

<table>
<thead>
<tr>
<th></th>
<th>Very Slightly or Not At All</th>
<th>A Little</th>
<th>Moderately</th>
<th>Quite a Bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>(01)interested</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(02)distressed</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(03)excited</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(04)upset</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(05)safe</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(06)guilty</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(07)scared</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(08)hostile</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(09)enthusiastic</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(10)proud</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(11)irritable</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(12)alert</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(13)ashamed</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(14)inspired</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(15)nervous</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(16)determined</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(17)attentive</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(18)jittery</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(19)active</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(20)afraid</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

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GPS EXPERIENCE (GPSE)

(01) Have you ever flown using GPS?  
- No  If 'No', please turn to page 8  
- Yes  If 'Yes', please continue below.

For the following set of questions refer to the scale below.

1 – Never  7 – Always

(02) Do you use the GPS as the main navigation aid for VFR flight?  
1 – 2 – 3 – 4 – 5 – 6 – 7

(03) Do you use the GPS as the secondary navigation aid for VFR flight?  
1 – 2 – 3 – 4 – 5 – 6 – 7

(04) How often do you use the following navaids when using GPS?  
(a)NDB  
1 – 2 – 3 – 4 – 5 – 6 – 7  
(b)VOR  
1 – 2 – 3 – 4 – 5 – 6 – 7  
(c)DME  
1 – 2 – 3 – 4 – 5 – 6 – 7

For the following set of questions refer to the scale below.

1 – Decreases Greatly  7 – Increases Greatly

(05) Extent that GPS changes your physical workload?  
1 – 2 – 3 – 4 – 5 – 6 – 7

(06) Extent that GPS changes your mental workload?  
1 – 2 – 3 – 4 – 5 – 6 – 7

(07) Extent that GPS changes your use of maps and charts?  
1 – 2 – 3 – 4 – 5 – 6 – 7

(08) Extent that GPS changes your 'head-down' time?  
1 – 2 – 3 – 4 – 5 – 6 – 7
(09) Extent that GPS changes your lookout?
1 – 2 – 3 – 4 – 5 – 6 – 7

(10) Extent that GPS changes your instrument scan?
1 – 2 – 3 – 4 – 5 – 6 – 7

(11) Extent that GPS changes your position awareness?
1 – 2 – 3 – 4 – 5 – 6 – 7

(12) Extent that GPS changes your airspace awareness?
1 – 2 – 3 – 4 – 5 – 6 – 7

(13) Extent that GPS changes your terrain awareness?
1 – 2 – 3 – 4 – 5 – 6 – 7

(14) Extent that GPS changes your overall situation awareness?
1 – 2 – 3 – 4 – 5 – 6 – 7

(15) Extent that GPS changes your tracking accuracy?
1 – 2 – 3 – 4 – 5 – 6 – 7

(16) Extent that GPS changes your frequency of flying in marginal conditions?
1 – 2 – 3 – 4 – 5 – 6 – 7
**USUAL AERONAUTICAL PRACTICES (UAP)**

If you are making a VFR CROSS-COUNTRY FLIGHT in a general aviation aircraft, what percentage of the time would you do the following?

<table>
<thead>
<tr>
<th>PERCENTAGE</th>
<th>0</th>
<th>10</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>90</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>(01) Get a briefing on the weather before take off.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(02) Compute my weight and balance before I take off.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(03) Compute my expected fuel consumption before I take off.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(04) Use a checklist for before take-off and before landing checks?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(05) File a flight plan.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>(06) Request weather updates during a flight.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(07) Fly VFR above overcast cloud layers.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>(08) Fly at less than 1000 ft AGL to maintain cloud clearance.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(09) Verify my fuel consumption rate in flight.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
If you wanted to make a VFR flight for some personal or business reason (not involving life or death), what are the minimum conditions under which you would begin that flight?

If the visibility was lower than this value you would not take off.

<table>
<thead>
<tr>
<th>(PMIN)</th>
<th>VISIBILITY (KM)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>5</th>
<th>7</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>(01)A LOCAL (30 minute) daytime flight.</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>(02)A CROSS-COUNTRY daytime flight.</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
</tbody>
</table>

If the ceiling was less than this value you would not take off.

<table>
<thead>
<tr>
<th>CEILING (FEET)</th>
<th>1000</th>
<th>1500</th>
<th>2000</th>
<th>3000</th>
<th>4000</th>
<th>5000</th>
</tr>
</thead>
<tbody>
<tr>
<td>(03)A LOCAL (30 minute) daytime flight.</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>(04)A CROSS-COUNTRY daytime flight.</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
</tbody>
</table>
**PAST AERONAUTICAL PRACTICES (PAP)**

In the past, how often have you experienced the following situations / events? Please answer by circling ONE of the numbers to indicate whether you have (0) never been involved in the event or involved 1,2,3,4,5 or 6 or more times.

01 How many times have you run so low on fuel (NOT because of equipment failures) that you were seriously concerned about making it to an airport before you ran out?  
0 1 2 3 4 5 6+

02 How many times have you made a precautionary or forced landing at an airport other than your original destination?  
0 1 2 3 4 5 6+

03 How many times have you made a precautionary or forced landing away from an airfield?  
0 1 2 3 4 5 6+

04 How many times have you inadvertently stalled an aircraft?  
0 1 2 3 4 5 6+

05 How many times have you become so disorientated that you had to land or call ATC for assistance in determining your location?  
0 1 2 3 4 5 6+

06 How many times have you had a mechanical failure which jeopardised the safety of your flight?  
0 1 2 3 4 5 6+

(For example, nav failure while on a cross-country; landing gear stuck in up position, engine running rough or quitting.)

07 How many times have you had an engine quit because of fuel starvation, either because you ran out of fuel or because of improper pump or fuel tank selection?  
0 1 2 3 4 5 6+
<table>
<thead>
<tr>
<th>Number</th>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>08</td>
<td>How many times have you flown into areas of instrument meteorological conditions, without an instrument rating or an instrument qualified craft?</td>
<td>0 1 2 3 4 5 6+</td>
</tr>
<tr>
<td>09</td>
<td>How many times have you become so disoriented after entering instrument meteorological conditions that you had difficulty in maintaining control of the aircraft?</td>
<td>0 1 2 3 4 5 6+</td>
</tr>
<tr>
<td>10</td>
<td>How many times have you turned back or diverted to another airport because of bad weather while on a VFR flight?</td>
<td>0 1 2 3 4 5 6+</td>
</tr>
<tr>
<td>11</td>
<td>How many times have you made what you later considered to be a very bad decision (something you would never do again) that could easily have resulted in an accident had circumstances been slightly different?</td>
<td>0 1 2 3 4 5 6+</td>
</tr>
</tbody>
</table>

(For example, deciding to press on to your destination in the face of deteriorating weather and landing just minutes before a severe storm front passes through.)

<table>
<thead>
<tr>
<th>Number</th>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>How many aircraft accidents have you been in (as a flightcrew member)?</td>
<td>0 1 2 3 4 5 6+</td>
</tr>
</tbody>
</table>
OPINIONS ABOUT FLYING (SLF)

<table>
<thead>
<tr>
<th>Circle</th>
<th>(01) I am a very careful pilot. 1 – 2 – 3 – 4 – 5</th>
<th>(02) I am a very cautious pilot. 1 – 2 – 3 – 4 – 5</th>
<th>(03) I fly enough to maintain proficiency. 1 – 2 – 3 – 4 – 5</th>
</tr>
</thead>
</table>

In comparison to other pilots of similar experience, how would you rate your own skill and judgement abilities?

<table>
<thead>
<tr>
<th>1 – Low 7 – High</th>
</tr>
</thead>
<tbody>
<tr>
<td>(04) Skill 1 – 2 – 3 – 4 – 5 – 6 – 7</td>
</tr>
<tr>
<td>(05) Judgement 1 – 2 – 3 – 4 – 5 – 6 – 7</td>
</tr>
</tbody>
</table>

In comparison to other pilots of similar experience, how would rate your own willingness to undertake risks in flying?

<table>
<thead>
<tr>
<th>1 – Much More Willing 7 – Much Less Willing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7</td>
</tr>
</tbody>
</table>

In comparison to other pilots of similar experience, how frequently do you take risks?

<table>
<thead>
<tr>
<th>1 – Much More Frequently 7 – Much Less Frequently</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7</td>
</tr>
</tbody>
</table>
Accident investigation statistics provide detailed information about the causes of general aviation accidents. Please estimate the percentage of general aviation accident which are attributed to each of the following categories. **Be sure to make your total estimates add up to 100.**

(GAAEST)

- Weather ______
- Pilot error ______
- Engine failure ______
- Maintenance problem ______
- Air traffic control error ______
- Structure/airframe ______

Accidents are more likely to occur in some phases of flight than others. Please rank order the following phases from **most** accidents (1) to **least** accidents (7).

(RANKP)

- Taxi-out ______
- Take-off ______
- Climb ______
- Cruise ______
- Enroute descent ______
- Final descent ______
- Touchdown ______

Rank the following factors in terms of how likely they are to cause accidents. Rank the items from **most likely** (1) to **least likely** (7).

(RANKF)

- Spatial disorientation ______
- Misuse of flight controls ______
- Flying into adverse weather ______
- Exercised poor judgement ______
- Problems with air traffic control ______
- Fatigue ______
- Violation of rules ______
Accident investigation statistics provide detailed information about the causes of general aviation accidents. If you were to be involved in such an accident, please rank order the following causal factors from most likely (1) to least likely (6).

(SRANKC)
(01) Weather
(02) Pilot error
(03) Engine failure
(04) Maintenance problem
(05) Air traffic control error
(06) Structure/airframe

Assuming you were the cause of an accident, rank the following factors in terms of the likelihood that these factors were involved. Rank the items from most likely (1) to least likely (7).

(SRANKF)
(01) Spatial disorientation
(02) Misuse of flight controls
(03) Flying into adverse weather
(04) Exercised poor judgement
(05) Problems with air traffic control
(06) Fatigue
(07) Violation of rules
Assuming that you fly 100 hours per year on average, what is the likelihood that you will be involved in an accident sometime in the next ten years? **Tick One.** (RISK10Y)

- 1 in 1,000,000
- 1 in 100,000
- 1 in 10,000
- 1 in 1000
- 1 in 100
- 1 in 10

What do you find most rewarding about flying?
AERONAUTICAL DECISION-MAKING QUESTIONNAIRE
2002 SR Flight, Decision Point One
(In Flight)

PilotID:
ANSWER THE FOLLOWING QUESTIONS FROM THE MOMENT BEFORE THE SIMULATION WAS PAUSED. PLEASE BE AS ACCURATE AS YOU CAN.

(S1PEST)

(01) How long did the flight take up until the time the screen was turned off? ______ minutes

(02) What is your airspeed? ______ knots

(03) What is your heading? ______ °

(04) What is your altitude AMSL? ______ feet

(05) What is your altitude AGL? ______ feet

(06) What is your rate of climb/descent? ______ fpm

(07) How much fuel is left? ______ % of full

(08) What altitude AGL is the cloud base at your current position? ______ AGL

(09) What altitude AMSL is the cloud base at your current position? ______ AMSL

(10) What altitude are the cloud tops at your current position? ______ AMSL

(11) What is your visibility? ______ kilometres

How comfortable were you with the situation when the simulation was stopped?

(S1COMF)

1 – Very Comfortable  10 – Very Uncomfortable

1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10
These scales consist of a number of words that describe different feelings and emotions. Read each item, and then circle the appropriate number next to that word. Indicate to what extent you feel this way right now. Use the following scale to record your answers.

<table>
<thead>
<tr>
<th></th>
<th>Very Slightly or Not At All</th>
<th>A Little</th>
<th>Moderately</th>
<th>Quite a Bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>(01)interested</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(02)distressed</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(03)excited</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(04)upset</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(05)safe</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(06)guilty</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(07)scared</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(08)hostile</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(09)enthusiastic</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(10)proud</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(11)irritable</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(12)alert</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(13)ashamed</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(14)inspired</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(15)nervous</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(16)determined</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(17)attentive</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(18)jittery</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(19)active</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>(20)afraid</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
What information do you remember about any airports in relation to your current position?
Please be sure to include the destination airport on the original flight plan.

**EITHER**

fill in the table below,

**OR**

draw a map in the space provided (see over) including the information under the headings in the table.

<table>
<thead>
<tr>
<th>Airport Name</th>
<th>Code</th>
<th>Distance</th>
<th>Estimated Flight Time</th>
<th>Heading</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESTINATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Map: Include the following information on each airport - name, code, distance, estimated flight time, heading.
Please be sure to include the destination airport on the original flight plan.
For the next question, please try to remember the overall situation the aircraft was in when the simulator was paused, and imagine yourself deciding what to do next. We would like you to describe the cues (personal, aircraft, environmental) you think are important in deciding what to do next.

Please write down the cues you can think of in the spaces below. You need not use all the spaces. Please be as specific as possible. For example, if there is feature of the weather that is important in your decision, try to name the feature itself, rather than putting just “Weather”.

<table>
<thead>
<tr>
<th>Name of Cue</th>
<th>Briefly describe cue.</th>
<th>Why is it important?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>
For the following question please do not refer back to, or add items to, your responses on the previous page.

From the following list, **tick** which cues are important in deciding what to do next. You may tick items that you did not mention on the previous page, if you think they are important. **Then** rate the importance of the cues **you ticked** in this decision using the scale below.

<table>
<thead>
<tr>
<th>(S1CUE)</th>
<th>TICK</th>
<th>RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(01)Cloud-base characteristics</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(02)Horizontal visibility</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(03)Darkened cloud</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(04)Increasing cloud concentration</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(05)Rain showers</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(06)Distance between cloud-base and horizon</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(07)Cloud type</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(08)Wind direction</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(09)Wind velocity</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(10)Cloud proximity to aircraft</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(11)Visibility of ground or water</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(13)Fuel</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(14)Terrain</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(15)Distance from departure/destination</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(16)Feelings of unease or anxiety about the general situation</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(17)Feelings of unease or anxiety about a specific aspect of the situation or environment (please specify)</td>
<td>☐</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
</tbody>
</table>

Aspect/s: __________________________

(18)Other (please state below)                      | ☐    | 1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10 |
Please rate the following possible courses of action options below using the scale provided.

(S1COA)

1 – Unsatisfactory  10 – Ideal

(a) Continue to Tillamook (S47).
1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10

(b) Make a precautionary landing at closest available airstrip.
1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10

(c) Divert to another airport other than your departure airport.
1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10

(d) Return to Departure Airport.
1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10

(e) Orbit at current position.
1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10

What is your **MOST PREFERRED** course of action from your current point onward?

(S1MPCOA)

**TICK ONE**

a) Continue to Tillamook (S47).

b) Make a precautionary landing at closest available airstrip.

c) Divert to another airport other than the closest available airstrip or your departure airport.

d) Return to Departure Airport.

e) Orbit at current position.

Please answer the questions on the following 3 pages as they apply to the *most preferred* course of action you have indicated in the question above. Write out your *most preferred* course of action on the line provided at the top of the next page.
My most preferred course of action is ____________________________________

Give specific details of your most preferred course of action under the headings below.

(S1ER)
(01) Destination:

(02) Estimated distance to destination:

(03) Estimated flight time to destination:

(04) Heading to destination:

(05) Cruise Altitude:

(06) Airspeed:

(07) Specify Intended Route:

(08) What navigation points will you use? (e.g. VORs, landmarks)

Describe important aspects of the terrain you will fly over on your most preferred course of action.

(09) Maximum terrain altitudes:

(10) Prominent features:

(11) Terrain (Circle One)

<table>
<thead>
<tr>
<th>RISING</th>
<th>LOWERING</th>
<th>FLAT</th>
<th>UNDULATING</th>
</tr>
</thead>
</table>

(12) What are your immediate goals for your most preferred course of action? (e.g. land as soon as possible, avoid cloud, etc.).
How confident are you that your most preferred course of action will have a successful outcome? (Circle)
(S1OCCONF)

1 – Not at all Confident 10 – Extremely Confident

1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10

(S1ER)
If you were now to fly your most preferred course of action, what weather would you expect to encounter on your intended route?

(13) Cloud Base AGL ______ AGL
(14) Cloud Base AMSL ______ AMSL
(15) Cloud tops AMSL ______ AMSL
(16) Cloud type(s)...

(17) Wind direction ______ o
(18) Wind speed ______ knots
(19) Visibility ______ km
(20) Additional detail...

How certain are you that this is the best course of action? (Circle)
(S1COACRT)

1 – Not at all certain 10 – Absolutely certain

1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10
(S1VFRVIO)

Does your most preferred course of action violate VFR flight rules?

Yes
No

If YES, in what respect?

No

(S1OPT)

Did you consider any other options before settling on the course of action you chose?

Yes
No

If YES, give specific details.

No

(S1MOD)

Once you decided upon your course of action, did you make any further modifications to your plan? If YES, give specific details.

No

(S1SHD)

Is there any other information that you think you should have considered in choosing your course of action but didn't? If YES, give specific details?

No

If your MOST PREFERRED COURSE OF ACTION was Option 'a' – Continue to Tillamook (S47) then please skip this question (and go to next page)
Describe important aspects of the terrain you would fly over if the original course to Tillamook (S47) is continued.

(S1ER)

(21) Maximum terrain altitudes:

(22) Prominent features:

(23) Terrain (Circle One):

<table>
<thead>
<tr>
<th></th>
<th>RISING</th>
<th>LOWERING</th>
<th>FLAT</th>
<th>UNDULATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight Options</td>
<td>Potential Benefits</td>
<td>Potential Costs</td>
<td>Riskiness (Circle)</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------</td>
<td>-----------------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td>Orbit at current position.</td>
<td>Your departure airport.</td>
<td>Available airstrip or other than the closest</td>
<td>1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10</td>
<td></td>
</tr>
<tr>
<td>Divert to another airport other than the closest available airstrip or your departure airport.</td>
<td>Available airstrip.</td>
<td>Landing at closest</td>
<td>1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10</td>
<td></td>
</tr>
<tr>
<td>Make a precautionary landing at closest available airstrip.</td>
<td></td>
<td></td>
<td>1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10</td>
<td></td>
</tr>
<tr>
<td>Return to Departure Airport.</td>
<td></td>
<td></td>
<td>1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10</td>
<td></td>
</tr>
<tr>
<td>Continue to Tillamook (S47).</td>
<td></td>
<td></td>
<td>1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10</td>
<td></td>
</tr>
</tbody>
</table>
AERONAUTICAL DECISION-MAKING QUESTIONNAIRE
2002 SR Flight, Decision Point Two
(In Flight)

PilotID:
ANSWER THE FOLLOWING QUESTIONS FROM THE MOMENT BEFORE THE SIMULATION WAS PAUSED. PLEASE BE AS ACCURATE AS YOU CAN.

(S2PEST)
(01) How long did the flight take up until the time the screen was turned off? ______ minutes

(02) What is your airspeed? ______ knots

(03) What is your heading? ______ °

(04) What is your altitude AMSL? ______ feet

(05) What is your altitude AGL? ______ feet

(06) What is your rate of climb/descent? ______ fpm

(07) How much fuel is left? ______ % of full

(08) What altitude AGL is the cloud base at your current position? ______ AGL

(09) What altitude AMSL is the cloud base at your current position? ______ AMSL

(10) What altitude are the cloud tops at your current position? ______ AMSL

(11) What is your visibility? ______ kilometres

How comfortable were you with the situation when the simulation was stopped?
(S2COMF)

1 – Very Comfortable 10 – Very Uncomfortable

1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10
These scales consist of a number of words that describe different feelings and emotions. Read each item, and then circle the appropriate number next to that word. Indicate to what extent you feel this way **right now**. Use the following scale to record your answers.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Slightly or Not At All</td>
<td>A Little</td>
<td>Moderately</td>
<td>Quite a Bit</td>
<td>Extremely</td>
</tr>
<tr>
<td>(S2PANA)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(01)interested</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(02)distressed</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(03)excited</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(04)upset</td>
<td>1 2 3 4 5</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(05)safe</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(06)guilty</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(07)scared</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(08)hostile</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(09)enthusiastic</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(10)proud</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(11)irritable</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(12)alert</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(13)ashamed</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(14)inspired</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(15)nervous</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(16)determined</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(17)attentive</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(18)jittery</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(19)active</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(20)afraid</td>
<td>1 2 3 4 5</td>
<td></td>
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</tr>
</tbody>
</table>

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What information do you remember about any airports in relation to your current position? Please be sure to include the destination airport on the original flight plan.

**EITHER**

fill in the table below,

**OR**

draw a map in the space provided (see over) including the information under the headings in the table.

<table>
<thead>
<tr>
<th>Airport Name</th>
<th>Code</th>
<th>Distance</th>
<th>Estimated Flight Time</th>
<th>Heading</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESTINATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Map: Include the following information on each airport - name, code, distance, estimated flight time, heading.

Please be sure to include the destination airport on the original flight plan.
For the next question, please try to remember the overall situation the aircraft was in when the simulator was paused, and imagine yourself deciding what to do next. We would like you to describe the cues (personal, aircraft, environmental) you think are important in deciding what to do next.

Please write down the cues you can think of in the spaces below. You need not use all the spaces.

Please be as specific as possible. For example, if there is feature of the weather that is important in your decision, try to name the feature itself, rather than putting just “Weather”.

<table>
<thead>
<tr>
<th>Name of Cue</th>
<th>Briefly describe cue.</th>
<th>Why is it important?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
For the following question please do not refer back to, or add items to, your responses on the previous page.

From the following list, tick which cues are important in deciding what to do next. You may tick items that you did not mention on the previous page, if you think they are important. Then rate the importance of the cues you ticked in this decision using the scale below.

<table>
<thead>
<tr>
<th>(S2CUE)</th>
<th>TICK</th>
<th>RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(01) Cloud-base characteristics</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(02) Horizontal visibility</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(03) Darkened cloud</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(04) Increasing cloud concentration</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(05) Rain showers</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(06) Distance between cloud-base and horizon</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(07) Cloud type</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(08) Wind direction</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(09) Wind velocity</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(10) Cloud proximity to aircraft</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(11) Visibility of ground or water</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(13) Fuel</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(14) Terrain</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(15) Distance from departure/destination</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(16) Feelings of unease or anxiety about the general situation</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(17) Feelings of unease or anxiety about a specific aspect of the situation or environment (please specify)</td>
<td></td>
<td>Aspect/s: ______________________</td>
</tr>
<tr>
<td>(18) Other (please state below)</td>
<td></td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
</tbody>
</table>
Please rate the following possible courses of action options below using the scale provided.

(S2COA)

<table>
<thead>
<tr>
<th>1 – Unsatisfactory</th>
<th>10 – Ideal</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Continue to Tillamook (S47).</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(b) Make a precautionary landing at closest available airstrip.</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(c) Divert to another airport other than the your departure airport.</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(d) Return to Departure Airport.</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
<tr>
<td>(e) Orbit at current position.</td>
<td>1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10</td>
</tr>
</tbody>
</table>

What is your **MOST PREFERRED** course of action from your current point onward?

(S2MPCOA)

<table>
<thead>
<tr>
<th>1 – Unsatisfactory</th>
<th>10 – Ideal</th>
</tr>
</thead>
<tbody>
<tr>
<td>(f) Continue to Tillamook (S47).</td>
<td>✔️</td>
</tr>
<tr>
<td>(g) Make a precautionary landing at closest available airstrip.</td>
<td>✔️</td>
</tr>
<tr>
<td>(h) Divert to another airport other than the closest available airstrip or your departure airport.</td>
<td>✔️</td>
</tr>
<tr>
<td>(i) Return to Departure Airport.</td>
<td>✔️</td>
</tr>
<tr>
<td>(j) Orbit at current position.</td>
<td>✔️</td>
</tr>
</tbody>
</table>

Please answer the questions on the following 3 pages as they apply to the **most preferred** course of action you have indicated in the question above. Write out your **most preferred** course of action on the line provided at the top of the next page.
My most preferred course of action is ____________________________________

Give specific details of your most preferred course of action under the headings below.

(S2ER)

(01) Destination:

(02) Estimated distance to destination:

(03) Estimated flight time to destination:

(04) Heading to destination:

(05) Cruise Altitude:

(06) Airspeed:

(07) Specify Intended Route:

(08) What navigation points will you use? (e.g. VORs, landmarks)

Describe important aspects of the terrain you will fly over on your most preferred course of action.

(09) Maximum terrain altitudes:

(10) Prominent features:

(11) Terrain (Circle One)

   RISING   LOWERING   FLAT   UNDULATING

(12) What are your immediate goals for your most preferred course of action? (e.g. land as soon as possible, avoid cloud, etc.).
How confident are you that your *most preferred* course of action will have a successful outcome? (Circle)

(S2OCCONF)

1 – Not at all Confident  10 – Extremely Confident

1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10

(S2ER)

If you were now to fly your *most preferred* course of action, what weather would you expect to encounter on your intended route?

(13) Cloud Base AGL  
(14) Cloud Base AMSL  
(15) Cloud tops AMSL  
(16) Cloud type(s)…

(17) Wind direction  
(18) Wind speed  
(19) Visibility  
(20) Additional detail…

How certain are you that your *most preferred* course of action is the best course of action? (Circle)

(S2COACRT)

1 – Not at all certain  10 – Absolutely certain

1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10
(S2VFRVIO)

Does your *most preferred* course of action violate VFR flight rules?  
Yes ☐  No ☐

If YES, in what respect?

(S2OPT)

Did you consider any other options before settling on the course of action you chose?  
Yes ☐  No ☐

If YES, give specific details.

(S2MOD)

Once you decided upon your course of action, did you make any further modifications to your plan? If YES, give specific details.  
Yes ☐  No ☐

(S2SHD)

Is there any other information that you think you *should* have considered in choosing your course of action but didn't? If YES, give specific details?  
Yes ☐  No ☐
If your MOST PREFERRED COURSE OF ACTION was Option 'a' – Continue to Tillamook (S47) then please skip this question (and go to next page)

Describe important aspects of the terrain you would fly over if the original course to Tillamook (S47) is continued.

(S2ER)

(21) Maximum terrain altitudes:

(22) Prominent features:

(23) Terrain (Circle One):

<table>
<thead>
<tr>
<th>Rising</th>
<th>Lowering</th>
<th>Flat</th>
<th>Undulating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight Options</td>
<td>Potential Benefits</td>
<td>Potential Costs</td>
<td>Riskiness (Circle)</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------</td>
<td>----------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Orbit at current position</td>
<td>Your departure airport or available airstrip or landing at closest airport</td>
<td>Make a precautionary landing at closest available airstrip</td>
<td>9/10</td>
</tr>
<tr>
<td>Divert to another airport other than the closest available airstrip or your departure airport</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
</tr>
<tr>
<td>Continue to Tillamook (S47)</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
<td>1-2-3-4-5-6-7-8-9-10</td>
</tr>
</tbody>
</table>
AERONAUTICAL DECISION-MAKING QUESTIONNAIRE

GPS QUESTIONNAIRE

(Post Flight)

No.
GPS EXPERIENCE

Answer the following questions from your experience of using the Bendix King KLN 89 GPS navigation system in this study.

For the following set of questions refer to the scale below.

1 – Never    7 – Always

Did you use the GPS as the main navigation aid for VFR flight?

1 – 2 – 3 – 4 – 5 – 6 – 7

Did you use the GPS as the secondary navigation aid for VFR flight?

1 – 2 – 3 – 4 – 5 – 6 – 7

How often did you use the following navaids when using GPS?

NDB  1 – 2 – 3 – 4 – 5 – 6 – 7

VOR  1 – 2 – 3 – 4 – 5 – 6 – 7

DME  1 – 2 – 3 – 4 – 5 – 6 – 7
Answer the following set of questions from the perspective of what difference the GPS made as compared with how you would imagine completing the flights without it.

Refer to the scale below.

**1 – Decreases Greatly  7 – Increases Greatly**

Extent that GPS changed your physical workload?
1 – 2 – 3 – 4 – 5 – 6 – 7

Extent that GPS changed your mental workload?
1 – 2 – 3 – 4 – 5 – 6 – 7

Extent that GPS changed your use of maps and charts?
1 – 2 – 3 – 4 – 5 – 6 – 7

Extent that GPS changed your 'head-down' time?
1 – 2 – 3 – 4 – 5 – 6 – 7

Extent that GPS changed your lookout?
1 – 2 – 3 – 4 – 5 – 6 – 7

Extent that GPS changed you instrument scan?
1 – 2 – 3 – 4 – 5 – 6 – 7

Extent that GPS changed your position awareness?
1 – 2 – 3 – 4 – 5 – 6 – 7

Extent that GPS changed your airspace awareness?
1 – 2 – 3 – 4 – 5 – 6 – 7

Extent that GPS changed your terrain awareness?
1 – 2 – 3 – 4 – 5 – 6 – 7

Extent that GPS changed your overall situation awareness?
1 – 2 – 3 – 4 – 5 – 6 – 7

Extent that GPS changed your tracking accuracy?
1 – 2 – 3 – 4 – 5 – 6 – 7
GPS RECEIVER DESIGN

For the following questions refer to the scale below.

Control Layout

1 – 2 – 3 – 4 – 5 – 6 – 7

Control Labeling

1 – 2 – 3 – 4 – 5 – 6 – 7

Alphanumeric symbols readability

1 – 2 – 3 – 4 – 5 – 6 – 7

Moving-map symbols readability

1 – 2 – 3 – 4 – 5 – 6 – 7

Overall, how easy is the receiver to use

1 – 2 – 3 – 4 – 5 – 6 – 7

Degree of design compatibility with other GPS systems

1 – 2 – 3 – 4 – 5 – 6 – 7

Consistency of receiver operation with your expectancy of how it should operate

1 – 2 – 3 – 4 – 5 – 6 – 7

Ease of learning

1 – 2 – 3 – 4 – 5 – 6 – 7

Ease of finding nearest waypoint

1 – 2 – 3 – 4 – 5 – 6 – 7

Ease of programming 'Direct to' function

1 – 2 – 3 – 4 – 5 – 6 – 7

Ease of using 'Nearest' function

1 – 2 – 3 – 4 – 5 – 6 – 7
Navigating with the alphanumeric (non-map) display.

For the following questions refer to the scale below.

| 1  – Extremely Poor | 7  – Extremely Good |

Overall usability

1 – 2 – 3 – 4 – 5 – 6 – 7

Use for VFR tracking

1 – 2 – 3 – 4 – 5 – 6 – 7

Use for position fixing

1 – 2 – 3 – 4 – 5 – 6 – 7

Use for terrain awareness

1 – 2 – 3 – 4 – 5 – 6 – 7

Use for airspace awareness

1 – 2 – 3 – 4 – 5 – 6 – 7

Use for overall situation awareness

1 – 2 – 3 – 4 – 5 – 6 – 7
Navigating with the moving-map display.

Did you use the moving-map display during the flights?

Yes ☐
No ☐

If 'Yes', continue below. If 'No', please go on to the next page.

For the following questions refer to the scale below.

1 – Extremely Poor  7 – Extremely Good

Overall usability

Use for VFR tracking

Use for position fixing

Use for terrain awareness

Use for airspace awareness

Use for overall situation awareness
GPS Receiver Functions/Information

For the following questions refer to the scale below.

1 – Not At All Useful   7 – Extremely Useful

Present position
1 – 2 – 3 – 4 – 5 – 6 – 7

Direct to
1 – 2 – 3 – 4 – 5 – 6 – 7

Nearest
1 – 2 – 3 – 4 – 5 – 6 – 7

Groundspeed
1 – 2 – 3 – 4 – 5 – 6 – 7

CDI-bar
1 – 2 – 3 – 4 – 5 – 6 – 7

Desired Track
1 – 2 – 3 – 4 – 5 – 6 – 7

Airport Information
1 – 2 – 3 – 4 – 5 – 6 – 7

Comms frequency information
1 – 2 – 3 – 4 – 5 – 6 – 7

Moving-map display
1 – 2 – 3 – 4 – 5 – 6 – 7