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THE DECIDE APPROACH TO TRAINING PILOTS IN PILOT DECISION MAKING

Presented by
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The Third International Pilot
Decision Making Conference
Ottawa, Canada
December 2-3, 1986

This paper presents an alternative approach to teaching pilot decision making and summarizes a research project conducted by the AOPA Air Safety Foundation to develop and test a new decision making training program.

Everyone at this meeting recognizes the importance of developing and teaching decision making in the aviation environment, therefore, the usual background discussion concerning the role of decision making in aircraft accidents will be omitted. Instead, more time will be devoted to the discussion of a decision making model which has been successful in training emergency response personnel and has now been tested on general aviation pilots.

In 1974, Ludwig Benner, Jr. developed a decision making training program for firefighters when responding to hazardous materials emergencies. The training developed from a need to teach new techniques for handling hazardous materials instead of the traditional fire fighting methods. Mr. Benner developed this training program based on his experience as an accident investigator with the National Transportation Safety Board (NTSB).

This training program presents a process approach to decision making, which differs from many of the traditional methods of teaching judgment on the basis of personality attributes. There are similarities between the traditional training administered to both firefighters and pilots. The traditional approach to pilot training is to teach student pilots the capabilities and flight characteristics of an aircraft and its systems; knowledge of the national airspace system; general knowledge of meteorology regulations; emergency procedures and "stick and rudder" type skills. The premise being that, if student pilots have this kind of information, they will be able to exercise the "good judgment" required to assure safe flight.

I was first exposed to Mr. Benner's training program eight years ago, and was impressed with the DECIDE model for teaching decision making and as a tool for accident investigation. The simplicity of DECIDE was successful with firefighters, and appeared adaptable for use by general aviation pilots.

The DECIDE training has an impressive record. Since first introduced in 1974, more than 135,000 emergency response personnel have received training in the DECIDE process. What is more impressive is there have not been any fatalities in the United States among the personnel receiving this training.

In 1985, the AOPA Air Safety Foundation received a grant from Buehler Aviation Research, Inc. (a private foundation dedicated to the advancement of general aviation safety and technology) to develop a decision making training program based on the DECIDE model for general aviation pilots. The following project team was assembled to develop and test the training:

- o AOPA Air Safety Foundation Russell Lawton
- o Events Analysis, Inc. - Ludwig Benner, Jr. and Richard Clarke
- o The Ohio State University - Richard Jensen, Ph.D., Janeen Adrion, Ph.D. and Jeffrey Maresh

Approach

The project was conducted as a three level program of research and methodological development. The first level applied new techniques in accident analysis to arrive at an accurate picture of selected accidents/incidents which exemplified problems in decision making. Development and refinement of a technique for reviewing decision making in these accidents/incidents followed. This technique was the basis for the new instructional approach.

The second level combined the decision making model with training techniques and the research resources of The Ohio State University (OSU) Department of Aviation. The result was a training package for student use, audiovisual support materials and an instructional approach/guide to teaching the DECIDE model.

The final level devised a method of testing and documenting decision making situations in flight. The OSU group combined flight simulation resources with a performance evaluation system that combined post-flight debriefings with recording aircraft performance and video recording the cockpit actions of the subjects.

Accident Model

One problem when analyzing decision making is the perception that accidents are single events with single causes. Where accidents involve the decision making process, there seldom is little comprehension of the complexity of the process. For this project, accidents were reviewed using a refined model. The accident was viewed as a process combining one or more people, the aircraft and the environment over a period of time. The technique is called Simultaneous Time/Event Process (STEP) and uses a graphic depiction of people's sequential events occurring parallel with each other over time (A sample STEP chart is shown in Figure 1 and was renamed Events Flowchart for ease of understanding by the subjects). The advantage to using STEP is to permit identification of decision events and the interactions of people and things during those events. Time constraints and the effects on the decision making process become apparent when STEP is used to review the accident process.

Accident Research

Representative accident cases were selected to illustrate the successful and unsuccessful outcomes of decisions made by pilots, controllers, managers, etc. Four accidents/incidents were selected for review. Three cases involved

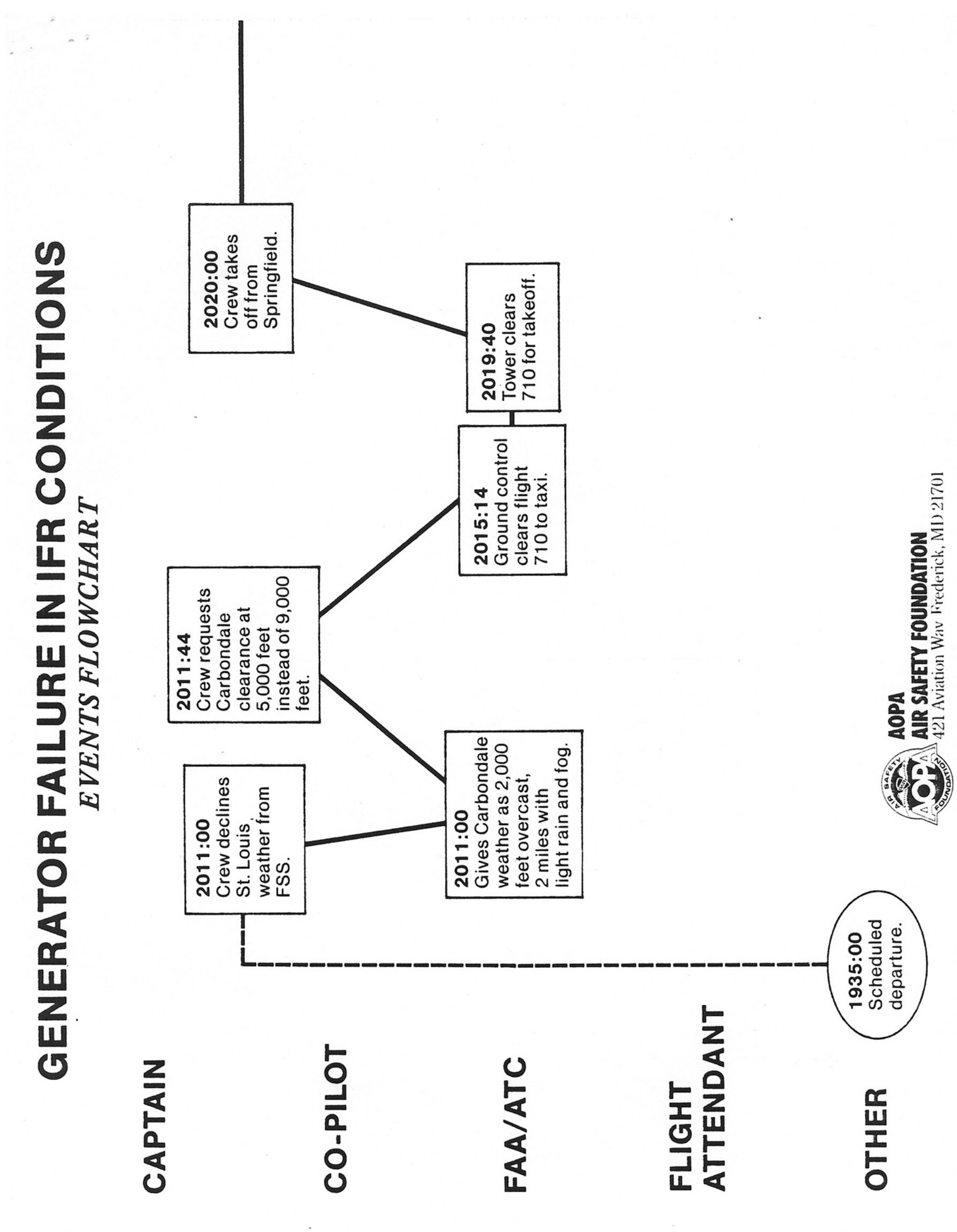
GENERATOR FAILURE IN IFR CONDITIONS
EVENTS FLOWCHART
CAPTAIN
CO-PILOT
FAA/ATC
FLIGHT ATTENDANT
OTHER
1935:00 Scheduled departure.
2011:00 Crew declines St. Louis weather from FSS.
2011:00 Gives Carbondale weather as 2,000 feet overcast, 2 miles with light rain and fog.
2011:44 Crew requests Carbondale clearance at 5,000 feet instead of 9,000 feet.
2015:14 Ground control clears flight 710 to taxi.
2019:40 Tower clears 710 for takeoff.
2020:00 Crew takes off from Springfield.
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Figure 1

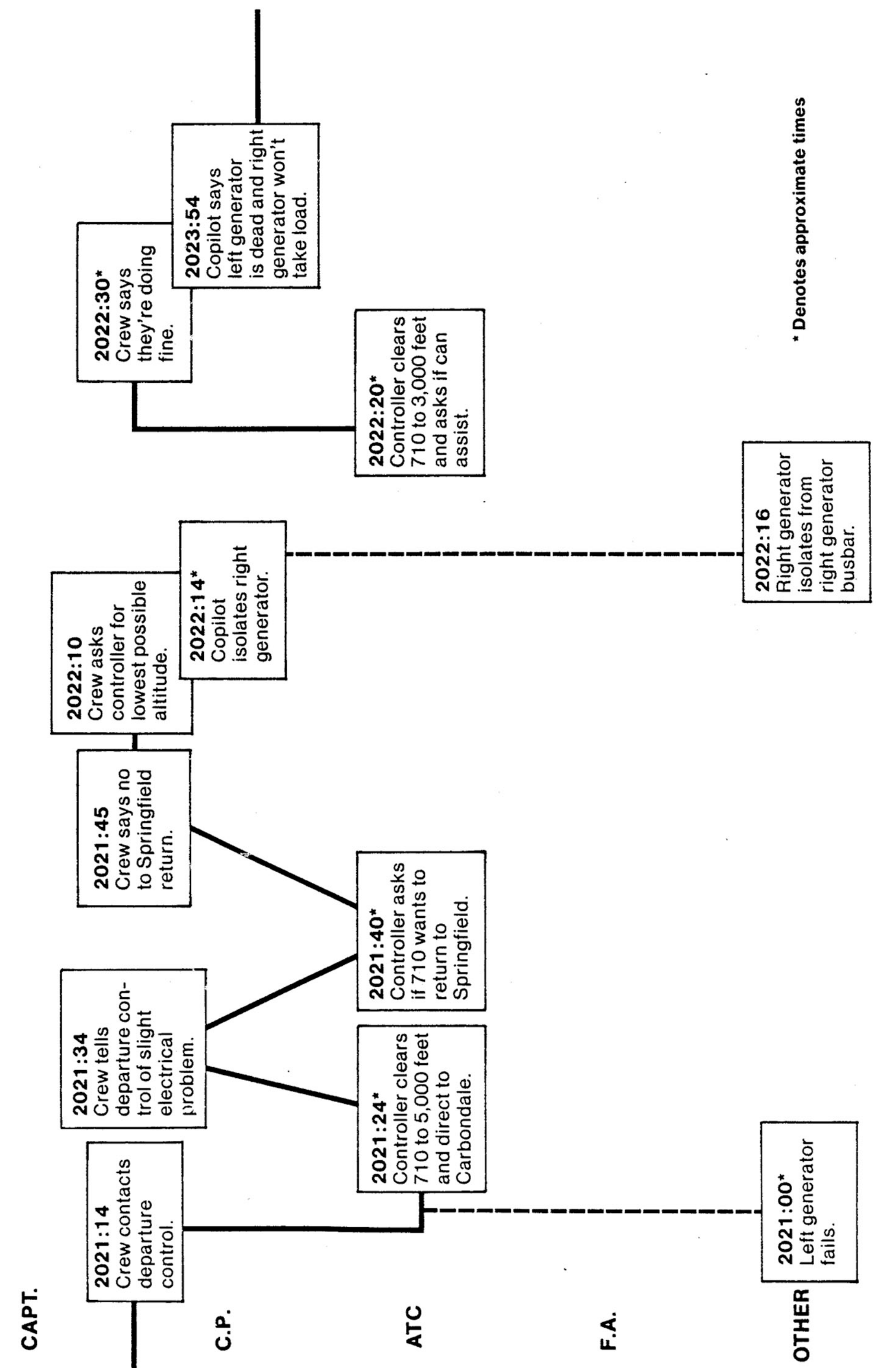


Figure 1 (continued)

Balance of chart not included here

fatalities or unsuccessful outcomes of the decision making process that were investigated by NTSB. The fourth case documented a successful outcome of pilot decision making. The four cases reviewed and subjected to STEP depiction were:

o A Pilgrim Airlines Twin Otter accident involving elements of flight planning, weather and fuel exhaustion.

o An Air Illinois HS-748 accident involving weather and mechanical malfunctions.

o A flying club Cessna 172 accident involving weather, flight planning and fuel exhaustion.

o An owner flown Cessna 210 incident involving weather, pilot qualifications and flight planning.

Each case was a good example of the process and act of decision making and each illustrated the time available for the process to continue. The major problem in seeking these cases was not one of finding examples of unsuccessful outcomes, since accidents are well documented. The difficulty was finding successful outcomes in decision making. There are requirements concerning investigation and documentation of accidents, but none exist for documentation of non-accidents.

Decision Model

Based on Mr. Benner's previous experience in researching the decisions of firefighters, a model of the decision making process (Figure 2) was developed and compared to the accident cases. The initial decision model consisted of the following steps:

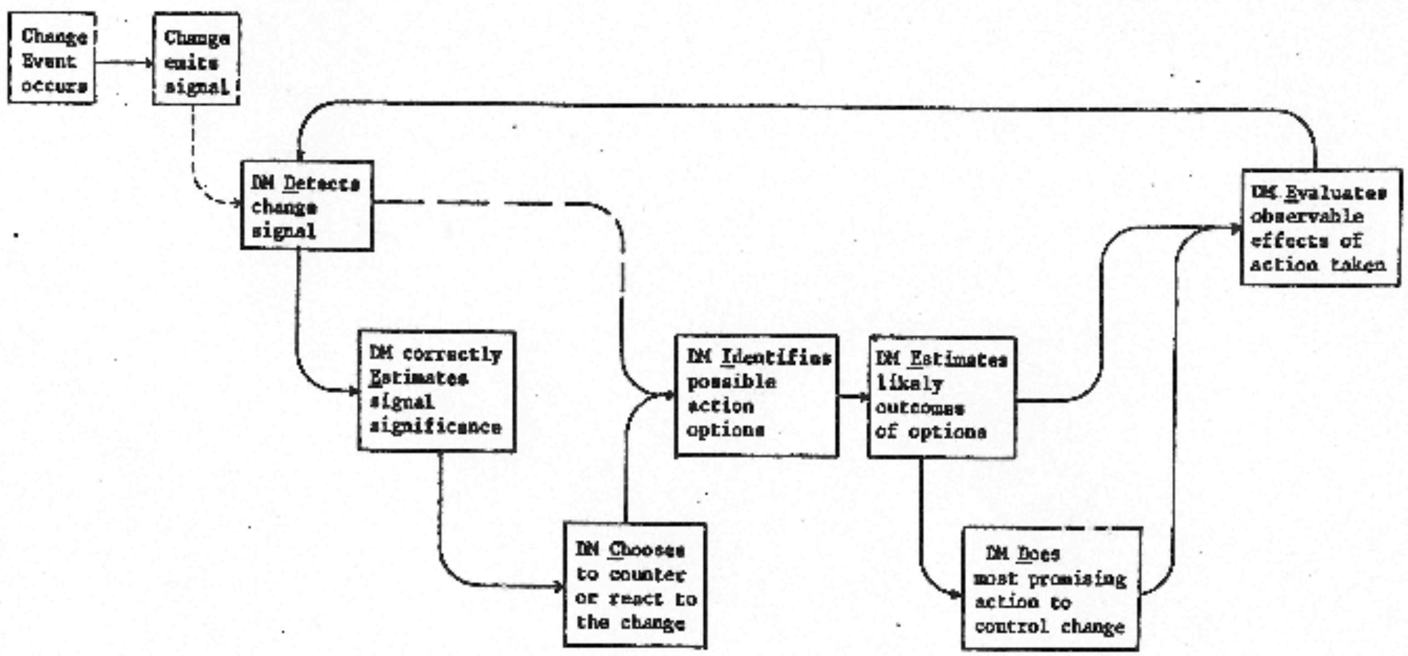
1. Unexpected change occurs/expected change doesn't occur/desired change doesn't occur - To the reviewer, this begins the decision set. The key is that some change occurs to the process of the flight, a change from normal, or from the expected condition, or from the desired condition. In the case of desire, it seems that there is sometimes a difference between what a decision maker expects to happen (implying certainty) and what the decision maker may hope will happen (implying uncertainty).

2. Change emits signal - The decision maker needs a signal from the change before reaction can begin. In many instances, the decision set is relatively brief and the change emits a signal, however, there are instances where the change may occur and the decision maker does not receive a signal for a period of time, e.g., a controller does not know if an aircraft is low on fuel until informed by the pilot. In this example, the decision set is operating even though the controller cannot act.

3. Decision maker detects signal - As mentioned previously, an important element in the process is the detection of change.

PILOT DECISION MAKING PROCESS MODEL

Representation of decision making cycle for each Aviation Decision Set



Source: Adapted from HAZARDOUS MATERIALS EMERGENCIES, Events Analysis, Inc.

Figure 2.

4. Decision maker correctly projects signal meaning - The reviewer looks for signs that the decision maker foresees the implication of the change on the outcome or success of the flight.

5. Decision maker recognizes the need to counter/react to change - Decision makers usually need to counter a change since many of the changes noted have potential negative or loss outcomes. In some instances, the change is benign in its occurrence, e.g., a controller may not react to a call from a pilot due to heavy involvement with other communications. Responding to a pilot's call is not an act of countering, but is one of reaction.

6. Decision maker seeks possible action options - The decision maker recalls or seeks options to counter/react to the change.

7. Decision maker estimates the likely outcome of the options selected - This requires a projection of the events likely to occur from each of the selected options. Seldom is there direct evidence of this step in the process unless the decision maker specifically refers to it or it is documented in conversation.

8. Decision maker picks best action to control change - This is viewed as selecting an action that successfully modifies the change. There are instances where it is possible to judge whether the action was the best option when the options are clearly known and the reviewer is knowledgeable on the subject.

9. Decision maker acts to adapt to the change - Action is either taken or not taken.

10. Decision maker watches for effects of the countering action or reaction -The decision maker may or may not stay involved in the decision process by monitoring his or her action to achieve the desired outcome.

Decision Making Analysis

The accident cases were reviewed for decision sets and coded on a matrix worksheet. Each decision was reviewed and coded on the worksheet as a yes/no evaluation for each of the steps in the decision making process. The purpose of this analysis was to determine whether the accident/incident reports contained sufficient information to make decision analyses, and to characterize the decision patterns between the successful case and the unsuccessful ones. The analysis revealed that each of the unsuccessful cases had different patterns in the yes/no elements of the decision making process, however, similarities existed in specific failures in the process and grouping of the negative characteristics. In one accident, there was a failure to evaluate the results after taking action; in another accident, the failure seemed to be one of not considering the potential problems which could occur with further development of the situation. The significant difference in the successful case was that both the pilot and controllers maintained an active and positive decision making involvement which demonstrated forethought and continuous evaluation.

The decision model appeared to work well by grouping decision elements in horizontal rows (decision sets) and coding each element was accomplished by using a commercially available database program to store, sort and display the information. For human factors accident investigators, this could be a useful technique. For purposes of teaching pilots the elements of the decision making process, the original model was too complex and was reduced to a six element decision process using the acronym DECIDE. The steps in the DECIDE process are:

1. Detect - The decision maker detects the fact that a change has occurred.

2. Estimate - The decision maker estimates the need to counter or react to the change.

3. Choose - The decision maker chooses a desirable outcome (in terms of success) for the flight.

4. Identify - The decision maker identifies actions which could successfully control the change.

5. Do - The decision maker takes action to adapt to the change.

6. Evaluate - The decision maker evaluates the effects(s) of the action countering the change or reacting to it.

The six elements of the DECIDE model are a closed loop decision process which was used during analysis and during the instruction of the subjects. This condensed version of the original model provided a self-reinforcing training approach in the experimental training program. The Decision Making Worksheet in Figure 3 incorporates the DECIDE model and decision matrix for training purposes.

Training Strategy

Due to the size of the project and the availability of subjects, the training package was developed for a single presentation, but could be expanded should time and resources permit. Each training session covered:

o The role of pilot decision making in general aviation accidents.

o The decision making process (DECIDE); effects of personal factors (health, attitude, etc.); risk assessment elements of pilot, aircraft, environment and time.

o A discussion of the personal experiences of the subjects with respect to decision making.

o A review of the documented cases, comparing the successful and unsuccessful outcomes.

Role playing and overnight assignments were contemplated, but could not be conducted due to the inability of the subjects to attend more than one instructional session before participating in a simulator evaluation.

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GENERATOR FAILURE IN IFR CONDITIONS

Decision Making Worksheet

CHANGE - An UNEXPECTED change occurs or an EXPECTED change or DESIRED change doesn't occur	DETECTS change signal	ESTIMATES the need to counter/ react to the change	CHOOSES desired outcome for the flight	IDENTIFIES successful actions to control change	DOES something positive to adapt to the change	ACTION/REACTION description	EVALUATES effects of counterchange/ reaction
1. Left generator fails after instrument takeoff	Y	Y	N	N	Y	Copilot misidentifies failed generator and disconnects right generator	Y
2. Copilot tells departure control of slight electrical problem	Y	Y	Y	Y	Y	Departure control offers return to Springfield	Y
3. Crew gets departure control's Springfield offer	Y	Y	N	N	Y	Captain rejects and continues to Carbondale	Y
4. Right generator doesn't take electrical load	Y	Y	Y	Y	Y	Copilot tells captain of loss of right generator power	Y
5. Copilot tells captain of right generator electrical failure	Y	Y	N	N	Y	Captain requests lower altitude for VFR conditions	Y
6. Copilot tells captain battery voltage is dropping fast	Y	N	N	N	Y	Captain tells copilot to put load shedding switch off	Y
7. Copilot reminds captain of IFR weather at Carbondale	Y	N	N	N	N	No reaction	N
8. Copilot turns on radar to get a position	Y	Y	N	N	Y	Copilot tells captain about dropping voltage	Y
9. Copilot tells captain battery voltage is dropping	Y	Y	Y	Y	Y	Captain turns off the radar	Y
10. Copilot warns captain of low battery	Y	Y	Y	Y	Y	Captain starts descent to 2400 feet in IFR conditions	Y
11. Cockpit instruments start failing	Y	Y	Y	N	Y	Captain asks copilot if he's got any instruments	Y

Figure 3.

Training Sessions

In June, 1986, two five hour training sessions were conducted at the OSU Department of Aviation in Columbus, Ohio. The sessions were identical in content and were supplemented by handouts and audiovisual presentations of the accidents/incidents discussed previously. The subjects participated in exercises which included the successful application of decision making during which the subjects listened to an actual recording of conversations between the controllers and the pilot. Following the tape, the subjects evaluated the decision sets of the flight and discussed their evaluation of the DECIDE items within each decision set. Contrasts between the two unsuccessful cases and the final successful application of decision making were discussed with the subjects. Following these sessions, the subjects were eligible for a familiarization flight in the simulator followed by the actual experiment.

Experimental Design

The experiment utilized a Frasca 141 fixed-base flight simulator with a Silicon Graphics visual display. The simulator replicated a single-engine airplane (Piper PA-28), and was configured for a fixed-gear, fixed-pitch propeller. Recording of the simulator sessions was accomplished using a PDP-l1 computer to monitor simulator performance, audio recording of radio conversations between the subjects and the air traffic controller/simulator operator, and audio/video recording of the subjects actions and instrument indications in the simulator cockpit.

The scenario contemplated by each subject was a visual flight rules (VFR) cross-country flight in visual meteorological conditions (VMC) from Columbus, Ohio to Frederick, Maryland. The flight started from flat terrain, progressed over the mountains to an airport at the foot of the mountains. A weak front was forecast for a portion of the route. The subjects were briefed concerning the reason for the flight, and were given a complete weather briefing. Both the experimental and control group subjects were informed that they were participating in an evaluation of a new simulator and by doing so were aiding in "debugging" software problems. All subjects were eager to log free time in a new simulator.

The subjects were non-instrument rated private pilots from the Columbus, Ohio area. Some were undergoing training for the instrument rating. The following charts list the groups' characteristics:

Subject	Group	Gender	Age	Total Time	Sim. Time	90 Day Time	Inst. Time	Solo XC
1	E	M	22	233	47	35	25	56
2	E	F	21	180	20	60	15	30
3	E	M	20	104	0	10	1	30
4	E	M	17	60	0	20	0	18
5*	E	F	39	148	0	30	6	65
			23.8	145	13.5	31	9.4	40

Subject	Group	Gender	Age	Total Time	Sim. Time	90 Day Time	Inst. Time	Solo XC
6	C	M	22	120	8	5	0	UNK
7*	C	F	34	115	9	15	3	25
8	C	M	52	136	1	4	1	28
9	C	M	45	120	0	15	2	60
10*	C	F	38	230	0	4	2	55
			38.2	144	3.6	8.6	1.6	42

* Did not fly.

Three scheduled "changes" were introduced as each flight progressed, and the subjects' adaptation to the changes were monitored. The changes were arranged to be individually manageable but a problem in combination:

o Failure of the attitude indicator while in VMC.

o Onset of carburetor icing.

o Lowering ceiling and flight into clouds.

Other changes that might occur during the flight would result from actions or decisions of the subjects. Although the aircraft and environmental factors were determined by the experimental design, the pilots were surveyed immediately following each flight by a questionnaire in order to evaluate their overall state of fatigue, stress and health. Two five person groups were utilized: an experimental group which received the DECIDE training, and a control group which did not receive any formal decision making training. All subjects were provided a proficiency/familiarization flight prior to the actual flight in order to acquaint themselves with the simulator equipment and visual display.

After completing the familiarization flight, one of the experimental subjects and two of the control subjects elected not to attempt the flight. No statistically based conclusions could be inferred from the small sample size, however, some trends were apparent that may serve as a preliminary indication regarding the validity of the training method.

Results

The four experimental subject that flew made safe and normal returns to the airport of origin. All three of the control subjects who flew crashed. One of the control subjects followed the failed attitude indicator into the ground, while the other two failed to diagnose and correct the carburetor ice problem.

One experimental subject turned back due to a self-induced avionics problem before any of the planned changes were introduced. One other turned back when the attitude indicator failed. None turned back at the onset of carburetor ice, but correctly diagnosed and dealt with the carburetor ice problem. One turned back at the first encounter with the lowering ceiling. The final experimental subject continued after maintaining VMC but turned back after entering the clouds at a lower altitude. The subject executed a 180 degree turn and contacted air traffic control.

In general, the experimental subjects trained in DECIDE were more successful than the control subjects who did not receive any formal decision making training. No quantification of the data is practical due to the small sample size.

Conclusions

o The DECIDE training should be expanded to include individual practice and more exposure to problem solving/risk assessment techniques and the interaction of personality with the choice of objective for the flight. Overnight practice should be incorporated to allow the subjects to reflect on and use the principles of DECIDE. Role playing could also be used when discussing the well documented accident cases. Subject/instructor interaction could be increased by evaluating the overnight assignment and through the role playing exercise.

o The accident and decision evaluation systems and materials, as well as the training packages and techniques were effective in gaining the interest of the subjects and in communicating the desired information. Adaptation to audiovisual and study materials is practical.

o The small group of relatively low time pilots was highly receptive to the training. The training materials and methods should be adapted for pilots with greater flight time and experience. Specific training in decision making is currently conducted in multi-crew curricula. DECIDE could be useful at this level with appropriate modification of the examples and instructional discussions for a more sophisticated audience.

o Efforts should be made to document successful decision making situations. At present, only accidents and incidents investigated by NTSB serve as reliable sources of information.

o The subject pilots found the playback of the audio/video tapes of their flights during the debriefings to be very instructive. The researchers were also able to "freeze" the action each time the subject indicated that a change occurred. The subject and researcher discussed the reactions to the circumstances of the change in detail. The DECIDE model provided a good model for discussion of the change related actions and events.

AOPA/OSU ADM

DEBRIEFING QUESTIONNAIRE

Instruction

The following questions have been designed for standard debriefing of research specialist induced changes. Additional space is provided for completing subject induced changes. A change begins with the occurrence of an unexpected/unplanned event or an expected event which does not occur.

Changes

A. What changes (events, happenings) in this flight did you feel required a decision to be made? Subject Induced Change (indicate on evaluation sheet).

1. When did you detect this change (event, happening, ate.)?
2. Was this change cause for concern?
3. What was your desired outcome in this situation?
4. What options did you have in order to reach this outcome?
5. What did you actually do?
6. What was your reasoning for taking action on that option? Did your action give your the desired result?

B. Design Induced Change - Attitude Indicator Failure.

1. Did you notice the attitude indicator failure?
2. Was this failure cause for concern? Why?
3. What was your desired outcome? What influenced this?
4. Did you perceive different options available to you? What were they?
5. Did you do anything to remedy the problem? What?
6. After you did this, how did you eel about the problem?

C. Design Induced Change - Carburetor Ice

1. Did you detect the carburetor ice? How?
2. Were you concerned about it? Why?
3. What was your desired outcome? What influenced this?
4. What were your options in dealing with this situation?
5. Did you do anything to remedy the problem? What?
6. After you did this, how did you feel about the problem?

D. Design Induced Change - Deteriorating Weather

1. Did you realize you were flying into a cloud?
2. Were you concerned about the deteriorating weather?
3. What was your desired outcome? What influenced this?
4. What were your available options?
5. Did you do anything to remedy the problem? What?
6. After you did this, how did you feel about the problem?

AOPA/OSU ADM

Debriefing Evaluation Matrix

Subject Number_______

Instructions

Enter a "Y" in the space if the indicated event did occur. Enter a "N" if the indicated event did not occur. Use the following definitions:

D = Detected change.
E = Estimated significance of change.
C= Chose outcome objective..
I = Identified plausible action options.
D = Did best option.
E = Evaluated progress.

Change Comments (Indicate Change)

A. D____
E____
C____
I____
D____
E____

B. D____
E____
C____
I____
D____
E____

C. D____
E____
C____
I____
D____
E____

D. D____
E____
C____
I____
D____
E____