EXPERIMENTAL STUDY ON DECISION MAKING OF JET AIRLINER PILOTS -A CASE OF WIND SHEAR-

Ayako KONO*, Hiroki HATAKE, Kenichi RINOIE*,**
Asei TEZUKA*, and Ro KOBAYASHI****
*** Dept. Aeronautics and Astronautics, University of Tokyo, 113-8656, Japan**
**** All Nippon Airways Co., Ltd., 144-0041, Japan**
*****Dept. Applied Mechanics and Aerospace Engineering,**
Waseda University, 169-8555, Japan

Keywords: *Naturalistic Decision Making, Flight Management Skill, Decision Making in Normal Operation, Wind Shear, Flight Experience*

Abstract

This paper deals with jet airliner pilots' "Flight Management Skill" according to their experiences. "Flight Management Skill" is "an experience-based skill which airline pilots should manage for flight safety, for economic fuel saving expenditure, for punctual flight operation and for passenger comfort." In airline companies, they stress more importance on training younger pilots with this skill, because the number of pilots with a variety of experiences is decreasing.

In order to evaluate the relationship between pilots' experience and their level of "Flight Management Skill", the authors carried out flight simulation tests co-operated by airline pilots with various experiences. In this paper, the authors show the results of the simulation experiments by setting a scenario in which a wind shear arises just before landing. This scenario asks examinees to make important decisions based on the information and knowledge they have. Eight pilots with various careers participated in the experiment as examinees (four experienced captains and four co-pilots).

To examine the outcomes of the experimentation, the authors recorded the examinees' utterances, flight paths, the amount of remaining fuel, and the interview after each experiment. These data were arranged into "timelines" and "decision trees" etc. and were analyzed to compare the difference of examinees' "Flight Management Skill".

Some suppositions about experienced pilots' decisions were concluded as follows: Their decisions are made 1)flexibly according to the situation, 2)after considering the risks, and 3) relatively independent of external sources of information.

1 Introduction

1.1 The Main Objective of this Paper

The purpose of this paper is to show the specific features of the airline pilots' "Flight Management Skill" by examining their decision making process and patterns correlated with their experiences from experimental results. Furthermore, the authors would like to discuss the factors underlying these differences.

First of all, the definition of "Flight Management Skill" should be explained. According to Ide, et .al [1], the definition of "Flight Management Skill" is "an airline pilot's competence in managing any situation independently, without reliance on other flight crews, while tending to and balancing the following four management factors: flight safety, punctual flight operation, economic fuel usage (minimizing fuel consumption by optimal air

route, altitude and aircraft configurations), and passenger comfort (avoiding air turbulence and rapid maneuvering)".

1.2 Background

The background that the authors decided to adopt the objective of this paper shown above is as follows.

Firstly, it is a fact that the methods of training airline pilots to learn "non technical skills" such as Crew Resource Management (CRM) are becoming more significant recently [2]. It is reported that more than 50% of airplane accidents result from factors unrelated to flight techniques [3]. CRM is a non technical flight operation skill, and CRM skill training tools such as Line Oriented Flight Training (LOFT) are introduced in actual flight training. Even within the cockpit where multiple crew members operate the flight, it is required for each individual member to recognize potential threats and take actions to cope with them [4].

Secondly, a need to transmit the skill of experienced pilots to younger pilots more effectively in many airline companies arises in Japan, because the number of captains with long careers is decreasing rapidly due to an imbalanced population. However, these skills were previously regarded to be only learned from experience and there were only a few studies dealing with decision making skills during "normal" flight. According to reference [1], Ide, et.al. established several methods of evaluating pilots' risk management skills during normal flight by comparing the results of the flight experiment dealing with the case of a sudden runway close due to an earthquake. In this paper, to examine these kind of skills from a greater variety of perspectives, the authors executed the experiments in which pilots encounter wind shear and make a go around, because the scenario demands examinees to make important decisions during flight operation, and low altitude wind shear is a characteristic phenomenon in that its transition can be estimated unlike in the case of an earthquake.

Moreover, the decision making of pilots, which is an important factor of "Flight Management Skill", has been discussed as an essential part of flight operation, and many analyses have been conducted since around the 1970's. Naturalistic Decision Making (NDM), for example, is an intuitive decision making process which is reported to be adopted by experienced operators [3]. Comparing these studies with the results of flight simulation experiments is helpful to discuss the relationship between the pilots' ability to make optimal decisions and their flight experiences.

2 Experimental Details

The authors carried out flight simulation experiments co-operated by jet airliner pilots with various levels of experience in order to compare the differences of their decision making patterns according to their experiences.

The experiment was executed using a full-flight simulator in the ANA (All Nippon Airways) Training Center which is usually used during the flight training for the Boeing 767. The scenario of the experiment was proposed by the authors and ANA pilots conducting the study together.

We simulated the case in which examinees must perform a go around due to wind shear just before landing. The reason why we adopted this scenario is because in the case of wind shear, cockpit crew members have to consider many factors such as the timing of deciding to go around, weather, fuel amount and so on simultaneously. Therefore, the features of flight decision making would appear more clearly for the authors to study.

2.1 Test Examinees and Equipment

The pilots who participated in the test as examinees were four captains and four co-pilots for the Boeing 767 whose flight times are 600 hours to 15,000 hours (Table.1). The authors divided them into four groups according to their flight time:

1) Co-pilot A (Co-pilots whose flight times are less than 1,000 hours): Examinee 1 and 2 whose flight times are about 600 hours and 950 hours, respectively.

2) Co-pilot B (Co-pilots whose flight times were more than 1,000 hours): Examinee 3 and 4 whose flight times were about 1,300 hours and 2,700 hours, respectively.
3) Captain A (Captains whose flight times were less than 10,000 hours): Examinee 5, 6, and 7 whose flight times were about 8,300 hours, 8,300 hours, and 8,600 hours, respectively.
4) Captain B (Captain whose flight time is more than 10,000 hours): Examinee 8 whose flight time is about 15,000 hours

During the experiment, the examinee sits on the side where they are usually seated (For example, if the examinee is a captain, he sits on captain's side), and flies as a PF (Pilot Flying). The role of a PNF (Pilot Not Flying) is played by a professional airline pilot or simulator engineer who understands the details of the scenario in advance. One of the authors is in charge of the role of the ATC, cabin attendants, and the company radio. Unlike in the case of actual flight, the PNF is asked not to give any advice to the examinees, nor follow any directions from them, in order to reveal the examinees' own decision makings.

The authors used a full-flight simulator of the Boeing 767, (250 passengers, 2 crews, glass-cockpit aircraft). (Fig.1)

2.2 Basic Data of the Scenario

Before the experiment, the examinees are informed with the five items listed below:

1) The purpose of the experiment is to study pilots' flight operation.
2) The flight number will be "All Nippon (AN) 602".
3) The original destination airport will be HND (RJTT, Tokyo Japan), and the first alternate airport will be NRT (RJAA, Narita Japan).
4) The weather and fuel plan for HND and NRT (Table. 2), and the presence of air turbulence at the holding altitude of 3,000 ft.
5) The condition of the aircraft at the beginning of the scenario; flaps 5, air speed 170kt, gear up, the amount of remaining fuel will be 18,000 lbs and aircraft's gross weight will be 24,000 lbs.

To determine the amount of remaining fuel at the beginning of the scenario, the authors referred to the amount of fuel consumption for actual flights in fine weather. Therefore, when the weather is not in good condition, such as in this experiment, pilots have to load more fuel considering extra fuel consumption due to weather. However, the authors set up a scenario to load a less amount of fuel, on the airplane in this experiment than in a regular flight in order that examinees may make a decision within a limited time.

2.3 Details of Scenario Settings

1) The detailed sequence of the scenario is as follows: The experiment starts from five nautical miles out on the final approach into HND (RJTT, Tokyo Japan) ILS Runway (RWY) 34R procedure, and the subjective pilots keep descending to the runway. (Fig.2)
2) While approaching, the examinee intercepts a message from the preceding aircraft having performed go around due to wind shear. After that, the company radio gives information that there is an ECHO north of HND. ECHO is a reflection of clouds displayed on the weather radar in the cockpit, and the clouds may cause wind shear. In addition, the ATC informs examinees of the wind shear report in HND as shown in Table.3. One of the authors plays roles of both the ATC and the company radio.
3) In the short final of the runway, a wind shear occurs. The wind shear is strong enough to cause the cockpit to give a "Wind Shear Warning". If the cockpit gives the "Wind Shear Warning", pilots are instructed to go around. After performing go around, examinees initially fly following the Missed Approach Course shown in Fig. 2, on which pilots should fly if they misses approach for some reasons.
4) Examinees are expected to decide whether to divert or hold over HND, the original airport. They are free to request information from the ATC, the company radio, and to communicate with a cabin attendant. If the

examinee asks for information about HND from ATC or company, the authors say, "Direction of the wind is variable and runway change could happen, although the ECHO is moving away from HND." The condition and weather of alternate airports (NGO and SDJ) are all the same; "Wind Calm" condition, which means there is no problem concerning wind conditions. The positions of alternate airports are shown in Fig.3. If there is the second contact from the examinee, or there is no contact in five minutes after performing go around, the ATC or company utters "Wind shear in HND is getting weaker, and the direction of the wind is moving toward northward."

5) The experiment is over when the examinee decides to divert to one of the alternate airports or to declare the condition to land original airport.

2.4 Measured Items

The measured items of the experiment are as follows; dialogs of the subjective pilots, ATC, Cabin, and Company Radio, location and the amount of fuel of the airplane for every 10 seconds, and interviews to subject pilots. The authors used video cameras to record these items. (Real time data of the examinees' location and remaining fuel are displayed on the monitor in the flight simulator and the authors recorded it.)

The authors made flight paths of examinees (Fig.4), flight timelines (Fig.5), reasons of important decisions (Table.4), and "decision trees" that show the process of considering the destination airport out of the measured items above (Fig. 6).

3 Results

3.1 Flight Paths

The examples of the flight paths of examinees are shown in Fig. 4. The results are parted into two patterns among all the examinees; one is to follow the Missed Approach Course and to hold over the waypoint called "CHIBA" (see flight paths of examinee 1 and 3 in Fig.6) and the other is to fly southward. The Missed Approach Course is a flight path on which pilots are asked to follow when they cannot make a landing for some reason. (The course is shown as the blue line in Fig.2) However, they can choose different courses as long as the ATC admits, and six examinees preferred to avoid ECHO rather than to follow the course, because there were clouds which caused strong turbulence around the area. In contrast, examinee 1 and 2 decided to follow the Missed Approach Course and to hold over "CHIBA".

Concerning the vertical flight path, three examinees (3, 5, and 7) decided to change altitude after making a go around (Table.4 "Altitude Change after GA"). The reasons were different among them; ATC ordered to do so due to traffic (examinee 7), examinee 5 himself decided to avoid traffic, and examinee 3 tried to reduce turbulence.

3.2 Timelines

The authors made timelines of the experiments out of utterances and communication logs of examinees, and remaining fuel amount. In Fig.5, experimental results of two examinees (examinee 3 and 5) are shown in the form of a timeline. This figure is made of two lines; time and the amount of remaining fuel are expressed in row 1, and in row 2, the examinee's decisions (upper side) and utterances of the ATC or the company radio (lower side) are shown. The time coordinate starts at the point when the examinee receives the message from the ATC for the first time.

3.3 Results of Interview

The authors carried out an interview after the experiment. The summary of examinee 7 and 8's interview results are shown as follows:

Examinee 7 (Diverted to NGO): "When I decided to make a go around, the autopilot of my airplane did not work well. After making a go around, I initially considered NRT for the first alternate airport from which ECHO was moving away southward. However, wind was

blowing from the north around NRT at that time, and I had to approach it from south of the runway. In short, it was inevitable to fly through clouds which would cause strong turbulence. Therefore, I decided to divert to NGO.

Examinee 8 (Tried to approach HND again): "I decided to make a go around, because Wind Shear Warning went on, though I was prepared since the preceding flight was involved in wind shear. Later, I initially tried to follow the Missed Approach Course and after that, I decided to fly southward because of clouds on the course. I decided to hold over HND for about 20 minutes and then if the weather in HND had not changed, I would have diverted to NRT. I was prepared to declare to divert when the amount of remaining fuel was about 13,000 lbs."

The same types of interviews were conducted with the other examinees.

3.4 Decision Trees (Collected Information and Decision)

The authors expressed the relationship between the examinees' process of choosing the airport and information they collected in Fig.6. In this section, we would like to see the result at every group of examinees- Co-PI A, Co-PI B, CAP A, and CAP B.

1) Co-PI A (Fig. 6a and 6b, Co-pilots whose flight times are less than 1,000 hours):
   The examinees of the Co-PI A Group (examinee 1 and 2) collected information of only NRT as an alternate airport. After performing a go around, they asked for HND's weather first and then asked the condition of NRT. Finally, they both decided to retry to approach HND as scheduled. Before making the final decision, these two examinees checked HND weather again.
2) Co-PI B (Fig.6c and 6d, Co-pilots whose flight times are more than 1,000 hours):
   In the Co-PI B Group, examinees 3 and 4 checked several alternate airports; examinee 3 considered NRT, NGO, and SDJ, and examinee 4 considered NRT and NGO. They initially checked HND's weather and after that checked NRT's weather, but the final intentions were different in that examinee 3 decided to divert to NRT, while examinee 4 kept holding over HND.
3) CAP A (Fig. 6d, 6e, and 6g, Captains whose flight times are less than 10,000 hours):
   The results of the CAP A Group are similar to that of Co-PI B Group. Examinees 5 and 7 checked the weather of HND and NRT simultaneously, and decided to hold over HND. In addition, examinee 7 decided not to retry to go to HND after being informed that HND's weather was still not in a suitable condition for landing.
4) CAP B (Fig. 6h, Captain whose flight time is more than 10,000 hours):
   Examinee 8, CAP B Group, collected information of HND and NRT, and finally decided to approach HND again.

3.5 Different Opinions for Decision Makings

The different opinions for the decision making of each examinee are shown in Table. 4.

Concerning the patterns of consideration for alternate airports and briefing with PNF before deciding to execute a go around, the results are roughly divided into three types: (1) Co-PI A Group, (2) Co-PI B Group and CAP A group, and (3) CAP B Group in consideration for alternate airports and briefing with PNF before performing a go around. Many of the examinees in the Co-PI B and CAP A checked the weather of two or three alternate airports, and talked about operation after performing a go around.

It is also clear that the Co-PI A Group asked about effect of Wind Shear on the following aircrafts approaching HND, while other examinees asked for reports on only the weather around HND. Moreover, time to make the final decision is slightly shorter in veteran examinees.

4 Discussions

The differences of the examinees' decisions according to their flight time appeared in the points below.

4.1 Comparison among all examinees

1) Experienced pilots, especially captains, chose flexible alternative options. Two co-pilots (examinee 2 and 4) and all captains decided to avoid clouds as a first priority over following the Missed Approach Course and holding pattern. In contrast, two co-pilots (examinee 1 and 3) chose to follow that course and hold over "CHIBA" while ECHO in which severe turbulence may exist was approaching.
2) Captains and co-pilots with longer flight times foresaw risks in the future and constructed the scenario of coping with them ahead of time. For example, this trend was seen when experienced examinees (examinee 4 (Co-PI B), 5 and 6 (CAP A)) made briefings about the sequence after performing a go around. Moreover, some captains (examinee 5-8) worried that ECHO may affect the weather in NRT, although the weather of NRT was not so bad according to the ATC's information. For example, examinee 7 decided to divert to NGO, being afraid that his airplane would fly through the ECHO which was moving away from NRT before landing there (see the interview results). However, on the whole, only two examinees finally diverted, which means the decision for the final destination and flight time do not have a strong co-relation.
3) Concerning the Co-PI B, CAP A, and CAP B Group, more experienced examinees collected less information about alternate airports (Table.4 "Alternate Airport whose Information was Collected"). This is because captains knew what information should be collected formerly, while examinees whose flight times were less than veterans took a longer time to make final decisions. One study of NDM reports that experts generally make decisions rather intuitively than analytically [5], and these results can be said to be an example of this discussion. On the other hand, examinees in the Co-PI A Group had a stronger dependency on external information. For example, they asked about the effect of wind shear on the following flights.

4.2 Comparison among co-pilots (Co-PI A Group vs. Co-PI B Group):

1) In selecting an alternate airport, examinees in the Co-PI A Group, examinee 1 and 2, examined limited options inside airports (HND and NRT) repeatedly, while pilots in the Co-PI B Group, examinee 3 and 4, (and the CAP A Group) considered several options. It can be said that the number of available options to choose in flight increases with more flight time.
2) The results from the flight of a more experienced co-pilot (examinee 4, Co-PI B Group, in particular) are closer to that of a captain's (especially examinees in CAP A Group) for the reason discussed in 4.2-2).

5 Conclusions

The authors discussed the pilots' decision making skills according to their experiences in this paper. Through experiments using the full-flight simulator cooperated by jet airliner pilots as examinees, the authors examined the "Flight Management Skill" of them. As a result of these experiments, several features of the flight decision making of experienced pilots were obtained:

Initially, they chose flexible decisions according to the situation they were facing, without sticking to any general rules.

Secondly, veteran pilots evaluated predictable risks beforehand and took some measures for them.

Moreover, more experienced pilots required less information to decide what to do next, because they tend to request information after thinking about what information should be collected. They were also less dependent on sources of external information..

Acknowledgements

The authors would like to express their gratitude to Captain Hiroshi Takahara, Mr. Masahiko Onko, and Mr. Nobuyuki Suzuki for their advice, and to the examinees who attended the experiments.

References

[1] Ide, Y., et. al., Evaluation on Flight Management Skill of Jet Airliner Pilots - A Case of Go Around-, ICAS2006-9.10.4, Sep. 2006

[2] John P., *Aviation Psychology in Practice*, *Training*, Avebury Technical, 1994, p.401

[3] Simpson, P. A., Naturalistic Decision Making in Aviation Environments, DSTO-GD-0279, 2001

[4] Dalziell J., Good Decision Making in the Approach Environment, Korusafe, 2009

[5] Zsambok. C. E., *Naturalistic Decision Making*, *Naturalistic Decision Making Where Are We Now?*, Lawrence Erlbaum Associates, 1997, p.28

Copyright Statement

Table.1 Data of the examinees

Examinee Number	1	2	3	4	5	6	7	8
Group	Co-PI A		Co-PI B		CAP A			CAP B
Flight Time(hour)	600	950	1,300	2,700	8,300	8,300	8,600	15,300
Co-PI/CAP	Co-PI	Co-PI	Co-PI	Co-PI	CAP	CAP	CAP	CAP

Table.2 Scenario settings of destination/alternate airports

Scenario Settings		**HND(Latest Data)**	**NRT(Data at making flight plan)**	**NGO**	**SDJ**
Airport Data	Approximate time		36 min	50 min	55 min
	Approximate amount of fuel required (Except Reserve Fuel: 3,000lbs)		7,000lbs	9,000lbs	10,000lbs
Weather	Wind	340deg/10kt	350deg/15kt	Calm	Calm
	Visibility	1,800m	5,000m		
		MOD ECHO North-North East MOVE South East			

Table.3 Scenario settings

Timing	**Instruction from ATC**	**Instruction from Company Radio**
START	Continue approach RWY34R WIND340/15	
START +30sec	Intercept preceding aircraft ' s communication saying it made GA due to W/S. "RWY 34R clear to land, WIND340/15, and W/S reported on short final by the preceding	Response to Contact from examinee : as follows (✳) • Isolated weak to moderate ECHO is moving to south east. • W/S of ± 10 knot is reported. • Preceding aircraft made GA due to W/S.
START+200sec **(2,500 ft)**		If no contact from examinee so far, provide information shown in (✳)
GA		
		Response to 1st Contact from Examinee • ECHO keeps moving toward the south east, and soon leaves HND . • Wind direction is still variable. • Runway change may happen.
		Response to 2nd Contact from Examinee • W/S is getting weaker. • Wind direction is still variable, moving toward north.

Table.4 Different opinions of examinees for decision making

	Group	Co-pilot A (〜1,000 hours)		Co-pilot B (1,000 hours〜)		Captain A (〜10,000 hours)			Captain B (10,000 hours〜)
	Subject Number	1	2	3	4	5	6	7	8
	Flight Time	600h	950h	1,300h	2,700h	8,300h	8,300h	8,600h	15,300h
Decision Making Differed According to Flight Time	Alternate Airport whose Information was Collected (Except 1st Alternate, NRT)			NGO, SDJ	NGO		NGO	NGO	
	Briefing with PNF before GA				Flight Path	Flight Path, Altitude	Flight Path, Decision Fuel		
	Flight Path after GA	Missed APCH Course	South	Missed APCH Course	South	South	South	South	South
	Consideration of Other Aircrafts	Effect of W/S on Following Aircrafts	Effect of W/S on Following Aircrafts		Traffic	Traffic	Traffic	Traffic	Traffic
	Announce of GA to Cabin	Did		Intended to Do but No Time		Did	Intended to Do but No Time	Intended to Do but No Time	Did
Other Main Decision	Altitude Change after GA			5000ft		4000ft		4000ft	
	Amount of Fuel at Final Decision	14,800	15,900	15,450	15,850	15,500	15,800	16,200	16,000
	Time to Make Final Decision	18:45	11:40	12:40	12:20	13:35	10:30	10:00	10:50
	Divert			NRT(1st Alternate)				NGO(2nd Alternate)	
	Experience of W/S in Past Flight					Stronger W/S	Weaker W/S	Weaker W/S	Stronger W/S

W/S: Wind Shear

1a) Full-flight simulator in ANA Training Center

1b) Scene of experiment

Fig.1 Equipment and experiments

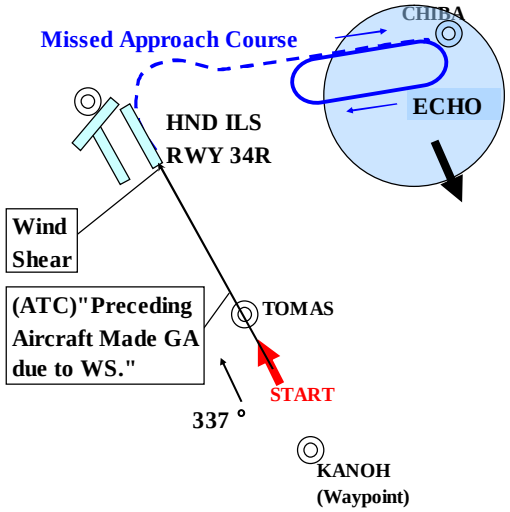


Fig.2 Scenario settings of flight path

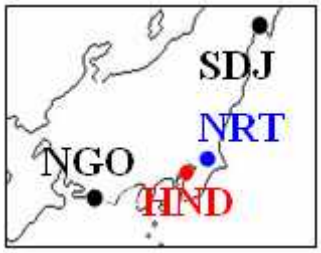


Fig.3 Position of destination/alternate airports

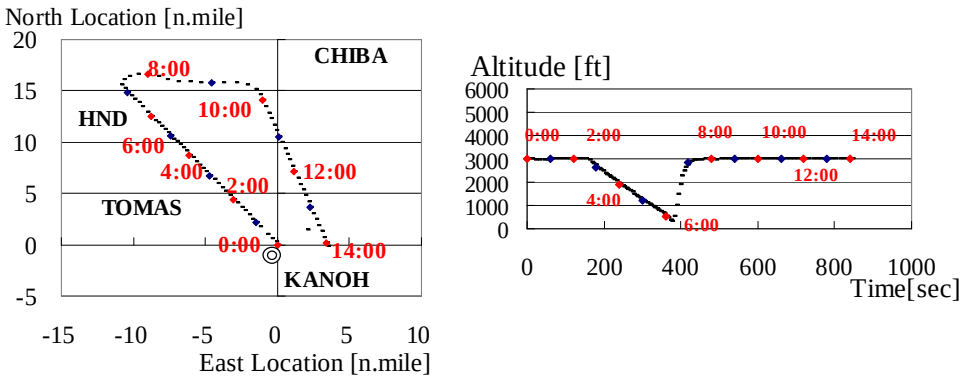
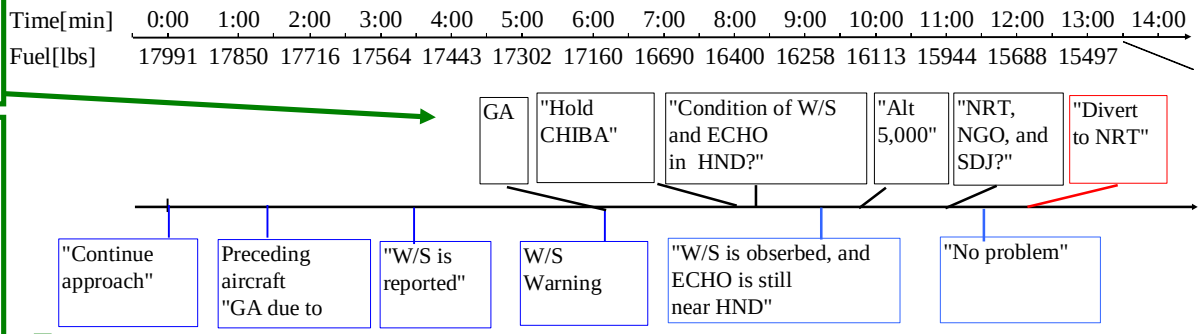


Fig.4 Example of lateral/vertical flight path (Result of examinee 4)

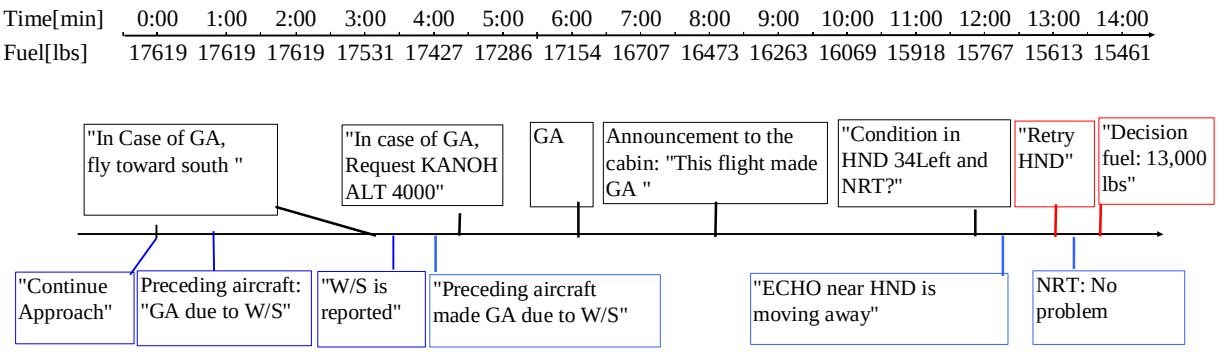
Decision of the Examinee: Black (※Final Decision: Red)

Utterances of ATC and Onboard Warning: Blue

Utterances of Company Radio: Light Blue

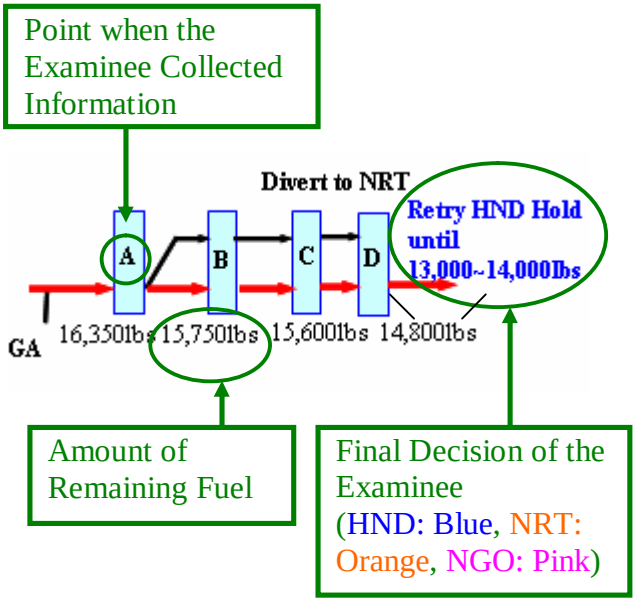


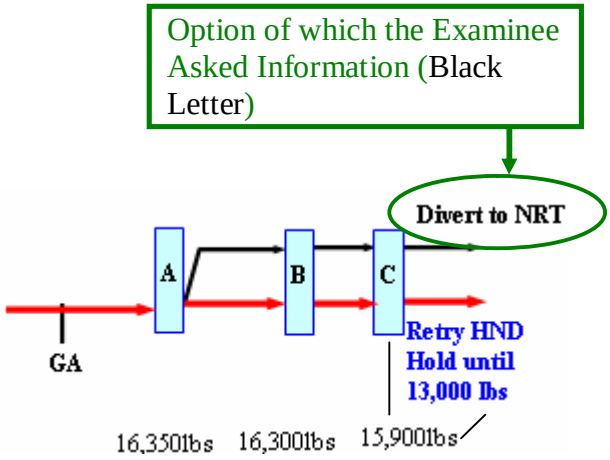
5a) Result of examinee 3



5b) Result of examinee 5

Fig.5 Examples of timetable of experiments





: Option which the examinee finally chose

: Option which the examinee considered

Collected Information

A			
Airport	W	ECHO	others
HND	●	△	※
NRT			
NGO			
SDJ			

B			
Airport	W	ECHO	others
HND			
NRT	●		
NGO			
SDJ			

W: Weather
※The Effect of Wind Shear to Following Airplane

C			
Airport	W	ECHO	others
HND		△	
NRT			
NGO			
SDJ			

D			
Airport	W	ECHO	others
HND	△		
NRT			
NGO			
SDJ			

Collected Information

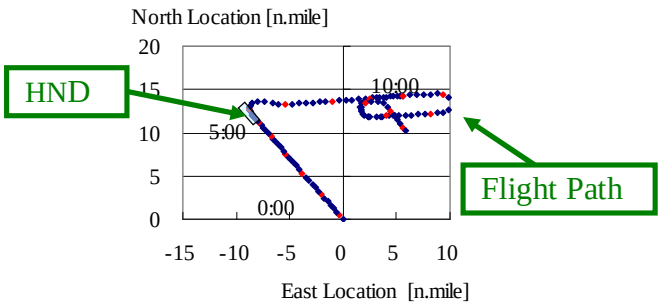
A			
Airport	W	ECHO	others
HND	●	△	※
NRT			
NGO			
SDJ			

B			
Airport	W	ECHO	others
HND			
NRT	●		
NGO			
SDJ			

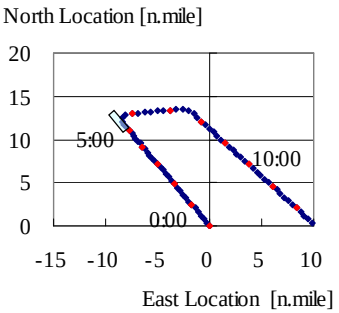
W: Weather
※The Effect of Wind Shear to Following Airplane

C			
Airport	W	ECHO	others
HND	△		
NRT			
NGO			
SDJ			

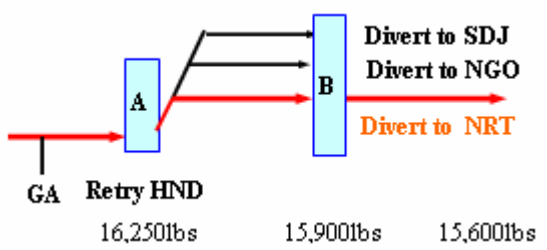
○：Suitable for landing
●：Not suitable for landing
△：Recover soon



6a) Result in a form of decision trees (examinee 1 (Co-PI A))



6b) Result in a form of decision trees (examinee 2 (Co-PI A))

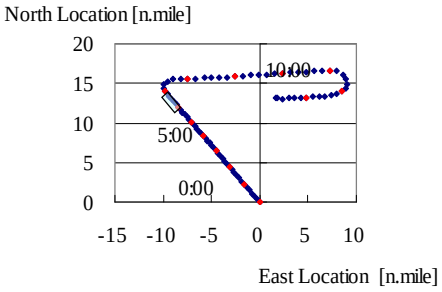


Collected Information

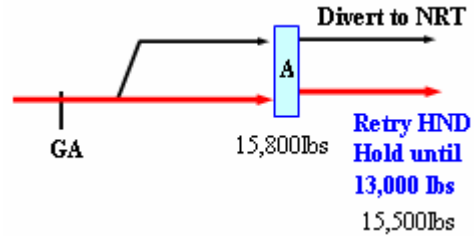
A	W	ECHO	others
HND	●	●	
NRT			
NGO			
SDJ			

B	W	ECHO	others
HND			
NRT	○		
NGO	○		
SDJ	○		

W: Weather



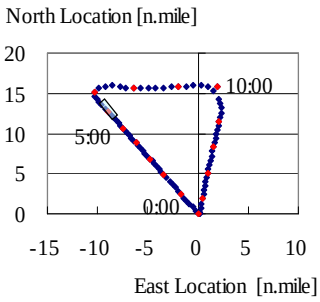
6c) Result in a form of decision trees (examinee 3 (Co-PI B))



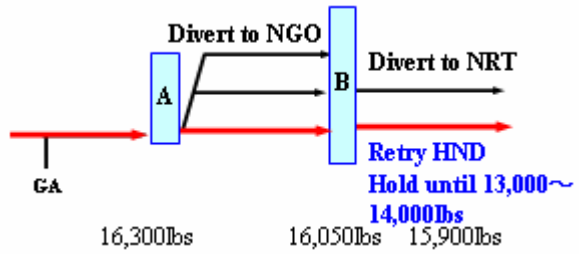
Collected Information

A	W	ECHO	others
HND	△	△	
NRT	○		
NGO			
SDJ			

W: Weather



6e) Result in a form of decision trees (examinee 5 (CAP A))

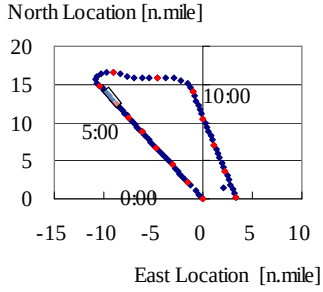


Collected Information

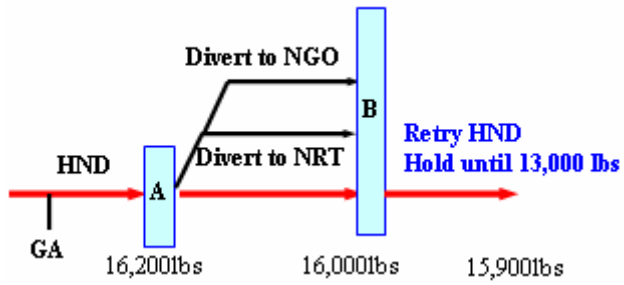
A	W	ECHO	others
HND	●	●	
NRT			
NGO			
SDJ			

B	W	ECHO	others
HND			
NRT	○		
NGO	○		
SDJ			

W: Weather



6d) Result in a form of decision trees (examinee 4 (Co-PI B))

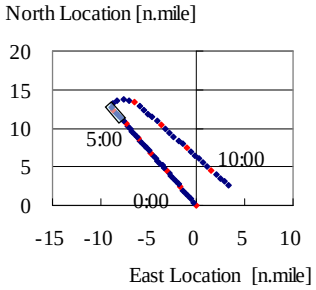


Collected Information

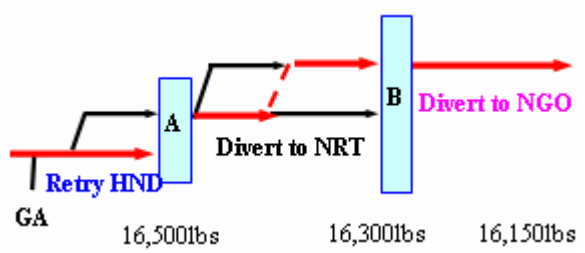
A	W	ECHO	others
HND	●	●	Traffic
NRT			
NGO			
SDJ			

B	W	ECHO	others
HND			
NRT	○	○	
NGO	○		
SDJ			

W: Weather



6f) Result in a form of decision trees (examinee 6 (CAP A))

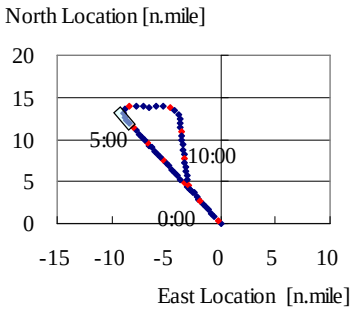


Collected Information

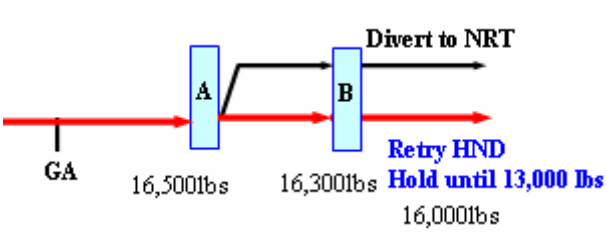
A			
Airport	W	ECHO	others
HND	△	△	
NRT	○		
NGO			
SDJ			

B			
Airport	W	ECHO	others
HND			
NRT			
NGO	○		
SDJ			

W: Weather



6g) Result in a form of decision trees (examinee 7 (CAP A))

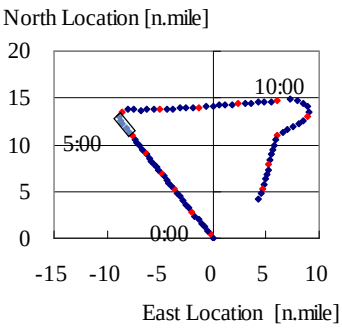


Collected Information

A			
Airport	W	ECHO	others
HND	△	△	
NRT			
NGO			
SDJ			

B			
Airport	W	ECHO	others
HND			
NRT	○		
NGO			
SDJ			

W: Weather



6h) Result in a form of decision trees (examinee 8 (CAP B))

Fig.6 Results in a form of decision trees