The Effect of Tactical Situation Display on Attack Helicopter Pilot's Workload

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Abstract: The attack helicopter performs numerous tasks, such as anti-armor operation, close air support, search and destroy, and reconnaissance. As 71% of aviation accidents are human-caused, high workload and stress level of pilots greatly affect their performance level. Additionally, pilots that are responsible for attack helicopters have to work under enemy threats, which increase their stress levels. In order to decrease their workload, we installed a TSD (Tactical Situation Display) in our helicopter simulator. Then, we analysed the results to find out if the TSD affects the work efficiency and mental pressure of the pilots. We analysed the task performance time and the pilot workload using the NASA-TLX with the paired sample method. The test indicates that the additional information provided by the TSD can help reduce the pilot workload.

1 INTRODUCTION

Attack helicopters perform a wide variety of tasks, such as target search and destroy, armed escort, and close air support for ground troops. Due to rapidly advancing technologies, attack helicopters are getting more sophisticated and powerful. During missions, attack helicopters performs the NOE (Nap of the Earth) flight at high speed, and the decision making process of the pilot should be quick and fast. This could lead to the increases in their stress levels. To help reduce the stresses, the provision of critical flight and mission information is necessary. The presentation of real-time, mission-critical information to the pilot can significantly enhance the situational awareness and the mission success rate. In this regard, we have decided that it is imperative to analyse the efficiency of operation and the effect of the TSD (Tactical Situation Display). By conducting a series of experiments with and without the TSD, we are going to determine if it could lower the stress levels of the pilot. In the experiments, we measured the performance of pilots during their search missions at the aerial warfare. We created a situation where there's no TSD, and the pilots have to rely on only voice communication with a command center. We also provided the pilots with TSD, and the situations are compared.

2 EXPERIMENTAL PROCEDURE

2.1 Task Assignment

The test subjects of this study are two Ajou University industrial engineering students. One performed the tasks of the pilot. The other performed the tasks of the instructor, while he was also responsible for radio communication and collecting data. The student pilot has been trained before this experiment, and he is very proficient with the helicopter simulator. The other student who is the instructor has been also trained, so he knows the route for each scenario and has knowledge about radio communication.

2.2 TSD and Simulator

We performed the experiments a total of four times. Each experiment has different air routes and is classified into two categories; Experiment 1 is performed only with the voice command from the command center. Experiment 2 is performed with the voice command and also with the TSD. We collected the data, including the pilot TLX data, the helicopter's altitude and speed, the time for each mission.

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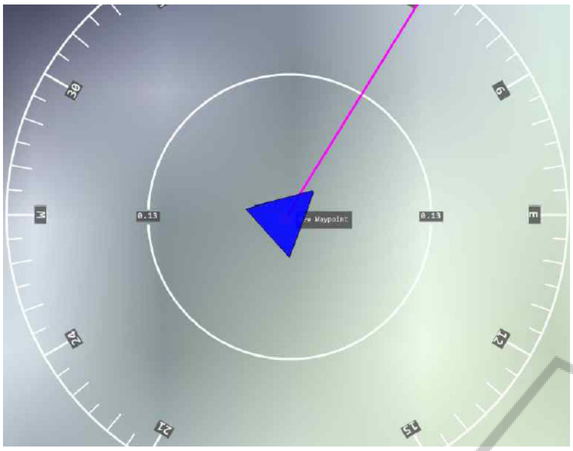


Figure 1: TSD Screen (Command Center).

Like Figure 1, command center is able to check the location of the helicopter anytime. The helicopter is the blue arrow, and its route is the pink line. Also, the white inner circle indicates the helicopter's 0.13nm (nautical mile, approximately 240m), and the outer circle indicates Heading. Figure 2 illustrates the attack helicopter simulator that has been developed and installed in our university.

Figure 2: The attack helicopter simulator at Ajou University.

2.3 NASA-TLX Data

In order to measure how much workload the pilots feel like they have psychologically, we used the NASA-TLX, a program invented by NASA that measures the amount of pilot workload. This program can be downloaded from the NASA website. Table 1 has the detailed explanation of six categories. After the pilot performs his task, we evaluates for each category. The score range is 0-100. The lower the score is, the lower amount of workload the pilot feels.

Table 1: Categories and descriptions of NASA-TLX.

Scale	Descriptions
Mental Demand	How much mental and perceptual activity was required? Was the task easy or demanding, simple or complex?
Physical Demand	How much physical activity was required? Was the task easy or demanding, slack or strenuous?
Temporal Demand	How much time pressure did you feel due to the pace at which the tasks or task elements occurred? Was the pace slow or rapid?
Performance	How successful were you in performing the task? How satisfied were you with your performance?
Effort	How irritated, stressed, and annoyed versus content, relaxed, and complacent did you feel during the task?
Frustration	How hard did you have to work (mentally and physically) to accomplish your level of performance?

2.4 Data Collection

Kangwon Province of Korea was chosen for this experiment because it's suitable to navigate through and perform the reconnaissance missions. Since the attack helicopter should not be detected by the enemy, the moving route is set according to the contour map. At each waypoint, the instructor gives the pilot voice commands or voice commands with texts. Then, the pilot communicates back to the instructor, if he wants to confirm the information. The pilot stays at the same altitude with a constant speed, and performs the reconnaissance mission according to the commands of the instructor. We compare a scenario where the instructor only gives voice commands and another scenario where the instructor gives voice commands, texts, the location of the helicopter, and the location of the enemy using the TSD. Then, we check if these scenarios affect the workload of the pilot. Table 2 shows four scenarios, ICAO (International Civil Aviation Organization) airport code and the number of waypoints that we set for the experiments.

Table 2: Scenario plan maps.

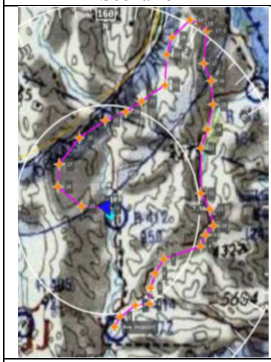
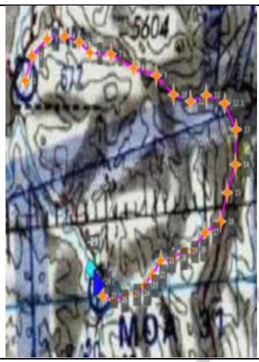
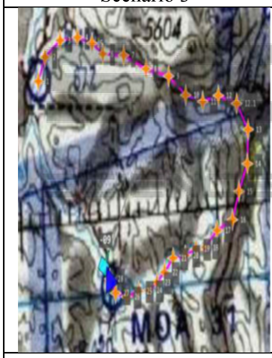
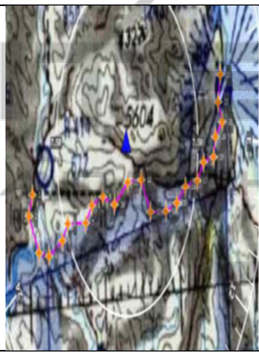
Scenario 1	Scenario 2
	
RK43-RK44 32 Waypoints	RK43 – RKOR 29 Waypoints
Scenario 3	Scenario 4
	
RK43 – RKOR 36 Waypoint	RK43 – RKND 23 Waypoint

Table 3: Results.

Scenario 1	1st exp.	Enemy detect time	17.84
		Deviate from course	6
		Number of re-inquiries	4
	2nd exp.	Enemy detect time	15.02
		Deviate from course	1
		Number of re-inquiries	1
Scenario 2	1st exp.	Enemy detect time	18.89
		Deviate from course	0
		Number of re-inquiries	2
	2nd exp.	Enemy detect time	9.27
		Deviate from course	1
		Number of re-inquiries	0
Scenario 3	1st exp.	Enemy detect time	19.81
		Deviate from course	1
		Number of re-inquiries	0
	2nd exp.	Enemy detect time	15.11
		Deviate from course	0
		Number of re-inquiries	0
Scenario 4	1st exp.	Enemy detect time	12.6
		Deviate from course	1
		Number of re-inquiries	1
	2nd exp.	Enemy detect time	11.34
		Deviate from course	1
		Number of re-inquiries	1

3 DATA ANALYSIS

3.1 Results

Table 3 and Figure 3 and 4 show the results of the experiment. Essentially, when the pilot was given more information, the time he took to find the enemy was shorter. The command delivery was more precise and accurate, while the pilot asked fewer questions back to the controller.

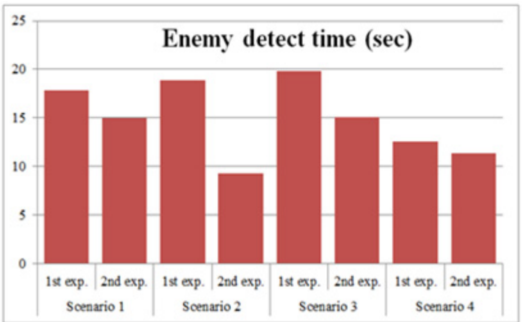


Figure 3: Result chart (Enemy detect time).

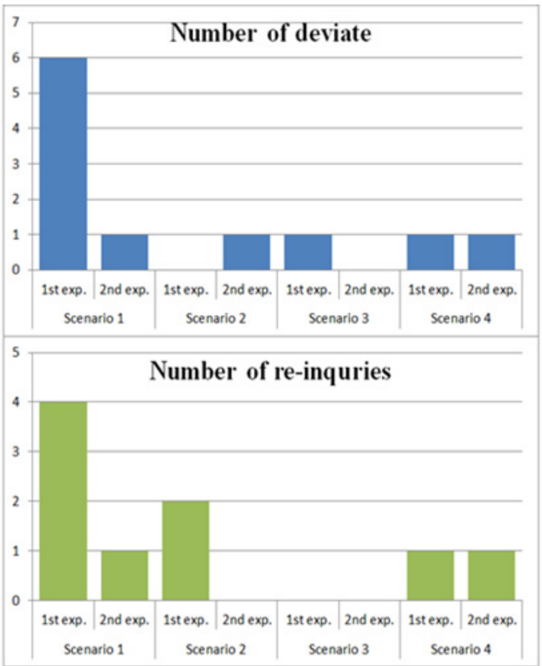


Figure 4: Result chart (Number of deviate and re-inquiries).

3.2 Analysis of NASA-TLX Data

Using the TLX data, we applied the paired sample method to find out if the difference in the way of delivering information affects the tasks. Table 4 and Figure 5 and 6 show the TLX data, and Table 5 shows its significance levels. The values for the pilot are significant for the Temporal, Effort, and Frustration category, which indicate that they do affect the pilot performance. Even when he does not have immediate threats, the pilot is constantly under pressure and physically stressed because he has to check the altitude, speed, and targets. The values for the Mental, Physical and Effort categories turned out to be not significant. On the other hand, the values for the Temporal, Performance, and Frustration categories were relatively high due to the feeling of relief he gets from accurate information delivery and readily available information that he needs at the moment.

Table 4: TLX Score.

Experiments		TLX Categories					
		M	Ph	T	P	E	F
Scenario 1	1st exp.	84	91	95	25	86	20
	2nd exp.	85	81	65	19	75	12
Scenario 2	1st exp.	64	58	30	24	75	10
	2nd exp.	70	60	21	12	71	8
Scenario 3	1st exp.	80	95	86	36	88	12
	2nd exp.	75	91	60	34	81	8
Scenario 4	1st exp.	68	65	43	12	58	25
	2nd exp.	61	62	31	11	51	20

Table 5: Paired sample data.

Confidence interval of paired data						
	M	Ph	T	P	E	F
Reliance	-5.7	-2.0	7.12	-0.6	3.87	1.80
Reliance	8.2	9.54	31.3	11.1	10.6	7.69
Signifi-	No	No	Yes	No	Yes	Yes

4 CONCLUSIONS

When the pilot performs the scenario where various information is given, the time he takes to detect enemy is significantly shorter than the scenario where only the voice command is delivered. Also, the number of questions he asks to confirm the given information is a lot lower. This indicates that more information rather than simple voice commands is more helpful for the pilot to perform his tasks better. From the TLX analysis, the Temporal, Effort, and Frustration categories have significant values. It is shown that the presence of TSD increases the accuracy of the pilot performance and decreases the mental pressure and stress level. According to the NHTSA (National Highway Traffic Safety Administration), about 71% of aviation accidents are human caused, and about 88% of those human-caused aviation accidents were brought on by their low situational awareness. More research on the TSD would lower the burden that pilots tend to feel, while maximize the task performance ability.

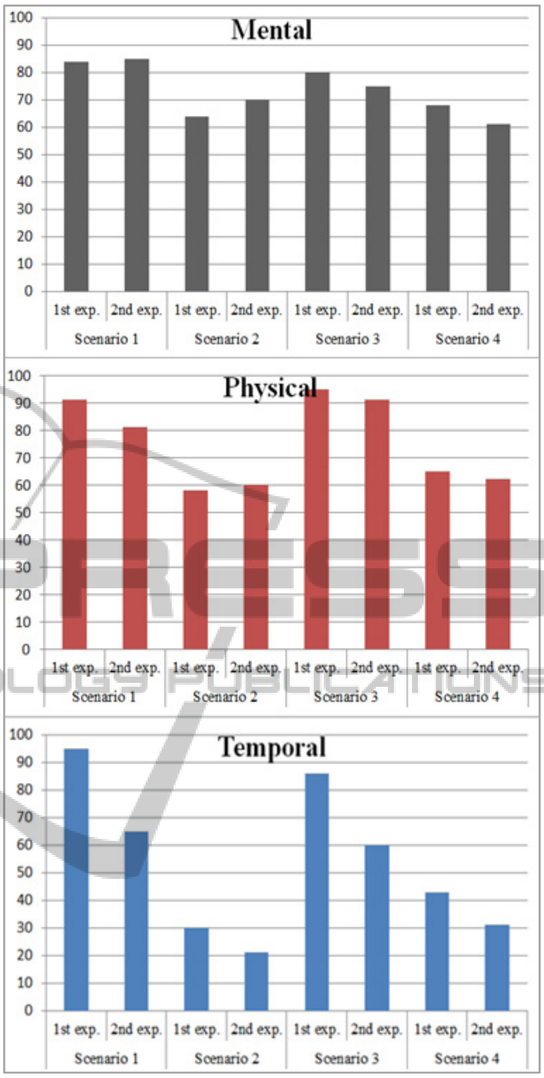


Figure 5: Result charts 1 (TLX Score).

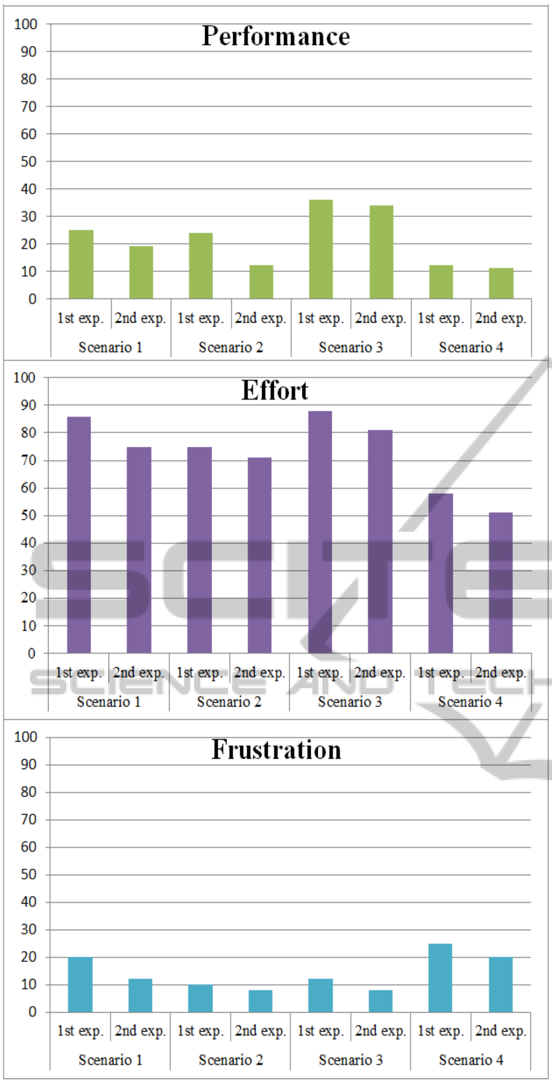


Figure 6: Result charts 2 (TLX Score).

REFERENCES

Kim Ki-Choel, Lee Jong-Sun, 2001. A Study on the Pilot Workload Analysis in Flight Phases using the Flight Simulator, *Journal of Korean Institute of industrial engineerings*.

Woo-Sub Oh, Sung-Woo Kim, Choi Ie-Na, Jin-Suk Jang, 2005. A Study on the System Concept of KHP Mission Equipment Package, *Journal of The Korean Society for Aeronautical and Space Sciences*.

Suk-Joon Yoon, 2002. Airplane R&D simulator, *Journal of The Korean Society for Aeronautical and Space Sciences*.

Jae-Moon Lee, Chi-Young Jung, Jae-Yeong Lee, 2010. The Combat Effectiveness Analysis of Attack Helicopter Using Simulation and AHP, *Journal of The Korea Society for Simulation*.

Jung Hoon Lee, Jun Ho Kim, Jung Yong Park, Iee Ki An, 2011. Current Status of Civil-Military Dual Use Helicopter Development Focusing on Conversion Case from Civil to Military Helicopter, *Journal of The Korean Society for Aeronautical and Space Sciences Conference*.

Jun-Woo Lee, Sang-Won Chae, Chil-Gee Lee, 2001. Development of Panel Part in Flight Simulator based on PC, *Journal of The Korea Society for Simulation*.

Sunh-Yun Choi, Sang-won Chae, Young-Sin Han, Chil Gee Lee, 2002. 3D Flight Simulator for Education of Flying Tactics, *Journal of The Korea Society for Simulation*.

Tomas Schnell, Yong-Jin Kwon, Sohel Merchant, Chil Gee Lee, 2004. Improved flight technical performance in flight decks equipped with synthetic vision information system displays, *The international Journal of Aviation psychology*.

Jung-Hoon Lee, Byeong-Hee Chang, Hwang In-Hee, 2009. Current Status of Civil-Military Dual Use Helicopter Development - Focusing on Conversion Case from Military to Civil Helicopter, *Current industrial and Technological Trends in Aerospace*.

Kang Byeong-Kil, 2010. Development of a Pilot Workload Prediction Program using TAWL (Task Analysis / Workload) Methodology, *Current industrial and Technological Trends in Aerospace*.