

Analysis of Design Approach for Navy Weapon System Operation Environment

Seungju Baek¹, Suhwan Kim², Eunghyun Lee¹, Yongjin James Kwon^{1*}

¹Department of Industrial Engineering, Ajou University, Suwon, South Korea

²1st Division, 3rd Department, Agency for Defense Development, Daejeon, South Korea

Email: *yk73@ajou.ac.kr

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Abstract

This study is a preparation phase for visualization of utilized information using ergonomic user interface and standardization of elements for anti-air weapon system. Therefore, we investigated the instances of Navy Weapon System operation environment for defense advanced country. Based on the collected data, we compared and analyzed the weapon system operation environment design. Ultimately, it is essential to share a variety of battle field conditions such as enemy threat, enemy/friendly information, terrain information that can be effectively recognized. In this paper, we conduct case study for ergonomically development of Operation Environment. It is expected that this research improves the situational awareness and reduces the operator's task load.

Keywords

Navy Weapon System, Situation Awareness, Task Load, Human Machine Interface (HMI), Ergonomics

1. Introduction

Modern warfare situation requires well-designed operation environment which is considering improvement of the operator's mission capability [1] [2]. Therefore, we conducted research and analyzation for the several navy weapon system's operation environment, for this it is needed to carry out design factors improving operator's situation awareness and reduces the its task load [3].

We conducted case study for 6 navy weapon operation environment (US navy Aegis, Us navy LaWs, Artisan, US navy P3C, US navy P-8, Comandanti). From those weapon system we carried out common design factors (Radar screen, UI, Tactical map design, text information, Screen layout) [4].

2. Case Study

1) Case study for 6 kinds of Navy shown in **Table 1**;

*Corresponding author.

- 2) Investigation on major Navy weapon system operation under several nation;
- 3) Screen displayed information, displaying method, number of screen, tactical situation information, the operation of the tactical map equipment;
- 4) Number of operators, operator’s position, hardware layout, operation environment.

2.1. US Navy Aegis

The Aegis Combat System is an integrated naval weapons system developed by the Missile and Surface Radar Division of RCA, and now produced by Lockheed Martin. It uses powerful computer and radar technology to track and guide weapons to destroy enemy targets.

At this weapon system shown in **Figure 1**, Position of radar screen mostly is displayed on the front of each operator. Its background color is usually black and dark blue. Also it uses black and white tactical map and the color coded text information for the user’s visibility. It uses keyboard and Analog Button as the interface.

2.2. US Navy LaWS

The LaWS is a directed-energy weapon developed by the United States Navy. The LaWS is a ship-defense system that has so far publicly engaged an unmanned aerial vehicle and a simulated small-boat attacker. LaWS uses an infrared beam from a solid-state laser array which can be tuned to high output to destroy the target or low output to warn or cripple the sensors of a target.

As shown in below **Figure 2**, the LaWs operation environment has three display screen. One of the screen is placed at the front of operator the others are placed at right and left. It uses the circle shape radar screen which is placed in right of the user. It shows color maps and text information. Also it has 2D tactical map.

2.3. Royal Navy Artisan

The Type 997 Artisan is a medium range air and surface surveillance 3D radar developed by BAE Systems. The Type 997 Artisan has a range of 200 km at 30 RPM and is reportedly capable of tracking more than 800 or 900 targets at once.

Table 1. Major Navy weapon system.

Weapon System	Nation
US navy Aegis	United State
US navy LaWS	United State
Royal Navy Artisan	United Kingdom
US navy P3C	United State
US navy P-8	United State
Italy navy Comandanti	Italy



Figure 1. US navy Aegis Operation environment.



Figure 2. US Navy LaWS operation environment.



Figure 3. Royal Navy Artisan operation environment.

At this weapon system as shown in above **Figure 3**, position of radar screen mostly is displayed on the front of each operator. Its background color is usually black and dark blue. Also it uses blue and white tactical map and the color coded text information for the user's visibility. It uses the circle shape radar screen which is placed front of users. It shows color maps and text information. Also it has 2D tactical map. Operator's interfaces are keyboard, buttons, and touch display panel.

2.4. US Navy P3C

P-3C patrol aircraft is also referred to as the Orion (Orion) as a four-shot turboprop anti-submarine patrol aircraft. It is developed by Lockheed martin at the late 1960s. It remodeled a large airliner so it has enough carrying capability for sensing device. Therefore it can operate various also it is equipped with frequency fluctuations (DIFAR) and Magnetic Anomaly Detection as the submarine detection device.

As shown in below **Figure 4**, it has rectangle radar screen which is placed front of the operator. Operator uses overhead interface (switch and buttons) also they has keyboard, control stick, and track ball to operate this weapon system. The tactical map is color coded.

2.5. US Navy P-8

The P-8 conducts anti-submarine warfare (ASW), anti-surface warfare (ASUW), and shipping interdiction, along with an electronic signals intelligence (ELINT) role. This involves carrying torpedoes, depth charges, SLAM-ER missiles, Harpoon anti-ship missiles, and other weapons.

As shown in below **Figure 5** and **Figure 6**, this operation environment has 2 display screen for each operator. Those screens are placed up and down. The operators are placed in a low in this environment. It uses the rectangle shape radar screen which is placed upper side of the user. It shows color maps and text information. Also it has 2.5D tactical map which is color coded as its geographical factors.

2.6. Italy Navy Comandanti

The ship's main missions are long and medium-range patrol and the vessel carries fuel and stores for an endurance of ten days. The ship operates with a crew of 80 with eight officers. The overall length is 88.40 m and the full load displacement is 1520 t. The maximum sustained speed is over 25 kt and the ship has a range of 3500 nm [5].



Figure 4. US navy P3C operation environment.



Figure 5. US navy P-8 operation environment.

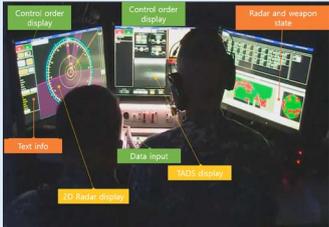


Figure 6. US navy P-8 operation environment.

The screen layout of this ship's operation environment formed with 4 rectangle screen. Those are placed in up and down to each user. The shape of radar screen is circle shape and it has Green back ground and white image information. At the center of screens it has outside camera to see target state.

3. Result

Radar screen which form is circular shape onto a quadrangle screen takes the largest proportion. Position of radar screen mostly is displayed on the front of each operator. Its color of background is usually dark color such as black, blue, indigo. Text information of radar screen is normally on its right side. Recent radar screen system has evolved into free-form with adapting its components to user's convenience. Recent trend of radar screen is including Tactical map into its components. Previous trend is using 2D color Tactical map. In the future warfare, it will need 2.5D Tactical map. Most of radar screens have 4 monitor up down left right side. The number of user will be 2 or 3, and their assignments are detecting radar screen, Management of arm and total control.

Name		US Navy Aegis	US Navy LaWS	Royal Navy Artisan
Image				
Radar screen	Shape	Circle	Circle	Circle
	Location	Front of operator	Right of the operator	Front of the operator
	Color	Blue, White	Color	White, blue
User Interface		Buttons, Switch, Control stick, key-board	Buttons, Switch, Control stick, keyboard	Buttons, Switch, keyboard
Tactical Map		Black and white, 2D	Color coding, 2D	Color coding, 2D
Text info		Green, yellow	White, text type	White
Screen Layout		Placed in the left and right	Rectangle, Place in the left and right	Rectangle
Name		US Navy P-3C	US Navy P-8	Italy navy Comandanti
Image				
Radar screen	Shape	Circle	Rectangle	circle
	Location	Center	Center	N/A
	Color	Green, black, Orange	Color coding	Green
User Interface		Buttons, Switch, track ball, control stick, keyboard	Buttons, Switch, control stick, keyboard	Buttons, Switch, control stick, keyboard
Tactical Map		Color coding, 2D	Color coding. 2D, 3D	N/A
Text info		Green, orange	White, black	N/A
Screen Layout		Rectangle, placed in a low	Rectangle, Place in a low, placed in the up and down	Rectangle, Placed in the up and down

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References

- [1] Olmos, O., Wickens, C.D. and Chudy, A. (2014) Tactical Displays for Combat Awareness: An Examination of Dimensionality and Frame of Reference Concepts and the Application of Cognitive Engineering. *The International Journal of Aviation Psychology*, **10**, 247-271.
- [2] Filippidis, A., Blandford, S., Foster, K. and Moran, G. (2006) Simulation Activities Using Gateway and Tactical Digital Information Links. Published by Defence Science and Technology Organisation, 1-13.

- [3] Brown, C., Fagan, P., Hepplewhite, A., Irving, B., Lane, D. and Squire, E. (2014) Real-Time Decision Support for the Anti-Air Warfare Commander. *Proc. 6th Int. Command Control Res. Technol. Symp. (ICCRTS)*, 2001.
- [4] Hong, J., Kim, S. and Kwon, Y.J. Analysis of Modern Design Approach for Anti-Air Radar Screen.
- [5] Commandante Class Patrol Ships, Italy. <http://www.naval-technology.com/projects/commandante/>