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Information Visualization Theorem for Battlefield Screen

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Abstract

Designing military screen (display) is not complicated in the past, the design should contains easiness of using, visibility and functionality. And it is important that contains all of the information what the system could be gotten. Today military display design can be valued by consideration of human's cognition model. A few information, which operators of military display could easily miss, could bring critical loss. So the military display needs the ability to help operator decide the military decision with sufficient consideration of battlefield information in a short time. The information is considerably complicated because it has many military entities and many attributes for each entities. For this reason this research contains the methodology of information organization especially for visual information. When the operator use military display, the required information should be recognized at a glance and located where the operator can place his eye easily. Therefore, the display screen should efficiently organize and effectively transfer the information. This paper specifically proposes design methodology to effectively organize and visualize the information in the display screen. The theory of information visualization in a variety of fields already exist, but it has no established theory for the origin of the display screen design. Since the theory was selected to organize the military display interface design for the display screen of the battlefield situation existing information visualization theory.

1. Introduction

Information that the operator use on the battlefield situation is provided in a short period of time and has a complicated feature, because a large number of objects is variable. In order to receive the information that the operator of display screen passed at a glance, it is best to take advantage of the view from the senses. Visual information is effective with a relatively space information transmission. Also possible infinitely re-reference, regardless of the passage of time, and it is effective to deliver the complex information. Also less affected in the

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noise of the surrounding environment on the battlefield situation. The Visual information is better suited to operate even if the user continues to display the screen in one place without moving. The purpose of this study is to establish a method of how to organize visual information efficiently and use visual media (metaphor or icon infographic). The following **Table 1** shall design aims to have this effect upon Visual information design that presents a typical effect obtained when designing Visual information.

2. Factors Improving the Communication Performance

First, the components of the information that affects communication performance. According to a study on the properties to visualize information, components of the information can be divided into content, structure, format. Contents can be classified based on importance in very critical information, needed information, minor information in a particular situation [1]. Structure is a property of the information represented or organized method. The format is a way to highlight or represent information. It is possible to improve the information delivery performance by controlling the components in the information purposes. Second, expression of the visualization information affects communication performance. Another method to visualize information, there are ways to take advantage of an icon, symbolism or infographics, and typography.

3. Using the Information Components

Information delivery performance indicators are organization property, definiteness, referentiality, clarity, efficiency and universality. Organization property is value of easiness to access information by organizing formats and structures of information. In order to enhance display's organization property, designer allow the operator to magnify and filter information. Operator needs to compare affecting parameter, so display needs to offer comparable parameter and property.
- Simplification and segmentation: the operator can figure out the general structure of the information and move the point to the detail area.
- Magnification: the operator can observe the variables and dimensions of information.
- Filter: The operator can filter out unnecessary information.
- Association: the operator can know the difference between the data by comparison, it can be seen that the trend of the data continuity.

Providing information of excessively increases the time it takes for the operator to figure out the important information, and it will give confusion. Definiteness is minimizing parameters of information and properties of information. e.g. reducing the amount of information to highlight and but delivering critical information when the operator need it. In order to increase definiteness of information, designer is required to focus on preventing operator's cognitive resource from being seized by unnecessary information.
- Avoiding displaying excessively technical information.
- Displaying important information, which is helpful to completing mission.

Referentiality is clarity of delivering information about what operator should do next. In order to increase referentiality, military display is needed to help operator predict overall situation after applying function of the display and by using various visualizing methods.
- The Visualized information is needed to be emphasized through overall visualization pattern of the display.
- Information, which priority is high, is needed to be recognized early than other.

Clarity of the display is Indicators of objectivity to deliver information. In order to enhance clarity, display is needed to mark the source of the data. This will shorten time for understanding information and allow operator

Table 1. Effect of information visualization.

Number	Effect
1	To helping operators intuitively understand the information
2	To exhibit discriminatory different characteristics and relationships between information
3	To help operators infer complex information
4	Inducing an interest and sensibility

to compare parameters. Furthermore, the display should express causality of information and offer data quantitatively.

Efficiency of the display is indicator about shortening time for grasping information at a glance. In order to increase efficiency of the display, designer should reduce amount of information appropriately, and bind information which means similarly. According to Adward Tufte's information visualization theorem, arranging complex information in a monitor is important to understand what they mean. On one screen arranging information (e.g.: text, images, figures, labeling, etc.) allows the operator to receive information efficiently and minimize the gaze movement [2].

Universality is indicator of how common the method of the display's visualization is. In order to increase universality, the display should use common perspective for highlighting important information. This could be found in Feynman-Tofte's visualization theorem [3].

- Show the source of information and provide the data to the quantitative determination to make clear decision.
- Provide data to compare the critical parameter.
- Use a structure that can demonstrate a causal relationship.
- Constantly improved in order to select the most efficient organizational layout information in certain circumstances.
- Using a universal method to the operator among the method of the information visualization.
- The chart diagram, which labels and legend has melted into, is even more effective.

4. Using the Visualization Components

Data on the display screen, there are much additional information to make the final decision. Providing the relationship between them visually makes it easy to recognize trends of data. And it can be improved to reduce the confusion of the operation of the display screen.

The visual representation of information, which is collected from military information system, helps operator make the precise decision in an environment where data is changing over time. When the operator need to figure out the trends in the data, it is effective to be identified.

We refer a variety of visual effects and expression elements from thesis studies the infographics for communication. Utilizing the visual effects should utilize the visualization elements, such as line, surface, color, size, case of visualizing the information. The selection of the appropriate visualization elements can improve the performance of the display screen.

Using shape with points, lines, planes offers the operator sensitive experience. The color can be used to highlight, compare, and contrast. However, the color types increased as good to minimize the concentration of the operator is so distributed. It is effective to use the size to compare to the two states.

When tendency, massive data set or situation data is needed to be discovered, visualizing data with coloring is effective. For example to represent urgent situation or dangerous situation gage of fuel change from white to red.

Recent trends screen size is growing, and using multi-display is general. Therefore, where the information is located in the display represents importance of information. In general, the top-left of the display screen, it is increasingly recognized as an important information. So in the upper left of the display to position the critical information that must always be considered. The lower the priority of the information is placed on the upper right or lower left.

When displayed data is a pair, visualizing quantitative difference is effective.

When using a map, the designer should consider whether the operator is familiar with the situation in the current location. If the answer is 'yes', using the map is effective. However, when it is frequent movement of the mission area or the operator is not familiar with the mission area, using map causes confusion. In this case, display's map should fix the operator and move the map. It make more [4] (**Table 2**).

5. Visualization of Organically Information

Information on the display screen has a causal relationship or association, consisting of some complex subelements. Because information is generated continuously, it can make critical overload to the operator. Thus for this kinds of information, military display should convey information in a more effective way to represent the changing information.

Table 2. Factors of visualization.

Factors	Effect
The relationship between data	• Show a causal relationship between data • Enhance the visual comparison • Show the relevance of similar data • Associated information, even if its format is different, visualize without splitting any information
Trends in the data	• Multiple variables to be displayed • Design to show a change in position rather than changes over time • Look for changes in location data than the data effective time • Specific numerical value of the data should be not omitted, as it increases the accuracy • Help to identify the trends at a glance • Take advantage of color change, a graph
Shape, size, color	• Use color to differentiate a large number of different types of data • Use size gap to differentiate two types of state information or • Representation with color to differentiate through form (outline) • Use a color to highlight, compare, contrast • Take advantage of color change, on differentiating large amounts of data efficiently (trends, identify patterns, highlights, change, communities)
Position in the display	• Position in the display information affects to recognize the importance and times to gaze position. • Use a position to emphasize the overall structure or layers of information current information • When the operator familiar with the area Good to secure the operators on the map • When the operator is not familiar with the area it is good not to all operators and fixed targets • Design to allow the viewer to express his position

First, organize data to express to populate data in order to identify a number of independent information of objects in the battlefield (e.g. armed status, connection status, and military decisions). Second, represent the change of status data intuitively with text or color change to help operator recognize change of status as soon as possible. Third, merge unrelated data column for enhancing recognition speed of implicit meaning of data. For example, missiles' rotational speed, height, location. Fourth, visualizing quantitative change of data for enhancing intuitiveness of data. For example, the number of missiles available. Fifth, unify format of representation of information for enhancing recognition speed. Sixth, make related data response to change of data, this can help operator make better decision. Seventh, do not lower the effect of visualization of around data, for example, when detectors' detecting area is overlapped, display should offer both areas. Eighth, represent entity's movement, for example, the display should represent missile's height by vertical scale [5].

6. Using Icon, Symbolism

By using an icon or the direction of the movement of the mission between the menu display screen can help to recognize information of the operator. By using the icons it can be easy to distinguish objects rather than text and could take advantage of the emotional side of the operator. In addition, the information, such as a long text, an increase or decrease of the value, or more efficiently in the presence or absence of the condition can be expressed as a single icon. In this chapter we want to organize to identify the design principles and utilization of icons.

In recent years, using metaphor icon in interface design has been in the spotlight to utilize operator's knowledge and experience. When designing metaphor icons, the purpose is to enhance intuitiveness for understanding the meaning of information and to make recognition faster. But icons should imply its function exactly not ambiguously. And the designer needs to utilize customary elements of the user's experience or society [6].

• Icon should have the unique feature.
• Icon should display the effect of an increase or decrease intuitively especially the execution results.
• Icon should be in consideration of the meaning of that operator's society belongs.
• Icon should be simple and implicit representation.
• Icon should minimize the visual stimuli from the operator.
• Icon should distribute the functions of the interface efficiently from the point of view of the designer.

Table 3. Effect of Typography and Infographics.

Method	Effect
Typography [7]	• Color, weight, size gap of letters should be effective when the classification based on the importance • Sans serif letters that should be used in peacetime has better readability • Serif letters should be used for emergency or critical information • Importance varies according to the location of letters (upper left >> central >> bottom right) • State change with the passage of time should be expressed by the movement of the letters
Infographics [8]	• Form a useful infographic of the structure in contact with the user information necessary • Information page, the movement of the interface, effective and convenient to configure how to connect with the movement of information between • Be composed of a conventionally predictable information • Configured so that users can understand the structure of the information at a glance • Configuration information is consistent • When the user has access to information, it offers a spiritual experience • Offers aesthetic experience • Improve the satisfaction of users

• Icon should prevent the loss of information by avoiding ambiguous representation.

7. Using Typography and Infographics

Typography as well as icons and images is used to visualize information of display screen. For example, object's characteristics, the operation log window take advantage of typography. Using typography can be intuitive and clear information transfer by following the points below.

Infographics is the same means of information visualization in the commercial sector. According to the thesis about infographics, general components of infographics is an icon, highlighted the number, selecting relevant images and detailed descriptions or supplementary information. The same as the information for the purpose of visualization, effective information delivery. Design of Infographics considers cognitive, psychological and physical characteristics of the operator. Operators in use of the interface on the urgent situation receives a significant mental load. The infographic can leverage to reduce the cognitive load on the physical and emotional aspects of the operator (**Table 3**).

8. Conclusions

Display screen design for the efficient management of the battlefield situation, the system data is largely divided into four phases.
• In the first step for the organization of information on platform screen. And appropriately placed in each stage of the mission.
• In the second pass, when displaying information, applying visualization enhancing organization property, definiteness, referentaility, clarity, efficiency, universality.
• The third element of the expressed and detail information to help implement an effective meaning.
• The fourth is to improve the completeness of the design through the use and application of info graphics, typography, use of icons and symbols.

Acknowledgements

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