1 OBJECT CONTROLS OR FRAME CONTROLS? A COGNITION STUDY ON USING ELECTRONIC-GUIDE INTERFACE

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In this study, we examine common interactive forms in digital/electronic guides and digital archives and explore such form users' possible control views, using experimental method with a 1x2 factor design and letting the *object view* and *frame view* be an independent variable while the users' cognition conformance a dependent variable. The main findings from this study are: (1) For all drag controls, be they for exhibit objects or graphics, the controls all belong to an "*object view*," to which both the group of users with a design background and the other group without all agree; (2) For translational controls, the cognitions between said two groups are different; the majority of the group with a design background recognize the "*frame view*", while the majority of those with no design background the "*object view*"; (3) Usage cognition will incur some gap between an object and a graphic, as an exhibit thing, and the gap is most noticeable in translational controls; (4) Object VR guide controls, be their users with or without a design background, all belong to an "*object view*," and the users' cognitions under panoramic VR controls with various backgrounds are still quite scattering.

Keywords: Digital/Electronic Guide, User Interface, User Cognition.

1. INTRODUCTION

Many museums' websites offering electronic guides and archives often display their collected objects with enlargement, shifting/translation and panoramic views; however, the collected objects often incur cognition contradictions during display due to different cognitions held between the designers and the users of the websites.

During a more traditional single-machine guide or mobile guide, we often encounter up-and-down, left-and-right object-translation display forms; at present, there exist *object* or *frame* views for the translation form. The software design for Object view (object control) of translational form is easier and more direct; the Frame view (frame control) design is an opposite form if adopted. This study's main purpose is to clarify the users' possible views (object control or frame control) to offer a solid reference for future electronic guide designs. This study uses a common guide carrier, namely display screens and mouse controls, as experiment facility.

In related literature, the mental model emphasizes the consistency between the user and the system. Johnson-Laird (1983) view the mental model as one describing how people resolve inference problems; Gentener & Stevens (1983) advocate that mental model is a method in helping us understand system functions. Norman (1983) considers that mental model requires three aspects, viz. the target system, the conceptual model for the target system, and the mental model for the users toward the target system. Through an interaction with the target system, people will form a mental model toward the system;

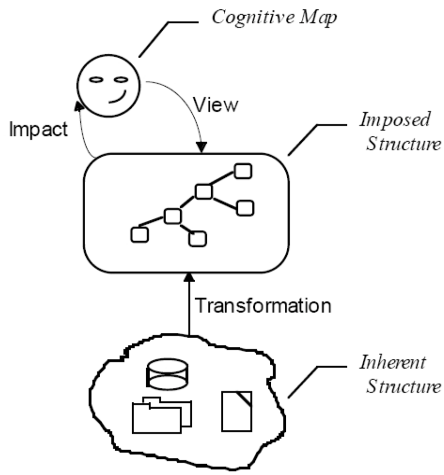


Figure 1. The structure layer of electronic guide (Jul & Furnas, 1997).

through the interaction, people will continuously modify their mental model to obtain an operable result.

Norman calls a visible structure a system image. If the system image cannot display the design model clearly and consistently, the users will obtain a wrong mental model (Norman, 1988). Only when the designer's model and the users' mental model are identical can it provide a good usability and an efficient interaction. The system image shall be consistent and understandable when viewed by the designer and the users. The conceptual model, in most conditions, is not agreeable between the users and the designer (Norman, 1983) and thus makes people feel hard to learn.

Jul & Furnas (1997) indicates that, in a guide design, we need to consider a structure of three layers, as shown in Figure 1, namely the inherent structure, the imposed structure via transformation, and the cognition map of the users. A view guide shall use the most often-seen imposed structure to better meet usage expectancy.

In addition, Norman (1988) also mentions the concept of mapping and analogies: A fine usage item needs to be clearly seen about its possible operation method, and the item's control and display shall try, as much as possible, to utilize natural mappings; with physical analogies, natural mappings will be immediately understandable.

Chen, *et al.* (2005) indicate, after evaluating the operation interface design of electronic maps, that the testees, in cognition, often feel a object-move rather than a frame-move, and diversified direction-buttons obtain better cognition unification in translational movement. Lin (2007), using electronic maps' interface as the subject, tries to resolve the usage problem related to directions. The two above-mentioned papers' study results, directing toward electronic maps, are not necessarily applicable to electronic guide. The control contents by the electronic guide users are not identical; it's still unknown whether different displayed objects will result in different cognitions on the guide users.

In this study, we take the electronic guide's contents as the main experiment contents, hoping to understand the cognition of the users toward directions and to, based on the results of this study, suggest a method better conforming to usability. We propose that whether the users' mental model represents a object or a frame should be clarified; when there exist two views for the controlled objects, contradiction might occur.

2. CURRENT SURVEY ON ELECTRONIC GUIDE

In this study conducted in May 2008, we take Taiwan's various large museums as our survey targets and examine the electronic guide forms often used on the archived objects to understand current

Table 1. The categorization of the experiment tasks.

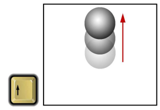
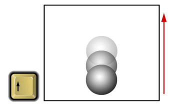
The two different views	Definition	Graphic example
Object View (Object Control)	When controlling with a keyboard, what is controlled is an object; the same to a drag control.	
Frame View (Frame Control)	When controlling with a keyboard, what is controlled is a frame; the same to a drag control.	

Table 2. The categorization of the experiment tasks.

Task item	Task	Control views
Object Translational control	Task-A	A1 object view
		A2 frame view
Object drag control	Task-B	B1 frame view
		B2 object view
Graphic Translational control	Task-C	C1 object view
		C2 frame view
Graphic drag control	Task-D	D1 frame view
		D2 object view
Object VR	Task-E	E1 frame view
		E2 object view
Graphic/Panoramic VR	Task-F	F1 object view
		F2 frame view

commonly- adopted control methods and control views. We found that the control methods, comprise translational controls and drag controls; the control views may be divided into an *object view* and a *frame view*. Also, exhibit things could be divided into two types: object and graphic.

3. METHODS

In this study, we take the experimental method, with a 1×2 factor design, treating *object view (object control)* or *frame view (frame control)* as an independent variable and mental-model conformance as a dependent variable.

The definition of an object view and a frame view is that an object view denotes that when the user is browsing the guide interface, the user recognizes that what is controlled should be an object; on the other hand, for a frame view, the user recognizes what is controlled is a frame. The two views in controlling an object are just opposite, as shown in Table 1.

3.1. The Experiment's Design

As shown in Table 2, our experiments are categorized into six experiment tasks: Object translational control (Task-A), object drag control (Task-B), graphic translational control (Task-C), graphic drag control (Task-D), object VR control (Task-E), and panoramic VR control (Task-F). Observation focal points: Whether the usage cognition of the participants toward *Object View* (object control) or *Frame View* (frame control) exhibits any gap. Each task includes two sub-tasks of two different views.

Tasks A,B and C,D will try to understand the usage cognition gap incurred when the exhibit thing is an object or a graphic. The gap between Tasks A and B, cf. C and D, mainly lies at the difference of the controlled things; the former control objects while the latter the graphics.

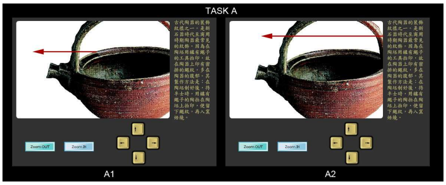


Figure 2. Task A1 Translational control, object view; Task A2 Translational control, frame view

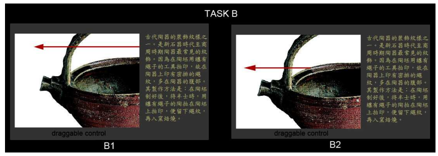


Figure 3. Task B1 Drag control, frame view; Task B2 Drag control, object view.

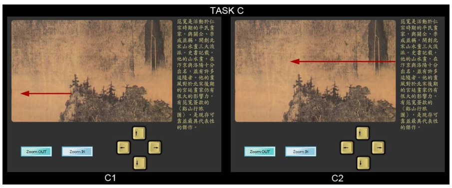


Figure 4. Task C1 Translational control, object view; Task C2 Translational control, frame view.

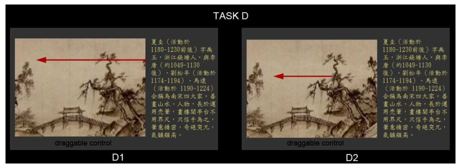


Figure 5. Task D2 Drag control, object view Task B2 Drag control, object view.

Object translation control (Task-A) and object drag control (Task-B)

The two tasks mainly proceed with controls toward objects; the difference between the two is merely the different control methods. Task-A provides *up, down, left, right* keys to proceed with translational control while Task-B merely uses *drag* method to control.

Task-A: Simultaneously display A1 (object view) and A2 (frame view) to let the participants use and then check one, out of the two, best conforming their mental model. In the Figure 2, the object will shift toward left when the left-key is pressed in Task A1, while the frame will shift toward left (i.e. the object will shift toward right) in A2.

Task-B: The same two objects; B1 (frame view) and B2 (object view) possess no up-down-and-left-right control buttons; the control method changes into dragging. Inquire the users which one, dragging an object or a frame, better conforms to their mental model. As shown in the Figure 3, B1 is the frame view while B2 the object view.

Graphic translation control (Task-C) and drag control (Task-D)

The diffidence between Tasks C and D merely lies at the different control method. Task-C provides up-down-and-left-right keys to proceed with direction control while Task-D merely uses drag control method.

Task-C: Simultaneously display C1 (object view) and C2 (frame view) graphics to let the participants use and then check one, out of the two, best conforming their mental model. The object will shift toward left when the left-key is pressed in Task C1, as shown in the Figure 4, while the frame will shift toward left (i.e. the object will shift toward right) in C2.

Task-D: Next, two identical screens appear; the control method changes to dragging without the up-down-and-left-right control buttons; drag the object and frame and inquire the users which one best conforms to their mental model. As shown in the Figure 5, D1 is the frame view while D2 the object view.

Object VR control (Task-E)

Task-E: Rotatable objects or rotatable frames When the mouse is dragged toward left, Task E1 represents a frame view, and the object rotates counter-clockwise; Task E2 acts the opposite, and the object rotates clockwise. Inquire the participants which one conforms better to their usage expectation. Inquiries merely direct toward the preference of control method; the object's beauty and control smoothness are not within our consideration. (Figure 6)

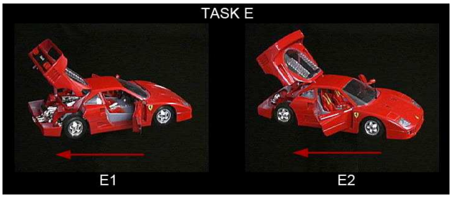


Figure 6. Task E1 Drag control, frame view; Task E2 Drag control, object view.

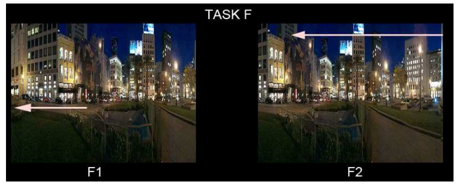


Figure 7. Task F1 The object view; Task F2 The frame view.

Panoramic VR control (Task-F)

Task-F: Rotatable scene (control scene) or panorama (control lens); F1 represents an object view, namely the cursor is placed at left and the graphic moves toward left; F2 represents a frame view and hence is opposite to F1, i.e. when the cursor is placed at right, the graphic moves toward left. Inquire the testees which one conforms better to their usage expectation. To avoid any possible influence from different hint effects by the cursor icon in this task, we only display the cursor's original *arrow* and place the cursor on the left or right of the graphic, without doing any clicking or dragging. (Figure 7)

3.2. The Experiment's Process

Six experiment tasks are taken by the participants; each task simultaneously displays guide experiment samples of *object view* and *frame view*. According to the following flow process, the testee, with his cognition, will select the sample better conforming his usage expectation:

1. Explain to the participant the experiment's purpose and steps.
2. Ask the paticipant to fill up basic data (age, sex, department of major).
3. Watch screen and use it; ask the paticipant to check the selection item for *which one better conforms your usage expectation*.
4. Repeatedly proceed with the experiments until all six are tested and completed.

We carry out this study using a classroom test form; for participant sampling, we select students, as our test target, comprising two specialization groups at Kao Fong College. Participant target: Digital-contents design school (design background) includes digital media design department (sophomores and juniors); management school (non-design background) includes distribution management department (freshmen and sophomores), and leisure management department (juniors). From the digital specialization group, we receive 100 questionnaires; out of them, 80 are valid and 20 invalid. From the management specialization group, we receive 77 questionnaires; out of them, 55 are valid and 22 invalid. To remove the inter-task mutual interference caused by too many times' back-and-forth between the two views on the participants, all participants only need to complete four out of the six tasks; hence, part of the participants complete ABEF tasks while the rest CDEF tasks. Since Tasks E and F are object VR and panoramic VR which are not easy to interfere each other, all participants are required to complete the tests in both Tasks E and F.

4. RESULTS

In this study, we are mainly aimed at understanding whether there is cognition gap between the users' *object view* and *frame view*; hence, we adopt goodness-of-fit test to proceed with statistical analysis. The main purpose of fitness of fit is to inspect whether the number of expectation corresponding to the number of data observation we collect (Lin, 1992; Chang, 1993). We hope to understand whether the two views of control methods by the participants of different study background are different. If the two views reach an obvious difference, that will indicate that a certain view conforms to the majority's usage habit or expectation, and the designer may follow the result as a design reference; when the difference is not obvious, that indicates that there is still a sizable number of users that share different cognition one another, and it is still hard to make a final safe judgment in design.

Table 3. Task A Number and Chi-square statistics.

	A1 Object view	A2 Frame view	N	χ^2	Sig
With non design background	22 (81.5%)	5 (18.5%)	27	10.704	0.001*
With design background	19 (44.1%)	24 (55.8%)	43	0.581	0.446
Total (desing and non desing)	41 (58.6%)	29 (41.4%)	70	2.507	0.151

Table 4. Task B Number and Chi-square statistics.

	B1 Frame view	B2 Object view	N	χ^2	Sig
With non design background	1 (3.7%)	26 (96.3%)	27	23.148	.000*
With design background	9 (20.9%)	34 (79.1%)	43	14.535	.000*
Total (desing and non desing)	10 (14.3%)	60 (85.7%)	70	35.714	.000*

Next, take a further step whether there is cognition gap between the two groups using test of homogeneity of proportions. Lin (1992) indicates that the test of homogeneity of proportions is to test whether the J groups of the researcher's interest share the same I response proportions, namely whether the groups' responses are homogeneous.

(1) Task A result analysis
The result of Task A is shown in Table 3, where Task A represents the object's up-down-and-left-right (translational) control test; A1 represents an *object view*, while A2 a *frame view*. There is a noticeable difference in the two views among the participants with non design background; namely, the majority of the participants feel that it should control objects, instead of frames, during their up-down-and-left-right tests. The participants with design background are somewhat opposite to those with non design background; the majority of the former feel that the control should be for frames. The two views in Task A do not reach noticeable difference, indicating diversified usage cognition; although the object view, from the total number, seems to better conform to the general public's usage expectation, it is still hard to make a final statement concerning which view shall be taken to proceed with the design.

Take a further step to observe the difference between the two groups using test of homogeneity of proportions: $\chi^2 = 9.507$ (Pearson Chi-square), df $= 1$, p $= 0.002$; the difference between the two groups of various backgrounds is significant, indeed, indicating a great cognition gap.

(2) Task B result analysis
Task B's result is shown in Table 4; both Tasks B and A take object control, and the only difference lies at that Task B adopts *drag* control method rather than the *up-down-and-left-right* method; B1 represents a frame view while B2 an object view. From the table, we observe that when the great majority of the participants drag, they will use the object view to control; those with non design background are even closer — almost all of them feel that the object view better conforms to their usage expectation. It is worth our attention that during Task A (up-down-and-left-right control), over half of the participants with a design background adopt a frame view but change to an object view after altering to drag control. Overall speaking, responses toward Task B are quite consistent, whether the participants are with or without a design background; namely, when the controlled subject is an object, the testees all use an object view to control.

The comparison result for the two background groups is: $\chi^2 = 4.020$, df $= 1$, p $= 0.045$, which also reaches a significant difference level, indicating that the praticipants with a design background can better accept the *frame* view. We infer that the groups' cognations should have less difference if the number of the testees with a design background increases.

(3) Task C result analysis
Tests C and A are identical, the difference merely lies at the different experiment samples, viz. with the object being switched to a graphic. The result is rather interesting; the majority of those with no design background all take an object view in controlling during Task A, although there is still a relative

Table 5. Task C Number and Chi-square statistics.

	C1 Object view	C2 Frame view	N	χ^2	Sig
With non design background	15 (53.6%)	13 (46.4%)	28	0.143	0.705
With design background	7 (18.9%)	30 (81.1%)	37	14.297	0.000*
Total (desing and non desing)	22 (33.8%)	43 (66.2%)	65	6.785	0.009*

Table 6. Task D Number and Chi-square statistics.

	D1 Frame view	D2 Object view	N	χ^2	Sig
With non design background	11 (39.3%)	17 (60.7%)	28	1.286	0.257
With design background	13 (35.1%)	24 (64.9%)	37	3.270	0.071
Total (desing and non desing)	24 (37%)	41 (63%)	65	4.446	0.035*

Table 7. Task E Number and Chi-square statistics.

	E1 Frame view	E2 Object view	N	χ^2	Sig
With non design background	12 (22.0%)	43 (78.0%)	55	17.473	.000*
With design background	13 (16.3%)	67 (83.7%)	80	36.450	.000*
Total (desing and non desing)	25 (18.5%)	110 (81.5%)	135	53.519	.000*

majority in Task C, with a clear increase in number for the frame view nevertheless. This is the same to participants with a design background; during Task C, the number recognizing the frame view greatly increases, reaching a significant difference level; from the view of the total population, the difference is also apparent, as shown in Table 5. Overall speaking, we should take a frame view to design when the exhibit is a graphic rather than an object.

Although there exists a distance in cognition between the two groups, i.e. $\chi^2 = 8.548$, df = 1, p = 0.003, it is still worth attention that near half (46.4%) of the participants with non design background recognize the frame view.

(4) Task D result analysis
Tasks D and B are identical, using drag control method to control; merely experiment samples (stimulant) are different. From the result we learn that, comparing to Task C, the participants with a design background switch from a frame view to an object view during this task (drag control), and viewing from the participants of different backgrounds, the responses are quite consistent (see Table 6). Observing the experimental results of Task B, drag controls, whether to an object or a graphic, can all be designed with an object view. The two groups' responses are quite consistent during this task, with little difference: $\chi^2 = 0.118$, df = 1, p = 0.731.

(5) Task E result analysis
Task E represents an object VR guide, and E1 is the frame view while E2 the object view. The result, as shown in Table 7, reaches a significant difference level whether viewing from the background or total number, indicating that designing with an object view conforms to the majority's usage expectation. The two groups' responses are quite consistent during this task, with little difference: $\chi^2 = 0.670$, df = 1, p = 0.413.

(6) Task F result analysis
Task F represents a panoramic VR guide; F1 is an object view, namely when the mouse is placed on the left of the graphic, the graphic will move toward left; F2 represents a frame view, namely when the mouse is placed on the left of the graphic, the graphic will shift toward the right. The result is shown in Table 8, indicating that to the general people, the two methods seem to have no great difference; during the experiment process, there are also many participants questioning if there is any difference between the two and expressing a feeling of not much difference. The participants with a dsign background

Table 8. Task F Number and Chi-square statistics.

	F1 Object view	F2 Frame view	N	χ^2	Sig
With non design background	32 (58.2%)	23 (41.8%)	55	1.473	0.225
With design background	26 (32.5%)	54 (67.5%)	80	9.800	0.002*
Total (desing and non desing)	58 (43.0%)	77 (57.0%)	135	2.674	0.102

obviously are more used to the *frame view*. Overall speaking, using a frame view to proceed with the panoramic VR guide might better conform to the users' expectation if the two views show not much difference to the general users.

The comparison result between the two groups is: $\chi^2 = 0.670$, df $= 1$, p $= 0.003$. The cognitions of the two groups with different backgrounds possess some difference; taking a step further to examine the conformance degree of usage expectation for F1 and F2 (five point scale, from high to low), we discover that many paticipants' checks merely have a single-scale difference, even checking the same degree, the same as what the participants described that their feeling is about the same. Although the two groups having different backgrounds possess cognition gap, the distance, viewing from those without a design background, between the frame view and the object view is rather small. Overall from the result, the cognition tilts toward a frame view; we may proceed with the design with a frame view.

5. CONCLUSION

In this study, we mainly locate the following findings:(1) For all drag controls, whether they are for exhibit objects or graphics, the controls all belong to an *object view*, and the views of the controls are in agreement for those users with a design background and others without; (2) For translational controls, the cognitions between the two mentioned groups of users are different; the majority of the users with a design background recognize the frame view, while the majority of others without a design background the object view; (3) Usage cognition will incur some gap between an object and a graphic, as an exhibit object, and the gap is most obvious in translational control; when the exhibit object is a graphic, the frame view conforms to the users' cognition better, be the users have a design background or not; (4) Object VR controls, be their users with or without a design background, all belong to an *object view*; the main reason is: the control movement and the metaphor of the cursor's icons make the users' cognition quite consistent. Panoramic VR, for removing the possible metaphors, make the two groups of testees share different cognitions, but the overall results tend to be in favor of the frame view.

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