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Study of Icons in Enterprise Application Software Context

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***Abstract*—**Icons are not merely decorative elements in enterprise applications but very often used because of their many advantages such as compactness, visual appeal, etc. Despite these potential advantages, icons often cause usability problems when they are designed without consideration for their many potential downsides. The aim of the current study was to examine the effect of articulatory distance – the distance between the physical appearance of an interface element and what it actually means. In other words, will the subject find the association of the function and its appearance on the interface natural or is the icon difficult for them to associate with its function. We have calculated response time and quality of identification by varying icon concreteness, the context of usage and subject experience in the enterprise context. The subjects were asked to associate icons (prepared for study purpose) with given function options in context and out of context mode. Response time and their selection were recorded for analysis.

***Keywords*—**Icons, icon concreteness, icon recognition, HCI.

I. Introduction

BUSINESS uses enterprise applications to run their day-to-day activities such as finance, sales, human resources, procurement etc. In today's corporate environment, enterprise applications are complex, scalable, distributed, component-based, and mission-critical. One of the fundamental aims of any human-computer interaction system is to facilitate fast and efficient performance and icons are one such element which not only helps in improving the efficiency of the system but also helps in increasing the aesthetic of the system if design effectively. There is profound knowledge available which tells that performance and appeal are inter-related [3], [4], [9]-[11]. Icons are a visual representation of an object, action, or idea. They are used to bridge the understanding of abstract analogies and practical use. In today's digital world, a lot of information, actions, process, statuses etc. are represented with the help of icons because of many advantages such as they require less space (compact), visually appealing, etc., and we have observed the same trend in the enterprise application, as well where process, action, navigation, etc., are represented by icons.

User-interface icons are much more than on-screen decorations. Icons play an integral role in enhancing end user productivity and an application's overall success. Cees Van Beers and Fardad Zand [2] have studied the effects of EAS (Enterprise application software) systems on four different performance indicators: revenue growth, productivity, market share growth, and profitability. Usability of enterprise apps can affect business directly or indirectly. Some of the problems and pitfalls businesses encounter due to poor usability of EAS include the following: (1) decrease in productivity of employees because of complex navigation, poor visibility of objects, and (2) late adoption of the system can affect the efficiency of employees and satisfaction. This makes our study more relevant because icons are an important element at the user interface level especially in enterprise applications. Research has shown that aesthetically pleasing designs tend to increase our perceptions of system usability [3], [4]. Some research available on icon characteristics like concreteness, familiarity, the age of users, etc. In McDougall's [5] study of icons and aesthetics, the concreteness and familiarity appeared to be an important determinant of aesthetic appeal. According to Suna Park [6], concrete icons describes the feature of an object as is and its contour shall be described clearly and abstract icons are understood as a concept which describes the state deviating from the concrete object. Concrete icons are superior over abstract ones [1], [8]. Tudor [7] found that icons which are designed to mimic their physical reference usually received more favorable recognition as compared to those which are more symbolic in nature. According to Suna Park [6], icons with detailed or realistic depictions enable ease of memory.

Since most of these findings are based on the investigation of icons within the mobile context, traffic, symbols, aesthetics, characteristic, etc., it is not yet known whether the same can be extended to the context of enterprise applications or not. This study is an attempt to understand how icon concreteness, context of usage and subject experience impacts icon recognition in the enterprise application. This study had therefore three major goals: (1) Understanding the effect of icon concreteness in icon recognition, (2) Understanding the effect of context in icon recognition, and (3) Understanding the effect of subject experience in icon recognition.

II. Method

A. Variables

Three independent variables i.e. 1) Icon concreteness (concrete & abstract), 2) Context of usage (in context and without context), and 3) Subject experience (novice and expert) were varied to measure two dependent variable i.e. 1) Response time - time taken by subject to lock their response, and 2) Quality of identification – how well or close subject has identified the icon with associated function. To analyze quality of identification we have map subject responses in 3 categories i.e., 1) Exact identified – Subject exactly map the icon with associate function, 2) Similar Identified – Subject

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recognize it, but map to closer associate function, 3) Not identified – Subject did not recognize the icon at all and was not able to map to associate or closer associate function.

B. Subjects

A total of forty subjects, volunteered to take part in this study out of which 20 were novice (<3 years' experience; M=1.88; SD=0.74) and 20 expert (>3 years' experience; M=6.45; SD=3.10) subject. The criterion used for selecting subject is 1) Subject have exposure to enterprise software on daily basis, and 2) their usage of internet and software were also high.

C. Apparatus

The study was run on a laptop with a 15 inch LCD screen. The icons were presented to the subject by software program specifically developed for study purposes. Each icon is displayed for 10 sec along with probable associate function options and the subject has to respond by selecting a function within that time. The difference between the displays of consecutive icons is 3 sec. If subjects are not able to identify function associate with the icon within that time, the response time should be noted as 10 sec and the system will register the response as not identified.

D. Material

The set of 20 icons (10 abstract and 10 concrete) to represent 10 functions were created (see Table I). To ensure good legibility, icons were scaled to a size of 120x120 pixels.

E. Procedure

Study was executed in two phases. In the first phase, the subjects were asked to select the function associated with the icon; however, the context of usage was not explained/given to the subject. The study was conducted with both novice and expert subjects. A total of 40 subjects were randomly divided into two groups so that each group will have equal number of novice and expert subjects. The set of Concrete icons were shown to first group and the abstract icons set were shown to the second group. The subjects were asked to associate the icon with given function option. In this study we have varied icon concreteness and subject experience to measure the response times and options selected by the subject were recorded for analysis.

In phase 2, the same study was repeated but this time subjects were aware about the context of usage of icons. For this study we have interchanged the icon type to be shown to groups, i.e. set of abstract icons were shown to first group & concrete icon set were shown to second group. The sequence of icons and their respective options were changed so that there will be less impact on user due to study conducted in phase1.

III. Result

After conducting the study, the results were analyzed for each independent variable separately i.e. icon concreteness, context of usage, subject experience in terms of response time and accuracy.

TABLE I
ICONS USED IN STUDY

Function	Abstract Icon	Concrete Icons
Analytics		
Appointment		
Approval		
Estimation		
Flag		
Helpdesk		
Process		
Security		
Shipping		
Workflow		

A. Icon Concreteness

In Table II, response time (average, standard deviation) and accuracy (average, standard deviation) of icon types (abstract, concrete) without context is presented.

B. Effect of Context

In Table III, response time (average, standard deviation) and accuracy (average, standard deviation) of icon types (abstract, concrete) with context is presented.

TABLE II
ICON IDENTIFICATION RESPONSE TIME AND ACCURACY IN 'WITHOUT CONTEXT'

Characteristics	Response Time		Accuracy	
	Average (in seconds)	Standard Deviation	Average (%)	Standard Deviation
Abstract	4.52	0.87	38.06	10.32
Concrete	5.81	0.76	51.02	11.97

TABLE III
ICON IDENTIFICATION RESPONSE TIME AND ACCURACY IN 'WITH CONTEXT'

Characteristics	Response Time		Accuracy	
	Average (in seconds)	Standard Deviation	Average (%)	Standard Deviation
Abstract	4.03	0.56	53.98	10.74
Concrete	4.16	0.59	57.03	9.48

C. Effect of Subject's Experience

1. Novice Subjects

In Table IV, response time (average, standard deviation) and accuracy (average, standard deviation) of novice subjects in both icon types (abstract, concrete) without context is

presented.

2. Expert Subjects

In Table V, response time (average, standard deviation) and accuracy (average, standard deviation) of expert subjects in both icon types (abstract, concrete) without context is presented.

TABLE IV
ICON IDENTIFICATION RESPONSE TIME AND ACCURACY IN WITHOUT CONTEXT WITH NOVICE SUBJECTS'

Characteristics	Response Time		Accuracy	
	Average (in seconds)	Standard Deviation	Average (%)	Standard Deviation
Abstract	4.62	0.63	36.9	10.56
Concrete	5.92	0.71	49.11	8.75

TABLE V
ICON IDENTIFICATION RESPONSE TIME AND ACCURACY IN WITHOUT CONTEXT WITH EXPERT SUBJECTS

Characteristics	Response Time		Accuracy	
	Average (in seconds)	Standard Deviation	Average (%)	Standard Deviation
Abstract	4.44	0.98	39.07	7.37
Concrete	5.89	0.88	58.01	7.88

IV. DISCUSSIONS

The present research was guided by three major goals. For the first goal, icon concreteness was varied without presenting the context to the subject and we have observed that the subjects have taken longer to recognize the concrete icon as compared to the time taken for the abstract icon (see Fig. 1), whereas the accuracy for identifying the concrete icons is higher than the abstract icons (see Fig. 2). For the system where accuracy is prominent, the concrete icon will work better. Concrete icons seem more natural to the user and require less learning because of its relation with the everyday object, but there is many information that cannot be represented effectively by concrete icons, especially in enterprise application where icons are used for representing operations, process, etc. In those scenarios, concrete icons will not be a better fit as those may not have relation with everyday objects and subjects will find it difficult to interfere, hence abstract will be a better fit in those situation as they can be derive meaning through metaphor.

For the second goal, context of usage was scrutinized and we have observed that there is a marginal reduction in the response time for both concrete and abstract when compared with the context. But accuracy has shown tremendous improvement for the abstract icon when compared with without context (see Figs. 1 and 2) while marginal improvement in accuracy were observed in the case of the concrete icon.

For the third goal, the subject's experience was scrutinized and it was observed that response times did not change much for both the abstract and the concrete icon when experience was increased. However, the expert subjects have registered higher accuracy, especially for the concrete icons compared with the novice subjects (see Figs. 3 and 4) because of its familiarity with the object depicted in the icon and the level of experience the expert subjects have with icons.

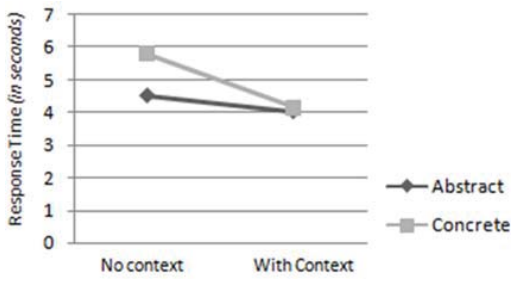

Fig. 1 Analysis of icon identification response time in 'with and without context'

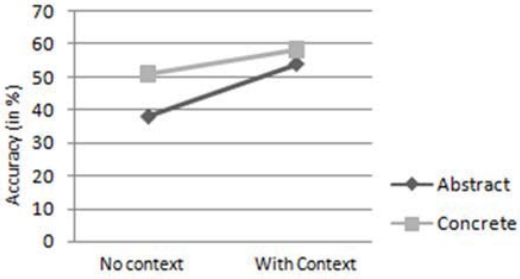

Fig. 2 Analysis of icon identification accuracy in 'with and without context'

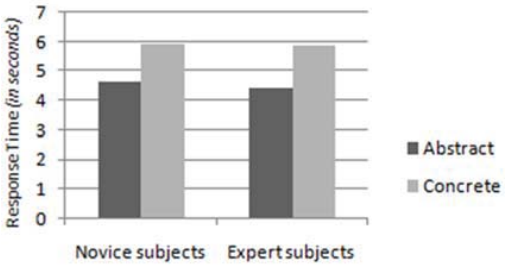

Fig. 3 Analysis of icon identification response time of novice and expert subjects

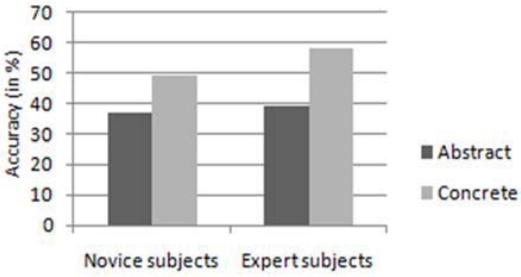

Fig. 4 Analysis of icon identification accuracy of novice and expert subjects

V. FUTURE DIRECTIONS

In this study, we have witnessed how icon characteristics i.e. icon concreteness, context of usage and subject experience have impacted icon recognition in the enterprise context.

Enterprise application has a wide range of operations and their respective user group is also quite different from one another, and thus, it has become quite a challenge to design an icon that actually communicates an idea and can still be used in some other application as well. There are some icons that are universally recognized which the subject can relate to everyday things, although most icons continue to be ambiguous to the subject due to their association with different meanings across various interfaces. We have observed that there are no standard guidelines for icon design yet, which can be followed while designing them across interfaces and the absence of which makes its adoption difficult over time. For future research, it is important to look beyond icon-function mapping to the wider context in which icon interpretation occurs. We are looking to extend this study and look for other variables that impact icon recognition. We are planning to analyze methods for designing usable, accessible, recognizable icons for enterprise applications, and how can we include end user in the icon design phase will also be a future research area, and we will also investigate how icon testing can play a vital role in enterprise applications. More detailed icon testing methodology can bring more insightful properties of icon comprehension and recognition. How to utilize the icon testing insights in the icon design phase will also be an area for further investigation. In future research, we will be targeting different enterprise contexts and domains to understand the user behavior and icon design inspirations.

VI. Conclusion

Our study has shown evidence of how icon characteristics i.e. icon concreteness, context of usage and subject experience play a vital role in icon recognition in the enterprise context. This shows that these characteristics of icon need to be considered while designing icons for enterprise. Accuracy for identifying concrete icons is higher than abstract icons, this shows that where system accuracy is prominent, the concrete icon will work better when compared to the abstract icon. When context was mentioned, accuracy has tremendously improved for the abstract icon when compared to without context, while marginal improvement in accuracy was observed in the case of concrete icons. Subject experience played a major role in icon recognition. Expert subjects have registered higher accuracy, especially for concrete icons compared with novices because of their familiarity with the object depicted in the icon and the level of experience expert subjects have with icons.

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