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Identification and Origin of User Interfaces

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Abstract. This paper identifies typical patterns of user interfaces in software applications and try to conclude their origin based on association with phenomena of the surrounding world. First, four basic phenomena are chosen (Time, Gravity, Space and Similarity) and then related user interfaces are assigned under them. Each user interface is described, explained and put into the right usability context. Author believes that when we identify and understand these connections between phenomena and user interfaces, and follow the concept of inspiration from the outside world, we will be able to create more usable software which will serve people better. The user interface patterns research is just a part of author's broader research in software ergonomics field.

1 Introduction

Software ergonomics is a domain of research which looks at software from the user's point of view. Its main goal is to harmonize the communication between a man and machine. People play a dominant role in software, and software design considers people from its very first design.

Software ergonomics covers all the parts in software which are related or dedicated to human being. Author's PhD dissertation (currently in progress) splits the ergonomics into four parts: Speed, Psychology of Colors, Psychology of Shapes, and External and Environmental Influences.

This article is related to the Psychology of Shapes part. Identification and origin of user interfaces and their archetypes is also related to Psychology, Physics or Sociology. All the interfaces described should be considered as "soft systems". Even the interfaces are just a reflection of the outside world and they are interpreted and used from human being perspective, their interpretation could be still subjective. Nevertheless, author tries to identify, categorize and describe these interfaces and link them with phenomena of the outside world to help to be used in the right context.

Current scientific research and publications look at software ergonomics vicariously or indirectly. For example, fragments of Psychology of Colors are mentioned in [1] and [2]. Human factors and Psychology of Shapes is partly described in [3]. Design patters related to software are mentioned in [4] and [5]. There are also general guidelines for software developers [6], [7], [8]. However, neither all the described interfaces nor single components miss a connection to their origin and association with the outside world. This way, it's hard to predict their behavior.

The author assumes the following:

1. Involving outside world phenomena, general user interface boundaries are set. Software user interfaces could be designed and developed inside these boundaries of the known world so its control and behavior will be more predictable.
2. User interfaces will be used in the right context.
3. Software will be consequently simpler for its users.

2 Phenomena

Based on observation of the surrounding world, four generally known phenomena have been chosen as a basis for user interface identification and classification.

2.1 Time

Time represents change, growth and perpetual moving, expresses a dependency of human being on surrounding environment, reflects interaction and links an action with a reaction. While perceiving time, we can refer basic time frames – past, present and future. On the mental timeline (how we perceive time in surrounding space), past is understood on the left and the future on the right [9].

User interfaces take time into account with horizontal layouts, unfolding information from left-to-right, and with determining components priority (on the right is the newest and so more important).

The following user interfaces have been categorized under *Time* phenomenon:

2.1.1 2-Column Horizontal Layout

The screen is split into 2 parts which are positioned next to each other. The left side displays older/less important data and the right side newest/more important data, or both sides show equally important data. This could be used for a comparison or for displaying duplicates.

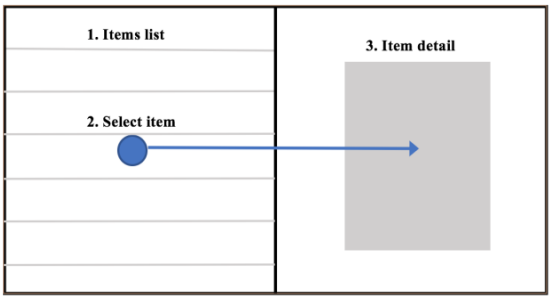

Figure 1: 2-Column Horizontal Layout user interface

2.1.2 3-Column Horizontal Layout

This interface is an extension of 2-column Horizontal Layout and adds another layer of detail or granularity. Displaying is in the form of 3 columns horizontally positioned next to each other. The left side could display Past, the middle one Present, and the right side Future. The interface could also follow granularity principle where coarse-grained data is on the left, data in normal resolution in the middle and fine-grained data on the right.

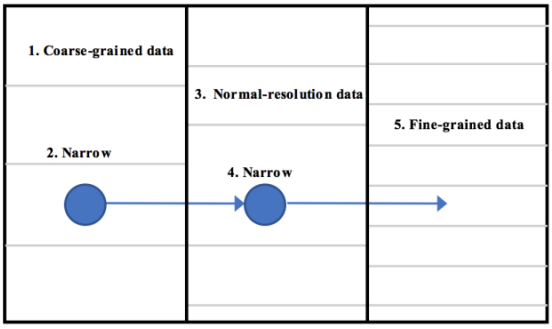

Figure 2: 3-Column Horizontal Layout user interface

2.1.3 Menu on the Left

This interface is a special variant of the *2-Column Horizontal Layout*. Application menu is positioned on the left. Therefore, the menu is the main control interface and could be used earlier than the middle (working) part of the application. For example, one needs to choose a file which he would like to work with.

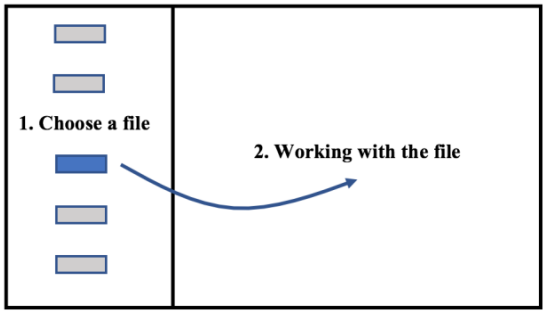

Figure 3: Menu on the Right user interface

2.1.4 Menu on the Right

The application menu in this interface is just an additional (second class) component. Due to mental timeline perception, the right part of the screen is recognized later than the left one. Hence menu contains control elements which are used less frequently compared to *Menu on the Left* interface. For example, one works with a photography and they decide to apply a filter on the photography.

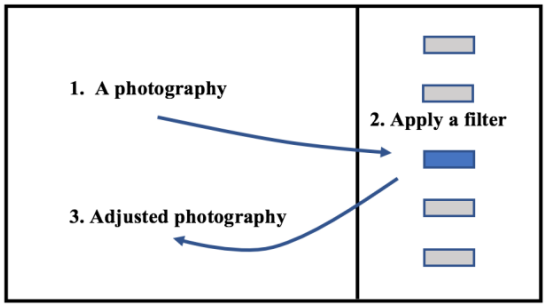

Figure 4: Menu on the Right user interface

2.2 Gravity

Perception of gravity as a law of nature and its influence on human being reflects user interfaces in top-to-bottom design. More important is on the top and less important on the bottom. We can understand gravity as a vertical timeline. Designing future is very difficult, maybe impossible here. In the vertical space, we can express future on the top but user interfaces are positioned just ahead of us which connotes present, not future. Therefore, it's reasonable to reduce time-frames under this phenomenon only to past and present.

The following user-interface type has been identified under *Gravity* phenomenon:

2.2.1 List

This user interface is represented by a vertical list of items, typically sorted by their priority. The most important or newest item is on the top and less important or oldest is on the bottom. One item represents one encapsulated information or entity (a task, email, document etc.). In case of many items it's advisable to split the list by a blank space or horizontal line into smaller groups (3-5 items in groups, for example).

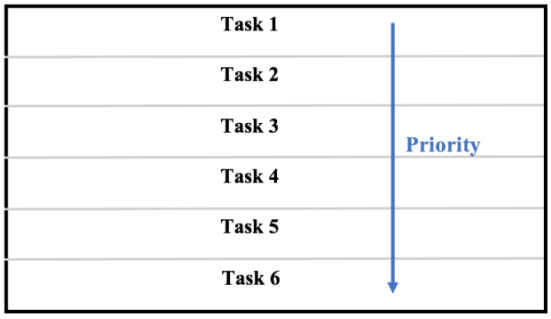

Figure 5: List user interface

2.3 Space

Space phenomenon is derived from perception of the world by human being. Assume that one perceives space around him, realizes the boundaries (and so the size of the space), recognizes objects inside it and knows his position. Then we can say that space perception is dependent on the size of the space and, objects perception is related to the distance of each object from the others. Objects placed close to each other are recognized as a group and we think

about them as the whole. If there are some groups and the object doesn't belong to any of them, it's independent and has an exclusivity. It differs from the others, grouped objects. This object has probably other, special attributes and so it is more important.

Space perception establishes relations among distance, size and importance in user interfaces. In general, when we strive for simpler interfaces we could have as few elements as possible. Each element occupies a part of user's field of vision, demands an attention and increases a possibility of interactions among elements, or between an element and user.

These user interfaces have been categorized under *Space* phenomena:

2.3.1 Workbench

Workbench is a composite interface derived from phenomena *Space* and *Similarity* (see *Similarity* below). A typical representation of the interface is a maximized window where the middle part is dominant and used as the main working area. Displaying is not split into more parts and the focus is in the middle of the window. The middle is the safest area because it has the biggest distance from borders (objects in the middle can't be lost because they can't fall off the borders). The similarity with a real workbench is obvious but the interface has been classified under Space phenomena because its attributes are more about distance and size.

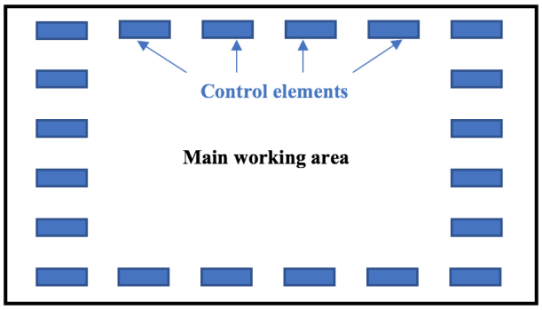

Figure 6: Workbench user interface

2.3.2 Bigger is more important

Importance can be expressed by size. Bigger objects grab more attention because they occupy larger area of the user 's field of vision which is limited. We can express superiority with larger cover of the field of vision. This interface can be combined with *Workbench* interface to highlight control elements which are used more often than the others.

By increasing elements visibility, cognitive load and knowledge activation are both increased [10]. Therefore, bigger control elements are becoming more important.

Importance can be also expressed by colors. White and lighter objects seem to be bigger than they really are and dark-colored objects are smaller [1]. This way, if there are more objects with the same size, colors can highlight their importance. Colors perception is also a subject of social, religious or geographical context [2].

2.3.3 Group

A group of items contains elements with similar or unique features. Elements can be grouped by their attributes, importance or frequency of use. A group encapsulates its members from the others. The importance is redeemed by space around the group which can't be used otherwise.

A group can be also split into subgroups. For example, in the *List* user interface we can optically shrink the number of elements by adding a space after every fifth element. The space makes the list lighter and the look will be simpler. One can recall and repeat about seven items from memory at once [11]. Hence the individual group size shouldn't exceed this limit.

2.4 Similarity

Similarity phenomenon means an association of user interface and its components with objects and their attributes from the real world. The advantage is an existing mental association followed by identification of the component with a pattern from the outside world and prediction of its function without a need of learning. The association decreases entropy. The similarity is only an approximation based on conformity of attributes and expressions of the original object (shape, color, behavior) with the component. In most cases, these attributes can be captured by eyesight or hearing.

The principle of the phenomenon can be described as follows:

1. A user has a pre-existing association from the outside world based on previous knowledge.
2. The user sees a component in user interface for the first time (he hasn't known it yet).
3. The user likens the new component with an object from outside world which is known already. A new association is created.
4. From now on, the component is recognized automatically.

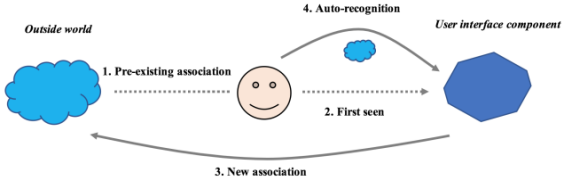

Figure 7: Similarity phenomenon principle

Following this principle, this user interface has been categorized under *Similarity* phenomenon:

2.4.1 Tiles

Tiles user interface puts components into a grid. The name evokes similarity with tiles on a pavement. The grid acts orderly if there is the same spacing among components in horizontal or vertical direction.

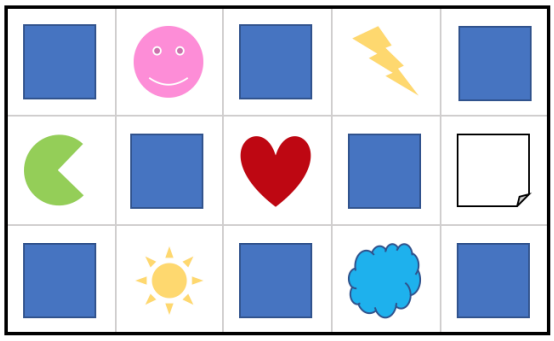

Figure 8: Tiles user interface

3 Relationships among Phenomena

Relationships among phenomena *Time*, *Gravity*, *Space* and *Similarity* can be visualized as Figure 9. As it is evident, phenomena co-exist as well as their patterns in the real world. *Gravity* relates to *Time* and *Space*, and *Similarity* occurs in *Space*. Phenomena interact with each other. Therefore, when mapping user interfaces to phenomena, it's possible to categorize one interface to more phenomena at once. Then, the interface is a composite type.

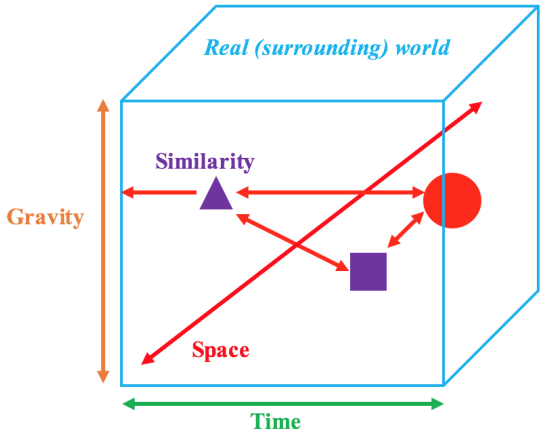

Figure 9: Relationships among phenomena

4 Conclusions

In summary, four basic phenomena with nine user interface types have been identified and described.

The purpose of this article is to show a connection between software and real world through user interfaces which are inspired by world's phenomena. People know described phenomena very well and understand their basic connections. If we apply this pre-learned experience to software user interfaces, we can shorten adaptation time on new software. Software control will be simpler and in the end, software would serve better.

The list of phenomena and user interfaces shouldn't be considered as final. It's just an introduction and inspiration designed to be extended. Level of their abstraction can be adjusted anytime based on current needs and research.

However, when software creators learn how to create and improve user interfaces according to patterns of the real world, interfaces will be designed better because the borders have been already defined and are generally known.

As a continuing research goal, described phenomena needs to be tested in a real, production environment. A search for other phenomena will continue. When found, more existing interfaces will be categorized under phenomena. As a final goal, this research will help to build ergonomic software which will be user-friendly, straight to use and allows people to achieve their goals through natural user interfaces.

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About the author

The author is a professional programmer and web-application developer since 1998. In 2004, he founded a software company Kyberie in the Czech Republic which had been developing a software platform for insurance brokers for 8 years. In 2012, he sold the company including the technology platform and co-founded another company Wikilane in the United States which offers an invoicing software platform Invoice Home. Currently, the system has more than 900,000 active users and it's offered in about 150 countries around the world. The author also teaches Web Technologies and Web Application Development at the University of Economics, Prague and his is involved in software ergonomics and financial systems.

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