

Tools for Evaluating the Visual Consistency Of Graphical Human-Computer Interfaces

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Abstract: The visual consistency of human-computer interfaces favourably affects the learnability and the ease of use. A pleasant and attractive presentation feeds the user's satisfaction and that is why it is a factor contributing the usability. This paper presents the functionality and the implementation of a tool set for the evaluation of visual consistency of the user interfaces. Our approach was to integrate these tools into the development environment as a stand-alone application in order to make them available for the design process.

1. Introduction

Modern human-computer interfaces include a large variety of dialogue components, starting from interaction objects like menus, buttons and boxes, and going as far as multimedia presentations like pictures, images, drawings or video sequences. The design of an interface requires both the structuring of dialogue components in dialogue units according to the user's task and their placement and dimensioning based on ergonomic and aesthetic criteria.

From the perspective of cognitive ergonomics it is essential to minimise user's efforts directed towards visual scanning, learning and remembering. From an aesthetical point of view the established principles of art should apply when designing the presentation layout.

The user interface consistency favourably affects both the learnability [Payne and Green, 1986], the ease of use [Tullis, 1988] and aesthetics [Le Corbusier, 1954; Rosenberg, 1980; Vanderdonck and Gillo, 1994].

Consistency is not a concept in itself but it is relative to something [Dix et al, 1998; Shneiderman, 1997]. In this respect a consistent relationship with the user's task (familiarity, compatibility), a consistent interaction scenario (dialogue regularity) and a consistent presentation (visual aspects of the interaction objects) can be distinguished.

The relative nature of consistency and the variety of its forms make it difficult to evaluate human-computer interaction and require a systematic approach. With graphical user interfaces, that include a large number of dialogue boxes, each of them displaying a diversity of visual objects, the evaluation of the visual consistency is a laborious task.

This paper aims to present a tool set able to assist in the evaluation of visual consistency. The main role of this tool set is to help in the analytical checking of visual objects that affect visual consistency, resulting in a less time-consuming evaluation and in more consistent user interfaces. This way, even "discount usability methods" like heuristic evaluation [Nielsen, 1994] let perform a detailed checking of the visual consistency.

The next Section presents some aspects regarding the visual consistency evaluation of the human - computer interface.

Visual consistency deals with the consistent dimensioning and placement of all visual objects and is closely related to the aesthetics of the presentation. Therefore, the established principles for the design of a visual layout are considered. As to be shown in Section 3 some principles of art allow the identification of requirements for the analytical checking of the visual consistency.

The functionality and the facilities of the tool set are described in Section 4. There are two steps in evaluation: an analytical check and a synthetic evaluation. The second step summarizes the main criteria used to assess the visual consistency.

The paper ends with Section 5 of conclusion and further work for extending these tools.

2. Evaluation of Visual Consistency

Consistency is a basic principle for the design of user interfaces. Nielsen (1992) includes consistency among the heuristics for evaluation, which amount to ten. Shneiderman (1998) says that the first "golden rule" in dialogue design is to strive for the consistency mainly of those components of the interface that ask for cognitive efforts from the user.

Dix et al (1998) show the multitude of forms this principle of design does have, since many features of the interface could be discussed in terms of consistency. For example, familiarity is a form of consistency with the real world, while generalisability is a form of consistency with other systems and applications.

Also, Shneiderman (1998) says that consistency is not a concept as such, but related to something. Visual consistency is mostly affected by the spatial organisation of the screen layout, the font, the colour and the typefaces used for a text, the attributes of visual objects.

One important aspect to keep in mind when designing the interface is the fact that the user's interaction takes place with more than one dialogue box. The interface is structured in dialogue units that display interaction objects in separate dialogue boxes. Even though only one is visible and active at a time, it will be compared with all the previous and their inconsistencies will affect the user.

Visual objects displayed in a dialogue box can be structured as follows:

- dialogue controls such as boxes (text, list, combo and check) or buttons (command and radio),
- labels that describe controls or panels for grouped controls,
- multimedia elements (images, animation sequences, pictures), and
- various decorative elements such as lines, rectangles, various decorative elements used to structure the visual information (lines, panels, images).

Each visual element may also have visual attributes such as colour, background, typefaces, special effects that compete for the visual aspect and affect the visual consistency of the interface.

In order to evaluate spatial organisation of interaction objects their relative placement and dimensions should be analysed. Preceding this analysis a great amount of information (height, width, co-ordinates) has to be collected, a difficult task to accomplish manually. There needs to be a tool able to collect and analyse spatial organisation but also to check typefaces, fonts and colours. This way the evaluator is spared boring tasks and the evaluation of spatial consistency can be done in a reasonable time.

Mahajan and Shneiderman (1997) presented a similar checking tool, used to evaluate the spatial and textual consistency of the user interface. An experiment reported by the authors showed a reduction in the execution time by 10-25 % for consistent interfaces. They have a degree of portability achieved through a translator module that translates interface description files (resource files) from Visual Basic or C++ into a canonical form. However, this portability slows down the evaluation time and complicates the use of the tool during the design process.

Unfortunately, to proceed on evaluation as a separate task, at the end of the implementation, leaves little room (time and budget) for changes. The need for an iterative design requires a step-by-step evaluation starting early in the development process. This means that the first to make an evaluation should be the designer himself and a tool to enable evaluation and corrections should be at hand. In this case it is better to use a tool integrated into the development environment that is fast and easy to use since it does not take intermediate stages such as the translation into a canonical form.

3. Principles of Art in the Visual Design of the Interface

ISO standard 9241-11 (1994) defines usability as the extent to which specified users accomplish specified tasks with effectiveness, efficiency and satisfaction. User satisfaction is a subjective measure that depends, among many others, on a pleasant, attractive layout of the presentation.

On designing interaction objects for a dialogue box, not only the functional and ergonomic principles of design should therefore be respected but also the principles of art borrowed from the visual arts [Vanderdonck and Gillo,

1994] for a comprehensive set of such principles. In this respect, placing interaction objects on the screen layout should be done according to composition rules.

The composition is the placement or the arrangement of visual elements in a work, usually according to the principles of art. The most referred principles of art are balance, rhythm, emphasis, harmony, unity, variety and proportion.

Balance refers to the placement of elements such a way that the feelings of equilibrium and stability should insinuate. Balance can be symmetric, asymmetric or radial. Usually it is evaluated by comparing occupied areas on the either side of a central axis (horizontal and vertical). Balance is affected by all visual weight factors: area, placement, and selection of colour.

Rhythm refers to the way of arranging visual elements in order to suggest the impression of a movement. It can be created by consistently placing similar elements. At least three similar elements need be to create a rhythm.

Emphasis creates a focal point in the composition by making one element or part of the work be more important than others. In a dialogue box emphasis can result from size, isolation, colour or position of visual elements. Also, grouping elements or using additional elements (rectangles, lines, visual effects) is a way to emphasise a part of the layout.

Harmony refers to the way of arranging the elements so that similarities are revealed. Modularity in the dimensioning and the placement of visual elements such as alignment to a grid, using constant distances between the elements which are associated in a group, between these groups and the margins of the dialogue box, creates harmony. In other words, spatial consistency is a factor of harmony.

A related principle is unity, by which parts of the composition work together as a whole. Use of consistent layouts for grouping the elements can create unity. Also, enforcing spatial and textual consistency of interaction objects of a given type can render the composition unitary. For example, a label that denotes a similar functionality for a given interaction object should have the same typeface and font colour along the interface. In this respect it is important to consider consistency not only within a dialogue box but along all the dialogue boxes of the interface.

Variety is also related to the visual consistency. A recognised principle in visual design is to associate the object semantics with its presentation. In this respect, elements that differ should be presented differently. For example, the button that allows to exit from a dialogue box could be presented differently from other buttons.

Proportion is the principle of art that refers to the size relationship of one part to another. Proportion is used either when designing an element as a stand-alone object (width / height ratio), in relationship with other objects or when placing visual elements in the layout. Using proportion is also a means to give unity to a composition.

It is recommended that the number of different proportions is minimised. This could be done by using modularity in the placing and dimensioning operation. An example of architectural design is the modulator defined by Le Corbusier (1954), that is based on the golden ratio (1.6218), and can be used for the dimensioning of architectural elements.

4. Criteria for Evaluating the Visual Consistency

To evaluate the consistency along the dialogue boxes of an application is a laborious task. Therefore to extract the information needed from each dialogue box and to present it in a form that helps a ready evaluation makes the evaluator's job simpler.

Main information that is needed in order to evaluate visual consistency relates to:

- spatial placement of elements,
- shape and dimensions of each element, and
- typefaces, fonts and colour used for the text.

A criterion of spatial consistency is the relative positioning of elements to the margins of a dialogue box. In this respect, based on the width and height co-ordinates, it is possible to calculate for each element the distances to the margins.

Another criterion is the relative placement of one element to another. In this respect the relative distance should be minimised. Distances should be related to the relationship between elements. In this respect, the distances between grouped elements should be smaller

than the distances between groups or independent elements.

Shape and dimensions reflect another form of spatial consistency. The criteria are the width and height of elements. Under certain conditions it is possible that the width of some controls is determined by the width of the label that denotes the functionality. However, the height of an element (for example a label) could be standardised along all the dialogue boxes of an application.

Typeface, height and font colour relate to the textual consistency of the interface. There are two aspects:

- consistency of formulating the functionality (for example "Exit" for all the buttons that allow to click "Close" on a dialogue box), and
- visual consistency determined by the fonts, the text height, the appearance (bold, italics) and the colour.

Based on these three categories of analytic information (placement, dimensions and text attributes) it is possible to evaluate synthetic criteria such as rhythm, proportion and balance.

Consistent placements of visual elements within a group create a rhythm of and are good for both the aesthetic impression and the cognitive ergonomics of the dialogue [Payne and Green, 1986]. One more criterion is the proportional dimensioning of elements that enforce visual consistency. Also consistent aspect ratio of dialogue boxes gives unity to the whole interface. As for balance, the vertical and horizontal balance of areas occupied by the visual elements has to be checked on all the dialogue boxes of an application.

5. Tools To Assist Evaluation

The main goal of this paper is to present a tool for assisting the evaluation of dialogue boxes within the Microsoft Access development environment. The tool is useful not only for the final evaluation of an application but also for an evaluation during the iterative development process. In this respect it can also be considered as a means for assisting the development of the dialogue boxes (forms, as termed in Microsoft Access).

The tool provides three categories of functions aimed to check and evaluate:

- forms along an application,
- interaction objects within a form, and

- interaction objects of a given type along an application.

For each type of function, there is a two-step evaluation: analytical checking and synthetic evaluation. During the first step information about the target object is collected. In the second, analytical information is processed and the results are displayed in a synthetic form that enables the evaluator to assess the visual consistency and to infer, on this basis, the extent to which the recognized principles of art are observed.

The evaluation of the forms in an application is illustrated in Figure 1. The synthetic information shows the number of different margins, proportions, sizes and background colours used in 6 forms. These are the main criteria that are commonly used to assess the visual consistency.

The number of forms that has been analysed is the weight factor that makes it possible to evaluate different applications. It is not possible to give strict recommendations for the designer but it is obvious that the ratio between any of these criteria and the number of forms should be minimised.

In the example in Figure 1, the forms that are analysed belong to the proposed tool itself, from which the first ("EvForm") and the fourth ("FormEv") are displayed in Figure 1. There is no reason why to have more than one different margin. Hence the consistency should be improved.

Also the extremes in horizontal balance, vertical balance and occupied areas are displayed in order to be evaluated within reasonable limits. For example, the degree of agglomeration measured by the occupied area is similar for the first three forms that are of similar type (the forms used for a synthetic evaluation).

Additionally, the display of the currently selected form is provided as a function that helps the evaluator to analyse the visual design in more detail. This facility is also useful during the design process in order to make corrections after a preliminary evaluation.

Consistency checking is done using the information regarding placement and dimensions of visual objects. Based on this information the following indicators are calculated:

- margins defined as distance from the border

to the closest object,

- proportion of objects defined as the width / height ratio,
- density of visual objects computed as the relative weight of the occupied area, and
- horizontal and vertical balance computed as the ratio between the occupied areas in the top (left) half versus the bottom (right) half of the dialogue box.

Checking the interaction objects is done for all the objects within a form or for the objects of a given type along the forms of an application. The information used by these two functions is similar.

In the example in Figure 2 for a total number of 10 buttons 2 typefaces were used and 3 different colours presenting a good textual consistency. An example of inconsistency is the fact that there were used 4 (instead of 3) different sizes of the button itself.

The toolkit for assisting the evaluation is implemented in Microsoft Access and comprises the following components:

- tables for temporary storage of information,
- queries based on these tables, and
- forms for interacting with the user (designer or evaluator).

Before using the checking and evaluating functions, an initialization operation is needed in order to generate a table containing the names of all the forms in the application. The table is the data source for the combo box that enables the choice of the form to evaluate. Generation of the table with the form names is done only once, at the beginning of the evaluation of an application.

6. Conclusion

Careful design of the visual interface serves two purposes: to imagine dialogue units that are easy-to-learn and to improve the aesthetics of the presentation. This paper advocated for integrating the various criteria of visual consistency with the recognised principles of art. In this respect it has been shown that the principles used to organise visual objects into an aesthetic composition such as unity, harmony and rhythm, are actually based on visual consistency.

Evaluation of the visual consistency of user interfaces is a hard-accomplishing task that

needs appropriate tools. On the other hand, the costs of a re-make are high if problems' identification comes too late. Therefore, an early integration of such tools into the development process is good for both the design and the evaluation purpose.

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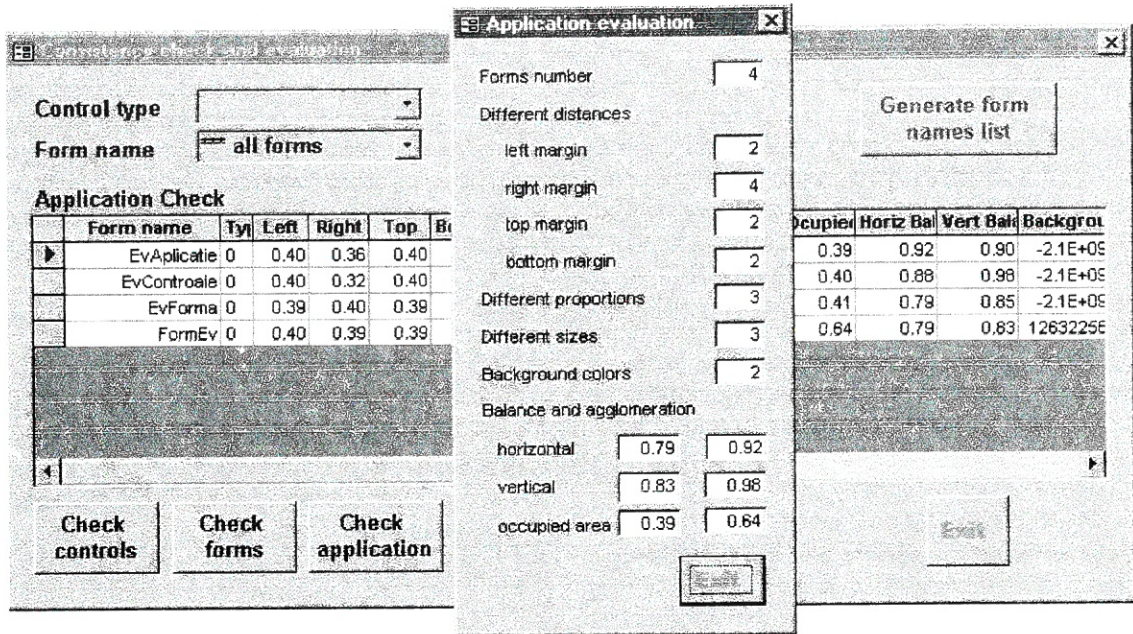


Figure 1. The Evaluation of Forms in An Application

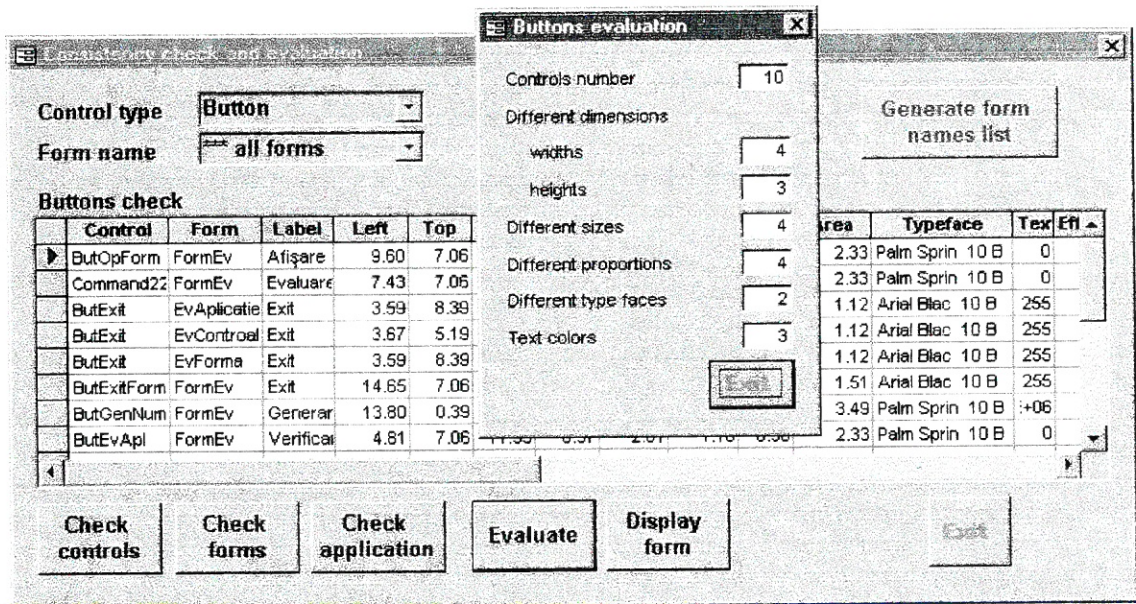


Figure 2. Checking Buttons in the Forms An Application