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# Designing for Web Usability and Accessibility

User-Interface Design Guidelines in Connection with Human-Computer Interaction

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<p>This thesis reports on the user-interface design guidelines for usability and accessibility in their connection to human-computer interaction and their implementation in the web design. The goal is to study the theoretical background of the design rules and apply them in designing a real-world website.</p> <p>The analysis of Jakobson's communication theory applied in the web design and its implications in the design guidelines of visibility, affordance, feedback, simplicity, structure, consistency and tolerance is conducted in order to shape the criteria used in accomplishing the practical part of the study. It concludes creation of the website design according to the design rules.</p> <p>The project has been successfully conducted, and the design stage of the website development has been completed with an aim to enhance the degree of usability and accessibility of the product through the design.</p> <p>The results of the analysis and the website design can be used for further investigation of the user-interface design guidelines. In addition, they can be implemented in other real-world websites.</p>	
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## 1 Introduction

This thesis reports on usability issues in web design in connection with human-computer interaction (HCI). User-centered design (UCD) approach is driven by the needs and limitations of the end user (Friedrich, 2013). Usability that is defined as “extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” is the cornerstone in the web development process that includes the UCD principles (Shawn and Thorp, 2016). Therefore, it is essential for a designer to understand how the user interacts with a designed product in order to enhance usability and to insure that the interaction between the user and an UI is successful.

In this thesis, I study the guidelines of user-interface design and the principles behind them that enhance user experience (UX). My study includes brief explanations on human-computer interaction (HCI) ideas that affect usability and accessibility, and solutions to existing issues in user-interface design. In order to achieve the goal of the thesis I will answer the following questions:

- What are the user-interface design principles that ensure usability and accessibility in web development?
- How are the principles connected to HCI?
- How are the user-interface design principles implemented in web design?

Using the theoretical information that I have gathered and analyzed, I describe how I have designed a website for a customer. In the thesis I consider the user-interface guidelines and possible obstacles the user may face while interacting with the UI of the website. I mostly focus on issues connected with web design, ruling out technical matters of programming. Since this study tells primarily about the theory of UI design and its application in web design, I will not provide theoretical data on user requirements, usability testing or user groups, which are a part of UCD.

The main contribution of the thesis is the investigation of the web design guidelines in connection with HCI and their implementation in a real-world website.

The second chapter is dedicated to the user-interface design guidelines and concepts behind them. In the third chapter I analyze the design of the website that has been created for the customer and explain my choices in design.

## 2 Designing for Usability and Accessibility

Early computers were not designed for general use but rather tailored to specific projects. It was not until 1968 when Doug Engelbart presented a system that emphasized features that seem natural nowadays but were new back then, such as a “windowed display, a graphical user interface, networking, hyperlinks, audio and video ‘conferencing’, dynamic file linking, shared-screen collaboration and a mouse” (Kolko, 2010, p.27). Engelbart introduced the notion of computing as a human-centered tool. Engelbart’s work did not pass unnoticed and HCI as a field of science emerged as a result. The field of HCI has shifted since then “from dealing with primarily the implementation of computing systems toward the understanding of how people ‘interface’ with technology”. (Kolko, 2010, pp.26-8.)

Design can be interpreted as means of communication. HCI adopted Jakobson’s communication theory that includes such notions as a sender that sends a message to a receiver through a channel. In terms of design the sender can be seen a designer that conveys the message through the channel. In this case, the one who receives the message is a user (see Figure 1). (De Souza, 2005.)

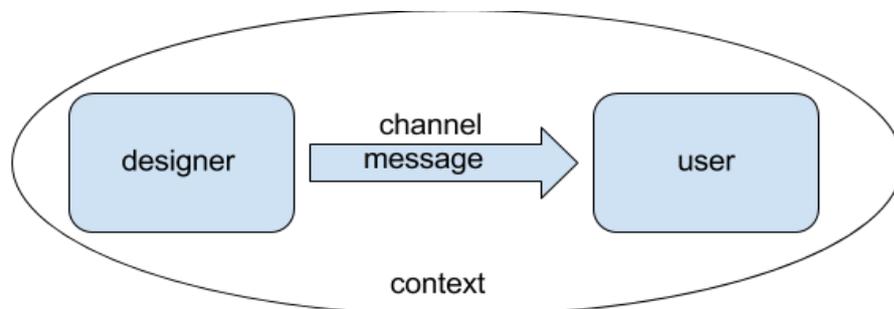


Figure 1. Communication between the user and the designer. Modified from De Souza (2005, p. 88).

In addition, the designer can be viewed as a persuader, and this leads to the implication of rhetorics in design. The purpose of it is to encourage the user to believe that a product is useful and serves the user’s needs (Kolko, 2010).

A successful communication requires certain steps. First, the designer sends the user a one-shot message that “conveys a complete and immutable content encoded in and made available by the system’s interface” (De Souza, 2005, p. 84). The UI informs the user that in order to achieve the user’s goals they have to use the system that is designed for them. If the user sees another meaning in the message that is not compatible with the designer’s, the communication fails; applied to web design this statement means that if the user does not understand how to use the UI of a website, the designer has not succeeded in creating an environment where a successful interaction between the user and a system can take place. (De Souza, 2005, pp. 84-89.)

In order to avoid break-downs in interaction the designer should ensure that UIs do not contain elements that may possibly prevent users from using the website or create unnecessary obstacles. For this reason many systems of the user-interface guidelines and principles that have been proposed correspond to the usability objectives applied in UCD, which are usefulness, efficiency, effectiveness, satisfaction and accessibility (Rubin and Chisnel, 2008). Although systems of design guideness might slightly differ, the core values remain.

Shneiderman (1987), Shneiderman and Plaisant (2009) (cited in Johnson, 2014, p.xv) offer the following guidelines for the user-interface design.

1. Strive for Consistency.
2. Cater to universal usability.
3. Offer informative feedback.
4. Design task flows to yield closure.
5. Prevent errors.
6. Permit easy reversal of actions.
7. Make users feel they are in control.
8. Minimize short-term memory load.

Nielsen and Molich (1990) propose the following guidelines for the user-interface design (cited in Johnson, 2014, p.xv):

1. Consistency and standards.
2. Visibility of system status.
3. Match between system and real world.
4. User control and freedom.
5. Error prevention.

6. Recognition rather than recall.
7. Flexibility and efficiency of use.
8. Aesthetic and minimalist design.
9. Help users recognize, diagnose, and recover from errors.
10. Provide online documentation and help.

Visibility, affordance, feedback, simplicity, structure, consistency and tolerance constitute another set of the design principles that is presented by Stone et al (2005). The principles proposed correspond to the well-known design guidelines by Nielsen and Molich, and Shneiderman and Plaisant:

- The principle of visibility includes the Nielsen-Molich rules of “visibility of system status” and “recognition rather than recall”, and the Shneiderman-Plaisant rule to “minimize short-term memory load”.
- The principle of affordance corresponds to the Nielsen-Molich rules of “match between system and real world” and “flexibility and efficiency of use”.
- The principle of feedback matches the Shneiderman-Plaisant rule to “offer informative feedback” and the Nielsen-Molich rule to “provide online documentation and help”.
- The principle of simplicity constitutes the Nielsen-Molich rule of “aesthetic and minimalist design”.
- The principle of structure corresponds to the Shneiderman-Plaisant rule to “design task flows to yield closure”.
- The principle of consistency constitutes the Nielsen-Molich rule of “consistency and standards” and the Shneiderman-Plaisant rule to “strive for consistency”.
- The principle of tolerance includes the Nielsen-Molich rule to “help users recognize, diagnose, and recover from errors” and “error prevention”, and the Shneiderman-Plaisant rule to “prevent errors” and “permit easy reversal of actions”.

The description of the principles introduced by Stone et al. is comprehensive and clearly structured, which is why it is regarded as the base for further analysis and description. Accessible design is described via four principles: perceptibility, operability, simplicity and forgiveness (Lidwell et al., 2010).

## 2.1 The Principle of Visibility

Visibility is achieved when systems' status, consequences of actions and methods of use are obvious. For example, a navigation menu that clearly indicates a link to a desired page and changes color when the link is selected or visited fulfils visibility requirements. "The principle of visibility is based on the fact that people are better at recognizing solutions when selecting from a set of options than recalling solutions from memory" (Lidwell et al., 2010, p. 250). The human brain is better accustomed to recognition, which may have been important for survival. On the contrary, it takes people much longer to recall memories, since it involves retrieving information without perceptual support due to the complicated neural activities that are involved in the process. Taking it into consideration, the designer can enhance visibility by ensuring that functions that are accessed frequently are visible; a big number of users might fail in using a product that hides its functionality, thus, forcing the user to recall necessary actions. Additionally, if the designer introduces thumbnails that depict full-sized images, the user will be able to recognize them easily. Picture galleries often consist of a roll or tiles of thumbnails to facilitate navigation and make it self-descriptive, as shown in Figure 2. (Johnson, 2014.)



Figure 2. The gallery for a photography website offers thumbnails depicting full-sized images. Screenshot (Hyvärinen, 2016).

Another factor connected to visibility is human perception being biased, which means it is affected by people's goals. When browsing a website people search for a particular element that leads them to their desired goal. They leave unnoticed anything that does not seem relevant. What is more, the human mind primes the perception "to be especially sensitive to features of what you are looking for" (Ware 2008 in Johnson 2014). For this reason, the designer should make important information easily available. Nielsen and

Tahir (2002) suggest that direct access to high-priority tasks should be offered to the user on the homepage. What is more, the designer should make sure that tools unrelated to the user's goals are not included in the website (Johnson, 2014).

Furthermore, the designer should avoid ambiguous elements in the UI that might confuse the user (Johnson, 2014). For example, conventionally the icon that represents the homepage depicts a house, which is why disguising another page with the icon might be confusing.

To conclude, visibility requirements are fulfilled by keeping relevant and frequently used functions in the highly noticeable places and avoiding misleading signs. Additionally, graphical representations can help the user to recognize items and understand functionality.

## 2.2 The Principle of System Feedback

The principle of feedback means that it should be obvious to the user when the system function has been triggered. It is related to responsiveness that is "measured in terms of compliance with human time requirements and user satisfaction" (Johnson, 2014, p. 196). Responsive systems provide some kind of response to the user even if they cannot complete an action immediately. An example of good responsiveness is a progress bar that indicates the percentage of loaded data (see Figure 3). It shows progress of a process that is important for the user who is waiting for results (Johnson, 2014).



Figure 3. A progress bar indicating percentage of loaded data. Data gathered from Johnson (2014, p. 197).

Time requirements connected to feedback are based on human neurophysiology. If the process of HCI is viewed as a conversation, it is not surprising people are impatient while using various computing systems, since the maximum gap between turns in the conversation is only 1 second on average. Perception of cause and effect is even shorter and takes 0.1 seconds that corresponds to the user expecting feedback for clicking on a button or a link. For this reason, long-lasting "pauses" on the side of the system should

be avoided; otherwise, the user might concentrate their attention on other tasks. There is only 1 second to provide the user with some kind of feedback during long operations (this might include progress bars or a short notification message), and 0.1 second for actions including “pointer movement, object movement, or resizing, scrolling, drawing with mouse”. (Johnson, 2014, p. 206-7.)

One solution to keeping the user updated on the status of the system is implementing simple design elements. Nielsen and Tahir (2002) state that if the website or some part of it is not working, it should be clearly stated on the homepage. They also suggest that link colors should indicate whether links have been visited or not; thus, the user obtains a response to their action while navigating.

Duration of time that is taken for perceptual and cognitive functions is relatively short. That is why providing fast and clear feedback to the user’s actions is highly important.

### 2.3 The Principle of Affordance

Affordance is a “property in which the physical characteristics of an object or environment influence its function” (Lidwell et al., 2010, p. 22). The design supports affordance when elements suggest the way they are used (Stone et al., 2005). Human cognition is based on metaphors that serve to facilitate understanding of abstractions through concrete objects and help “people make sense of the complex, dynamic surroundings” (Gajendar, 2010, p. 116).

One example of metaphors is GUI that “comprises the interaction metaphors, images, and concepts used to convey function and meaning on the computer screen” (Lynch and Horton 1999 in Jadav 2003, p.94). A metaphor functions through mapping; thus, it helps to comprehend the unfamiliar in terms of the entities already known to the user (Gajendar, 2010). When the user presses a button, they expect a certain effect. If the effect corresponds to their expectation, mapping is natural. “Good mapping is primarily a function of similarity of layout, behavior, or meaning” that makes the control-effect relationship predictable (Stone et al., 2005, p. 152). The designer should ensure that control-effect relationships are simple enough and avoid using one control for mapping multiple functions. An example of mapping is a shopping basket used in e-commerce websites, the concept of which is clear to the user from its real-world implications. In addition, a linguistic concept of the metaphor can be framed in a way that it facilitates understanding

of its meaning (Gajendar, 2010). For instance, navigation through the website can be viewed as a journey, and the homepage that is often mapped through a graphic icon of a house symbolizing a starting and returning point makes browsing inviting, since it evokes familiar concepts in people. Thus, affordance is connected to mapping and framing of metaphors.

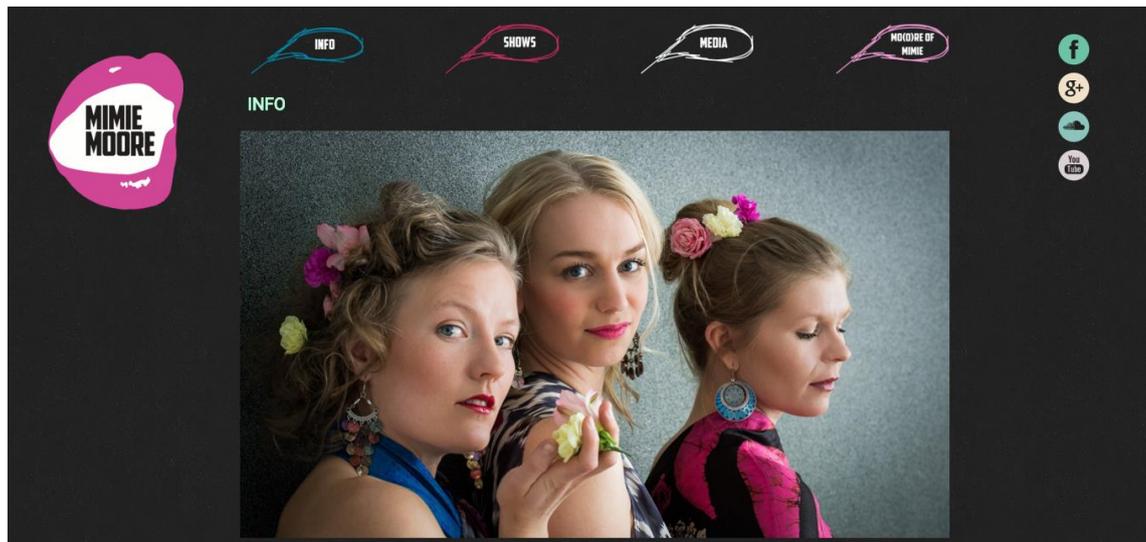


Figure 4. The navigation menu framed as speech bubbles. Screenshot (Mimie Moore, 2015).

Figure 4 illustrates the metaphor of speech conveyed through the navigation menu items shaped as speech bubbles. This framing makes the UI welcoming and natural for the user who associates it with a dialog between the user and the system.

Nevertheless, designers should take into consideration “the dangers of interpretation, familiarity, and culture when using them [metaphors]” (Jadav, 2003, p. 96). Nielsen and Tahir (2002) suggest that if it is hard to come up with an icon for a certain function, there is a chance that the user will not be able to recognize it either; what is more, using icons when simple text is sufficient is not advisable.

## 2.4 The Principle of Simplicity

The principle of simplicity means that the UI of the system should be designed simplistically. Elements that are implemented in the UI should be clear and natural to the user, and complex tasks should be divided into smaller ones. (Stone et al., 2005, p. 170-1.)

Simplicity is connected to the principle of accessibility, since the user learns how the product works faster when the UI is easy to comprehend.

Overbearing design and poor representation of information can disrupt the use of the UI. For example, uncommon vocabulary can confuse the user. Another example of abstruse design is placing text over a patterned background. In addition, unusual and cumbersome typefaces can be problematic. The human visual system, which is a neural network, “must be trained to recognize certain combinations of shapes as characters” (Johnson, 2014, p.73). As a result, a typeface with unfamiliar features is difficult to read. A solution to this issue is to choose simple and common typefaces that are familiar to a big number of users (Johnson, 2014). For this reason, implementing typefaces that are commonly recognized, and backgrounds that ensure readability of textual data is advisable as seen in Figure 5.

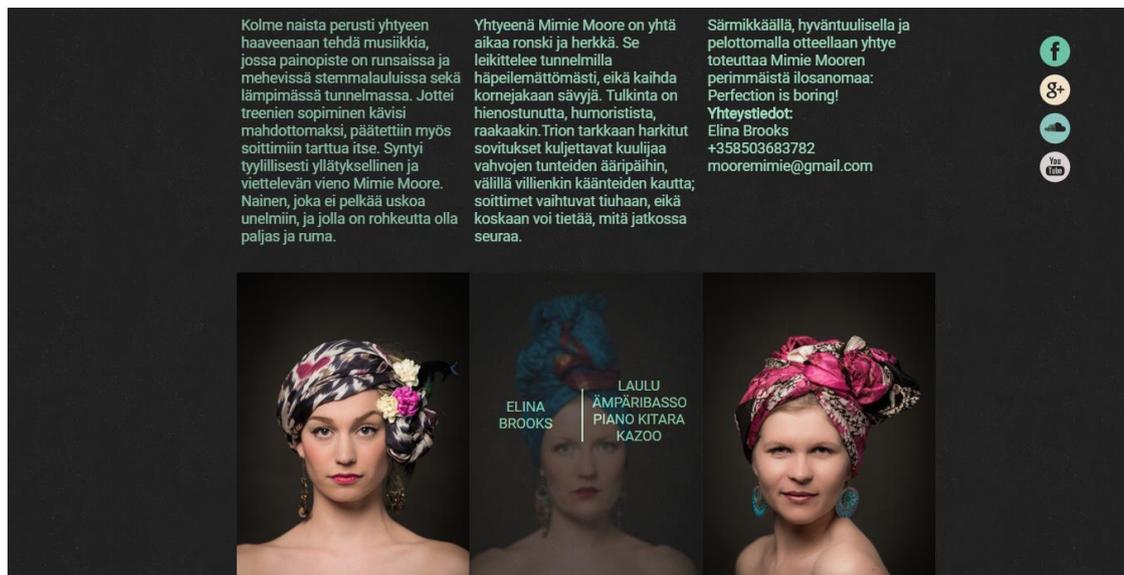


Figure 5. Dark solid background. Screenshot (Mimie Moore, 2015).

Complex tasks that require multiple steps should be broken into smaller ones. This statement is based on the fact that the human working memory is “evanescent”. Although the true capacity of human working memory is under question, it is known to be volatile. In real-life situations, this volatility is manifested in people’s attention being limited. “If items in working memory don’t get combined or rehearsed, they are at risk of having focus shifted away from them” – the user might forget what they are supposed to do in order to accomplish a task if their attention is overloaded or distracted. (Johnson, 2014, p. 94.) Consequently, placing multiple competing calls to action on one page distracts the user, which is why it is advisable to avoid it. Another feature affected by the human working

memory is navigation. If it exceeds two levels of hierarchies, there should be navigation “breadcrumb” paths provided; otherwise, the user might forget their initial goal in using a product or simply get lost in complex submenu items (Bielsen 1990 and van Duyne et. al 2002 in Johnson 2014).

Furthermore, if the user is forced to perform calculation or solve problems while using the UI, it overloads their short-term memory because “all the chunks of information needed to execute a given procedure compete with each other for scarce attention resources” (Johnson, 2014, p. 139). In order to avoid this, Johnson (2014) suggests that the designer should guide the user towards their goals; eliminate unnecessary and complex settings and calculations, and make the UI familiar.

## 2.5 The Principle of Structure

Stone et al. (2005) suggest that the structure of the UI should fulfil the user’s expectations and reflect their comprehension of the domain. Structure requirements are connected with visibility, simplicity, consistency and accessibility principles. Johnson (2014) states that people’s vision is designed to see structure and this is the reason why structural forms are important for the user-interface design. Gestalt principles are significant for describing human visual perception, according to him. There are seven Gestalt principles, which are applied in web design: proximity, similarity, continuity, closure, symmetry, figure/ground and common fate. (Johnson, 2014.) The last one is not discussed in the thesis due to the fact it concerns animated objects while this thesis reports on static elements in the UI.

### 2.5.1 The Gestalt Principle of Proximity

The proximity principle means “that elements close together are perceived as a single group or chunk, and are interpreted as being more related than elements that are farther apart” (Lidwell et al., 2010, p.196) (see Figure 6).

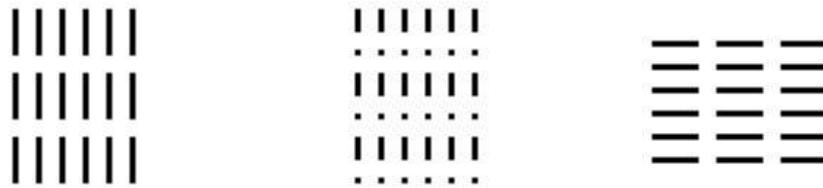


Figure 6. Items close to each other appear grouped. Data gathered from Lidwel et al. (2010, p. 196).

The principle is widely used in web design, as designers place related items close to each other; thus, encouraging users to see a group of objects. However, if controls are spaced in a wrong way, proximity might obscure the user; for example, if unrelated elements are too close to each other, they appear connected even when semantically they are not. On the contrary, if there is a big gap between related items they might not seem grouped. (Johnson, 2014.)

### 2.5.2 The Gestalt Principle of Similarity

According to the similarity principle, “similar elements are perceived as a single group or chunk, and are interpreted as being more related than dissimilar elements”; similarity can be based on different features – color, shape or size (Lidwell et al., 2010, p. 226). In web design Similarity is frequently used with other principles such as Proximity to show grouping (Johnson, 2014). For example, Figure 7 illustrates two principles – the thumbnails are visually similar due to their shape and size, however, the user does not confuse photo and video thumbnails due to the elements spaced appropriately.

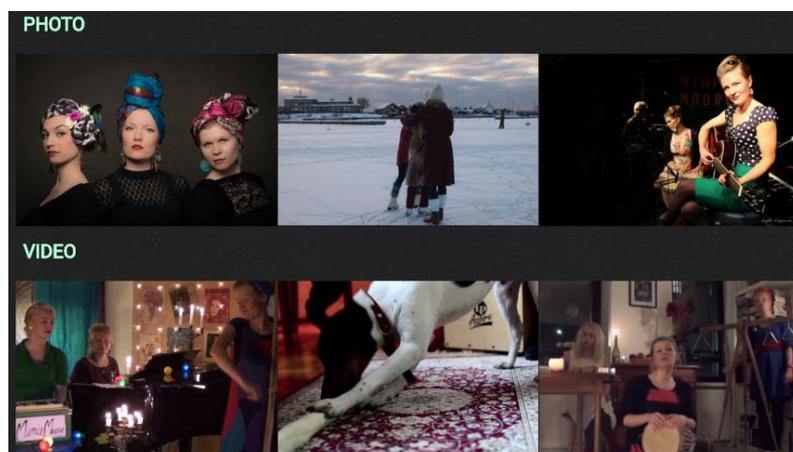


Figure 7. Proximity and similarity used for creating groups of elements. Screenshot (Mimie Moore, 2015).

### 2.5.3 The Gestalt Principle of Continuity

It is suggested by the principle of continuity that “our visual perception is biased to perceive continuous forms rather than disconnected segments” (Johnson, 2014, p. 18). Johnson (2014) states that slider controls are an example of continuity use in web design (see Figure 8) because the slider is viewed as a single item, not as two separate ones. Continuity is also used in design for creating three-dimensional objects on two-dimensional surfaces.



Figure 8. Slider design based on continuity. Modified from Johnson (2014, p. 19).

When creating slider controls, it is important to draw them in a way that human vision perceives them as a single unit, thus, making elements familiar and usual to the user.

### 2.5.4 The Gestalt Principle of Closure

What is suggested by the principle of closure is that “we tend to ‘close’ or complete lines or objects that are not, in fact, closed” (Dabner, Calvert and Casey, 2010, p. 39). Johnson (2014, p. 19) states that closure is frequently used in the GUI design and “showing one whole object and the edges of others ‘behind’ it is enough to make users perceive a stack of objects.” The principle is related to the figure-ground relationship, since it is based on humans distinguishing background from figures (Dabner, Calvert and Casey, 2010).

### 2.5.5 The Gestalt Principle of Symmetry

It is suggested by the principle of symmetry that the human vision “automatically organizes and interprets the data so as it to simplify it and give it symmetry” (Johnson, 2014, p. 20). In design this principle is used to recreate three-dimensional objects. What is more, generally symmetry associates with harmony and balance (Dabner, Calvert and Casey, 2010). Stone et al. (2005) propose that people “tend to perceive regions bounded

by symmetrical borders as coherent figures”; hence, symmetry in the UI design enhances structure.

### 2.5.6 The Gestalt Principle of Figure/Ground

The figure-ground relationship refers to the figure/ground principle stating that “visual elements are always seen in relation to a visual field” (Dabner, Calvert and Casey, 2010, p. 40). Forms are regarded as positive, and the space around them negative. Figures are in the center of the user’s attention, since humans always see a shape before they notice a background (Dabner, Calvert and Casey, 2010). When the principle is applied in web design, the background of the website often creates the context, while the message is included in the figure. In addition, the figure/ground principle is used in pop up information boxes, when a new figure is placed over some content, thus, making the content a new background (Johnson, 2014).

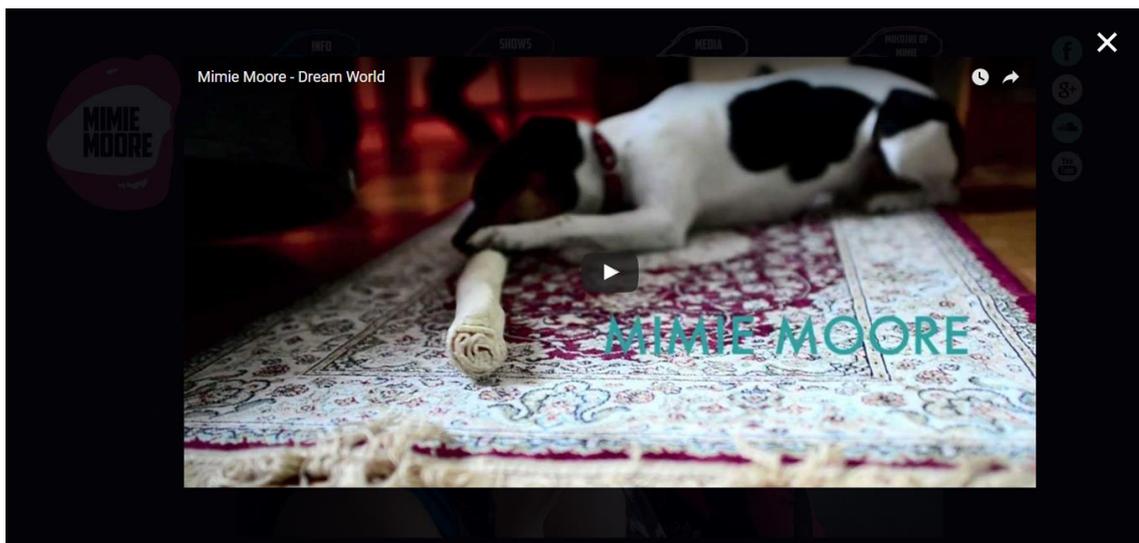


Figure 9. Video container overlaying the web page. Screenshot (Mimie Moore, 2015).

Figure 9 illustrates how the figure-ground relationship is used in pop-up messages and boxes, as the body of the website is darkened and a new figure (the video player) overlays the body making it the background. This approach is better than temporarily changing information, because it keeps the same context of the web page that facilitates the user’s interaction with the product. (Johnson, 2014.)

The Gestalt principles are important for designing structured web UIs, as they explain human perception of visual information and reveal the reason why people see some

items connected as a group or unrelated to each other. Structure is a staple in web design due to the fact that users comprehend information faster and more efficiently in highly hierarchical systems. Johnson (2014) proposes several rules that enhance Structure: breaking large chunks of information into sections, labelling sections to make their content evident and presenting sections hierarchically.

## 2.6 The Principle of Consistency

According to the principle of consistency, similar items are arranged in the same way. Aesthetic consistency is presented through style and appearance. For example, a company might decide to use a set of colors on their website (see Figure 10). Functional consistency “refers to consistency of meaning and action”. (Lidwell et al. 2010, p. 56.) It helps the user to understand how to use controls leveraging their previous knowledge. Internal consistency ensures consistency of elements with other items in the product. “External consistency refers to consistency with other elements in the environment” implying consistency through multiple systems (Lidwell et al. 2010, p. 56). The main role of consistency in an interactive system is to enable users to learn its functionality fast and foster the growth of motor habits when dealing with various functions. “In a highly consistent system, the operation of a particular function is predictable from its type”, which



Figure 10. The principle of consistency applied to a website. Screenshot (Hyvärinen, 2016).

is why the designer should strive for consistency (Johnson, 2014, p. 156). One way to keep a website consistent is to place navigation menus in the same place throughout all pages (Dabner, Calvert and Casey, 2010).

Figure 10 illustrates the principle of consistency applied to a website. Aesthetically the web pages are consistent through colors, functionally they are consistent through navigation and galleries.

## 2.7 The Principle of Tolerance

The principle of tolerance means that the UI should prevent the user from making errors while using the product. Errors can be of two types – slips and mistakes. Slips occur when the user makes an error by accident. (Lidwell et al., 2010.) According to Stone et al. (2005) one way to minimize the occurrence of this kind of errors is to eliminate possibilities to enter wrong information. This can be implemented by setting limitations in the input fields of characters and offering country code lists; for example, accepting only a certain number of digits in a mobile phone number field. The same principle can be applied to email address fields. What is more, it is important to provide feedback when a slip takes place.

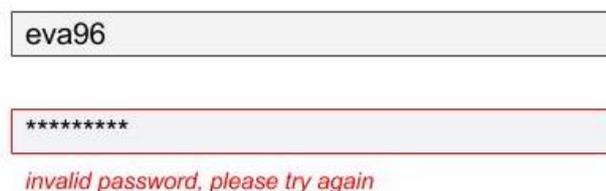


Figure 11. Error message. Modified from Johnson (2014, p. 57).

Johnson (2014) emphasizes that error messages should be placed in visual fields where the user can see them, outside peripheral areas. If the user makes a mistake in their authentication details, a corresponding error message should appear close to the login and password fields (see Figure 11).

This feature might be significant when used for services containing important personal data and finances, since the user might be blocked after several unsuccessful attempts to log in.

Mistakes, unlike slips, occur when the initial intention of actions is inappropriate (Lidwell, et al., 2010, p.82). They can be avoided if the designer decreases environmental noise. What is more, highly critical and significant tasks should require multiple confirmation steps in order to verify the user's intention. (Lidwell et al., 2010.) Confirmation is often implemented in online banking and e-commerce where mistakes can lead to significant consequences.

However, if errors take place the UI is supposed to provide the user with a way to overcome them. Stone et al. (2005) suggest that recoverability shows whether the users can recover from their errors and despite them achieve their objectives. Recovery can be divided into types. Forward error recovery ensures that the user can complete necessary tasks in spite of erroneous actions. For instance, if the user has chosen a shipping address, an e-commerce website should provide a possibility to edit it without canceling an ongoing check-in process. Backward error recovery allows reversing slips and mistakes. In this case the user can safely navigate to the previous page and edit erroneous information. (Stone et al., 2005.)

## 2.8 Designing for Accessibility

One of the main tasks of the designer is to make web content accessible for a wide range of users including those with special needs. A number of accessibility guidelines have been developed to systemize evaluation of accessibility. Generally, the guidelines ensure that a product is "usable by people of diverse abilities, without special adaptation or modification" (Lidwell et al., 2010, p. 16). Accessibility issues concern a wide range of users with special needs.

### 2.8.1 Content Perceptibility

The principle of perceptibility means that content can be accessed by users regardless of their sensory abilities. Not all people perceive the visual and text content in the same way. There is a significant number of users who are color-blind or visually-impaired. What is more, there are different aspects that affect how visual information is comprehended among all users regardless of their condition. First, the human "vision is optimized to detect contrasts (edges), not absolute brightness" (Johnson, 2014, p. 37). Another feature that influences users' color recognition is their hardware – different types of displays

might present colors differently. In addition, there are three factors that affect differentiation of colors: paleness, color patch size and separation. The designer should take into consideration that various features affect color selection, since colors bear not only aesthetic but also functional meaning. For example, if visited and unvisited links have almost the same color the user might have difficulties in distinguishing them. (Johnson, 2014.) Another issues connected with color perception is color-blindness. A significant number of people have a color perception deficit and designers are recommended to ensure that colors used in their product are easily distinguished. Red-green color-blind users cannot see a difference between dark red and black, blue and purple, light green and white. Practically, it means that light green text placed over a white background is indistinguishable for certain users. There are a plenty of solutions to the above mentioned issues. Johnson (2014) recommends following guidelines for using color: distinguishing colors by saturation, brightness and hue (ensuring that contrast between colors is high by viewing a webpage in grayscale, as Figure 12 illustrates), avoiding color pairs indistinguishable by the color-blind, ensuring there are other ways to represent functionality except for color, avoiding strong opponent colors (red text placed over a green background causes unpleasant shimmering). Additionally, due to the fact that “the colors that people can distinguish most easily are those that cause a strong signal” on one of the human color-perception channels and neutral signals on the rest of the channels, it is advisable to use one of the following colors: red, green, yellow, blue, black and white. (Johnson, 2014., p.45.)



Figure 12. Distinguishable webpage in grayscale. Screenshot (Mimie Moore, 2015).

Another issue connected with visual perception that causes problems in accessibility is peripheral vision. Placing objects in the area of peripheral vision might present a visibility problem. “The spatial resolution of the human visual field drops greatly from the center to the edges” for three reasons: pixel density (most retinal cone cells are situated in the fovea, which is the center of people’s visual field), data compression (“information from the visual periphery is compressed (with data loss) before transmission to the brain, while information from the fovea is not”), processing resources (although the fovea occupies only 1% of the human retina, the brain’s visual cortex spares 50% of its area for data originating from the fovea) (Johnson, 2014, p.50). One design mistake is to place an important message or tool to where the user does not notice it. A solution to this is to make it pop by accentuating it using contrast colors or bold text. Another way to keep significant elements easily accessible is to place them in a highly noticeable place. (Johnson, 2014.) Nielsen and Tahir (2002) recommend keeping a navigation menu, which is an essential part of any website, attached to the main body of the page.

In Techniques for WCAG 2.0 (World Wide Web Consortium, 2016) it is stated that non-text data, such as graphics, should be available through text alternatives that serve the same purpose and represent the same data as the original non-text objects. It is recommended that an alternative is brief but comprehensive. The following issues should be taken into consideration when writing the alternative: the initial non-text content purpose, information it conveys, the reason for including it in the web page and words that describe functionality of the content. For example, the text alternative to the icon that disguises a link to the home page of the website could be *home page*. Providing the alternative ensures that sight-disabled users can use the website successfully. (World Wide Web Consortium, 2016.)

People with poor vision might face obstacles when reading text content. WCAG 2.0 guidelines recommend using *em* units and percentage values for text containers and font sizes respectively, thus, making it possible for user agents to resize the text content without any loss. What is more, this method ensures that the text content of the website can be viewed using a variety of devices with different screen sizes. (World Wide Web Consortium, 2016.)

### 2.8.2 Operability

Operable design ensures that everyone can use the product regardless of their physical abilities (Lidwell et al., 2010, p. 16). Johnson (2014) states that users who might face obstacles using the UI are those suffering from hand movement restriction related diseases, such as Parkinson's disease and arthritis. When the website controls and navigation menu are represented with a small area of action where the user can interact with them, using the UI appears troublesome. Nevertheless, this can be improved by taking into consideration Fitts' law that describes pointing at targets. According to Fitts' law, the larger the target is and the closer it is to the user's starting point the faster they can hit it. However, "the more the distance decreases or the target grows, the less the decrease in pointing time" is (Johnson, 2014, p.189). That means that there is a certain size for an element, beyond which there is no point in increasing its size. Fitts' law implementations in design are the following guidelines:

- Click-targets should be big enough for people to hit them.
- Actual click-targets should be as large as their visible area.
- Switch controls should accept clicks on their labels not only buttons.
- Space between buttons and links should suffice so that the user is able to click the intended link or button.
- Important targets should be placed near the edge of the screen, closer to the starting point.
- Choices are recommended to be displayed in pop-up and pie menus.

(Johnson, 2014.)

Another law affecting operability is the Steering law that states that "the wider the path, the faster you can move the pointer to the target". This law works with pull-right menus that require the user to keep the pointer within one menu item in order to move to the next submenu item. In case it is narrow, the user might experience difficulties navigating and the slower their movement between menu items is. (Johnson, 2014, pp. 187-193.)

### 2.8.3 Simplicity and Forgiveness

The principle of forgiveness means that the occurrence and consequences of errors should be minimized; hence, it corresponds to the earlier introduced principle of tolerance (Lidwell et. al, 2010, p. 104). The principle of simplicity is discussed in subchapter 2.4.

## 2.9 Implementation of UI Guidelines in Web Design

Design of UI is a way of communication between the user and the designer who ensures that interaction between the product and the user runs smoothly. In order to achieve successful communication, the user should understand how to use the UI to reach their goals, and be able to physically use the system. The user-interface guidelines of visibility, affordance, feedback, simplicity, structure, consistency and tolerance support and enhance usability of UI in web design, and accessibility principles ensure that users can use the product regardless of their sensory and physical abilities. The design rules, which are connected to HCI, lead to their implementation in web design in the following way:

- Visibility is achieved by making essential functionality visible and available and conveying it through graphical representations, as it facilitates recognition.
- Affordance is supported by encouraging the user to apply real-world concepts in understanding how to use GUI.
- Feedback is delivered when the system responds to the user's actions by showing results or notifications on progress of an operation.
- Simplicity is ensured when the product contains only necessary functionality, and content representation is not restrained by unfamiliar items.
- A well-structured website is based on hierarchy that is natural to the user and meets their expectations about it.
- A consistently designed website bears both aesthetic and functional similarity facilitating the user's interaction with it.
- Tolerance ensures that the user can complete their tasks regardless of their errors by preventing them or making it possible to reverse erroneous actions, and overly supporting recoverability.
- Accessibility involves measures to make the product safe and usable for people with various conditions.

(Stone et. al., 2005.)

### 3 Case Study of UI Design

UI design is based on user requirements and functionality of the website. The case study that is considered in this chapter is based on the design of a website for a composer who wants to promote his works online and obtain a portfolio published on the Internet. There are four webpages, each created for its own purpose. On the home page for desktop views the customer would like to present his show reel; one page is dedicated to the full list of his works; another page holds his biography as an artist; there is also a contact page containing his email address and social media links. The design of the website is analyzed according to the user-interface guidelines described in chapter 2.

#### 3.1 The Home Page

The home page contains a logo, a navigation menu and a container with an embedded video selected by the customer (see Figure 14). First, I consider visibility of the most frequently used function that is the navigation menu, which is placed in the upper part of the layout of the web page. When a menu item is being clicked, its color changes to 70% grey; when a link is visited, the color is replaced with 50% grey in order to provide feedback on the user's action (see Figure13). The same color change is applied throughout the website. The logo is an interactive element that leads to the home page when clicked.



Figure 13. The navigation menu as the main functionality.

The home web page is designed using a simple, familiar layout with the menu and the logo positioned in a traditional way for web design. In addition, I chose typeface *Lato* due to its enhanced readability and common graphical implementation as a sans serif. Simplicity is also supported with the self-explanatory menu items.

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WORKS    BIO    CONTACT

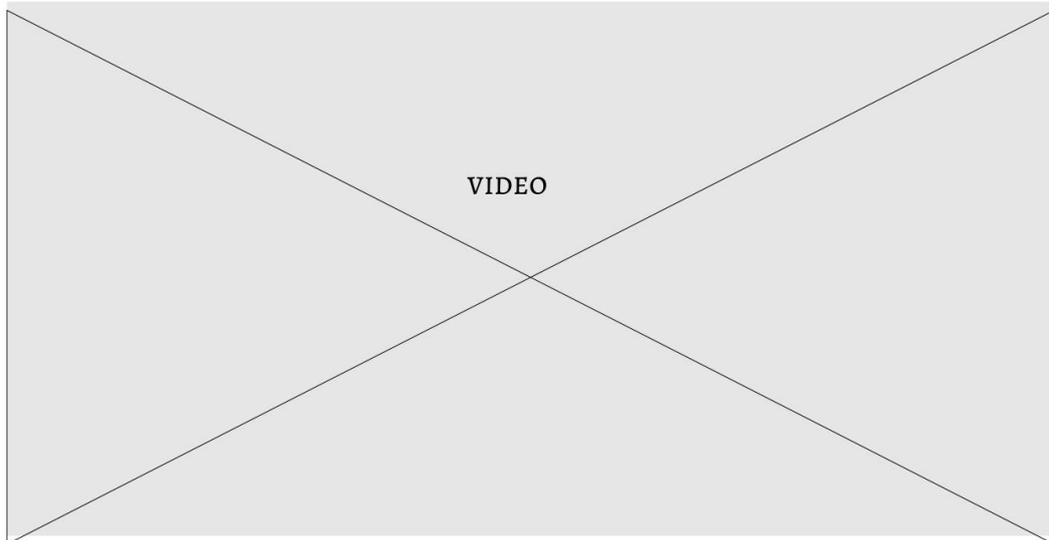
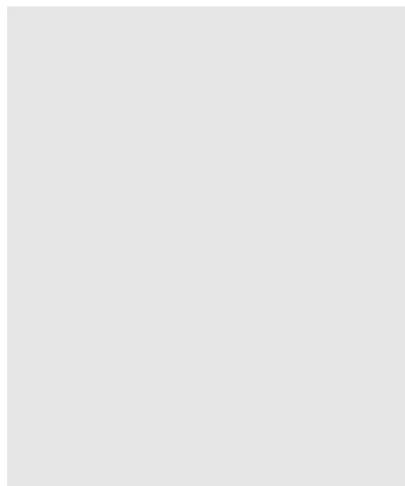
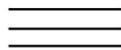


Figure 14. The home page of the designed website.

The structure is ensured with proximity among the menu items. The same font and colors throughout the website are used for similarity. The home page strongly conveys the figure-ground relationship by making the video player that is the figure in the figure-ground relationship to visually “pop up”, thus, indicating the main element. Symmetrically the upper part is well-balanced with the lower one (see Figure 14).

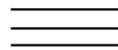
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CONTACT

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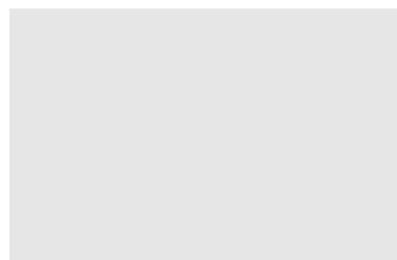


Figure 15. The mobile home page with the sandwich icon menu.

The mobile version of the web page is designed following the same principles, however, with changes in the navigation menu design and the main body content. Figure 15 illustrates the principle of affordance adopted for the web page, as the sandwich menu icon that has become standard for mobile menu navigation is implemented in order to enhance usability and save space in the mobile layout that is restricted due to the size of the device. The menu icon is responsive to the user's action of tapping: it expands overlapping the main body content. The main content of the page in the mobile version is different from the desktop one due to the feedback principle – mobile devices might not support high-speed Internet connection that can lead to postpones in the video player work, which is implemented in the desktop version of the website; what is more, mobile browsers are not consistent when it comes to support of video players. Thus, the main content will include a picture of the customer.

Since the home page contains the non-text content, the alternatives will be provided for the graphic and video data, hence ensuring that visually impaired users can access it. The colors used support high contrast between the figures and the background; thus, color-blind users can view all the content without any loss.

### 3.2 The "Works" Page

The "Works" page is dedicated to the list of the composer's work published online or performed live. The main functions of the page are the navigation menu and the sections dedicated to different groups of compositions (see Figure 16).



Figure 16. The "Works" page of the designed website.

The principle of visibility is conducted through the structure of the page. Instead of creating submenu items that lead to three separate pages, the sections are placed on one page that is divided into three columns. The Gestalt principles of Proximity and Similarity are applied to convey hierarchy among the items. The user can see that two groups, "Films" and "Commercials", are represented in the same manner through their size and shape, while "Concert" materials are placed slightly aside and listed in text format. The reason for the current structure is to distinguish works connected to different genres of music – movie and commercial compositions separated from classical ones. As a result, the user can find the intended information faster by scanning through items grouped according to their type. In addition to the principle of structure, visibility is enhanced by placing thumbnails of videos, instead of text links, that lead to corresponding web pages where the user can watch them. The page design is simplistic, the font types and the structure do not cause artificial obstacles for the user; the section titles are clear and self-descriptive.

The mobile version of the web page includes the sandwich menu icon and one column structure for the sections (Figure 17).



Figure 17. The "Works" Page in the mobile version.

The principle of structure is applied in the mobile version as well as in the desktop version. The Gestalt principles of proximity and similarity are used for grouping the thumbnails. However, placing all three sections in one mobile page at once appears bulky and

requires a lot of scrolling, which is why the section titles expand and close when clicked. The principle of affordance is used in the design of arrows pointing down and up indicating that the titles perform corresponding functions.

Since the navigation menu and the sections are clearly positioned, the user should not face any obstacles while browsing the web page. Both desktop and mobile versions include click-targets that are big enough to hit an intended click-target; they are appropriately spaced, so that the user does not click on a wrong click-target by accident. Accessibility of the non-text content will be fulfilled by the descriptions placed under each thumbnail and the alternative function description of the click-targets.

### 3.3 The “Bio” and “Contact” Pages

The layouts of the “Bio” and “Contact” pages dedicated to the biography of the customer and his contact details are identical except for the text contents. The main functionality of the pages is the navigation menu, the social media and email address links (see Figure 18).



Figure 18. The "Contact" page of the designed website.

The principle of simplicity is especially important for the current layout, since the user has to access the text content. The font type and the strong figure-ground relationship enhance readability of the contact details. The principle of symmetry is strongly evident

in the structure of the pages (see Figure 19), and it facilitates the user scanning the pages when searching for particular information. The internal consistency of the “Bio” and “Contact” pages helps the user to browse through the content more efficiently.



Figure 19. The "Bio" page of the designed website.

The mobile version of the two pages excludes the image content in order to enhance system responsiveness, focusing the user’s attention on the text content that has the biggest role (see Figure 20).

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Maecenas ullamcorper, dui et placerat feugiat, eros pede varius nisi, condimentum viverra felis nunc et lorem. Vestibulum ante ipsum primis in faucibus orci luctus et ultrices posuere cubilia Curae; Sed aliquam, nisi quis porttitor congue, elit erat euismod orci, ac placerat dolor lectus quis orci. Donec sodales sagittis magna. Etiam sit amet orci eget eros faucibus tincidunt. Aliquam erat volutpat.

Maecenas vestibulum mollis diam. Fusce risus

Figure 20. The mobile layout for the "Contact" and "Bio" pages.

### 3.4 Summary of UI Design Case Study

The user-interface guidelines presented in chapter 2 have been successfully implemented in the design of the website. The principle of visibility has been taken into consideration when planning the position of the navigation menu and the functional structures of the website in a way that they are visible and available.

System responsiveness that corresponds to the principle of feedback has been ensured by distinguishing between active, non-active, visited links and menu items. In addition, the mobile version of the pages bears only necessary functionality, excluding some video and graphical content in order to decrease the system response time.

The affordance has been implemented in the mobile version to save space in the layout. The sandwich menu icon, which is familiar for the mobile device users, and pointing arrows convey concepts that facilitate interaction between the product and users.

The principle of simplicity has been ensured through the following features: usage of a clear font type, solid background that allows users easily to read the text content regardless of their hardware. The navigation menu titles are comprehensive, every page offers one activity call, letting the user to concentrate on one task at a time. The general layout of the website is familiar to the user; hence, they can learn how to communicate with it fast.

The website is well-structured. The hierarchy of the navigation represents a semantic tree that is natural for the user (see Figure 21). On the graphical level structure is ensured by proximity, similarity, symmetry and figure-ground relationship. The menu items and the section thumbnails are placed close enough to be appear grouped; what is more, they are similar in color, size and shape. The layout of the web pages is well-balanced from the point of view of symmetry and the figures are distinguishable from their surroundings that create context for the website.

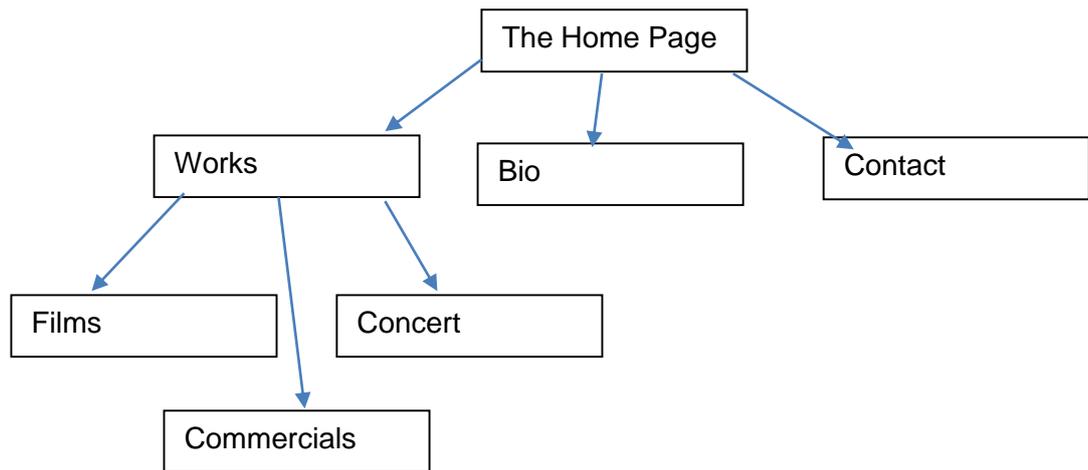


Figure 21. Hierarchical structure of the website.

The website is consistent both aesthetically and functionally, the colors, fonts and shapes are similar and repetitive throughout all the pages. This adds certain framing and context to the website, and keeps the user aware of their position while browsing and completing their tasks. The consistency is internal – the menu is kept in the same place, which makes navigation natural and straightforward.

The system is designed to minimize appearance of errors while using it by keeping the navigation apparent, and avoiding a noisy background.

The website is accessible to color-blind users, since only grayscale scheme is used in marking system feedback and designing the text content. All the non-text content will be supplied with the text descriptions and alternatives to ensure that visually-impaired user can use it too. The responsive approach to design will make scaling and zooming possible for those user who require bigger text sizes. In addition, click-targets are appropriately spaced for users who suffer from physical conditions that make pointing hard. Last but not least, all the important functions and information are placed outside peripheral areas.

## 4 Conclusion

In this thesis I have studied the user-interface design guidelines that are essential for usability and accessibility in web design and their connection to HCI. Design is a way of communication between the designer (or the sender) and the user (the receiver). In order for the interaction to take place participants should understand each other, and in the context of web design the user should comprehend the product. The way users perceive information, complete their goals and access content is affected by the human cognition and sensory and physical conditions. Consequently, the designer should be aware of connections between the various design guidelines and HCI. Although there are numerous design rules on how to plan and implement a usable and comprehensive UI, in the core of the matter all of them can be summarized in the following manner:

1. Visibility is achieved when the user understands how to use the product and can see the main functions.
2. Feedback, which is sent by the system as a response to the user's action, ensures that the system is responsive.
3. Affordance means that the product appears natural and inviting to the user, and if the user comes across unfamiliar concepts they can be understood through real-life metaphors.
4. Simplicity ensures that the system's design is not burdened by unnecessary functionality, overcomplicated and unfamiliar visual details and navigation.
5. Structure is connected to visibility and simplicity, as it is based on the human vision peculiarities. It is strongly bounded with the Gestalt principles of proximity, similarity, continuity, closure, symmetry and figure-ground relationship. A well-structured website is apparent and easy to browse.
6. Consistency can be aesthetical, when the system's graphic design is persistent. It also can be functional, external and internal; all of these ensure that the user learns how to use the website faster, and consequently they complete their tasks more efficiently.
7. Tolerance of the system is connected with its degree of recoverability that shows to which extent the user can achieve their goals using the product regardless of errors. The latter can be of two kinds, slips that occur unintentionally and mistakes that are often made intentionally. Slips can be avoided by preventing their appearance, mistakes can be eliminated by ensuring confirmation of tasks.

8. Accessibility is a major issue in web design, and it can be achieved by taking into consideration different groups of users who have special needs due to their sensory or physical disabilities. In addition, accessibility concerns not only handicapped users but also those who suffer from such conditions as color-blindness and poor vision. Accessible design ensures that the product can be used by a vast majority of users regardless of their background.

When performing my case study, I have considered the user-interface guidelines in order to maximize usability and accessibility of a website. Bearing in my mind the reason for every rule, I have ensured that the website can be used by a wide range of users. The main functions of the website are well-placed; hence, a high degree of visibility has been achieved in the design of the website. The website responsiveness has been ensured through the optimization of its mobile version. Additionally, the mobile version of the website contains the graphical icons that are designed according to the principle of affordance. The simplicity requirements have been fulfilled through the usage of a clear font type, a solid background and a comprehensive navigation menu. The website is well-structured with its hierarchy being straightforward and coherent. It is also consistent both aesthetically and functionally. The website design ensures that a majority of errors is prevented. Last but not least, any user, regardless of their sensory or physical abilities, can access the website; hence, the accessibility requirements are met.

The user-interface guidelines described in this thesis can be applied to web designing. They apply to any website that is meant for the average user.

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