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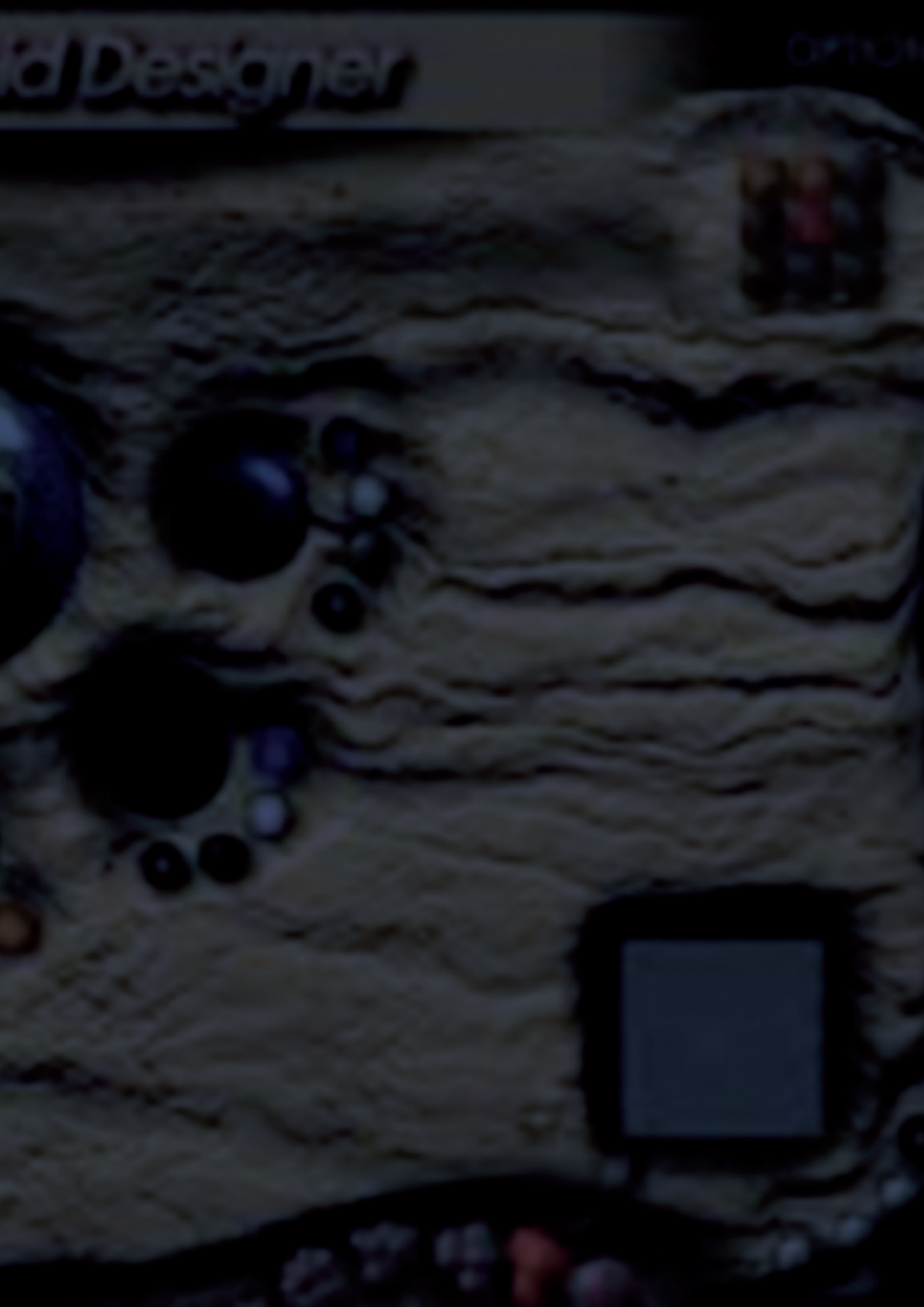
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THE EVOLUTION OF THE GRAPHICAL USER INTERFACE:

FROM SKEUOMORPHISM TO MATERIAL DESIGN

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ABSTRACT

Graphical user interfaces are an evolution of the command line user interfaces of the past. Graphical user interfaces allow users to interact with devices while using the metaphor of a desktop surface. As technology evolves, user interfaces become more elaborate, going through various design phases such as skeuomorphism and modern flat design. User interfaces have become more simplified and use fewer non-essential design elements. This also allows for easier cross-platform development. Due to the widespread adoption of technology, clear user interfaces that put usability first are of great importance. We present the very beginnings of the GUI, its evolution through the years and finally focus on modern graphical user interfaces while also going over various problems.

Keywords:
Interface design, Skeuomorphism, Material design, Flat design

1. INTRODUCTION AND BACKGROUND

A Graphical User Interface, or GUI, is a type of user interface that enables a user to interact with an electronic device through the usage of graphics, icons and audio cues. Graphical user interfaces serve as replacements to the command line interfaces of the past. A graphical user interface allows a user to control an application without extensive background or knowledge. In today's world, GUIs also use various commonly adopted and agreed-upon concepts such as warning sounds, the trash bin, the so-called "hamburger menu" of modern design, or the ubiquitous compact disc or diskette as an image for saving. The graphical user interface can be found today in every electronic device. Due to our everyday lives being strongly connected to electronic devices and the internet, graphical user interfaces have become equally important. The Graphical User Interface has evolved with the times. Cleaner, higher resolution images are used, sharper graphics and text is displayed. Despite exponential advices in computing power and display, the graphical user interface's goal has remained the same. Its goal is to adequately display and convey information in a clean and organized manner. As expressed in the classical Garret's diagram, the visual design of the interface surface is the space where the interaction between digital and people happens (Garret, 2010).

The aim of this paper is to present the evolution of the modern user interface from its very beginnings (the command line user interface) to the familiar form that we know today (flat design and material design). Furthermore, we shall highlight important stages in the evolution of the user interface, as well as the reasons behind the adoption of various design languages and elements that are seen and used to this day. Finally, we shall examine the way that user interfaces reflect the evolution of our society and technological advancement and how those same interfaces can be used to aid people from different age groups and backgrounds. The main contribution of this paper is to help designers understand the areas of UI design and allow them to make informed decision as to which design approach to use when creating their own designs.

2. THE EARLIEST BEGINNINGS OF THE GUI (GRAPHICAL USER INTERFACE). XEROX, APPLE, WINDOWS.

Despite common misconceptions, the modern user interface did not begin with Apple or Windows, but rather a printing company. The Xerox Corporation was the first to come up with the idea of the desktop metaphor back in 1973. Instead of using a command line user interfaces (Jones, 2011), the Xerox Alto was designed to operate using a graphical user interface (Wadlow, 1981). The desktop metaphor aimed to make interaction with a machine easier by using a computer's monitor as a desktop and the items placed on top of it as design elements. These could then be opened in a window. An icon depicting a piece of paper when pressed, opens a user's documents. The icon of a pocket calculator opens a calculator application. The rubbish bin, or "trashcan" serves as a way to "get rid of" or delete data. Over the years with countless iterations from various developers, the look of the desktop interface has changed considerably, but the logic behind it reminds largely the same.

Nearly 10 years later the Apple LISA was released in 1983, with the aid of members who worked on the original Xerox Alto's user interface (O'Grady, 2009). The LISA featured a user interface that was extremely forward- thinking at the time (Freiberger,1981). It utilized the concept

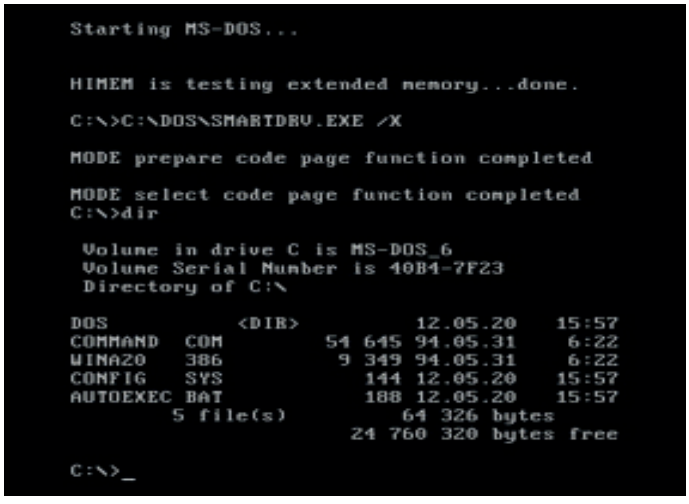


Figure 1: The command line user interface of MS-DOS 6.0, released in 1981

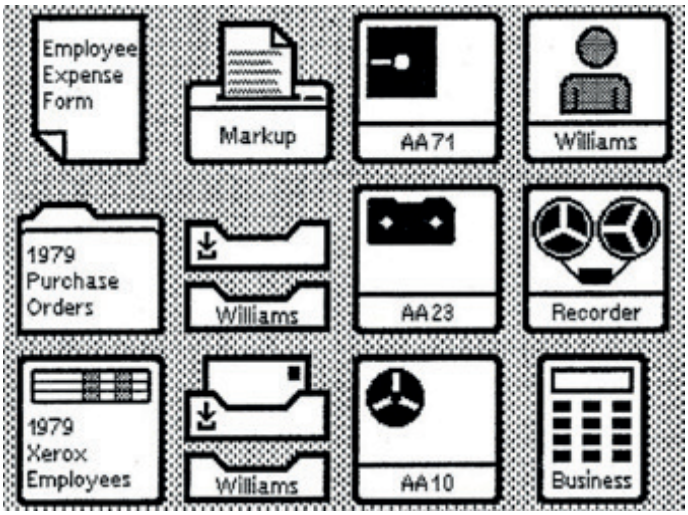


Figure 2: The graphical user interface of the Xerox Alto, released in 1973. The first instance of the desktop metaphor in a user interface.

of multiple windows, thus allowing the user to launch and operate multiple applications simultaneously. The limited capabilities of the machine, however meant that true multitasking was out of the picture. It was the first mainstream graphical user interface. It was later refined by Microsoft and their Windows 1.0 OS (Markoff, 1983). An operating system that could multitask properly. In their early days, graphical user interfaces were simplistic, often monochromatic. This was due to the low computing power of computers of the time. As time passed however, color was gradually introduced.

The color selection of the interface served to maximize legibility. The characters were almost always white with a red, green or even blue background in order to increase their contrast. Later in the development of interfaces different shades were introduced as a way to differentiate between different layers of the interface (such as the selected or deselected parts of the screen). The color depended on the technology of the monitor that was used, often in the form of amber or green phosphor displays.

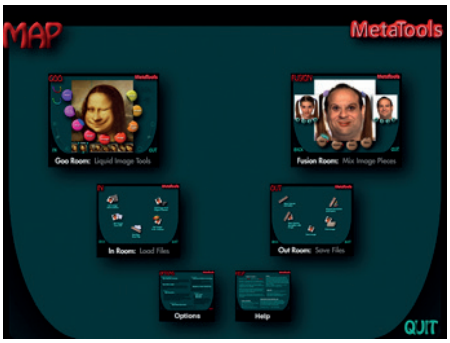
In the future, the early utilization of color in computers of the time allowed for shading and color tones. The tradeoff was that resolution was sacrificed in order to achieve color depth. It would be some time before color and devices that could fully support it would come to play a more important role in regards. The more colorful the picture, however, the less detailed it was, and vice versa. A colored screen often meant a full redesign of the elements of a user interface, while also having to keep in mind that different display adapters of the time had vastly different architecture. Designers and software engineers often rendered the user interfaces they designed in one or two modes, keeping them as simple as possible (IBM CGA, 1981). They were almost always monochromatic and high-resolution. Ideal for work and spreadsheets, but not much else. Design flourishes such as ASCII symbols were used as scroll bars or loading indicators, but creativity was always constrained by the technology of the time.

Figure 3: 1984's Word 1.0. While almost completely a command line interface, small design touches such as borders or highlighted text are visible. It also offered color as a way to differentiate between different menus.

3. THE ADVENT OF WEB 2.0 IN THE BEGINNING OF THE 21ST CENTURY. THE NEED FOR A CHANGE IN LOGIC AND DESIGN PRINCIPLES FOR THE GUI.

In the late 20th and early 21st centuries, computers were starting to become widely available to consumers. This availability in combination with the rapidly improving skills, toolsets and training for the average user, meant that content was becoming available to more users. This

Figure 4-Figure 5: "kai's power tools" and "kai's power goo" by kai Krause ,1992. The distinct design language and user interface helped the software stand out in a sea of many similar looking plugins for adobe's photoshop.



large influx of users and user-generated content led to the creation of the term "Web 2.0". A term that emphasized the evolution of computing and the World Wide Web. Through this revolution, computing would become available to more.

This large change in computing brought a change in the characteristics and design philosophy of the era with it. Gone were the limited color palettes of the past. They were replaced with vibrant colors, rounded shapes, and smooth shading (Müller-Prove, 1998), (Nicol, 2006). Since a large amount of the content in web 2.0 would be user-generated, a clean and professional look meant little to the average user. In order to attract more users, interfaces were designed to be first and foremost attractive. Transparencies and organic shapes with intense contrasting colors became the norm for programs geared to an ever-growing user base (Curtis, 2015).

One of the largest inspirations of the web 2.0 style was none other than Kai Krause. The German designer's extremely distinctive style was incorporated into many an interface. The rounded corners and abstract "biological" look meant that the design language lent itself easily to adding and removing buttons and features. The "Kai's Power Goo" and "Kai's Power Tools" programs were many people's first contact with the new wave of interface design and inspired many to create more elaborate and visually interesting content.

It was then that the graphical user interface and its design became a selling point. This prompted many developers and UI artists to create good looking, colorful and informative interfaces. More complex programs meant that new design elements were also used. Transparencies, shading, drop shadows and reflections were used in abundance. The futuristic aesthetic of the early 00s, more commonly known as the "Y2K aesthetic" made stark white spaces and glossy tabs the norm for years

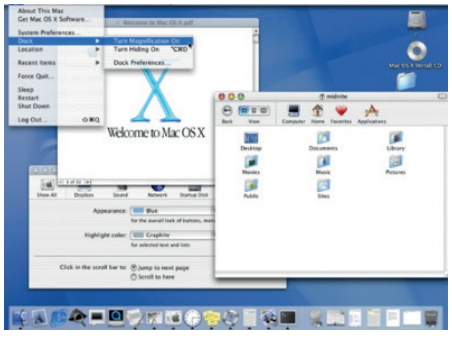


Figure 6: Apple's Mac OSX user interface (2001). Note the rounded shapes, transparencies, and detailed iconography on the desktop.

to come (Nguyen, 2020). These interfaces would be considered overbearing and cluttered by today's standards.

Later Web 2.0 interfaces would become more conservative in their design. Colorful elements would give way to a more subdued and easier to read user interface. The iterative design process would eventually mature into the cleaner, flatter designs of more modern times.

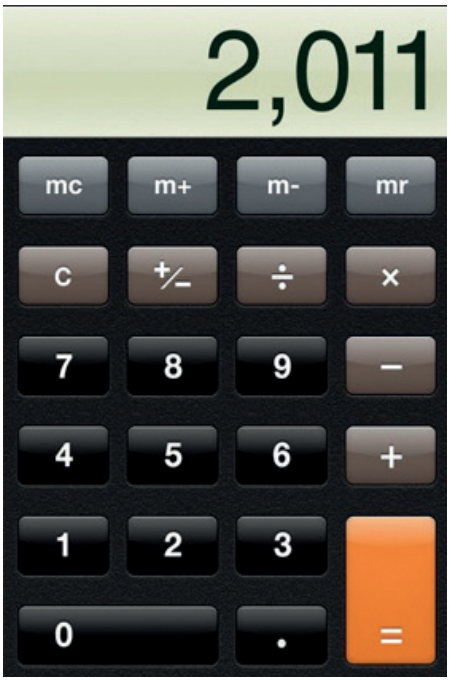
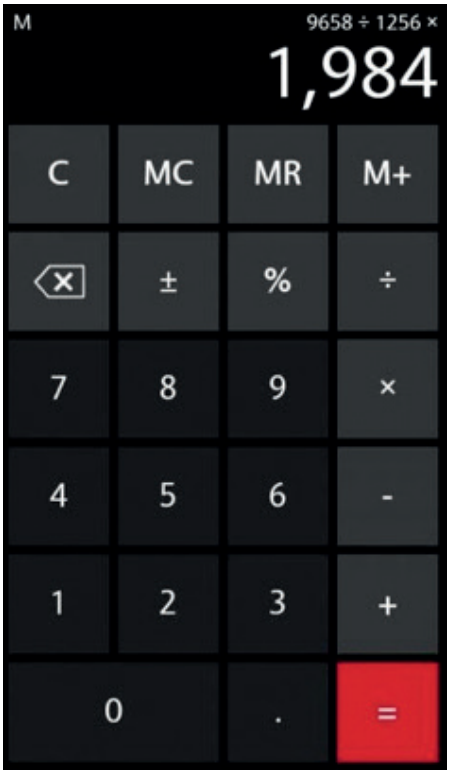


Figure 7- Figure 8: Two versions of the "calculator" app for iOs 5.0 (left) and Windows Phone (right). A stark difference in design languages.



4. SKEUOMORPHISM – THE COMBINATION OF ABSTRACT CONCEPTS WITH THE ACTIONS OF OUR EVERYDAY LIFE AND THE LOGIC BEHIND IT

One of the biggest stepping stones in the design of the user interface was "Skeuomorphism". Skeuomorphic design follows the principle of making design elements resemble their real-world counterparts (Norman, 1999), (Spiliotopoulos et al., 2018). Skeuomorphism has been used in many design fields, including architecture, interior design and even jewelry and ceramics. A wooden texture on a plastic wall, a cloth-like mesh effect on a bracelet or even the act of painting something to resemble metal or brick or even concrete are good examples. Expanded as a concept, skeuomorphism can also include sound as well as texture into its design.

In UI and web design, Skeuomorphism attempts to replicate the look of a 3D object on a 2D surface (Baker, 2017). It imitates analog elements such as sliders, knobs or switches. In a graphical user interface, it takes the aforementioned desktop metaphor even further, using icons and elements that resemble real objects and their functions. The buttons of a keypad symbolize numerical inputs. Switches symbolize something being active or inactive. Sliders and knobs are used to control functions such as intensity and volume.

Skeuomorphism also remedies lack of tactility through visual feedback, providing the user with finer control over their actions. This was especially effective in the mid to late 2000s, where users were being introduced to touch screen surfaces. Having just come to grips with touchscreen technology, Skeuomorphism was invaluable for users having come from a desktop experience. Due to its archetypical design principles and widespread adoption, it proved very useful for graphical user interfaces. Skeuomorphism was adopted by almost every hardware manufacturer and software vendor into their interfaces, marking one of the few instances where design language would be unified across platforms. The modern-day equivalent would be "flat design."

Skeuomorphism was often criticized as being too cluttered. Having to insert a lot

Figure 9: The UI of Re-Birth, an iOs application for the Apple IPad. An example of skeuomorphic design in action.

of information and interactive elements meant an almost complete lack of negative space. A conscious effort was made to further streamline these types of interfaces. The trend toward a flatter design was inevitable however, and later skeuomorphic interfaces would often find themselves adopting flatter elements.

Skeuomorphism would eventually take a back seat to more modern design principles. A cleaner and simpler design language would take its place. Skeuomorphism would follow user interfaces well into the mid-2010s, albeit with a rather dated look to them. Simplicity became the norm and skeuomorphic elements were often relegated to the enthusiast or professional market. Skeuomorphic design is still sparingly used to this day. Certain design cues were incorporated into modern flatter designs. Toggle switches and sliders are still used but often depicted in a more abstract style. Often found in wearables, they are used to depict analogue devices such as watch faces. Usually as a stylistic flourish or design choice (Brownlee, 2014).

5. THE RISE OF MOBILE COMPUTING, SMART TECHNOLOGY AND THE NEED TO KEEP THINGS SIMPLE

Modern user interfaces are clean, bright and lack any unnecessary features or flourishes. Usability is at the forefront. They are presented in bright, high contrast colors or dark grey with simple fonts and soothing pastels as accents. Icons are simple and lack extraneous detail. They are often referred to as “flat” (Spiliotopoulos et al.,2018), (Burmistrov et al., 2015). A modern user interface will only present the user with what is strictly necessary. Further navigation happens through expandable tabs, scrollable lists and easy to navigate buttons and shortcuts. It can be argued that the trend of moving away from skeuomorphism and visual textural metaphors was the increased resolution of displays. Flat design is built on the principle of completely stripping the interface of visual elements that we use to help us interact.

Figure 10: The evolution of the “save” icon. As time passes, iconography moves from detailed, skeuomorphic designs to flatter, more abstract ones

The main reason toward this shift in aesthetic is modern cross-platform app development. Due to the popularity of smart devices and their expanding user base, multiple platforms need to be considered to ensure smoother development. (Hall, 2021). A simple user interface is much easier to scale and edit for different screens and aspect ratios.

Along with the clean and minimal presentation of the iconography, Modern user interfaces also emphasize smoothness when it comes to interaction. Smooth animations and transitions are used to move between windows and screens without snapping or rough motions. The loading icon, the swipe between windows, or the “bounce” of an app drawer are small design cues that can enhance the user experience. This smoothness should not be allowed to interfere with usability and the application cannot be slowed down in order to display animations for no particular reason.

Technology and its adoption have been made synonymous with our daily lives (Müller-Prove, 1998). The widespread use of electronic payments, online marketplaces, and even education programs means that scalable and easily graphicaluser interfaces are essential.

As user interfaces move toward a more unified look, terms such as “material design” or “fluent design” are often used. This terminology often serves more as marketing and doesn’t illustrate a no-

table shift in sensibilities. If anything, we should expect design interfaces to become even more similar and indistinguishable from each other in the future. Along with software, hardware is also becoming more difficult to distinguish between. The formerly distinct categories of smartphones, tablets and desktop computers have started to blur together, and a unified and fluid user experience has become increasingly important.

6. FRAGMENTATION OF USER INTERFACES

Fragmentation occurs when the design elements of a user interface are too complicated and different from each other. By performing certain actions, we expect the user interface to behave in a certain manner. When expectations are not met, we have fragmentation in our UI.

Figure 11: An example of UI design becoming fragmented. Large tiles in combination with small icons are used. The interface is not cohesive and offers too many options with too little explanation and doesn't guide the user organically.

A fragmented user interface is difficult to comprehend and get accustomed to. The user experience can devolve from something contiguous and simple to something that can be very unintuitive (Kapadia, 2017).

Another factor that contributes to a fragmented design interface is the "design relic". Design relics are a byproduct of user interfaces being developed in isolation from each other. Hardware also plays an important role. A good example of this is Apple's insistence on using the top parts of the screen as a location for the "back" button. This was due to the user interface not being updated even after the company's mobile phones became too large and unwieldy to control by one hand. A one-handed phone user could easily reach the top parts of the screen in order to perform tasks such as moving between pages or manipulating the status bar. Not so when the phone is over 6 inches in size. Another notable example is the location of the "menu", "back" and "multitasking" button. In most Asian countries, the direction of reading is right to left, and as such, the "virtual manipulation" of a page turning backwards happens from the right side of a screen. In the West, since the reading directions are flipped, the "back" button is almost always located on the left side of the screen. Similarly, user interfaces designed in Asian countries will have most interactive elements on the left side, and Western developed interfaces have them on the left. Since both markets are so large, however, it's often prudent to have an option to flip or change these elements.

Most user interfaces will offer shortcuts or gestures as a way to mitigate these issues. Through simple design and the use of commonly accepted elements (Cox, 2017), this problem can be sidestepped. Design elements such as certain shapes, graphics and symbols are used to convey a similar message through various user interfaces, often ones that are designed for different applications. The "hamburger menu" (Usability.gov, 2020) conveys the idea of a list. The "meatballs" or dots convey something is in the process of happening. It is often seen when a message or conversation is being written. An animated circle indicates loading or data transfer. The return button is usually situated on the bottom left of the screen and means "back", whereas the floating tiles on the bottom right of the screen indicate "expansion" or "multitasking". All these graphics have been widely used and almost always carry the same meaning.

Due to the public being exposed through many interfaces and devices to these design elements, they have come to expect the same result when interacting with

Figure 12: Widely accepted and used graphical elements in modern UI designs. They are used in almost every program and their function is to provide an abstract representation of their function. E.g. hamburger menu = list, kebab menu = options.

them. Thus, these shapes have adopted a certain meaning for the average user.

The design of a simple user interface that can be considered "airtight", however difficult, can prove beneficial in the long run. A designer's job is often to reduce the possibility of something going wrong, or a user having an unwanted interaction through their inputs.

Different brands and different software vendors have started to incorporate these commonly accepted design cues into their design language. This creates a type of unspoken language between the designer and the user.

7. CONCLUSION

As technology evolves further and comes within reach of more people, user interfaces will prove invaluable to its widespread adoption and usability. While design trends may change from year to year, a simple and clean user interface will aid users from different age groups and backgrounds and help them to fully utilize their software and devices. User interfaces have moved from being eye-catching to being more mature and understated. As the abilities of programs and devices improve over time, a user interface that can filter out extraneous information and allow the user to focus on a few things at a time will be of great importance.

Over the years and through countless iterations the look of the desktop interface has changed considerably. The logic behind it however, remains largely the same. Even on multiple platforms today, icons, interactions and multitasking via windows on top of a non-interactive background have scarcely changed. This is testament to how enduring the desktop user interface and metaphor have been, and how important the role of a well-designed user interface is to the average user.

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