A Visual Language for Human-to-Human and Human-Computer Interaction

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Abstract

Communication between teams should be agile and smooth when it comes to web interface design. When working in web design projects, designers often sketch rough drafts of the overall website to quickly and easily test different ideas; however, different designers employ different representations, resulting in various interpretations of the same sketch. To combat these visual divergences, designers use annotations to explain their vision, which in turn makes sketches too noisy and hard to understand.

To obtain specific information regarding common website characteristics, we asked designers in the field to create free-hand websites sketches with two goals in mind: (1) to understand how a web page is represented in different screen contexts (e.g. screen size), and (2) to understand how features such as the sitemap, the storyboard, and the wireframes are represented together.

After collecting this data, we proceeded to create a visual language based on a systematic analysis of the emerged patterns. This new visual language was then the target of a second survey, where we studied if the resulting sketches were clear, unambiguous, and easily recognizable by most designers.

We conclude that such derivation of a visual language by direct observation of empirical artifacts exhibits characteristics that are semantically intuitive for the majority of the participants with no previous contact, while still accounting for human-to-machine desiderata such as symbolic unambiguity.

Resumo

A comunicação entre equipas deve ser ágil e suave quando se trata de design de interfaces para a web. Normalmente em projetos de web design, os designers esboçam rascunhos do site geral para testar rapidamente várias ideias facilmente, no entanto, cada designer usa a sua representação que por sua vez, resultam em interpretações diferentes do mesmo esboço. Para tentar minimizar o impacto destas divergências visuais, é normal que sejam feitas anotações extra para explicar o que foi representado o que por sua vez, torna os esboços confusos e ainda menos compreensíveis.

Para obter informações específicas sobre características comuns de sites, pedimos a web designers que criassem esboços de sites à mão livre com dois objetivos em mente: (1) entender como uma página da web é representada em diferentes contextos de ecrã (por exemplo, tamanho de ecrã) e (2) para entender como recursos como o mapa do site, o storyboard e os wireframes são representados juntos.

Após a coleta desses dados, procedeu-se à criação de uma linguagem visual com base numa análise sistemática dos padrões que emergiram. Esta nova linguagem visual foi então alvo de uma segunda pesquisa, onde estudamos se os esboços resultantes eram claros, inequívocos e facilmente reconhecíveis pela maioria dos designers.

Concluímos que a derivação de uma linguagem visual pela observação direta de artefatos empíricos exibe características que são semanticamente intuitivas para a maioria dos participantes sem contato anterior.

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Ivo José Oliveira Amaro

"I know that I know nothing"

Socrates

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Abbreviations

GUI	Graphical User Interface
HCD	Human-Centered Design
AI	Artificial Intelligence
HTML	Hypertext Markup Language
CSS	Cascading Style Sheets
CMS	Content Management System
NCSA	National Center for Super computing Applications
W3C	World Wide Web Consortium
WaSP	Web Standards Project
UI	User Interface

Chapter 1

Introduction

1.1   Context

The World Wide Web is one of the most important media of our time that keeps fast-growing. Therefore, designing content for it is an important task to ensure self-explanatory websites where users can reach their desire outcome without thinking too much [KBM14].

Designing interfaces involves knowing the users and understand how they will or might interact with the interface to, finally, be able to design it effectively [Tid10].

This approach is known as the Human-Centred Design (HCD), with the designer taking into account human needs when designing, testing, and iterating to correct mistakes and find, fine-tune solutions. This iteration process goes on until the system is optimized for the problems at hand [Nor13], making this process time-consuming.

Interface designers usually sketch rough drafts of the overall website [LM95]. In these sketches, designers try to understand how the website should behave in terms of navigation, interaction, and structure. For this, they create a visual language that mainly combines the sitemap, storyboards, and wireframes into sketches [NLHL03] and, because we are talking about hand-drawn rough sketches, the representation can differ from person to person. So, this embarks problems such as misunderstandings in design teams. These problems are fought with annotations [LM95] that, in turn, make wireframes too noisy and even less understandable.

1.2 Problem Description

When web interfaces first start to appear, designers used their previous knowledge on Graphic Design and Graphical User Interface Design on them. Naturally, this merge started to look more evident with time, having web pages sharing similarities with printed pages and interfaces from computer systems [Gal07].

The first web page defined a visual culture of what a web page was. Consequently, with internet evolution, this culture began to shred into branches that in turn, were subdivided into other branches making up to the designers decide which visual representations they would adopt to fasten their process.

Designers, unintentionally or not, gather these representations and form their visual language that is used to represent web pages, therefore, in big teams, this creates a gap between conventions slowing the work once everyone must understand everyone else's languages.

This problem can be seen in digital wireframing tools once a vast amount of them give total freedom to designers to use their language. On the other hand, others restrict the use of an outside visual language by implementing their own. Furthermore, this problem is now being more evident with the developments in Artificial Intelligence (AI) field where research is conducted to create websites from sketches.

We must study how designers interact with each other when representing websites by sketching. Consequently, with this knowledge, we will reach a standard visual language that can be applied to Human-to-Human and Human-Computer interaction.

1.3 Motivation

The field of web interface design has not established a standard visual language on how web designers represent the web when sketching interfaces. This work is motivated by the belief that improving the field of visual languages, on web design, can have a broader impact on how designers interact with each other, and how they interact with digital tools. Consequently, we are motivated that we can positively change less efficient methods and approaches, or, create new ways of web design.

1.4 Goals and Contributions

With so many different visual representations of the web, we must try to establish one that may suit everyone's needs and have a simple learning curve for a smooth transition.

This dissertation aims to increase and to facilitate interaction between designers, stakeholders, and other members of an interface project. For that, one goal is to learn what designers do when sketching contributing to the field by pointing out the problems with existing visual languages as well as pointing their solutions to dilemmas previously raised. Another goal is to understand

how web pages are formed by contributing to the field with the deconstruction of them in layers to categorize their constituents.

With this knowledge, we will reach a visual language that leads us to the third goal of this dissertation, create a visual language that can contribute to the field by providing a better way for designers to communicate whether on paper or digital sketch software.

Finally, we also believe this study may provide an impact on the field of sketch recognition in AI, by using this language once it will help on topics such as automatic web page development from sketches.

1.5 Methodology

We will approach this project by reviewing the background and the state-of-art to have a clear idea about how we got here and what was already done in the field.

After this, we will write a questionnaire where we will describe two websites for designers to sketch. With the data retrieved, we will catalog it and analyze it to understand if patterns exist when representing websites.

Having the analysis concluded, we intend to create the first version of the visual language having in mind what we previously learned.

Finally, we will create a survey to validate the visual language and understand what can be improved.

1.6 Thesis Structure

We structured this document in 8 chapters, where this first one provides an introduction to a brief context of this work and describes the problem this thesis intends to solve. This chapter also presents our motivations, goals, and contributions we aim to achieve.

Chapter 2 (p. 5) introduces the background to inform the reader about the concepts and topics that support this thesis providing a review on the historical events behind the creation of the Graphical User Interface and the World Wide Web. We will also explain how the web is structured and why it is different from the physical pages and GUI interfaces. Concluding this chapter, we will make a review of the process of web design.

Chapter 3 (p. 15) introduces the state-of-art where we will analyze some already existing visual languages as well as analysis methodologies used to create them.

Chapter 4 (p. 25) summarizes the problem and introduces the statement of this thesis as well as, the research questions, threats to the study and, the work we plan to do.

Chapter 5 (p. 29) introduces our work explaining the procedure used to collect data, the tool developed to catalog it, and finally, doing a systematic analysis to it identifying problems that may appear designing the visual language.

Chapter 6 (p. 57) describes the visual language created passing through the constituents intended to study for this thesis and explaining the process behind each of them such as the decisions to work around the problems encountered.

Chapter 7 (p. 65) describes the process to validate the visual language explaining the survey conducted and doing an analysis of the responses obtained from it.

Chapter 8 (p. 73) concludes the thesis by explaining the main difficulties and contributions during the work and providing the reached conclusions as well as the further work that can still be made to improve the field.

Chapter 2

Background

Through the history of the computer, humans have been trying to ease interaction with the machine. One of the first interaction types achieved by scientists was writing simple lines of code. This method was a struggle once people with no computer knowledge could not interact with a computer. With time and research, new forms of human-computer interaction appeared. With graphical interfaces, the majority of people became able to understand and therefore interact with a computer visually [Gal07].

In this chapter, we will discuss the history of graphical user interfaces to understand how today's visual mechanisms appeared. Next, we will discuss how the web is structured and how it evolved to become one of the most popular mediums nowadays. In this matter, we will address the history of it, as well as its characteristics, such as the similarities it may have with Graphical User Interfaces and Physical Pages.

Finally, we will review the process and mechanisms used when designing for the web.

2.1 Graphical User Interfaces

One of the most remarkable discoveries that boosted the field of graphical user interfaces (GUI) was the Sketchpad by Ivan Sutherland in 1962. The Sketchpad was an interactive graphics program that allowed users to sketch on a screen showing computers could perform as a visual medium [GB02].

The first computer similar to what we know today as a computer only appeared around 1981, the Xerox Star from the Xerox Palo Alto Research Center. The Star was the first *"comprehensive direct manipulation system intended for business applications in an office environment"* [Bae14]. A
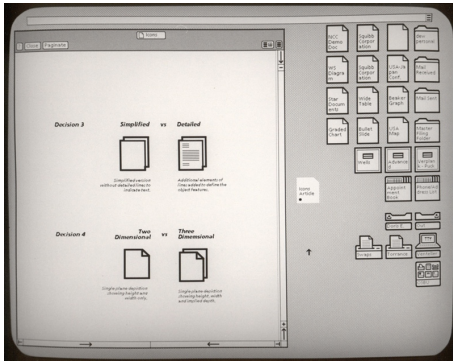
Figure 2.1: Xerox Star Computer Interface.
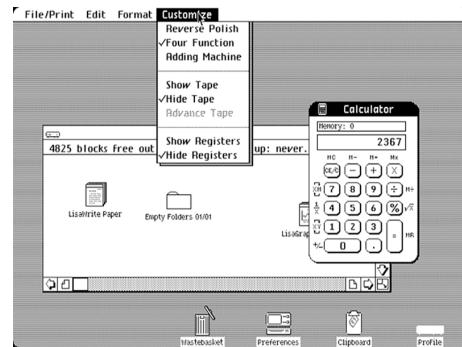
Figure 2.2: Apple Lisa Computer Interface.
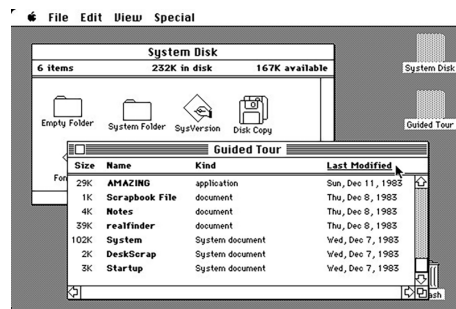
Figure 2.3: Apple Macintosh Computer Interface.

factor for the interface success of the Star was "*the extensive prototyping of ideas, pencil-and-paper analyses, and human factors experiments with potential users*" [Bae14].

Even though the Star remains one of the tremendous milestones of the graphical user interface, the computer was not a commercial success and, the same happened to Apple Lisa, a computer with a similar graphical user interface.

Society did not realize the use computers could have in their lives until 1984 when Apple released a second machine, the Macintosh [Bae14]. This computer was lesser in terms of hardware but was the first entering effortlessly in people's lives.

The Xerox Star, the Apple Lisa, and the Macintosh innovated the field of user interfaces. As we see in Figure 2.1, Figure 2.2 and Figure 2.3 the computers share the same interface logic and more interesting, they are similar to today's computers graphical interfaces which imply after them, all interfaces based their graphical roots on these concepts.

2.2 World Wide Web

In 1989, with the computer already established in everyday life and widely used in the scientific community, Tim Berners-Lee conceptualized the World Wide Web at CERN, describing the basic structure of the internet.
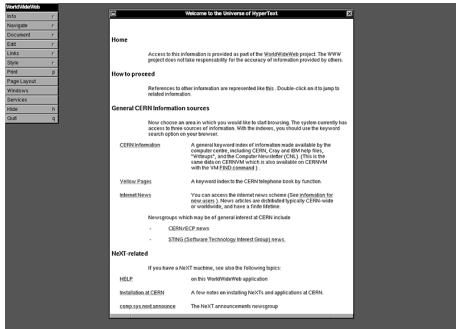
Figure 2.4: First web browser.
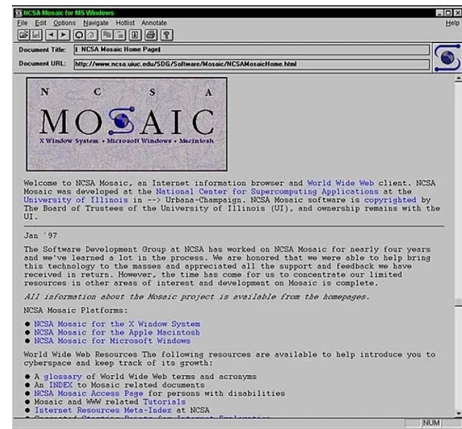
Figure 2.5: Mosaic web browser.

Berners-Lee named it the "WorldWideWeb" a project that by the end of 1990 had for the first time a server and a browser running [CER95] along with the first web page that at the time was formed only by text and links [CER] as we can see in Figure 2.4.

In 1993, CERN released the source code of the WorldWideWeb into the public domain. With this, everyone who wanted was able to use and modify the software free of charge [W3C11].

Consequently, the number of browsers started to increase [BLF08] standing out among them the Mosaic (*cf.* Figure 2.5) by the National Center for Super-computing Applications (NCSA) which allowed users to view images in addition to text [GG06].

With the arising of so many technologies and protocols to build the web, in 1994, Tim Berners-Lee founded the World Wide Web Consortium (W3C) to develop guidelines and recommendations without forcing them into browsers. This method was not successful and, therefore, to build a website was necessary to know how to program to every single browser.

To fight this problem, in 1998, web developers and designers banded together to form the web Standards Project (WaSP) where they took W3C recommendations and called them standards to convince browsers (which were at the time Netscape (*cf.* Figure 2.7, p. 8) and Internet Explorer (*cf.* Figure 2.8, p. 8)) to support them, however, only around 2000, companies began to hear these standards by implementing them on the browsers. With this, new technologies emerge, allowing new forms of design and interaction cross browsers [W3C11].

The Google Chrome team elaborated an info-graphic (*cf.* Figure 2.6, p. 8) showing in detail how the web evolved and why standards were critical to developing it.

2.3   Web Structure

This section intends to explain what are the bones of the web by introducing the Hypertext Markup Language (HTML), the Cascading Style Sheets (CSS), and JavaScript, technologies used to build websites. Following, we will do a brief analysis describing the differences between web pages and paper pages, as well as the difference between web pages and the GUI.
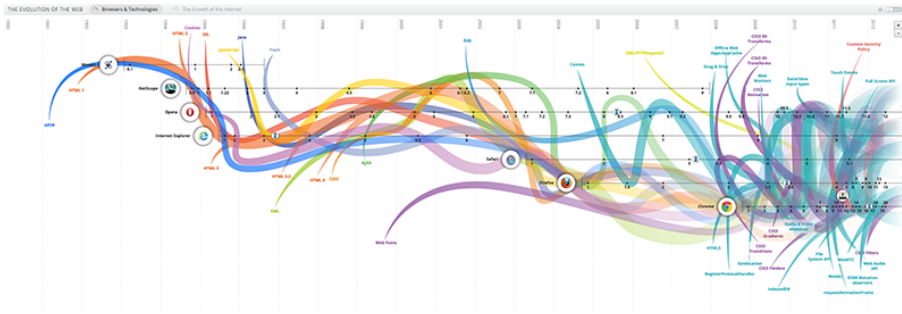
Figure 2.6: Info-graphic of the web Evolution [Goo].
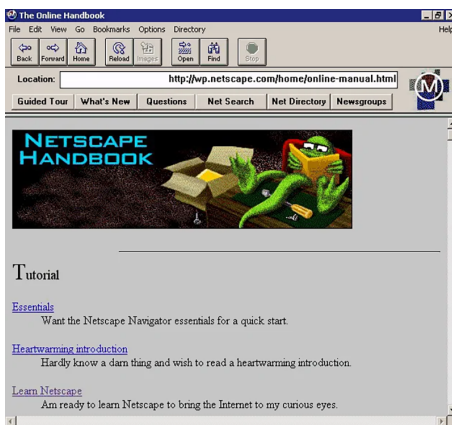
Figure 2.7: The first version of the Netscape navigator, 1994.

Figure 2.8: The first version of Internet Explorer, 1995.

2.3.1 HTML, CSS, JavaScript

In the early days of the web, designers did not have total freedom when creating websites once the platform could only create text and links that would redirect users to other pages with the same characteristics (*cf.* Figure 2.4, p. 7).

These pages were possible due to the Hypertext Markup Language (HTML) which is, the markup language responsible for the structure of a web page by using tags to insert semantics such as headings, paragraphs, lists, links, and later images, video, sound, and forms.

Today's version of HTML, HTML5 evolved in a way "*the web is not just about reading the text on the page and clicking on the links anymore*" noted Bruce Lawson, a browser developer at Opera Software [VN10].

HTML allowed to structure the web but not stylize it, a nice-to-have feature that became a necessity with time [Wor]. Therefore, in 1994, Cascading Style Sheets (CSS) was introduced, solving this gap on web pages without complicating the original structural markup and bringing designers freedom to design on this new medium.

Around 1999, JavaScript, also known as ECMAScript, integrated the web as well, introducing scripting, making it more dynamic once it allowed features such as change element focus, altering pages, changing image loading behavior, or interpreting mouse actions [GG06].

These three technologies gave freedom for designers to start shaping and manipulate the web in infinite ways and, therefore, with this freedom, the design field started to embrace the new medium.

2.3.2 Web Page Interface vs Paper Interface

The web captured the interest of designers once it gave the ability to dynamically change content which was, a static feature of graphic design. Consequently, web interface design acquired much of the knowledge of graphic design that has centuries of research and experience creating fundamental guidelines to bring clarity and organization [Gal07, MP11] to physical interfaces.

Graphic design had his first roots from the publishing industry, with the term first introduced in 1950. With the development of print technology, new possibilities, and a demand for good design appeared until it grew so much that spread to other sectors of the economy. The world continued to evolve and reached the digital age where the computer, and later the internet, brought new paradigms to design [AHB19].

Accordingly, with Ambrose and Harris, graphic design knowledge implies taking *" ideas, concepts, text and images and presents them in a visually engaging form through print, electronic or other media"* [AHB19], such as the web. This knowledge was practiced on the web because it was a platform visually similar to printed pages and therefore needed *" order and structure to the content to facilitate and ease the communication process"* [AHB19].

Although web pages share similarities with printed pages, some of the rules used are not applicable once they are different mediums. Galitz points some of these differences, such as in paper documents, navigation is performed by turning pages, while in web pages requires a decision

to choose what link to follow. With so many choices, the user can feel lost without knowing how to go back to a specific page, a problem that doesn't happen on printed pages.

Interactivity is also very different from one medium to the other. Physical pages involve the eye traversing static information. Web pages, on the contrary, implies moving the content with the hand by scrolling, pointing, expanding, and clicking [Gal07]. These differences exist once the web is an interface embed on another digital interface, the GUI, and consequently, it also acquired knowledge and functionalities from it.

2.3.3   Web Page Interface vs GUI interface

Wilbert O. Galitz makes an interesting comparison of a web page with a GUI. The author gathers information and explains that GUI and web interfaces share similar characteristics. Both are interactive, deliver visual experiences through screens, and are composed of many identical elements. However, some differences also exist. Galitz points out one of the differences is in the navigation. In the GUI interface, to navigate, we use menus, lists, and trees, that are constrained by design. In web pages, to handle navigation, we use links, bookmarks, and URLs that can make the user easily lost [Gal07]. This idea is corroborated by Jakob Nielsen that points out the navigation in the GUI interface is controlled by the designer within the system while on web pages, it is not.

In a GUI interface to go from point A to B, the designer knows the user must go through a specific set of paths while in web pages, the user can jump from point A to B in multiples ways without going through an exact path [Nie97]. Nielsen also points out that, in the GUI interface, every aspect of the screen is under control meaning, everything designed will look, precisely as intended on the user screen. On the other hand, on web pages, this does not happen because the same web page can be open to different screen sizes like a cellphone or a computer screen. The web page must adapt to all these resolutions, therefore, the "what you see is what you get" philosophy does not apply to this medium once" looking different is a feature, not a bug" [Nie97]. Concluding, Nielsen points out that in the GUI interface, the user takes time to get acquainted with the applications used, and consequently, they have more time to learn about how to use them. On web pages, the user moves faster and always jumping between pages that completely change the design, and because of this, users feel they are using the web as a whole and, they expect websites to work in specific ways. They complain whenever a web page does not go into "the normal way doing things" once they do not expect or want to learn about specific websites and how to use them [Nie97].

Galitz points out that *" from a design implication perspective, GUI and web differences can be extensive. Today these differences must be considered in web design, although many GUI interface design techniques and guidelines are applicable in web design. In the future, many of these GUI-Web differences will diminish or disappear as the discrepancies are addressed by technology"* [Gal07].

It is already possible to verify this statement once some years have passed since this book came out, and nowadays, it is possible to distinguish several types of websites, some of which are very similar to a GUI interface. This argument is corroborated by Cooper that points out that web sites
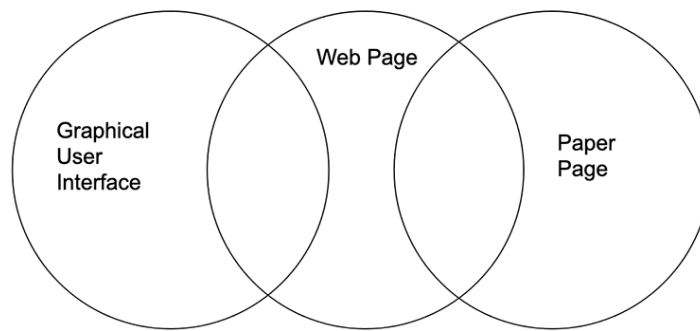
Figure 2.9: The web shares similarities with GUI and Physical Pages.

have different categories [CRCN14], reinforcing Galitz's idea of a GUI-WEB diminish differences. However, the author also points out the fact the web still has room for different types of websites once it serves a lot of purposes.

2.4 Web Design Process

We've seen how the web is structured and why it is different from paper pages and the GUI. This section will describe the process behind web design (the HCD), why designers need to do rough sketches of websites, and what are the problems or solutions of most software when trying to ease the web design projects.

2.4.1 Human-Centered Design

Looking at all the specifics characteristics of the web and acknowledge that part of them differs from graphic design and the GUI interface design, research started developing new methods to approach web design.

Designing interfaces to ensure straightforward websites, involves knowing the users, and understand how they will or might interact with the interface. Then, we will be able to create interfaces where users can reach their desire outcome without overthinking [KBM14] [Tid10].

This approach is known as the Human-centered design (HCD) and, it puts human needs at the center. Only then, the system that tries to support those needs is delineated [Nor13]. It implies an observation phase where designers understand the fundamental aspects of the design problem and understand what are the user needs when using the interface. If the user does not know it, it is the designer's job to perceive it through, as the phase name indicates, observation. After that, the designer moves on to the next phase, idealization, to generate numerous ideas through brainstorming and therefore find solutions to the design problem. After gathering some possible solutions, it is necessary to understand if the solution works entering the third phase, prototyping. Donald Arthur Norman describes prototyping as a way to visualize ideas and that, is usually done by rough sketches to fast test with potential users in the fourth phase of the process.
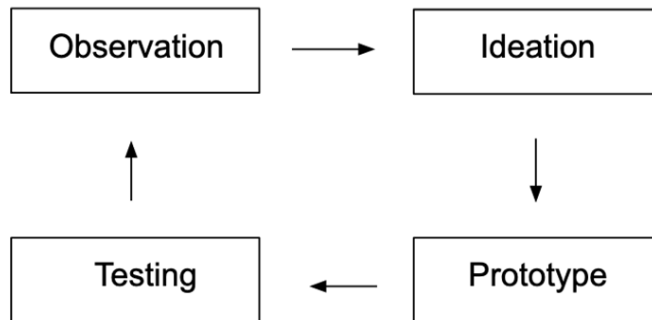
Figure 2.10: Human-Centered Design Process [Nor13].

The methodology (*cf.* Figure 2.10) is applied iteratively to correct mistakes and find fine-tune solutions until the interface becomes error-free but also optimized for the problem at hand [Nor13]. Only then does the process of visually improving the interface begin. HCD is a time-consuming process but provides valuable information that brings long term benefits to the interface, stakeholders, and ultimately the users.

2.4.2   Rough Sketching

The process of web interface design is time-consuming so, designers started to find ways to speed up the process where they could and rough and fast sketches proved to be a medium that allowed testing and visualize ideas quickly [LM95]. Newman and Landay verified this in a conducted study where they observe the whole process of a web design project [NL00]. Robinson argues the same saying many projects start with sketched or digital wireframes [Rob19].

Sketches are a big deal in a web design project but, they carry lots of misunderstandings when talking about them once they are also known as wireframes, mockups, or even prototypes for some. When searching the bibliography, many similar concepts were detected.

Brown argues that wireframes are controversial tools even, with their narrow definition [Bro10]. In part, this problem arises because drawing representations of a web design project is a practice that happens in various stages of the design process [NL00].

For this dissertation, the term wireframe will be used to refer to a *"simplified view of the screen that describes the content of a page and must be aesthetics neutral"* [Bro10] as Brown points in his book where he deconstructs the wireframe concept.

Although wireframes are great tools in the design process, other artifacts are built along and assembled with them to explain the website logic in the form of rough sketches [LM95]. Sketches for this dissertation will address the full representation of a website that includes wireframes, sitemap, and storyboard that, as Newman and Landay also verified in their paper, support communication between teams, clients, and stakeholders.

They point a sitemap is a diagram, commonly represented by labeled rectangles and lines, to show the structure of a website [NL00]. However, the diagram representation will not be the focus once it will probably not suit to explain along with the wireframe, what pages are interconnected, and what are their relation.

The sitemap for this thesis will address the relationship between pages, a definition pointed by Brown [Bro10] in his book and also a concept used in a study where Landay worked as well with James Lin and Michael Thomsen on a visual language [LTL02] as we will see in the next chapter.

For the storyboard, Landay and Newman describe it as representations of interaction sequences [NL00] that goes in agreement with the other work of Landay with Lin and Thomsen [LTL02] that argues storyboards serve to illustrate behaviors, therefore, this will be the definition used for this thesis.

The visual language that results from these three artifacts combined often fails and, designers must annotate things along with the sketches to explain what they meant to represent. These annotations often occupy more space in the rough draws than the actual interface design [LM95] and, consequently, the sketch gets too noisy and visually misunderstood.

Although the sketch can get too noisy with too many annotations, it is not our intention to eradicate them once we also believe they provide information about the design process [LM95]. The idea is to minimize the annotations to create a clear sketch without redundant footnotes that can be replaced by a better communication system.

2.4.3 Sketch Software

Due to the different ways of representing the web, rough sketches, are often misunderstood. Therefore, having in mind these problems, the design field started to be occupied with software to ease the process of communicating interface ideas with teams, stakeholders, and users [Car19]. This software, although it serves different purposes, employs different methodologies on representing web characteristics.

Again, it is possible to notice the concept of a wireframe is ambiguous once these softwares provide tools to do more than representing a website page. Some softwares allows users to build the site map and to storyboard along with wireframing while others only allow high-fidelity sketching and able users to live-build a website without passing through the observation or idea phase from HCD.

These technologies often use image data and built-in features to show a realistic preview of the sketches [Car19], but it takes time to manipulate the software to do it. Although they have problems (*cf.* Chapter 3, p. 15), they are widely used by designers once they may not be the best solution but offer one, so their visual representations of the web become part of the designers' visual culture. This visual culture is later used on sketches once they provide faster ways of testing quick ideas.

2.5 Conclusion

The first graphical interfaces defined what we today see as an interface. The web came to revolutionize and incorporated ideas from graphical design and graphical user interface design.

The process of web interface design is time-consuming so, to fasten the process, designers do rough sketches to communicate visually interface ideas where they mainly represent the sitemap, the storyboard, and the wireframe. These sketches employ different representations of the same web characteristics and, to make sure they are understood, designers do redundant annotations that lead to even less understandable draws.

Wireframe software tries to ease this problem, but on various occasions, manually sketching has proven to be a fast and easy way to work.

Chapter 3

State of Art

The previous chapter showed the need for a visual language that is understood by most designers. In this chapter, we will analyze the visual representations of four distinct tools used in web design. The goal is to understand their strengths and weaknesses by focusing on an evaluation with three-layers (*cf.* Figure 3.1, p. 16) developed by reading the literature.

In the first layer, we will study if the visual languages provide a way to sketch a sitemap, a storyboard, and a wireframe as Landay points in his study [LM95]. After this, we will subdivide the wireframe layer in other three-layers to study if the language provides a way to specify the screen size, the structure, and the elements of the page, having in mind Brown's work [Bro10] where is explained how a wireframe, is assembled. Finally, we will subdivide the page elements layer into two-layers to understand if the language provides semantic to represent different types of web elements. We named these layers as simple and complex where, simple ones are the atomic elements of a web page, and complex, are containers that can accommodate the simple.

In this chapter, we will also address the sitemap, the storyboard, and the wireframe that we will subdivide to focus on the screen size, the structure, and the elements, as we can see in Table 3.2 (p. 16). Taking into account the number of existing elements on the web, we will give special attention to the page elements also listed in Table 3.2 (p. 16). We identify these elements after analyzing several websites and wireframing software and realizing they are some of the most common in web pages.

Finishing the review of visual languages, we will make a review of some methodologies used in the field.

First Layer	Second Layer	Third Layer
Sitemap Storyboard		
Wireframe	Screen Size	
	Structure	
	Elements	Simple
		Complex

Table 3.1: Scheme of the methodology to review the visual languages where we subdivided the wireframe to create the second layer. The same goes for the Elements that form the third layer.

Sitemap	**Storyboard**	Wireframe			
		Screen Size	Structure	Elements	
				Simple	Complex
				Link	
				Image	
				Video	
			Columns	**Text**	
		Desktop	**Row**	**Input**	**Navbar**
		Tablet	**Container**	**List**	**Footer**
		Mobile	**Section**	**Table**	**Form**
			Grid	**Button**	
				Chart	
				Map	
				Calendar	

Table 3.2: Features in focus for this thesis.

3.1 Visual Languages Analysis

In this section, we intend to do a review of visual languages presented in four distinct technologies. The first visual language integrates software that uses the sketch as a form of interaction. The second integrates a software called Balsamiq Mockups that intend to *"reproduce the experience of sketching on a notepad"* [LLC08]. The third integrates a software titled Webflow were users can use a visual interface to build a website without coding. Finally, the fourth and last visual language integrates a software called Uizard that intends to live build websites by sketch them and upload it to an AI algorithm.

3.1.1 A Visual Language for Sketching

Visual Languages to ease interaction, was a subject studied by James Lin, Michael Thomsen, and James A. Landay back in 2002 on a paper titled *A Visual Language for Sketching Large and Complex Interactive Designs*. In the article, they implemented a visual language around the core concepts of pages and arrows to use on tools like DENIN and SILK, where they used the act of sketch as primary interaction [LTL02].

As for the sitemap, the visual language uses arrows that can go from specific points of one page (such links, and buttons), to other pages. We can see this mechanism to do the storyboard as well, however, for the storyboard, it is also necessary to repeat the wireframe and draw the interaction sequence.

The language use arrows as one of the concepts [LTL02] and, it seems to be a great choice to represent these two characteristics. In large systems, it can become confusing having so many arrows, but the paper acknowledges this problem and reports that it was not completely solved.

For the wireframe, the paper does not express how the language specifies the screen size of the interface but, they point the technology works for desktop [LTL02] so, we assume the visual language only works for it. We also presume the screen size is a container around all the elements, with a label on top specifying the name of the page, a pattern we commonly saw. The label reinforces the idea the container is indeed the representation of the screen by changing on every page to the intended page name.

The wireframe structure is also not specified but, again, looking to the provided images, we noted the elements were not randomly placed reinforcing, some organization was though before adding them to the wireframe.

The web elements are specified in the paper as components and, separated into two types, intrinsic and custom. The intrinsic, are the elements recognized by the visual language, and on the other hand, the custom, must be created and added to the language library by the user. The paper points only one intrinsic element, the text field, was implemented [LTL02] on so, this language cannot help this project by providing a list of relevant web elements to map.

A problem detected with this language is the fact it can slow down the work of users once they must create custom elements for every interface project. Apart from this, the visual language provides valuable information regarding the custom elements by explaining to the users they can
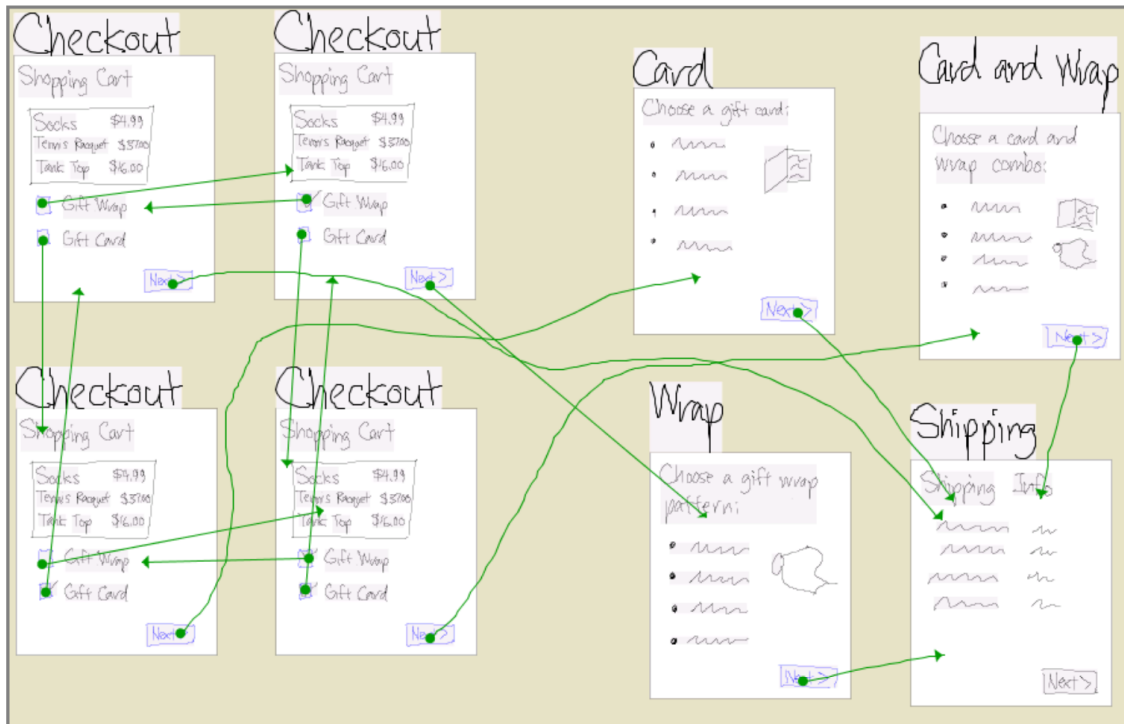
Figure 3.1: A visual Language for Sketching [LTL02].

create elements and reuse them so, there is no need to start from zero every time they are needed. For example, the user can create a navbar and then reuse it by pointing it to the page intended with arrows speeding up the process.

Concluding, this visual language intends to work along with existing tools and, for that matter, it was built around their limitations, resulting in a visual language that can improve once it still has unsolved problems as the paper points [LTL02].

3.1.2 Balsamiq Mockups 3

"Balsamiq Wireframes is a rapid low-fidelity UI wireframing tool that reproduces the experience of sketching on a notepad or whiteboard but using a computer" [LLC08].

Instead of freely sketching on a paper, Balsamiq software mimics all kinds of web characteristics in the form of web elements. The user can drag premade sketches onto a canvas where the software can choose between two types of view, the sketch view and the wireframe view (which is more detailed). This software implemented its visual language so that users do not have to resort to another type of representation and consequently interact better with each other.

The sitemap has available an independent web element so, there is no possibility to integrate it with other web elements. This web element is composed of labeled rectangles that are connected by lines, a representation mentioned in Chapter 2 (p. 5). In Balsamiq, if users want to integrate the sitemap with the wireframes, they must use their system recurring to web elements provided by Balsamiq, such as arrows. This methodology creates an unnecessary struggle since the user must
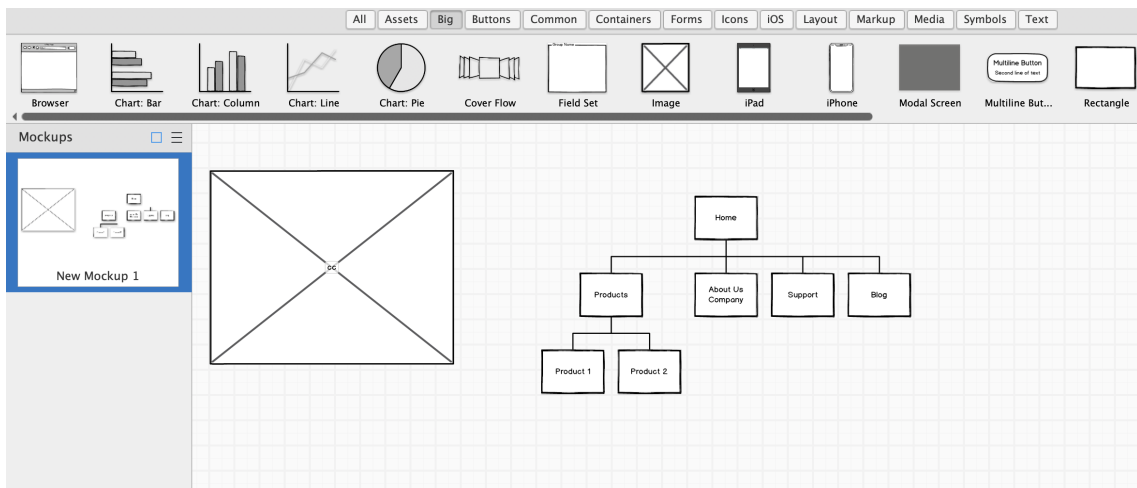
Figure 3.2: Visual Language of Balsamiq Mockups.

concentrate on two places at the same time, or drag other elements to explain how the pages are related.

The storyboard is the less optimized feature of Balsamiq once it does not allow the representation of storyboard characteristics since it is a purely static technology. Balsamiq published an article explaining how to specify interaction sequences, but their solution relies on annotations. The users have to spend time building the storyboards and creating annotations that can be represented easily through sketches [Bal].

In the wireframe, to specify the size of the screen, the user can recur to elements that are *"iPad, iPhone, Smartphone"* and, for the Desktop interfaces, *"Browser and Window"* which is a simplified version of the browser element. Apart from these, Balsamiq also allows the use of simple containers such as rectangles. The screen size feature is robust using web elements for different types of screens. However, we do not understand why the software makes the distinction of the screen size elements by specific company's devices.

The specify the structure, the user must align the elements in the desired way once there is nothing to define columns, rows, or other structural characteristics. The only thing to ease this is a general grid that Balsamiq has embedded.

The elements of the wireframe are the feature Balsamiq shines once it is where the software focuses as it tries to mimic paper. Everything in the software resides on web elements. From simple ones like buttons to complex ones like tab bars, which can be a considerable disadvantage since the number of web elements is so extensive, the user gets lost trying to find them in an interface that repeats the same web elements over and over. Beyond this, the software acknowledges everything as elements such as the screen size or the sitemap creating an ambiguity in the features they provide.

The advantage of this software is that in a team that only uses it, the visual language will be the same for everyone, so, with time, communication can ease, although not optimized.

3.1.3 Webflow

Webflow is an all-in-one platform that combines a web design tool, a Content Management System (CMS), and a hosting platform [Wil]. This platform can build and deploy an entire website with the possibility of CMS integration without writing a single line of code, just dragging, clicking, and adding content into a viewport to, therefore, click on a button and deploy.

The sitemap feature enables users to manage and create web pages. This feature has downside once users only can administer the pages as a server where they can deal only with files so, it is not possible to know which pages are interconnected. Another downside for this feature is the need for previous knowledge in server file management and, for a designer with no education in technology, this can be a struggle.

The advantage of this system is that at any moment, users can switch to a preview mode. There they can navigate through pages if they previously defined some links. This way, users have a precise view of what the relation of pages are without the necessity of having arrows explaining to where the pages lead.

Because the purpose of this technology is creating code while building the interface, the storyboard is automatic because users can design the interface and see the animations and interactions live to have a fast understanding of the interaction of the project. Nevertheless, the interface can be confusing once users need to iterate from a "design view" to a "preview view" to build the website and to check if it's going as planned. Some properties of the storyboard, are integrated with the settings of the elements, on the other hand, others have specific locations to be handled (such as mouse events), so at first glance, it is confusing for the user until he knows where all the resources are.

As for the screen size, the interface provides a Desktop, Tablet, Mobile Landscape, and Mobile Portrait feature easy to reach at any time and respecting the major web standards. However, it lacks the Tablet Landscape option that is not a considerable disadvantage but a nice-to-have feature.

Talking about the Webflow structure, it offers valuable features such as Sections, Containers, Grids, Columns, and Div. These features are easy to manipulate and restructure at any moment of the project (if necessary) in the viewport.

The wireframe web elements are few, but those necessary for efficient interaction and organization such as images, text, links, on so on. Because they are few, they are easily reached by the user that can drag them into the viewport and iterate from there having different characteristics for every web element. For example, when iterating with an image element, the user can then choose the path to the image file but, when adding a link element, the user can add the path to where the link redirects and also label it. As for the complex web elements, the platform acknowledges the concept of them once it allows the user to join simple ones inside a container. The software does not have many complex web elements but, it provides the most important such as the navbar and, apart from that, users can also create their web elements, a feature presented on the visual language for the DENIM and SILK tools.
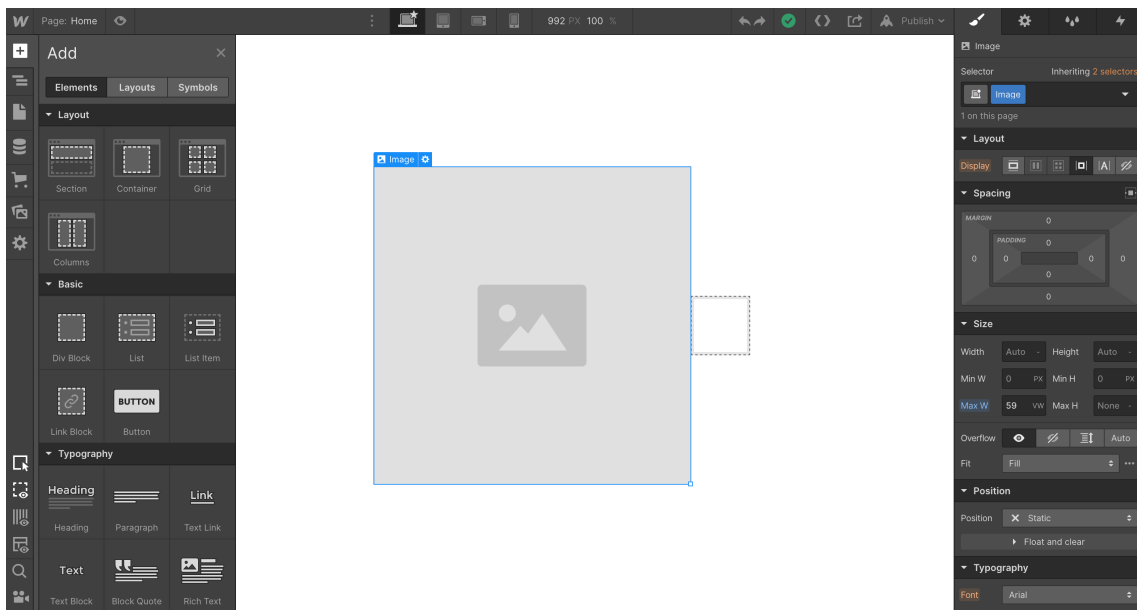
Figure 3.3: Visual Language of Webflow.

3.1.4 Uizard

Uizard is a prototyping tool, still in beta, that transforms captured images of sketches into code using computer vision and machine learning. [Ogu19]. Users can sketch on paper or in digital low-fidelity software and then upload the resultant draws to the Uizard software that, once he gets it, starts to transforming it into a high-fidelity prototype based on a design system that is also chosen by the user. The algorithm can only guess about 80% of the sketches so, users need a little effort to customize the wireframes [Bel].

To specify the sitemap, users can create arrows that go from the elements to the pages without a way to indicate specific sections of the page. This feature will improve the working prototype but, it can be a downside once users must spend time making all the connections, a time he already spent to sketch the interface in the paper.

The storyboard feature is semi-automatic once all the wireframes are static and, the interface does not offer a way to explain interactions. As mentioned, users must choose a design system before creating a project. Posterior, that design system will be applied to the resultant prototype and will automatically perform all interaction features such as color buttons on hover. To specify more difficult interaction mechanisms such as a pop-up, the user must duplicate a wireframe and push an arrow to it. This way, the wireframe will work to show an interaction feature and not a sitemap. However, the functionality is the same.

The Uizard platform allows two types of screen sizes. The mobile and the Desktop that, after creating the code, can adapt to other sizes although, a Tablet size could also be beneficial once it is a middle ground between Phone and Desktop.

As for the structure, the algorithm takes care of some of it. As mention, the algorithm can only guess part of the sketches so, users need to, in some cases, manually place some of the web
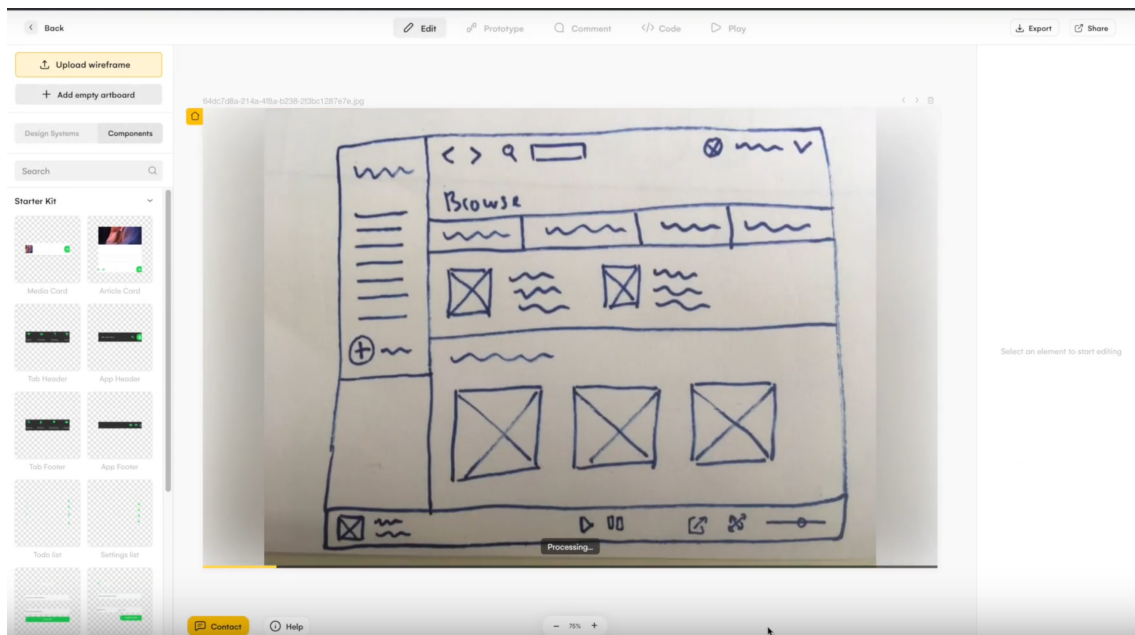
Figure 3.4: Visual Language of Uizard.

elements having in mind the structural characteristics.

Concluding, for the wireframe web elements, the platform can only guess a few of them so, users must use a cheat-sheet [UIz] to know what web elements are recognizable by the platform. After the prototype generated, users can complement the resultant interface and manually correct what the algorithm could not guess. A feature of this platform is the fact users can also edit the code generated by the algorithm and do even more low-level changes but, for that, they must have basic knowledge on HTML, CSS, and JavaScript [Bel].

3.2 Methodologies Found

We intend in this section to review methodologies used to build visual languages and to point their positive and negatives aspects to start thinking about possible approaches to use in the course of this work.

3.2.1 A Complexity Analysis of Widget Representations

Facilitating the interaction of an interface design project through a visual language was a theme addressed before by Suzanne Kieffer, Adrien Coyette, and Jean Vanderdonckt. They conducted an experiment to identify the representations preferred by designers and end-users and a second experiment to understand how they would sketch these representations.

In their paper, they described the first experiment saying they took 60 subjects from a list of volunteers and formed two groups, one with designers and the other with end-users. With the groups, they started a two-phase analysis. The first one *"was to determine how members of each group would intuitively and freely sketch the widgets"* (web elements). They asked if the subjects

knew the web elements before asking them to sketch. The study identified a catalog (from a cross-platform comparison of widgets) with 32 web elements, grouped into "categories with strong similarities". In the second phase, they ranked the catalog of the first phase by the groups, and they choose the best representations having in mind the global preference of the groups [KCV10].

This work proved to be quite useful and influential to this dissertation once it showed methodologies to get feedback from designers and how they sketch web elements. However, the work intends to fill the communication gap between designers and end-users, a problem that we do not plan to explore in this dissertation.

3.2.2 SILK and DENIM Methodology

Landay and his advisor, Mayers, in the investigation of SILK, a sketch recognition software, decided to opt for informal methodologies based on interviews with interface designers as well as visits to their workplaces.

They described the whole process explaining they first wrote the questionnaire and tested it with the help of three designers for later reviewing and correcting the faults and then, send it by email to analyze the data received.

Afterward, they asked the designers what their background was, what techniques they used in interface design, and what they liked and disliked in paper sketching, as well, the electronic tools for the same purpose. After that, they gave designers an overview of SILK and asked to comment on its strengths and weaknesses and to estimate the time they wasted when designing different types of interface elements. To conclude, they asked the designers to send sketches made in the initial stages of interface design. With the data retrieved, they were able to obtain valuable information that they use to build the visual language for SILK [LM95].

This paper offers a remarkable methodology for information retrieval and analysis that will be crucial when building the visual language for this dissertation. However, this paper does not focus on the web interface that was what Landay later did on another conducted study with Newman, Lin, and Hong. This time they focus on a new tool called DENIM, a more sophisticated AI sketch recognition for web designers. In their study, the team took a similar approach to SILK work, however focusing on the web made them refine the work and to create a new form of iterations [NLHL03].

3.3 Conclusion

This chapter reviewed four visual languages presented in distinct tools for web interface design and applying the three-layer analysis. We noted the visual semantics were similar but also different in the functionalities they provided. For example, when analyzing the web elements, we realized that, while in *"A visual language for Sketching"* the user can draw freely and create their web elements, however in *"Balsamiq Mockups 3"* the user already has all the web elements he might need. These are very distinct approaches, but we cannot say one is better than the other.

The methodologies found addressed specifically visual languages for hand-drawn sketches, and the other tools analyzed were property software so, we did not have access to their method of work. These methodologies gave us crucial clues to answer the question of how can we retrieve data to understand how designers sketch?

Summing up, this chapter gave us some knowledge of the advantages and disadvantages of the tools and methodologies analyzed.

Chapter 4

Problem Statement

As we saw in the previous chapter, there are a lot of techniques and approaches to the interface design field and, all of them have their pros and cons that we will take in mind in the course of this work.

4.1   Problem Summary

Creating a visual language for communicating web interface ideas and create a standard in web development can be a difficult task once there are a lot of pre-made assumptions in the field.

Designers already use their visual standards when sketching quick ideas to developing web interfaces and that standards may not be compatible with other professionals. This problem creates a gap between conventions, and designers find themselves putting annotations to explain interface ideas making the sketches too confused and less understandable culminate in more time spent.

Between all these languages, we cannot say one is better than the other, and the proposals to solve this problem typically do not focus only on web interfaces.

A detailed study of a visual language to be used in human-to-human and human-computer interaction could improve the field of interface design.

4.2   Thesis Statement

We believe that communication between teams should be smooth and agile when it comes to web interface design. Therefore, we aim to achieve **a visual language** that (a) can ease **the**

communication among teams, stakeholders, and clients, as well as (b) **help minimize the time spent** in project development of web pages.

Our main hypothesis is that (a) such language exists, and (b) the result will be semantically intuitive to the majority of designers.

We also believe that our contribution may provide a broader impact. In particular, we identify a potential advancement to the field of sketch recognition in AI, by offering a language that is both consensual among humans and easily interpretable by machine learning algorithms, which will help on topics such as automatic webpage development from sketches [Car19].

4.3 Research Questions

1. **What form would a visual language appropriate for free-hand sketching of websites would take, and what would the relationships between its constituents be?**

   To answer this, we might attempt to provide an answer to several secondary questions; for example, is there a clear pattern that emerges when analyzing website representations? Does every constituent of this pattern assume the same form for the majority of the population, or are there variants that would be equally probably to be used? Can these constituents form such visual language, or would we need to introduce changes to make the language consistent?

2. **Would websites designed using this visual language be understood and accepted by most web developers?**

   Depending on our findings in RQ1, we might discover that the emergent patterns are highly consensual among the population, or that there are variants and/or mismatches that would require some selection criteria to achieve a consistent language. How would designers, when exposed to this language, react? How broad/specific would this language become?

4.4 Threats

1. **Web Characteristics**

   Being a fast-growing medium, the web allows designers to push boundaries and try new forms of visual communication therefore, the range of web characteristics to map increases creating the challenge of understanding "What characteristics are important to map".

   item **Retrieve Data**

   Gather people to participate in this study and take some time sketching and designing interfaces can be a difficult task. The subjects participating will be volunteers making their time available for free and, so, we expect they will not be in their maximum effort.

2. **Human Behaviour**

Looking for the state-of-art, it appears that it is not consensual on the amount of fidelity a rough sketch must have therefore, we expect some of them to be more detailed than others creating a problem of understanding how much detail we need on the visual language.

3. **Ambiguity**

Being the range of web characteristics so extensive, the probability of having similar representations to different elements is very high.

4.5 Methodology

After gathering all the information needed in the state-of-art, we can now proceed to the investigation.

First, we will write a questionnaire where we will describe two websites and ask designers to sketch them. After completing it, we will submit it online to reach designers and gather the most answers possible.

The questionnaire will be closed when we retrieve enough data but, while waiting, we will develop a tool intended to organize and catalog it. This tool will provide better data visualization by facilitating data crossing.

With the tool developed and all the data uploaded, we will start the second phase of this project that consists of a detailed review of every feature intended to focus on this thesis.

After developing the first version of the visual language, we will validate it to establish what worked and what needs to be changed. The validation process will consist of an online survey with two parts.

In the first part, we will verify if the web elements of the language are recognized by most designers. In the second, we will understand if features such as the sitemap, storyboard, and others, are recognized as well.

When we gather all the answers, the validation survey will be closed, and the validation data will be analyzed. We will then take some notes, document, and conclude this project having in mind the problem statement and research questions of this chapter.

Problem Statement

Chapter 5

Data Collection and Analysis

So far, we have gathered all the information necessary to proceed. When sketching web interfaces, designers do rough sketches to understand the overall structure of a website [LM95] and, that includes the sitemap, the storyboard, and the wireframe.

In this chapter, we will do a description of the applied methodology for data collection and the problems we encountered. Next, we will introduce the tool developed to ease the work of studying the data retrieved. With this information, we will explain how the data was analyzed and the problems encountered to create the visual language. Finally, a brief conclusion will summarize all we previously said.

5.1   Data Collection

To analyze how designers represent the web, we gathered sketches from three distinct sources. The main idea was to retrieve only information from the questionnaire doing sessions with the participants to observe and understand their thinking because that way, we would get more consistency and certainty about the results. However, due to the pandemic outbreak, we had difficulty in finding participants and, therefore, we needed to send the questionnaires online and complement the data collection with sketches from professionals in the field and sketches found on the internet to then, compare them all. The resultant data is 67.4% from the questionnaire, and 16.3% from professional and online each.

To develop the questionnaire, we first planned to gather images from real websites for people to sketch but, that proven to be not a great idea, as people would try to mimic the pictures and not represent the elements like they thought would be the best way. The images would give the subject

Figure 5.1: Cataloging Feature of the data analysis tool.

an "obligation" to make a more detailed sketch that, on the other hand, with our second approach, didn't happen.

Our second approach was a two-part script, that can be view in detail in Appendix A.1, where were we describe two websites. The first part intended to understand how people represent the screen size for desktop, tablet, and mobile. We describe a website with one page, and we ask the volunteers to design it according to the instructions. The second part intended to focus only on a desktop website to understand how people would represent the specific key features we saw in Figure 3.2 (p. 16) allowing us to analyze the sitemap, the storyboard, and the structure.

Both parts of the questionnaire intended to understand how web elements are represented on sketches by designers.

This survey reached 15 subjects and brought a total of 29 sketches. The sketch list expanded to 43 sketches with 7 more drafts from professionals in the field and 7 from searching on the internet. We do not know how many designers worked on drafts we retrieved from the internet and professionals. All data retrieved can be view in detail in Appendix A.2.

5.2 Tool for data analysis

As soon as we retrieved all the information, it became clear that we would need a system to catalog and analyze all the data and so, we implemented a simple website with three main functions.

1. To upload the sketches retrieved, extract the representations intended by cropping them from the original sketch and finally catalog them (ex: sitemap) to, therefore, save it on the database as we can see in Figure 5.1.

2. To view all the sketches and the crops associated with them. The main goal of this feature was to view all the entries and filter them by Survey, Professional, and Online, as we can see on Figure 5.2 (p. 31). We could also filter the database entries, to see the associated crops and notes as we can see in Figure 5.3 (p. 31)
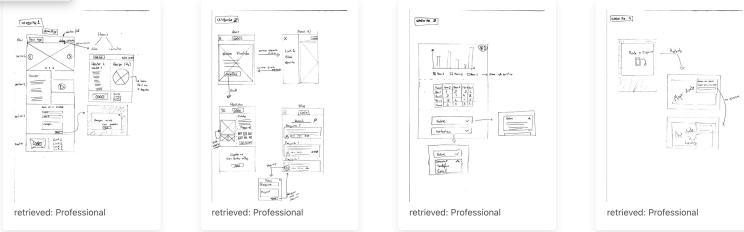
30
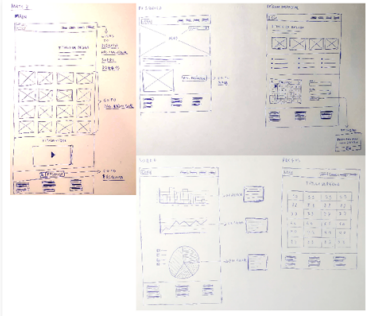
Figure 5.2: List of all entries in the data analysis tool.

Figure 5.3: Particular entry in the data analysis tool.
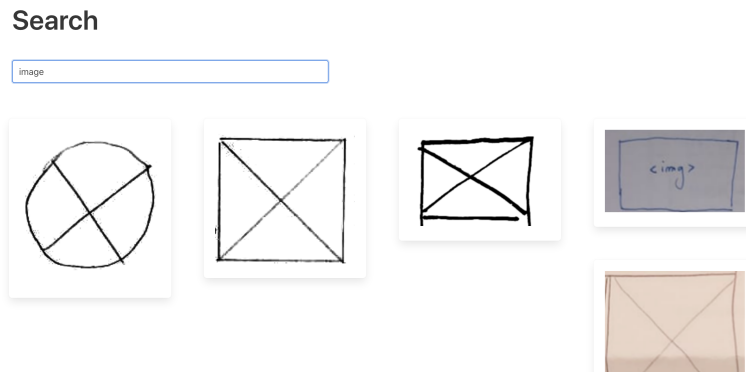
Search

Figure 5.4: Filter feature of the data analysis tool

3. To filter all the representations such as images, video, link, and so on. This function allows us to filter by type of web element and see the patterns on it, as we can see in Figure 5.4. We later developed an extra feature to this function to allow a rearrangement of the representations to group them by similarity.

After finishing the tool, the process of adding images to the database started. As the Table 5.1 (p. 33) shows, for every parameter we found X representations.

Note that we found two extra parameters (Logo, Iconography) that we will address in the Data Analysis subsection.

5.3   Data Analysis

The Data analysis started when all the images were uploaded to the database and cataloged. We individually analyzed every representation listen in Table 5.1 (p. 33) and realize some of them needed to be scrutinized together for a better understanding of their characteristics.

For this matter, we group the Sitemap and Storyboard, as well, the Screen Size and the Structure subcategories. Having the groups composed, we searched for similarities inside them and, we named each group with the terminology of A plus the number of the group (ex: A1, A2, on so on). It is critical to mention this nomenclature only works inside each group to differentiate the subgroups meaning the A1 representation of one group has nothing to do with the A1 of another group.

5.3.1   Sitemap and Storyboard

When we started to analyze the sitemap from the retrieved data, we noticed that most of the subjects did not bother to represent it despite being asked. We believe the reason this happened is the fact the participants were volunteers working in their spare time, a threat mentioned in Chapter 4 (p. 25) so, they may not have dedicated as much effort as possible to the project. We noticed the same in the professional data but, because there was no control, there is no way to know why they did not represent the sitemap.

	A1	A2	A3	A4	A5	A6	A7	A8	A9	Total
Sitemap	10	5	1							16
Storyboard	24									24
Desktop	141									141
Mobile	66									66
Tablet	22									22
Structure	0									0
Link	331	86	580	169	27					1193
Text	68	50	9	7	10	66	16	12	6	244
Image	258	31	34	2	13	12				350
Video	37	13	4	3	2	2	4			65
Input	40	30	4	3						77
List	43	108	219	26						396
Table	13	1	1							15
Button	35	28	5	2	3					73
Charts	35	6	3							44
Map	7	2	2	2	1	1				15
Calendar	9	3	2	1						15
Navbar	101	38	7	1						147
Footer	98	31	3							132
Form	23									23
Logo	154									154
Iconography	109									109
Total										3321

Table 5.1: Number of times we found each representation.

Nonetheless, the sketches retrieved online gave strong assumptions that the sitemap is used for big brands such as Netflix and Amazon and searching for the real web pages we saw they are very similar to the sketches found. With all this information plus the work of Landay mentioned in Chapter 3 (p. 15), we believe the sitemap is an essential characteristic to analyze so, looking to all the data, we found three different patterns labeled A1, A2, A3 as we can see in Table 5.1 (p. 33).

Beginning from the end, the A3 pattern with only one representation, was a traditional sitemap (*cf.* Figure 5.5, p. 35) were boxes with the name of the page would be made and connected to others. This representation of the sitemap gives no accurate information about the relationship between pages because users must sketch it as a separate artifact from the storyboard and the wireframe. With this project, we intend to achieve a central semantic that together can build a system.

The A2 pattern (*cf.* Figure 5.6, p. 35) with five representation showed an interesting solution to solve the problem of "spaghetti" arrows mentioned in [LTL02]. We found this group in navbars and, it consisted of naming the links to where the page led with the name of the page itself. This way, users could easily know the "about" link would redirect to the "about" page, decreasing the number of arrows on the overall page that was the most common pattern found and grouped in the A1 pattern. This pattern was the major found with ten representations, and as mentioned before, the pattern used arrows to explain when clicked on some element the site would redirect to another page. (*cf.* Figure 5.7, p. 35).

Some of the A1 representations used text to make the representation clearer but, others used different colors on the arrows and, that can be a good idea although using a different color is not so practical as just sketching with one color. As for the text, it seems unnecessary once looking to the overall sketches writing is immensely used as support when in doubt. The A1 group is also the reason the sitemap is associated with the storyboard. We noticed the storyboard feature also used arrows to specify interaction, such as a pop-up (*cf.* Figure 5.8, p. 35).

The storyboard group gathered 24 representations with the pattern of arrows. The difference was, while in the sitemap, the participants used them to specify the relationship between pages, on the storyboard, the participants used them to connect the parent wireframe to a simplified version with the interaction sketched.

For some sketches, we noticed participants horizontally aligned the storyboards with the parent wireframe. We did not observe this in every representation and, there is no proof the participants drew it intentionally.

The sitemap and storyboard need further study but, we conclude the link feature with the arrow feature can decrease the "arrow problem" mentioned in by Landay [LTL02] although, it is unknown how this will work in a system. As for the storyboard, the arrows are the only representation found but, because we gathered few data on it, some doubts still exist such as, how to specify interaction sequences with the child element of the wireframe or, if using arrows is the best way at all to represent interaction.
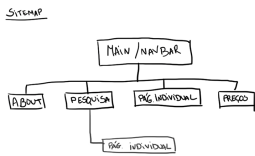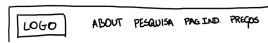
Figure 5.5: Traditional Sitemap.

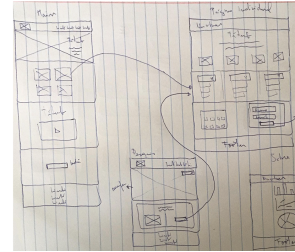Figure 5.6: Example of the A2 pattern.
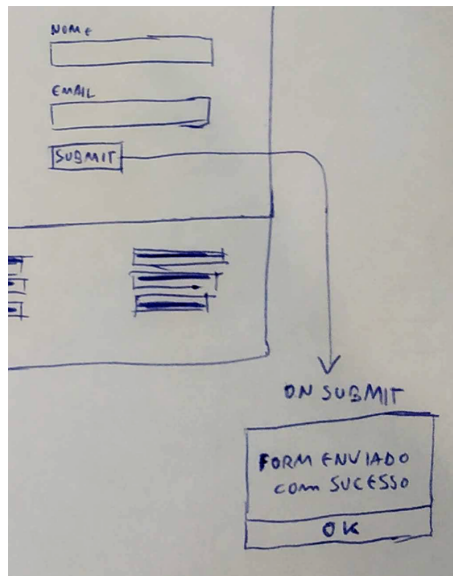

Figure 5.7: Example of the A1 pattern.
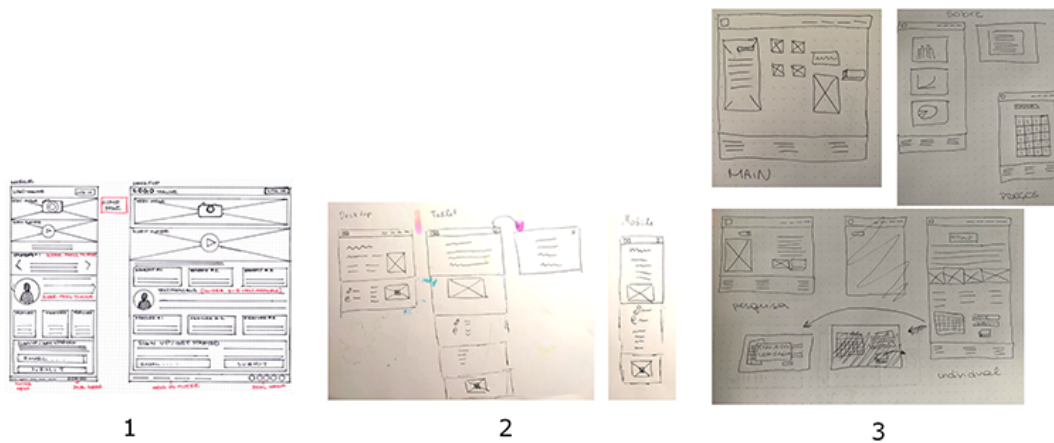

Figure 5.8: Example of a Storyboard.

Figure 5.9: Screen Size examples.

5.3.2 Desktop, Tablet, Mobile

To understand the scenario of how to represent a desktop, mobile, and tablet, we had to look at the raw data (43 images) once this category works as a container of the wireframe.

When asked to draw a website, the subjects would always do it in a desktop version once it is what appears to be the default screen size. We are not sure of it, and we need to conduct further study.

We noticed, the screen size was a knowledge the subjects already knew beforehand so, the representation was always a rectangle with the intended ratio of the screen. If needed to represent desktop, mobile, and tablet at the same time, the subjects would sketch it with different proportions and put a label for more clarity.

When the page had a scroll, the height of the rectangle would change according to the content emphasizing the need for a label once altering the height, increased the ambiguity of the screen size. As we can see in Figure 5.9, the sketches one and two have labels to specify the screen size. However, the third has not because we asked participants to sketch only a desktop website and so, the subjects intended no label was needed.

Perhaps adding a label is the best way to achieve an accurate understanding of the screen size once this characteristic is dependent on the content. Another factor to use a caption lies in the fact that, on hand-drawn sketches, human error will make the representations more unclear.

5.3.3 Structure

At first, we intended to scrutinize the structure layer into subgroups such as grid, columns, rows, containers, and sections but, trying to categorize it based on the data proved to be a hard task to maintain the integrity. We noted most of the sketches did not have the structure subgroups objectively drawn and so, analyzing specific features such as columns became very subjective. We end up concluding designers do not sketch structure features but, they implicitly represent

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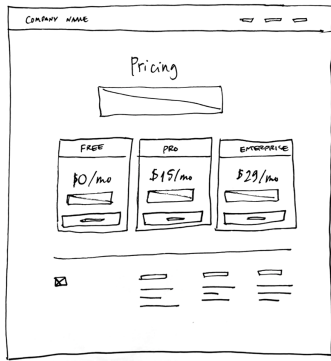
Figure 5.10: Sketch Retrieved for the Dissertation.
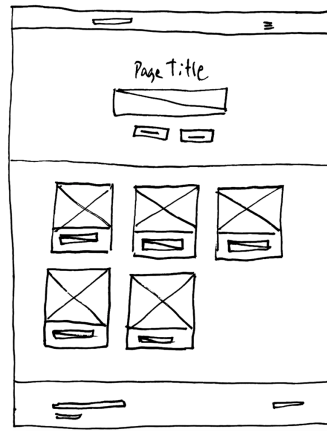
Figure 5.11: Sketch Retrieved for the Dissertation.
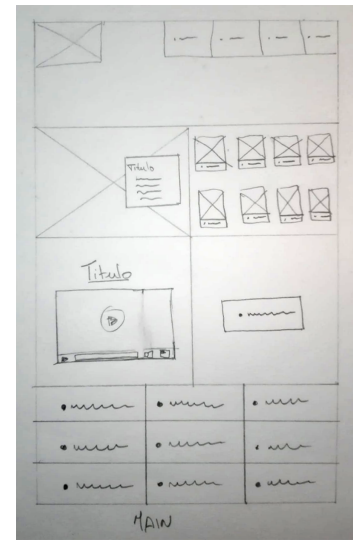
Figure 5.12: Sketch Retrieved for the Dissertation.

them with the web elements once we noted the participants placed them on the wireframe showing some logic and hierarchy. If we look, into Figure 5.10 and Figure 5.11, both made by the same subject, we can notice that in Figure 5.10 we probably have one section with two rows where the first has one column, and the second has three columns, each with a container. We can notice this description can be highly subjective and can be changed when described by someone else.

The same happens in Figure 5.11 that is more subjective. If we take a look at what is the second section (the part of the sketch that has five rectangles with a cross), we can assume the image has three columns or we can estimate it has a grid, but to be sure, we must ask the person who sketched it.

Although most sketches do not specify the structure objectively, some have tried to do so. Looking to Figure 5.12 we can see a space that is delimited by lines. However, with this method, it is hard to understand how many sections the sketch has or where the footer begins. The representation also has the characteristics of the previous figures where is indistinguishable if the subject tried to represent columns or a grid.

Concluding, on the questionnaire, we asked for a specific structure and, we noticed all representations were different or subjective emphasizing, this feature needs further study to have a clearer idea of how people represent it.

5.3.4 Link

One of the most important aspects of a web page are the links once they provide a way to navigate through pages working side by side with, and as the site map, therefore they can be in every part of the website. We noticed links are confused with content text and, they can be on the content text so, trying to identify them was an arduous but not impossible task once we asked on the questionnaire for the participants to put links on specific parts of the sketch.

We noticed five patterns when searching for link elements, as shown in Table 5.1 (p. 33). The most common was the A3 pattern showing only lines as a link representation (*cf.* Figure 5.13, p. 39). Because most of the information was retrieved from volunteers sparing their free time, we assume their effort was not at their best, and so, to sketch fast representations of link elements, this method is perfect. However, this representation is confused with other web elements giving no accurate information. The same happens in the A4 group, where the pattern was the same as A3.

As for the A1 representation, we noticed it specifies where the link is on the page using the label "link" but, it does not show where the link leads. That is important once the purpose of a link element is to redirect users to other pages. The A5 representation started to do this but fail once it initiates with the "www." initial implying that it will show to where the link leads but, after it, only display a line which can make the representation more ambiguous than the link label (*cf.* Figure 5.13, p. 39).

Finally, the A2 representation has some flaws but is probably the best one. This representation is a label with the name of the page to where the link leads. However, if in the A1 group, we see the element is a link but cannot tell where it leads, in the A2 is the opposite. Because of this, it is hard to identify the link on the wireframe but, once we found it is immediately understood.

The link element provided some relevant concepts that must be tested for a better understanding once they can be used to express the relationship between pages as the sitemap.

5.3.5 Text

The text element represents annotations, as pointed in Chapter 2 (p. 5), however, it also represents content, and content is a considerable part of a web page. When searching for this web element, we only took into account content text.

The length of the content determined how participants represented the text element on the sketches. We found three dominant patterns being the A1 group, the most commonly represented only with lines (*cf.* Figure 5.14, p. 41). This pattern is similar to the A3 link pattern as we saw.

We noted participants used the A1 pattern when the text was extensive and probably because writing all of it would take lots of time which is, what designers want to avoid.

The A2 pattern was the same as A1 but added a title at the beginning of the representation (*cf.* Figure 5.14, p. 41). We assume that if they knew the actual title of the content, they would write it instead of the caption and, we consider this based on the final dominant pattern found, the A6. The A6 group is delineated by, pieces of text the subjects wrote instead of representing it with a line. We noted this when we asked the participants to sketch a contact and an email and, the participants wrote random content (*cf.* Figure 5.14, p. 41). We also note this pattern in the A7 group, where was written more extensive text.

The A2 group was similar to the A3. It added the "title" representation but, instead of writing the caption, used a box. This representation ambiguous once we also found it in group A8 where participants represented the whole text instead of just the title. We also encountered this box pattern to represent other elements such as the image and the video so, this type of representation is to avoid.

Pattern	Sample
A1	LINK LINK4 LinK 1 Link 1 LINK 1 H' Link
A2	ABOUT PRECOS
A3	
A4	
A5	www

Figure 5.13: Samples of the link patterns

The A5 group uses an HTML like syntax to represent the elements with the drawback of not being so intuitive for everyone once users need to know HTML. We found this representation in other web elements wherein some there was no real HTML tag but an imitation.

Finally, the A9 uses simple text as in the A7 but adds a "Z" pattern expressing the size of the written content covering the space where it would be.

5.3.6 Image

The dominant pattern for the image element was the A1 pattern, with 258 representations, as we can see in the Table 5.1 (p. 33). We noted that all the Image representations used a simple shape to define the ratio of the image and a symbol inside them (*cf.* Figure 5.15, p. 42). We also noted some of the image representations assumed a more detailed symbol. For example, in the A2 group, instead of a cross, users drew other symbols.

Moving further to the A3 group, we noted it could lead to ambiguity once it only used shapes to specify an image. The same goes for the A5 group that added a label, which makes the web element more understandable. However, for the whole system, it is most likely to be lost inside of so many visual abstractions. The A5 pattern is observed as well in the A4 group having a shape with a label. The shape was redesigned and is more detailed meaning, the problems mentioned in A4 are present, and also new ones appeared like the complexity. Users will lose to much time to draw the shape and, that aggravates if a project requires many images.

Concluding, the A6 introduces again the HTML pattern seen in other elements. In the Image element, the same simple shape defines the ratio of the image, but, in contrast, as a symbol, it uses an HTML syntax. This pattern brings the problems already mentioned before constraining the potential user to know HTML syntax.

5.3.7 Video

For the video element, we found 7 different patterns of representations (*cf.* Figure 5.16, p. 44) where, most of them were the A1 type, which shows a consistent pattern where is represented a simple shape and, a triangle is placed in the center referring to the play of a video. Inside this group, we found other variations of this pattern where subjects would draw more detailed representations of video mechanics such as the pause or the timeline. We noticed the outside shape had the ratio of 16:9 but, because it is a video element, we assume it can have other proportions like 4:3.

The A2 representation shares many similarities with the image representation using a cross inside a shape. It also presents the triangle as in the A1 group or a label reinforcing what the element is. This representation shows the subjects can recur to mechanics applied to other web elements when in doubt. We can see that in the A3 pattern, participants used only shapes and a label, a standard also seen in the image element so, it is most likely that the A3 will probably not suit as a solution when designing the visual language.

In the A4 pattern, participants used the HTML syntax and, it presented the same drawbacks mentioned before.

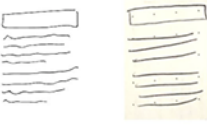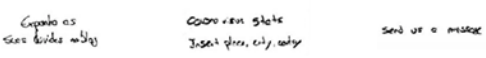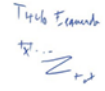| Pattern	Sample
A1	
A2	
A3	
A4	
A5	
A6	
A7	
A8	
A9	

Figure 5.14: Sample of the text patterns

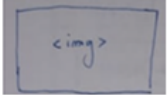| Pattern	Sample
A1	
A2	
A3	
A4	
A5	
A6	

Figure 5.15: Samples of the image patterns.

The A5 uses instead of a triangle, a detailed camera that can have the same problem of the A4 image pattern, taking too much time and effort to draw.

For the A6, we grouped it in a different pattern once it is equal to the A1 but integrates with other elements showing the video in the background. We separate this to show how well the A1 can work with other web elements. However, this raised questions about complex web elements and, when are they recognized as such because we can always group simple web elements but, they will not consistently form complex ones. Another question raised is if the other simple web elements will provide a stable environment like this one with the video to fast and easy sketch.

Finally, we found the A7 pattern in other elements so, it has the same problems as the over simplicity of the web element providing ambiguity since it is so similar.

5.3.8 Input

When looking at the images collected, we found 4 different patterns (*cf.* Figure 5.17, p. 45). The most common was the A1, where participants sketched a rectangular shape with a label or an icon, as Table 5.1 (p. 33) shows.

Inputs serve in different contexts like forms or search fields (that was, what we told participants to represent). We noticed this representation is a label or an icon (a characteristic that we will address later) and is almost always present to make the element more identifiable. One problem with this pattern is the similarity with the button element, as we will see, so when creating the visual language, this will be a problem that we must try to solve.

The A2 pattern showed the same patterns as in A1. It did not use a label so, we assume that happened once the context provided explained it was an input. We found most of this pattern on forms. For the search field, we noted that when participants did not add a label, the icon was always present.

The A3 pattern was a minor pattern encountered with 4 representations and, it consisted of labels with arrows pointing to the rectangular shapes. We also found pointers in the sitemap and storyboard so, this representation is ambiguous and can make the page too confusing.

Concluding, the A4 pattern was a minor representation found with an HTML like syntax and addressing the problems stated in the previous HTML like elements.

5.3.9 List

The list element provided serious doubt and no clear meaning of what a list is. We searched and concluded that from an HTML perspective, a list element is a group of items ordered or not [Con]. We do not understand if the participants perceived a list this way and so, we searched the data for elements that in the survey were asked to be a list. We found similarities in the navbar elements once the same pattern appeared. We can see this in Figure 5.18 (p. 46) in the A1 pattern figure 2 and the A4.

We noted in the A1 pattern users used an HTML perception once they drew dots and numbers on the elements. In the A2 pattern, participants sketched the list with the items grouped and did
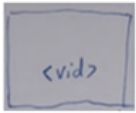
Pattern	Sample
A1	
A2	
A3	
A4	
A5	
A6	
A7	

Figure 5.16: Samples of the video patterns.
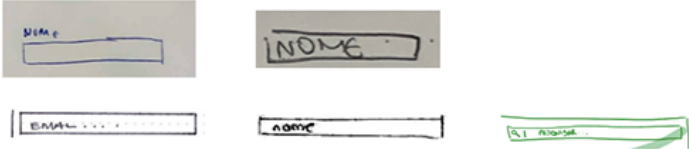
Pattern	Sample
A1	
A2	
A3	
A4	

Figure 5.17: Samples of the input patterns.
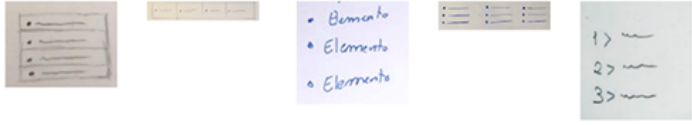
Pattern	Sample
A1	
A2	
A3	
A4	

Figure 5.18: Samples of the list patterns.

not provide other visual cues to demonstrate the web element was a list. Finally, the A3 and A4 patterns are like the previous and as well, do not provide other visual marks indicating it is a list.

This element still raises many doubts and must be conducted a future investigation to identify if designers need to represent a list or if it is an element like the structure where there is no visual clue but, the web element is present.

5.3.10 Table

Table representations mostly show one pattern. The participants sketched a grid with the intended size and put random content on each cell, as we can see in the pattern A1 in Figure 5.19 (p. 47). They added random values because, in the questionnaire, we said each cell of the table had a number.

The A2 representation is only one and showed a grid with an arrow pointing to a label describing the size of it. The sitemap and storyboard also used this methodology and, the caption provided shows information that is perceived as not needed once it shows the size of the table, information that can be seen just by looking to it.

The A3 representation showed the same labeled grid with a tag similar to HTML and on each cell. This methodology leads to problems such as users having to know HTML syntax.

Pattern	Sample
A1	
A2	
A3	

Figure 5.19: Samples of the table patterns.

The examples provided can be inconclusive once we probably mislead participants by specifying the table had numbers on each cell. Perhaps without it, the subjects would sketch more like the A2 pattern that could also be a problem once, as we saw, this pattern can be ambiguous. Therefore this element needs further investigation.

5.3.11 Button

The representation of the button element is very similar to the input element, as we can see in Figure 5.20 (p. 48). We noted the A1 pattern is a rectangular shape along with a label or an icon like the input A1 pattern. However, they differ in size once the button size is smaller. This similarity can be problematic when trying to design the visual language.

The A2 pattern is the same as in A1 but does not provide a label getting even more ambiguous. We found this pattern in the input. The difference, some of the elements in this pattern assumed a dimensional shape, a feature not presented in the input element.

The A3 pattern is a rectangle with no label but, it has an outside one and an arrow pointing to it, a shape similar to the sitemap and storyboard.

The A4 is again the HTML syntax and brings the problems already mentioned in other elements where this pattern appears.

Finally, the A5 pattern is a fascinating achievement once incorporated the rectangular shape as its predecessors but, inside, it added a small arrow as the enter buttons on the keyboards showing a clue to solve the similarity problem.
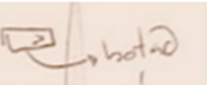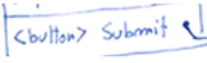
Pattern	Sample
A1	
A2	
A3	
A4	
A5	

Figure 5.20: Samples of the button patterns.

Pattern	Sample
A1	
A2	
A3	

Figure 5.21: Samples of the chart patterns.

5.3.12   Charts

There are a lot of different types of charts, so, for the analysis, we asked the subjects to draw three types (pie chart, histogram, and line chart) and, the results were not that far from the expected.

In the pattern A1, as we can see in Figure 5.21 the charts are easily distinguished between them and seem to be the better representation once it is the most common pattern.

As for the other two representations found the A2 and A3, we already saw them in other elements. The A2 shows the shape and the cross with the reinforced label, a pattern seen in the image element. The A3 shows the HTML syntax presented in other web elements.

5.3.13   Maps

The most common pattern on maps was unexpected once it was a shape with a cross and a label, as we can see in Figure 5.22 (p. 50). These patterns although, we saw them in other elements, never were the most common ones, which indicates the subjects had a hard time trying to represent this element.

The A2 pattern although it was the less drawn, provides a more recognizable representation with a detailed map as we can see in Figure 5.22 (p. 50) but, it is probably not the best solution once it takes some effort to draw that is why the A3 pattern is a middle ground between the A1 and A2. While the A1 is very ambiguous when compared to other elements, the A2 is too detailed and
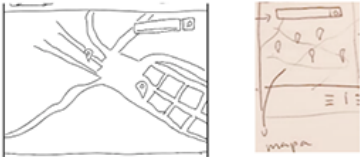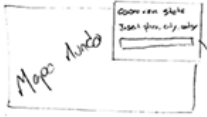
Pattern	Sample
A1	
A2	
A3	
A4	
A5	
A6	

Figure 5.22: Samples of the map patterns.

time-costly so, the A3 brings an idea that combines a shape to specify the ratio of the map and an icon very recognizable to be from a map element.

We will address the icon feature in the icon subsection, but we will not enter into detail why it is a recognizable map icon.

The A4 pattern uses a label and a shape and, the pattern A6 is only a shape already seen on other elements. Concluding, the A5 uses an HTML syntax.
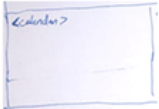
Figure 5.23: Samples of the calendar patterns.

5.3.14 Calendar

The most common pattern on maps was unexpected once it was a shape with a cross and a label, as we can see in Figure 5.22 (p. 50). These patterns although, we saw them in other elements, never were the most common.

Analyzing the data, we found four patterns for the map representation where the most common was the A1 showing with various degrees of fidelity, as we can see in Figure 5.23. This pattern, although similar to the table element, is probably the best representation for the calendar once all the other ones showed traces of ambiguity with other web elements.

The A2 patterns were very similar to the image representation showing a cross with a shape or adding a label "calendar" to reinforce it was a calendar.

The A3 pattern showed only a shape with a label providing ambiguity with text or other elements that also showed a shape and label pattern.

Finally, the A4 pattern was the HTML syntax putting between tags the word calendar, which is not an HTML tag so, lead to confusion.

5.3.15   Navbar

The navbar is crucial once it provides central control for the user to navigate between pages. Because it is a complex element, the navbar gathers the logo of the brand, which we will address in other subsections, and a list of links to other pages or specific sections of the website. The A1 patterns showed that as we can see in Figure 5.24 (p. 53). On the left side of the navbar, we can see a "Logo" written or and image because the logo of a brand on a website is an image. On the left side, we can see links.

The A2 pattern is the same as A1. Instead of a list of links, introduced another icon that works as a button. If pressed, it will show the list of links. This pattern was most commonly saw on mobile and tablet representations but is also present in some desktop ones if the designers intend so.

The A3 representation only added a label, an interesting point of view once these navbars are present in other pages other than the main one. On the main page, we saw representations as in A1 but, on the other pages, the subjects only put the label which introduced the concept of reusable components once the participant only draws the element on time and then references them in other pages.

The A4 should be along with the A1 group (that was the most common pattern encountered) but was gather in a different one to mention that other representations can appear on a navbar such as this one that added a search input and other icons.

Concluding, we noticed the navbar was always on the top of the page and, it is the first thing the user sees when opening a website.

5.3.16   Footer

The footer is an element that is also present in almost every website because it provides a way to "bypass" the regular navigation. We noted that all footers encountered on the data had a video and links or only links once we asked for the footer to have them on the surveys. On the online and professional data were found links and images also.

With that said, in the A1 pattern, as we see in Figure 5.25 (p. 54), all the content of the footer is recognizable. In the A2, the same happened because there is less space available.

Finally, the A3 has the same patterns found on the navbar A3 pattern where was used only labels saying "Footer" to specify a reusable component.

Concluding, we noted the footer is present at the end of the pages and, this is common to every page being the last thing the user sees when scrolling down.

5.3.17   Form

A form is a way to collect data from the user to send it to the server and is formed by inputs, buttons, and other elements that we will not address in this dissertation.

In the representations gathered, we can see in Figure 5.26 (p. 55) that all the forms have the same pattern, are quite simple, and use inputs and a button to submit the data once it was what we asked on the survey. The inputs and the button are very similar and are only distinguished once the
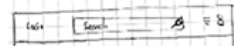
Pattern	Sample
A1	
A2	
A3	
A4	

Figure 5.24: Samples of the navbar patterns.

Pattern	Sample
A1	
A2	
A3	

Figure 5.25: Samples of the footer patterns.

input element is considerably enormous than the button element. However, having this single factor of difference can be a problem when designing the language for this dissertation.

5.3.18 Logo and Iconography

We did not intend to study these two elements and, it became necessary to look into it once they were present in all sketches (*cf.* Figure 5.27, p. 55).

The first one was the logo that is present on every website. Instead of the label logo, it is the logo of the brand, company, or project and is an image that links to the homepage.

The second element was the iconography seen in inputs and on the navbar for mobile and tablet devices. These two examples are only the tip of the iceberg once the iconography of a website is a complex subject the needs further study to comprehend.

5.4 Conclusion

From this analysis, we conclude all the elements share similar patterns. They will not interfere with each other once there are better solutions inside their groups.

The input and button element will present themselves a problem when creating the visual language due to their similarity. The same goes for the map element, where the most common pattern is very similar to the most common image pattern and, the other representations of the map are equal to the table element.

Pattern	Sample
A1	

Figure 5.26: Samples of the form patterns.
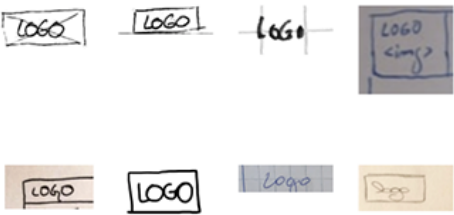
Pattern	Sample
Logo A1	
Iconography A1	

Figure 5.27: Samples of the Iconography and Logo patterns.

Another problem encountered is the list that has no concrete way to be represented and, the same goes to the link once it must explain to where the page is redirected and cannot be confused with content text.

The sitemap and storyboard are interconnected and, because they use similar mechanics, the too will present a problem to distinguish from one another.

Finally, The image and the video element are the elements with the most concrete visual representation once the most common patterns found were very understandable.

Chapter 6

Visual Language

The previous chapter served to make an analysis and to understand how designers represent the web elements defined for this dissertation. It worked as well to find some conclusions to use in this chapter so, we now have some insights to start working on a visual language to facilitates the interaction between designers.

In this chapter, we will systematically approach the same elements of the analysis to reach a convincing and easy to understand representation.

The workflow to find the representations is to check the most common one on every element and then iterate between the similarities if they exist until every web element is different and recognizable.

6.1   Sitemap and Storyboard

As we saw in Chapter 5 (p. 29), the sitemap, and the storyboard are very similar once they both use arrows. In the case of the sitemap, the to point to other pages. In the case of the storyboard, to point to a similar version of the same page explaining an interaction sequence.

The difficulty in these two characteristics is that both use the arrows as a dominant pattern and, so, we needed some breaking point to differentiate them. This pattern brings up other problems once in larger systems, can get too noisy and confusing with a lot of arrows in the sketch. A problem that was expected and referred [LTL02] to in Chapter 4 (p. 25).

Going in sync with the link, we noticed on the sitemap that some of the subjects used a tag system or named links to specify the relation between pages, as mentioned in the previous

subsection. Because this was not a dominant pattern, not all the link elements had the label referring to the page.

With these problems, we decided that for the visual language, the user will have to use the links with the page's label and then recur to the arrow method. Instead of an arrow, the user will draw small circles in the beginning and end of a line if there is no other choice, as shown in Figure 6.1 (p. 59).

For the similarity between the sitemap and storyboard, we decided that to represent a storyboard, users need to do a dashed arrow, as shown in Figure 6.1 (p. 59) pointing to a representation of the interaction intended to explain.

This way, we can differentiate the arrows used for the sitemap and storyboard. For the sitemap, we can also reduce some of the arrows on the overall sketch.

6.2   Desktop, Tablet, Mobile

The size of the screen depends on the content the page has. For example, if the page has no scroll then, it is obvious to identify the screen but, the other way around, it gets difficult once the shapes of the container start to get very ambiguous. To not doubt this, we decided to specify on the top corner of the sketch the screen size that can be Desktop, Tablet, and Mobile. In Figure 6.1 (p. 59) it is possible to see a "Desktop" label in the top-left corner.

6.3   Structure

The structure has no representation because we noted in the analysis that it needs further study. The structure feature is implied by the user when placing the elements on the wireframe, as we can see in the example of Figure 6.1 (p. 59) where we note some structure but the visual references to delimit them are practically null.

6.4   Elements

6.4.1   Link

Trying to find a representation for the link was no easy task once the most common pattern found was only a horizontal line and, that could not be it due to the ambiguity of the representation. We look back and try to comprehend what we wanted to know when sketching a link and realize we wanted to know where it redirects the user. Therefore, the link shows, as well as the sitemap, the relationship between pages.

With this in mind, we noted on the analysis that some links had a label of the page to where the link would lead but, that alone was not noticeable enough once it could be mistaken for a simple caption. Therefore, we needed to find a way to make the link element perceivable as a link, and we found the solution in icons.
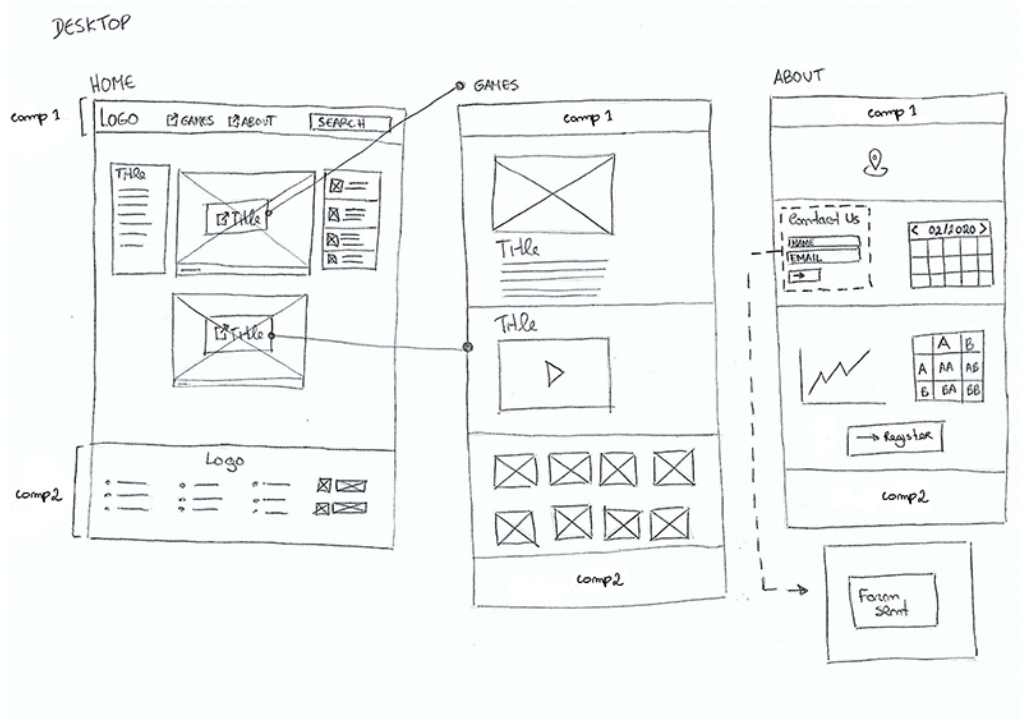
Figure 6.1: Example of the visual language in action.

Two dominant icons exist to represent an internal and external link [Awe20], as we can see in Figure 6.2 and, the one chosen was the internal one, however, because the sketches are hand-drawn the first icon is not that simple to draw, so we opt for the second. This way, along with a label named with the page name, we found a way to represent the link. Some examples of this representation are in Figure 6.1.

For links in the navbar, this works but, some links do not have the name of the page labeled therefore to fully represent a link we must use the icon with a label that must be the name of the page to where it leads if possible because it will improve, the sitemap of the website.

6.4.2 Text

As seen in the analysis, the text can be the content written down if it is not too long so, we decided, for big blocks of text, to use only lines as shown Figure 6.3 (p. 60) on the left side, once it was a

Figure 6.2: Internal and External Link.
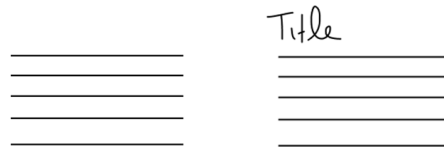
Figure 6.3: Representation of the Text element.

frequent pattern. We also noticed the users want to specify the titles of the content and, if they do not write it down, they will use the label "title" to determine it, so the following representation in Figure 6.3 on the right, can also be used.

6.4.3 Image

The image ended up offering no resistance since the data spoke for itself. The most common representation was by far the rectangular shape with the cross so, that was the representation chosen to represent the image element that we can see on Figure 6.4.

6.4.4 Video

The same happens for the video element once looking at the data showed that the most common representation was a shape with a triangle representing the play of a video so, trying to simplify we reached the Figure 6.5 (p. 61).

6.4.5 Input and Button

The most common representations found for input and button were similar, as we can see in Figure 6.6 (p. 61). We thought necessary to iterate between the two to understand which one was the best to change to have different visual characteristics.

First, we tried to see if the context or the label they used would have a feature good enough to differentiate them. However, that was not a great solution once we could not control every situation
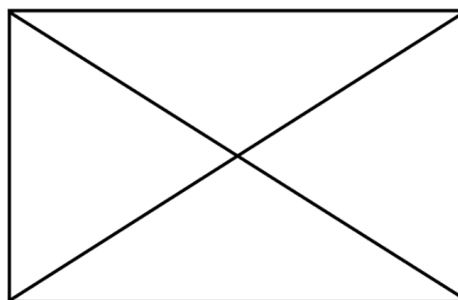
Figure 6.4: Final Representation of the Image.
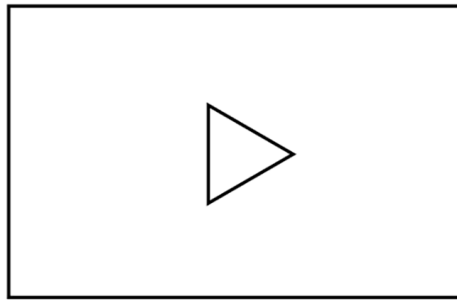
Figure 6.5: Final Representation of the Video.

where the elements would be. Another solution was to look back into the data retrieved to look for clues. In the input element, we did not accomplish something different but, in the button, we noted that some representations had a small arrow inside the button expressing an enter like the ones in the keyboards. We decided to maintain the input as it was and add the arrow to the button element. This way, the tow elements became different from one another, as we can see in Figure 6.7 (p. 62).

6.4.6 List

For the list element, the analysis provided did not show how to differentiate a list on the sketches. We note that some of the list elements had dots at the beginning of the items that integrate them so, we decided that the list representation would be as shown in Figure 6.8 (p. 62). These elements still need further investigation to do a more accurate representation once it is not sure when it is imperative to represent a list or not.

6.4.7 Table and Calendar

The Table and the Calendar, as we can see in Figure 6.9 (p. 63), are very similar once they both are a grid with data, therefore looking into the calendar data, we noticed that most of them added a data at the top. Thus, we added it to the calendar representation to differentiate it from the table. To the table, we added random values. We consider this element to need content even it has an inconclusive analysis.

This way, both elements became different but, the table got too complex to sketch and, that was a problem intended to avoid. To solve it, we rethought the table to the representation seen in the left side of Figure 6.10 (p. 63). However, we assume that whenever users draw a table element, they know what content to put there so, we created one more representation of this element, as shown in
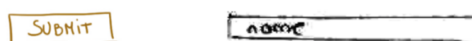
Figure 6.6: On the left a button, on the right an input.

→ Submit   Email

Figure 6.7: On the left a button, on the right an input.

the right side of Figure 6.10 (p. 63). This assumption needs further development but we assume users will replace the content drawn on the right side of Figure 6.10 (p. 63) by the actual content of the website represented in the sketch.

6.4.8 Charts

In the analysis, we found 3 different types of charts, as we can see in Figure 6.11 (p. 63), although for the visual languages, it seems redundant to have various representations for the chart element, therefore, we only chose one using as a criterion the speed and ease of drawing. The result is the web element on Figure 6.12 (p. 63)

6.4.9 Maps

The most common pattern used to represent a map was a rectangular shape with a cross and a label, as we can see on Figure 6.13 (p. 64). However, if we compare it with the image element on Figure 6.4 (p. 60), we can easily conclude they are very similar and are a problem to detect. The only identifying feature of this element is a label and, everyone has different ways of writing so, we rethought the map element to the one of Figure 6.14 (p. 64).

This map was created based on the A3 pattern once the A2 had to much detail and, consequently, was time costly. This new approach gathered an icon used to represent a location in a map. However, without the map element in the background, we noted the icon lost his meaning so, we changed it again as we see in Figure 6.15 (p. 64). In the final representation, we changed the icon and added a semi-circular shape to the bottom of it.
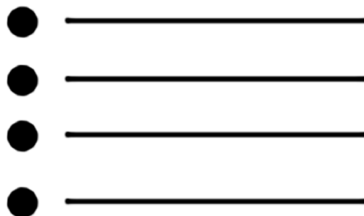
Figure 6.8: Example of list element.
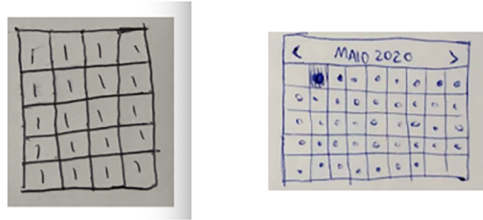
Figure 6.9: Example of similarity between table and calendar.

Figure 6.10: Table element for the Visual Language.

Figure 6.11: Charts Encountered on the Data.
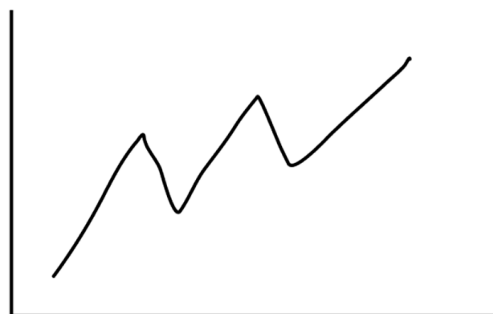
Figure 6.12: Final representation for the chart element.
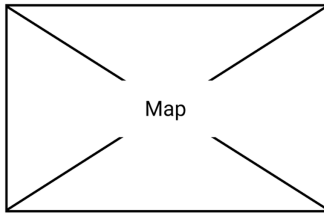
Figure 6.13: Most Common Representation for Map.

Figure 6.14: First Experience for the Map representation.
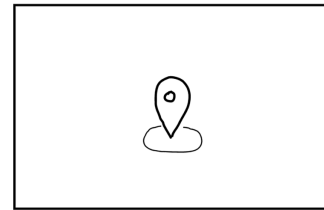
Figure 6.15: Final representation for the Map element.

6.4.10 Navbar, Footer, Form

As stated before, complex elements are containers assembled by simple web elements, so, to create them, users need to apply the rules set to the simple web elements. However, this rule works for the three examples gather in this dissertation. For other web elements, we need to future study them. We may conclude that yes, it is possible to create complex web elements from the simple ones but, doing so can be time-consuming.

We noted on some elements, more specifically in the navbar and footer, that because they appeared on all pages, some of the subjects decided to sketch them once and then add a label to it, as we can see in the example on Figure 6.1 (p. 59). The participants only represented the elements once and reused them as "comp1" and "comp2". For complex web elements, we decided to create this feature as well on the visual language.

6.5 Conclusion

Due to some similarities with the data retrieved, we thought it necessary to make some choices to create a diverse and different specter of elements.

We concluded that most of the choices made must pass through a validation process and need to be tested in different systems to make sure that no errors exist.

When creating this language, we raised some doubts, due to the problems mentioned in the analysis of the web elements on Chapter Chapter 5 (p. 29).

Chapter 7

Validation

In the previous chapter, we created a visual language to find a standard interaction between designers.

The visual language was created based on the data retrieved from a questionnaire, from professionals in the field and an online search. It is now imperative, verify if the visual language is optimized or if it needs more investigation and development.

In this chapter, we will explain how the visual language was validated and do an analysis of the information retrieved.

7.1   Validation Survey

To validate the visual language, we developed an online survey that can be found in detail in Appendix B.2, with two parts where we got responses from 102 people.

The first part presented an image with the visual language in action. For each element, we asked if the participants could recognize them.

For the second part, we presented the same image but, this time, we marked specific parts, to make some questions regarding the structure, the screen size, the storyboard, and the link.

The survey is for designers but, because this was an online survey, we had no control over who answered it, although we specifically asked for web interface designers.

7.2   Validation Data Analysis

This section is subdivided into two parts. Each part analyzes the first and second parts of the survey respectively. A detailed presentation of the validation data is in Appendix B.1.

7.2.1 Part 1

C / L	Image	Map	Text	Button	Calendar	Chart	Form	Input	Link	List	Table	Video	Navbar	Footer
1-Image	94,12%		1,96%	0,98%			0,98%				1,00%	0,98%		
2-Map		100,00%												
3-Text			100,00%											
4-Button				88,24%			2,94%	3,92%	3,92%					0,98%
5-Calendar			0,98%		98,04%						0,98%			
6-Chart	0,98%					97,06%					1,96%			
7-Form			0,98%				85,29%	8,82%	1,96%	1,96%				0,98%
8-Input			1,96%	9,80%			1,96%	69,61%			1,96%		14,71%	
9-Link			5,88%						91,18%				1,96%	0,98%
10-List			4,90%						0,98%	90,20%			1,96%	1,96%
11-Table	0,98%				0,98%	3,92%	0,98%	1,96%			88,24%		0,98%	1,96%
12-Video									0,98%			99,02%		
13-Navbar			0,98%					0,98%			0,98%		95,10%	1,96%
14-Footer	0,98%		0,98%			0,98%	8,82%	0,98%		8,82%	0,98%		3,92%	73,53%

C) First column represent the question number and the the intended answer.
L) First line represent all possible answers

Table 7.1: Results of the first part of the survey.
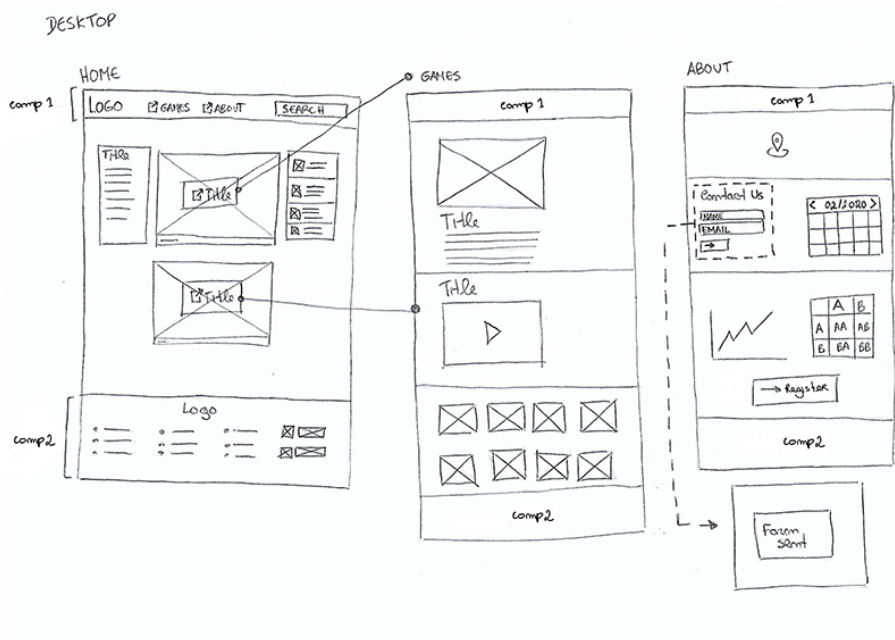
Figure 7.1: Sketch present on the first part of the survey.

In the first part of the survey, we intend to verify if the elements were recognized. The results returned satisfactory once in almost every question we noted a success rate higher than 90%, as we can see in Table 7.1 on the marked cells.

In this part, we presented the image shown in Figure 7.1 and therefore asked individually for each element where every question had a crop of the specific web element of Figure 7.1 as we can see in detail in Appendix B.2.

For the image, 5,88% of the answers did not match the expected, which is interesting once the image element was one that seemed more standardized in other visual languages.

The map had a 100% success rate, which is also interesting once we needed to recur to an icon used by some of the subjects.

As for the Text element, there was no big surprise once it is a widely used element on websites. The representations retrieved on the data were a safe choice to use as the returned result show with a 100% success rate.

The button element was not so successful, but we already expected some difficulties once it was very similar to the input. The arrow added to the button proved to be a favorable choice but was very unexpected why some of the answers returned "Link" and "Form" once the elements had a context and, they are very distinct.

The Calendar and Table elements were problematic due to the difficulty of differentiating them so, the results for the Calendar were pretty surprising with a success rate of 98,04%. However, the Table was not so successful with an 88,24% success rate. While the Calendar was easily distinct once it had a label referencing the date, the Table relied on random values, and, as we saw, the analysis was inconclusive and doubtful but, 88,24% is not a bad result. For clarity, this element must be future investigated.

A problem that might arise with these elements is the efficiency (that we did not test) so, they might not be easy or fast to represent when putting into practice in different systems.

The Chart element was very satisfactory, with a success rate of 97,06%. We already expected it once in the data retrieved, the charts were all similar and easy to recognize.

Looking at the input element, we noted it was the less successful one with a success rate of 69,61%. We expected this once, as already mentioned in this text, the input was very similar to the button. Because the button element was more successful than the input element (probably because of the arrow added), we think the input might need a symbol as well to make it more perceptible and decrease the 9,8% that taught the element was a button. As for the 14,71% that answer, the input was a navbar. We do not understand this once we believe they are very different.

The icon added to the link element was also a favorable choice once it got a success rate of 91,18%, although we thought it was a very ambiguous element. It is necessary to do future investigation on this because this element is an ally of the sitemap and, they will work if integrated. Still, on the link, it was unexpected why 5,88% of the answers misunderstood it with a button once they are very different.

The list element is controversial because most of the lists gather on the data did not have the dots. We decided to put them to represent a list that returned a success rate of 90,2%. However, it is necessary to do more investigation on this element once there is a lot we do not know about it.

The last simple element, the video, was also very successful with a 99,02% rate. The video did not achieve 100% but, only 0,98% of the respondents did not recognize it.

Concluding, the complex elements, Form, Navbar, and Footer, were left to the end once, except for the navbar element, they presented the worst results with a success rate of 85,29%, 95,1%, and 73,53% respectively. The Navbar had good results probably because of the logo once it stands out as an element. However, because these elements are a joining of simple ones, they can be easily misunderstood and, a future investigation would improve the understanding of them.

7.2.2 Part 2
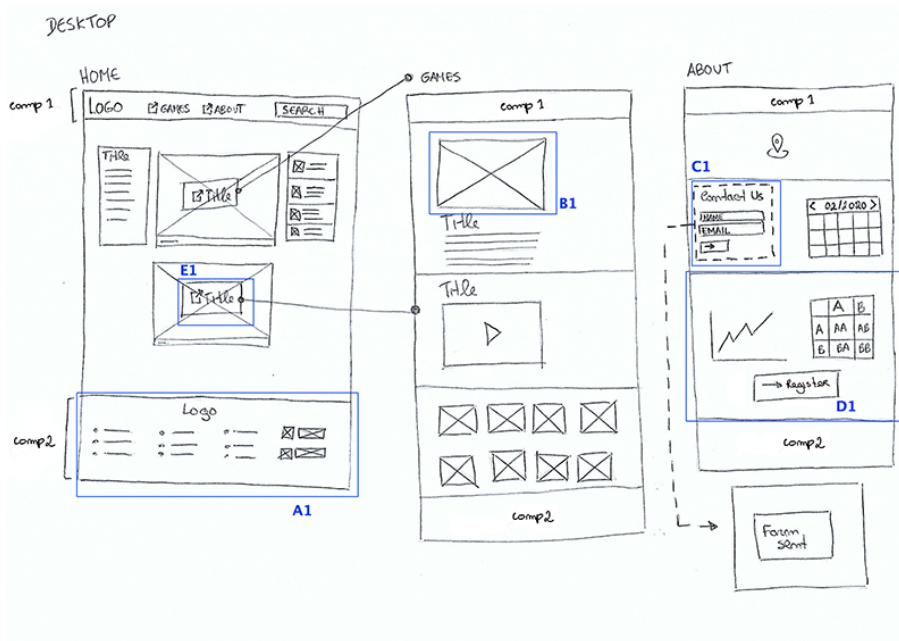
Figure 7.2: Sketch present on the second part of the survey.

In the second part of the survey, we intended to study characteristics such as the sitemap, the storyboard, the screen size, and the structure. For that, we presented the same image of part one with some changes, as we can see in Figure 7.2, to ease the process.

In the First question, we asked what was the screen size of the sketches and was expected a near to 100% success rate in the answers once the sketch had a label saying "Desktop" in the top left corner as we can see in Figure 7.1 (p. 66) and Figure 7.2. However, only 72,55% recognized the sketch as a desktop sketch, as we can see in Table 7.2. Because the survey was online, there is no way to tell why this happens. We assume it was because they taught having the label was too obvious, but this does not invalidate the label to specify the screen size once 74 people in 102 did recognize it.

1 - What is the screen size of these pages? Correct Answer: Desktop		
Desktop	Tablet	Mobile
72,55%	9,80%	17,65%

Table 7.2: Survey Part 2, question one results.

In the second question, we intended to understand if the storyboard was recognized and 70,59% perceive it well, as we can see in Table 7.3 (p. 69), which tells us the dashed arrow was a favorable choice to specify storyboard. However, 21,57% also answered they would be redirected to another page, which is not a wrong answer once at the end of the arrow it is presented another wireframe is

and, there is nothing to tell it is the same. As for the last choice, 7,84%, a total of 8 people answered that when clicking on the button element, nothing would happen which is a curious choice once the storyboard has an arrow pointing to a wireframe thus, this raises the question of why did they though nothing would happen?

2 - What happens when you click on the Button at the bottom of "C1"? Correct Answer: A pop up will appear showing a message		
A pop up will appear showing a message 70,59%	I am redirected to another page 21,57%	Nothing 7,84%

Table 7.3: Survey Part 2, question two results.

The analysis and the validation of the link element pointed we could use it to specify the sitemap so, the third question intended to clarify if the subjects could understand the relationship between pages. Thus, we sketched two ways to go from the Home page to the Games page, as we can see in Figure 7.2 (p. 68), and asked to where the one marked with "E1" would lead.

As we can see in Table 7.4, 74,51% answered correctly pointing they would go to a specific part of the page but, 21,57% responded they would go to the games page making no distinction between the two ways of specifying the sitemap. It is not so relevant once most of the people understood what it meant but, it should be understood how people represent the relationship between pages as well as understand if there is a better way to represent, the sitemap than using arrows. Perhaps the links are a clue for that. Finally, a small percentage said they would go to the about page which, is not understood once there is no clue of that.

3 - On the Home page, what happens if you click on "E1"? Correct Answer: I will go to a specific part of the Games page		
I will go to a specific part of the Games page 74,51%	I will go to the Games page 21,57%	I will go to the About page 3,92%

Table 7.4: Survey Part 2, question three results.

Question 4 to 8 we addressed to the structure of a website. We saw in the analysis participants did not visually specify structure elements as columns or rows. However, for others like section, they would recur to simple lines that could be very ambiguous. Looking at the general sketch, we noted some structure was present.

In the fourth question, we asked the respondents to specify how many sections did the about page had, which were three once the navbar and footer did not count. However, as we can see in Table 7.5 (p. 70), people had difficulties to understand how many there was. 48,04% said it was 4, probably because some though the footer was also a section. 32,35% responded correctly saying the page had 3 section features. And, 19,61% said the page had 6 section features probably because they subdivided the page in different ways.

The validation shows that sections are not yet well established in the visual language. In question 5 with no visual subdivision, 95,10% responded correctly on how many columns the A1

had and, in the question 6, 83,33% responded correctly on how many rows did the D1 had as we can see again in Table 7.5 and, with no visual clue on it which is impressive.

Continuing the structure saga, in question 7, we asked if B1 was a container, and this time, we noticed a considerable doubt on the answers once 41,18% said it was no container, 33,33% said that maybe could be, and 25,5% said it was a container.

Finally, on the eighth question, we asked on the games page if was presented a grid of images or columns of images, and 83,33% responded correctly saying, it was a grid.

The structure questions show designers can understand structure but, this is still a topic that raises many doubts and needs future investigation to understand why the respondents understand structure when they have no clue but, otherwise, they immediately have doubts.

4 - How many sections does the About page have?
Correct Answer: 3

4	3	6
48,04%	32,35%	19,61%

5 - How many columns does "A1" have?
Correct Answer: 4

4	3	2
95,10%	4,90%	0%

6 - How many rows does "D1" have?
Correct Answer: 2

2	4	1
83,33%	14,71%	1,96%

7 - On the Games page, is "B1" a container ?
Correct Answer: No

No	Maybe	Yes
41,18%	33,33%	25,49%

8 - On the "Games" page do you see ...
Correct Answer: a Grid

a Grid	Columns
83,33%	16,67%

Table 7.5: Survey Part 2, question four to eight results.

The last three questions were open answers and, intended to consolidate the previous ones. On the ninth question, we asked how many links could participants see on the home page, and, with a success rate of 39,22%, 40 people out of 102 said it was four. As we see on the Figure 7.2 (p. 68), only four links are visible, which are the labels with the icon, however, 23,53% said the page only had two links either ignoring the ones on the navbar or the ones in the text.

The other answers, as we can see in Table 7.6, were not significant but one brought an interesting point to the discussion.

The "a)" answered "Visible (as in with the symbol), there are four. But could be more it is not clear." which reinforces the idea the subjects acknowledge the four links with the symbols. However, they also think the page can have more links that are not pointed as links. This uncertainty about link elements raises questions on how they are perceived.

It is to reinforce this was only one answer out of 102 and needs more development for a clear perspective of what it meant. We brought this to attention because the link element still raises doubts and needs further investigation.

9 - On the "Home" how many links do you see ?
Correct Answer: 4

1	2	3	4	5	6	7	8	9	10	12	14	20	22	23	44	+=5	∼16	a)
0,98%	23,53%	5,88%	39,22%	7,84%	4,90%	1,96%	0,98%	1,96%	1,96%	0,98%	1,96%	1,96%	0,98%	0,98%	0,98%	0,98%	0,98%	0,98%

a) Visible (as in, with the symbol), there are four. But could be more it is not clear

Table 7.6: Survey Part 2, question nine results.

Moving further to the tenth question, we asked how many buttons existed on the About page. As expected, because participants recognized the button element in the first part, in part 2, 70,59% of people answered correctly, as we can see in Table 7.7. The others answered were not so significant but, 9,80% said the page had four buttons maybe, due to the similarity of the button with the inputs that were also two.

10 - How many buttons exist on the "About" page ?
Correct Answer: 2

0	1	2	3	4	5	6	8	10	23
0,98%	4,90%	70,59%	2,94%	9,80%	4,90%	1,96%	0,98%	1,96%	0,98%

Table 7.7: Survey Part 2, question ten results.

Concluding, in the eleventh question, we asked about how many ways could we go from the Home page to the Games page which was three, the two links pointed with arrows to the games page, and the link in the navbar with the name of the page. 55,88% answered correctly to the question, as we can see in Table 7.8. The second most answered question was two with 34,31% that shows these subjects ignored the navbar link.

11 - In how many ways can you get from the "Home" page to the "Games" pages ?
Correct Answer: 3

1	2	3	4	5	6	7
1,96%	34,31%	55,88%	3,92%	0,98%	0,98%	1,96%

Table 7.8: Survey Part 2, question eleven results

7.3 Conclusion

In the first part, we notice all the features measured were understood but, this does not mean the language is finished. We still need to measure the features for metrics like efficiency to find out if they are effortless and fast sketched, and consistency to understand if they perform well in small or large systems.

The second part treated different features and demonstrated that future work must be done on the structure once there is so much we do not know. It also showed that we might have some problems and, as we already mentioned, these problems must be future studied.

These problems came to the surface and are relevant for us to continue work for a better visual language that can improve the web design field.

Chapter 8

Conclusions and Future Work

Web Design is always changing and improving and had been built upon graphic design and GUI interface knowledge being the ancestors of the web medium and providing already some principles that could be applied to the web as we saw in Chapter 2 (p. 5). In every design project sketching by hand is a method that seems to be and will be present in the field once it provides a fast and easy way to express visually interface ideas.

We've seen that the HCD is a time-consuming approach but one that carves the best results once it iterates between four stages and puts the user needs at its center. We also saw the current solutions seem to be faulty and did not provide consistent communication among teams, clients, and stakeholders. However, they contributed with clues to what we can improve on visual languages for the web.

Having a standard visual language that is consensual among designers can impact the field of web design as well as being applied in AI sketch recognition to generate automatic web pages. With these insights, we built a questionnaire to retrieve rough sketches of websites from subjects from the field to, therefore, analyze them to find similarities between them.

To cross the sketches' information and catalog them, we created a tool and systematically analyzed the data with it. With that, we created the visual language, and consequently, we validated it with a survey.

8.1 Main Difficulties

The work conducted for this thesis suffers in the retrieved data due to the outbreak that affects us all. We intended at the beginning of data collection, to observe the subjects while doing the

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questionnaire. The idea was to answer their doubts (if one appeared) and to guide them to make sure every aspect intended to study was represented (for example, the sitemap which almost none did). We also expected to ask them about their decisions in the process of sketching to understand why they decided to do it in a certain way.

Instead of this approach, we only got to send the questionnaires over the internet and to wait while asking to complete it as quickly as possible. Because of this, the project rhythm slowed down and, we did not get a detailed explanation regarding the way participants sketched the websites.

Another difficulty with the project was to think about how to catalog and easily visualize the data. At the beginning of the process, we started by categorizing the data manually but, we abandoned this idea because it would take lots of time, and, at a certain point, it became hard to cross info and data. Instead, we created a web-based tool to insert all the data and analyze it.

The last main difficulty was, when we design the visual language once with the information collected in the analysis, we noticed some ambiguities existed and, other doubts appeared. We could not answer it because the questionnaires were not made physically with an interview, so we had to work with what we had and tried to handle the problems.

8.2   Main Contributions

This dissertation hopes to have contributed to the field by pointing out the problems with existing visual languages as well as pointing their solutions to issues previously raised. It also contributed to the field by deconstructing web pages in layers to survey its characteristics and map some of its elements. Thus it also contributed to survey people from the web design field to understand how they sketch websites.

This thesis also contributes to the beginning of a database and a search mechanism that researchers can use to add more data or to insert a new one from scratch to posterior analysis in subjects of this matter. This way, people working on visual languages for web design can have a system to work on without managing data manually.

We made a first systematic analysis of the web characteristics describing how the subjects from the survey reacted to them visually and what were the problems and conflicts that arise when comparing them with others contributing this way, to a better understanding of human methodologies on hand-drawn sketches.

With the investigation analysis, this thesis also hopes to contribute to the field with a beta version of a standard visual language that can be used when sketching web interfaces to easily interact with other designers and posterior to be used in AI sketch recognition software.

Finally, we hope to contribute by validating the previously mentioned visual language that, although we can, future work on it, it already provides syntax and guidelines to use.

The last main difficulty was, when the visual language was designed once with the information collected, we noticed some ambiguities existed. We did not answer other doubts that arose because the questionnaires were not made physically with an interview. Therefore, we had to work with what we had and tried to work around the problems.

8.3   Future Work

During this work, problems have arisen due to the fact we could not anticipate them because they appear naturally. With a future investigation on this, the language can improve.

The first thing for future study is the data retrieved by this work once we noted some flaws in the sketches. Some of the participants misunderstood what was needed to do or were effortless sketching some of the features.

This work could improve by conduct interviews with subjects about how they represent the websites in their sketches and why they did it in that specific way. These interviews can also serve to take any doubt that may appear on the sketches and to make sure every aspect intended to study is represented, by participants.

With this in mind, the systematic analysis we made can naturally improve and extend to reach a better understanding on web features which as shown in this document, although, some showed results to work on, others raised doubts that we had not yet realized that could appear such as the link element which proved to be way complex, than the expected.

We discover features while doing the analysis and cataloging. The Logo and the Iconography did not enter the scope of this thesis but, they clearly showed they need further study to comprehend and possibly, apply on the visual language.

We conduct the visual language having in mind the data collected and trying to work around the problems that appear such as, the ambiguities and element complexity. We stated the complex web elements are composed by joining simple ones. However, in the tests we conducted ourselves, sometimes joining several simple web elements to create a complex could take more effort than have a unique web element to specify a complex one.

With the validation process, we learned the majority of people recognized the web elements. However, we did not validate how they would perform in a real-life situation meaning the language must be tested for the time it takes to sketch with and how it performs in different systems.

Concluding, this work is far from ending and, it is to note that although we made some progress, future work can always change due to discoveries that may appear.

8.4   Conclusions

Creating a visual language proved to be a complex problem. During the development of this project, we have gathered information that now we can use to answer the research questions of Chapter 4 (p. 25).

In our first research question: **what form would a visual language appropriate for free-hand sketching of websites would take, and what would the relationships between its constituents be?** we attempted to provide an answer by answering to several secondary questions:

1. Is there a clear pattern that emerges when analyzing website representations?
   This question got answered when we first look into the data retrieved and, it became clear

that yes, a pattern emerged among the sketches designers do have similar ways of sketching when compared to others.

2. Does every constituent of this pattern assume the same form for the majority of the population, or are there variants that would be equally probably to be used?

    Doing a more detailed analysis, we note although designers sketch in a similar way, the representations do not assume the same form because designers have their way of sketching. However, ones are more probably to be used than others, as we saw in 5.1 and Chapter 5 (p. 29) once some patterns were more used than others.

3. Can these constituents form such visual language, or would we need to introduce changes to make the language consistent?

    With the analysis, we noted some patterns were similar among some features therefore, we needed to introduce changes that we explain Chapter 6 (p. 57) to make in our opinion, the language more consistent.

When answering these sub-questions we concluded that a visual language appropriate for free-hand sketching of websites has similar forms however, the relationships between its constituents can differ because some features are similar so, changes must be introduced to distinguish them. We attempted to solve it Chapter 6 (p. 57).

Our second research question: **would websites designed using this visual language be understood and accepted by most web developers?**, depended on our findings on RQ1 and, we also attempted to provide an answer with several secondary questions.

1. How would designers, when exposed to this language, react?

    To answer this, we put our visual language through a validation process were we surveyed to find how recognizable the language was. The results were satisfactory proving our approach is a good start and that yes, the reaction to it was very positive. However, the language still needs future validation to test for efficiency and time cost in small and larger systems.

2. How broad/specific would this language become?

    Since the beginning of this thesis, we noted the web is fast-growing every day. Because of that, we needed to select specific features to study, so we believe this language can be broad however we can decrease the amount of syntax by reusing it to create new elements as we saw with the complex web elements. These elements must have future studies but, we believe with them the language can be more specific but cover a broad range of web features.

These sub-questions allow us the say that this visual language can be understood by most designers however, it must be validated for other metrics and fine-tuned to correct all possible problems that may appear.

Concluding, our main hypothesis referred to in Chapter 4 (p. 25) proved to be true. A visual language for sketching websites does exist and can be semantically intuitive for the majority of designers. We believe it can help communication and interaction among teams, stakeholders, and

clients. We presume that when fine-tuned, the language can be used on AI sketch recognition software. However, there is a lot of work to be done until we can have a fully mature and consistent visual language. We hope this document can serve as a starting point for future investigation.

Conclusions and Future Work

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Appendix A

Work Documents

A.1 Data Collection Questionnaire

Visual Language Questionnaire

Introduction

Hello,
I am a student of the Master of Multimedia, Faculty of Engineering, University of Porto (FEUP) and I am finishing my dissertation.

The purpose of my dissertation is to develop a visual language that facilitates interaction between designers when they are sketching ideas for a web interface project. Another goal is to use this visual language as a middleware so that with machine learning it is possible to generate prototypes (with code) through sketches.

For this, I need to gather as much information as possible to analyze how most designers design websites.
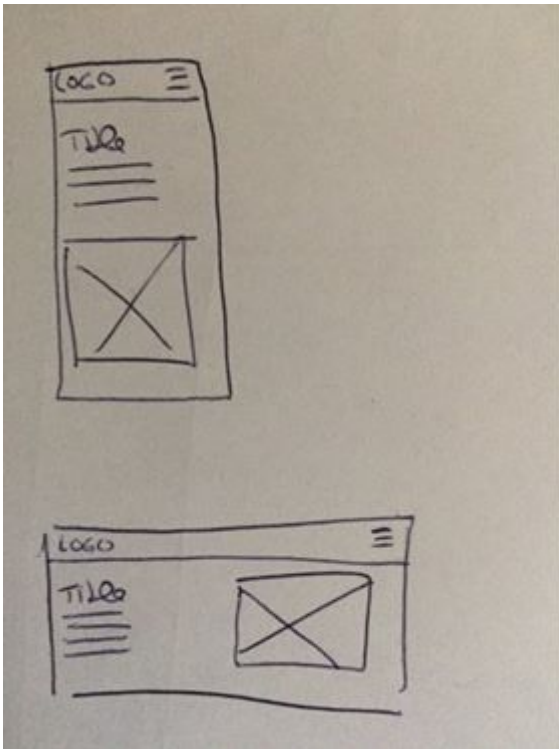
Instructions

This exercise has two parts.

In the first part, we want you to design a small website for several screens.

In the second, we want you to design a more complex desktop site.

The goal is to understand how the elements described in \tableref{appendix_web_elements} are sketched.

You will have to draw the descriptions made in this document and upload them to the links at the end of the document

Disclaimer.

We admit the existence of more components that together form a web page however, for this investigation, only a few were chosen which, based on the study of other software, were considered the most common on the web.

SiteMap
Storyboard
Wireframe

Screen Size Desktop Mobile Tablet	**Structure** Column Row Container Section Grid	**Web Elements**	
		Simples Link Text Image Video Input List Table Button Chart Map Calendar	**Complex** Navbar Footer Form

Part 1

Screen representation.

The table below describes a one-page website.

Please try to represent it through sketches for Desktop, Tablet and mobile.

Desktop	Tablet	Mobile
Navbar Positioned at the top of the page. On the left side there is a logo and on the right side there are 4 horizontally aligned links. **Body** It has a section that occupies the entire width of the screen. The section is divided into two columns next to each other. The first column has a title and underneath, a small text. The second column has an image. **Footer** It has three columns. The first has a cell phone number and an email. The second has 4 links vertically aligned. The third has a video.	**Navbar** Equal to the Desktop one. The 4 links turn into an Hamburger menu. When clicking on the hamburger menu a rectangle appear with the 4 links. **Body** The columns align vertically in one column. **Footer** The columns align vertically in one column.	**Navbar** Equal to the Tablet navbar. **Body** Equal to the Tablet page. **Footer** Equal to the Tablet footer.

Part 2

In this exercise we intend to understand:

Sitemap

How the sitemap is represented?
- How to represent that A leads B?
Storyboard
How the storyboard is represented?
- how interactions are represented ?
Wireframe
How a wireframe is represented?

Platform
Desktop

Website Pages
main - about - pesquisa - página individual -preços

Main
Navbar   Has a Logo on the left side and 4 inline links on the right side.   The links refer to the other pages of the site.   The navbar is present in all pages of the website.   **Body**   4 sections with the screen width.   First Section   Has an image on the background.   On the right side is a title and below a paragraph.   Second Section   Has a 4 x 4 image grid that is clickable to the individual page.   The grid has space between the images.   Third Section   Has a title and below, a video.   They are both centered   Fourth Section   Has a centered button that leads to the search page.   **Footer**   Occupy the screen width and has 3 columns.   Each column has 3 links displayed in block..   The footer is present in all pages of the website

Search

Navbar
Body
Has 2 sections that occupy the screen with

First Section
Has a map. On the top right corner presents an input on the map to search by places.

Second Section
Has a container with text. Below the text there is 2 inline columns.
The first has and image and the second a button that leads to the individual page.
Footer

Individual Page

Navbar
Body
Has 3 sections.
The first has a title and below a description. After it, 4 inline images are presented which occupy the screen width.
The second is subdivided into 3 columns, each with a list of 3 elements.
The third is subdivided in 2 inline columns.
The first column has a calendar.
The second columns has a form with 2 inputs displayed in block (name, email) and a submit button.
When clicking on the button a message pop up saying "form successfully sent".
Footer

About

Navbar
Body
Has three charts centered on the screen and displayed in block.
By order, Bar graph, line graph and pie chart.
When passing the mouse on top of them a container with text appear.
Footer

Prices

Navbar
Body
Has a title centered on the screen.
Below, there is a 4x6 table also centered on the screen
Each cell has a number.
Footer

End

Thank you for you collaboration

A.2   Data Collected from Questionnaire

Home

Editor

Database

Search

Database

List of all entrys

Retrieved On

All ⌄

retrieved: Professional
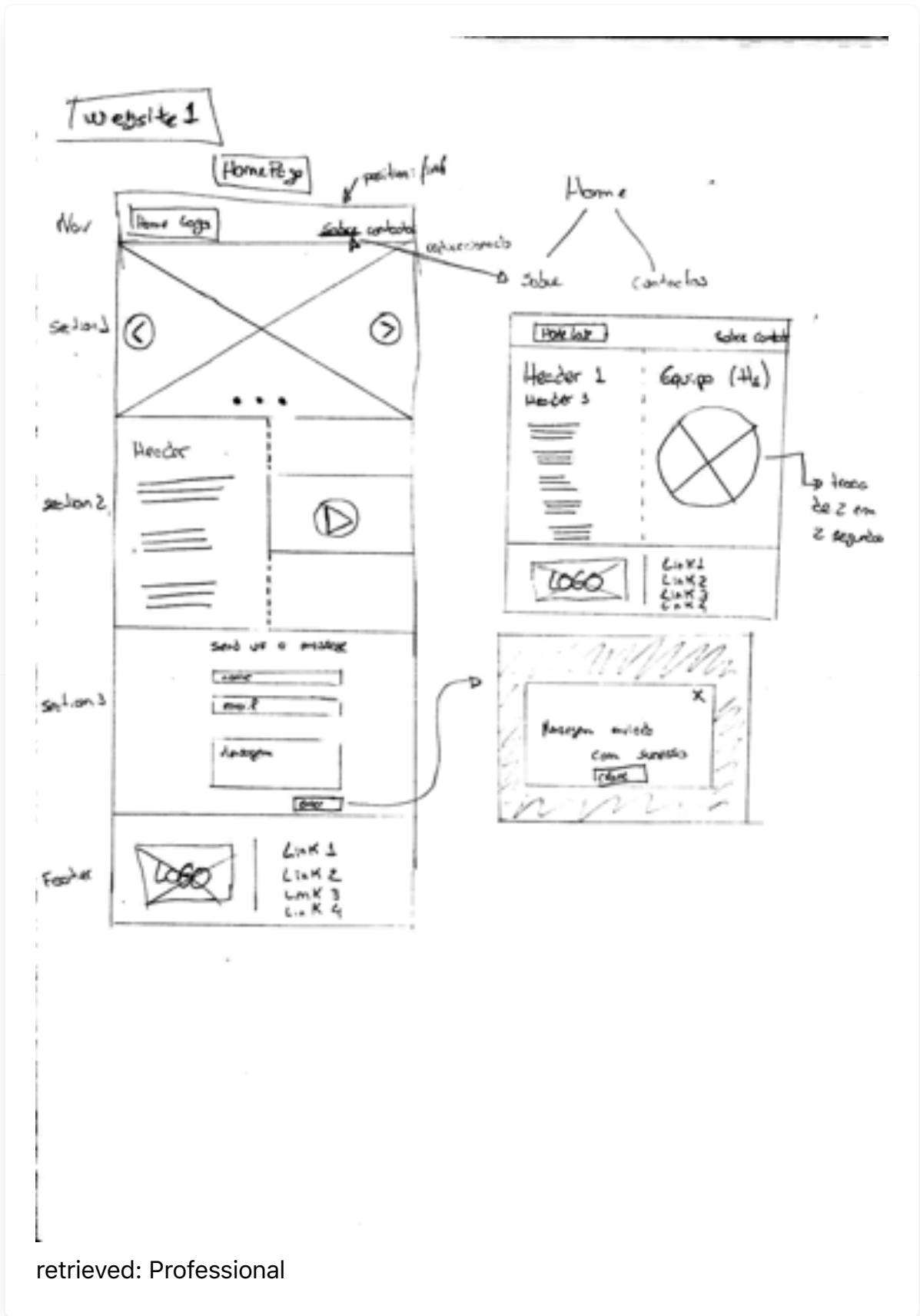
retrieved: Professional
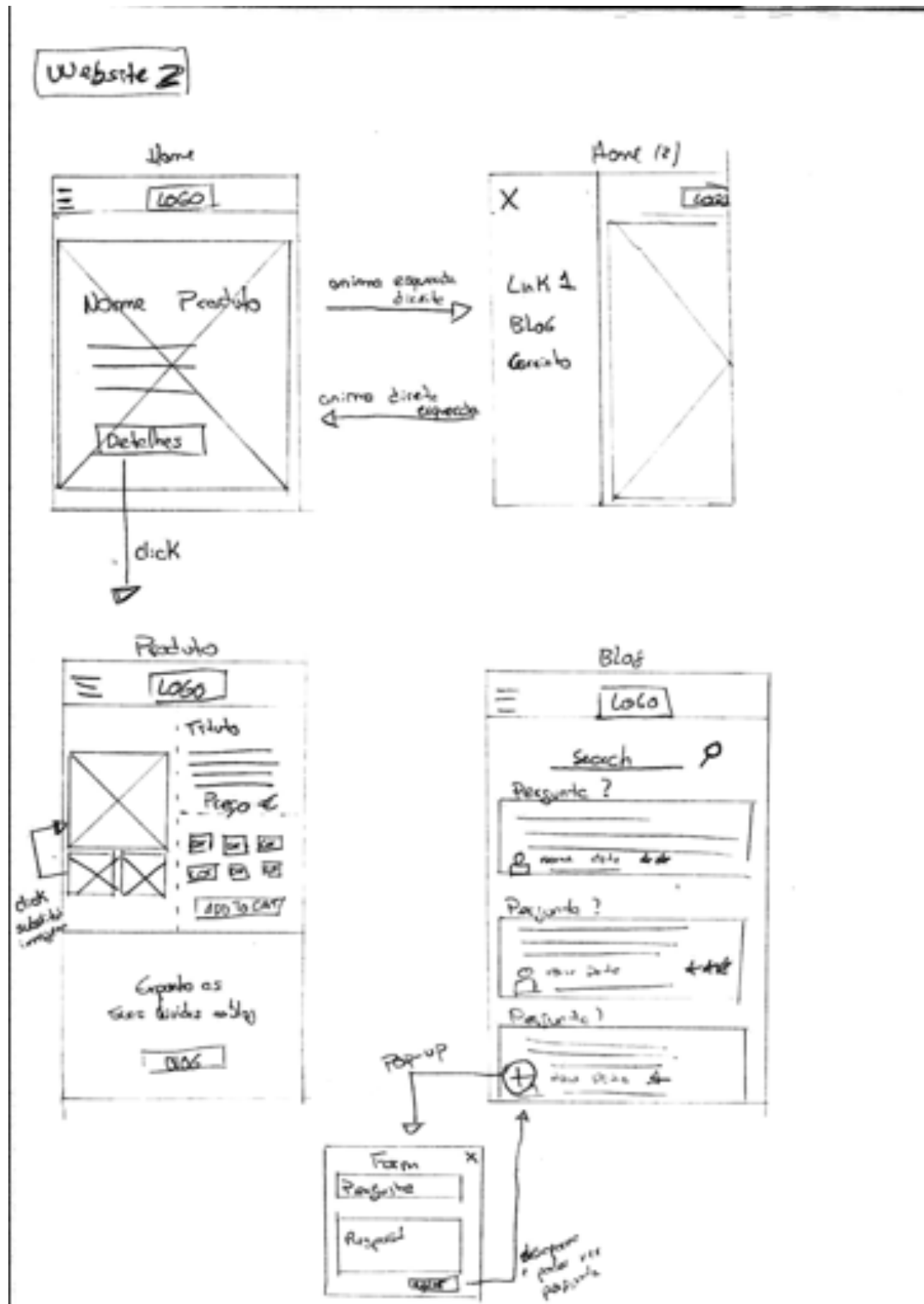
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website 4
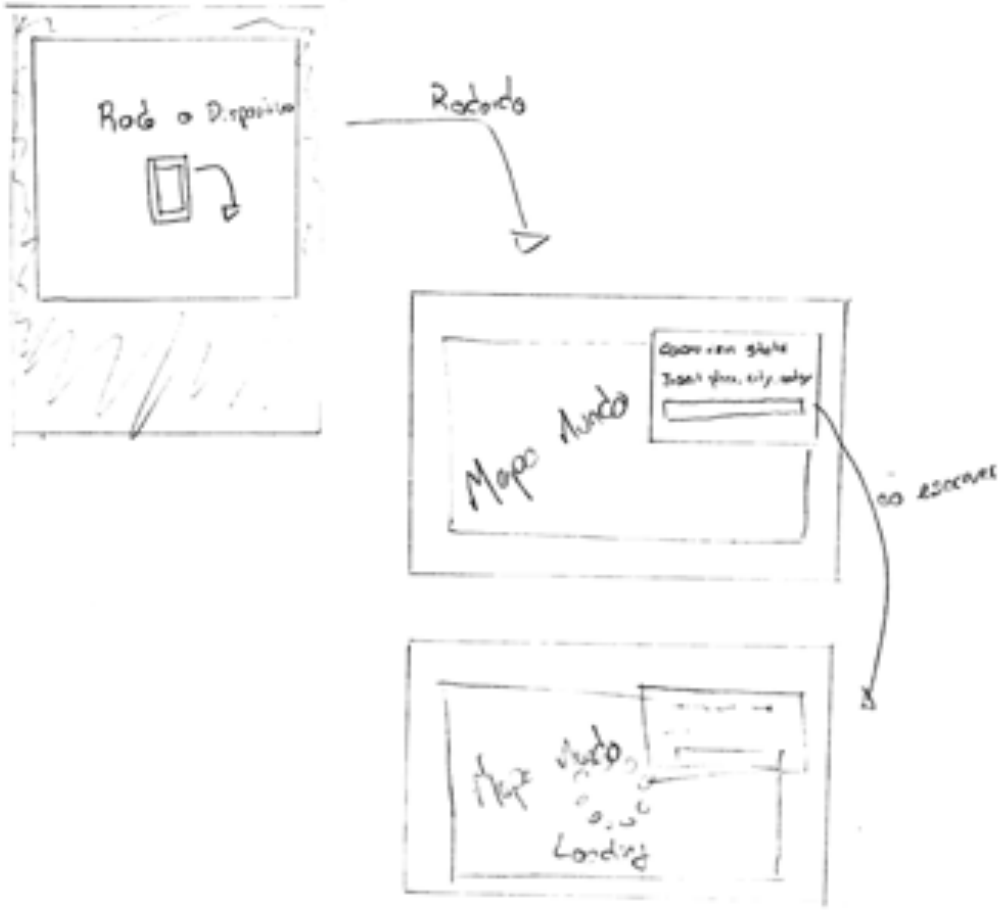
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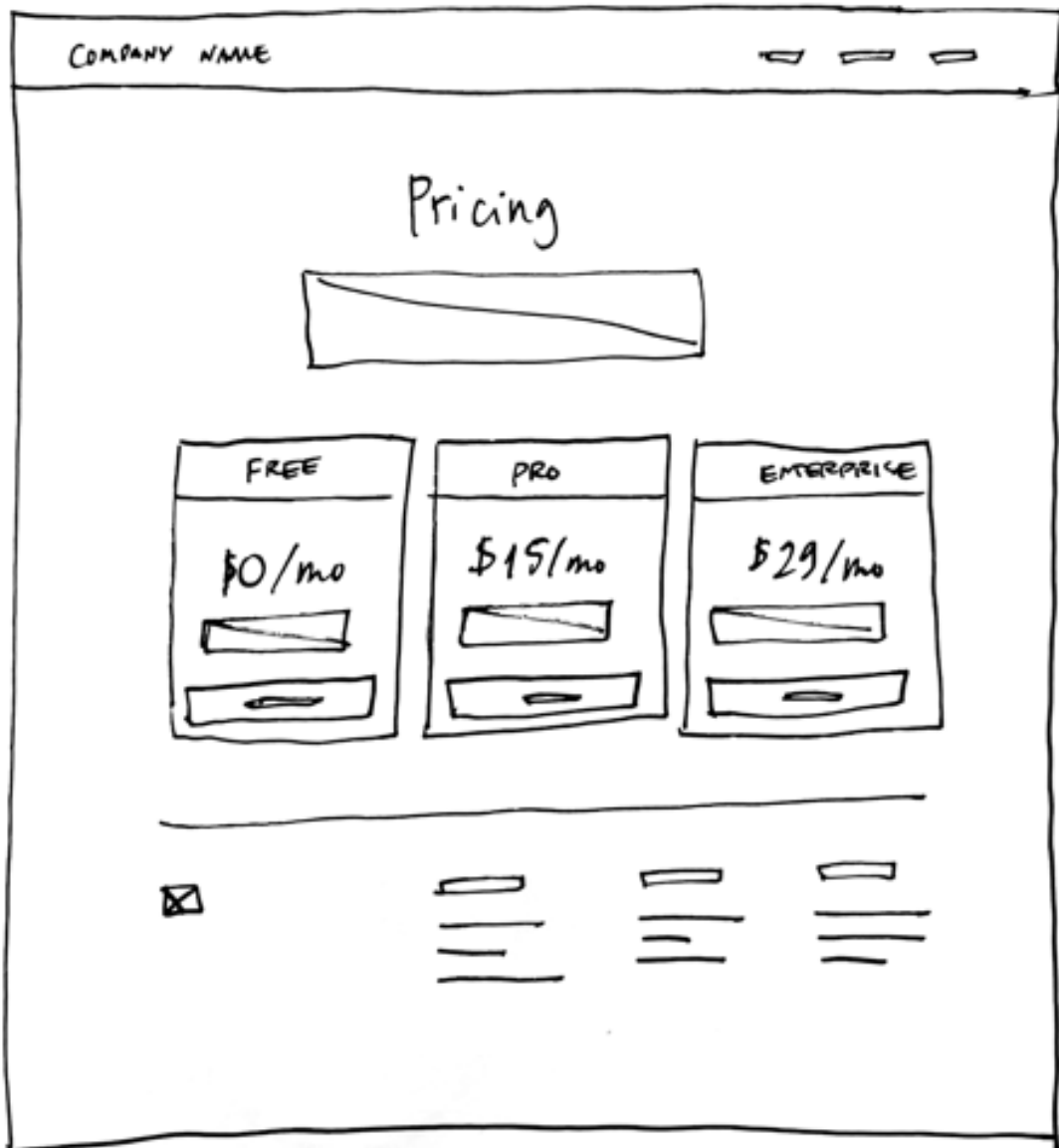
retrieved: Professional
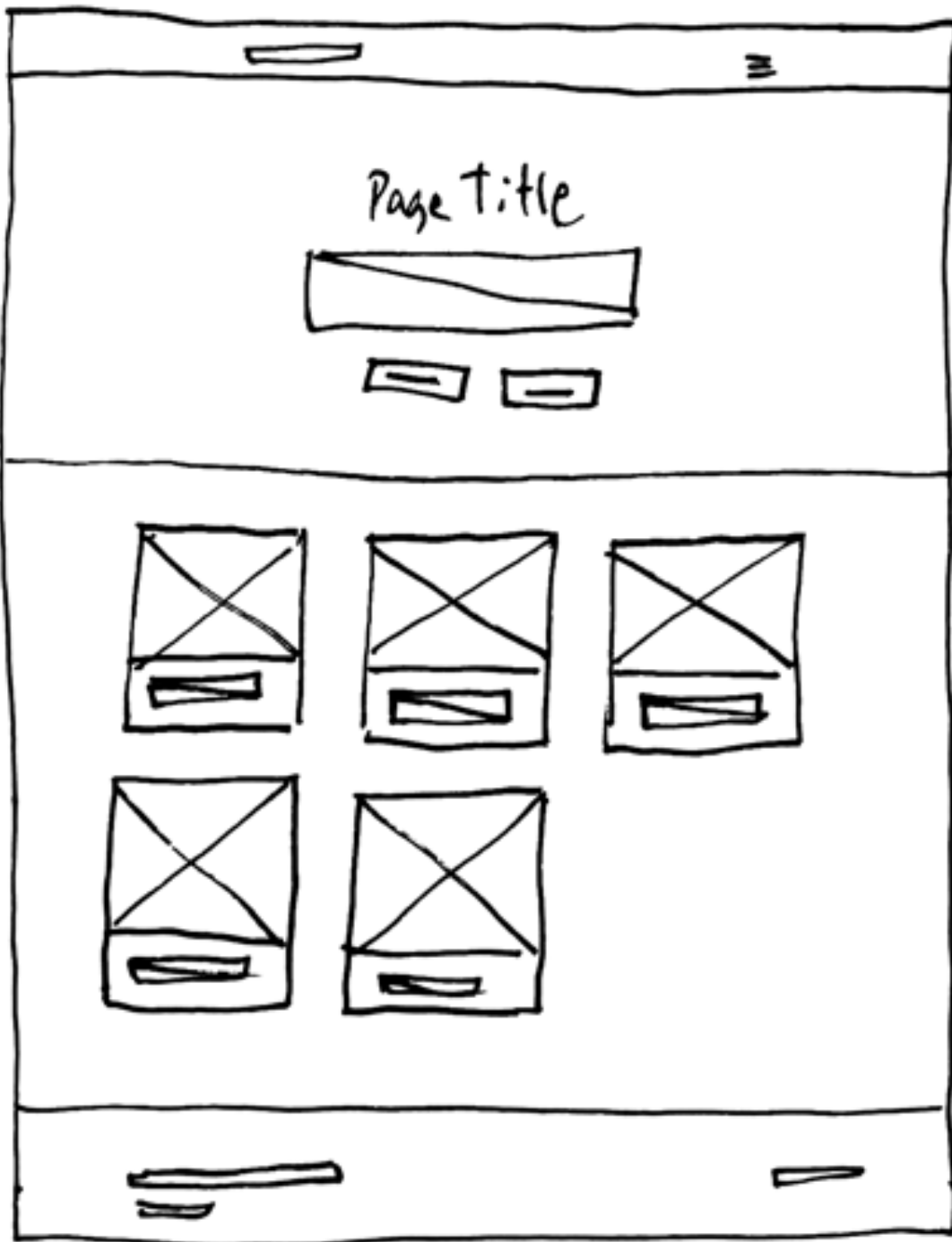
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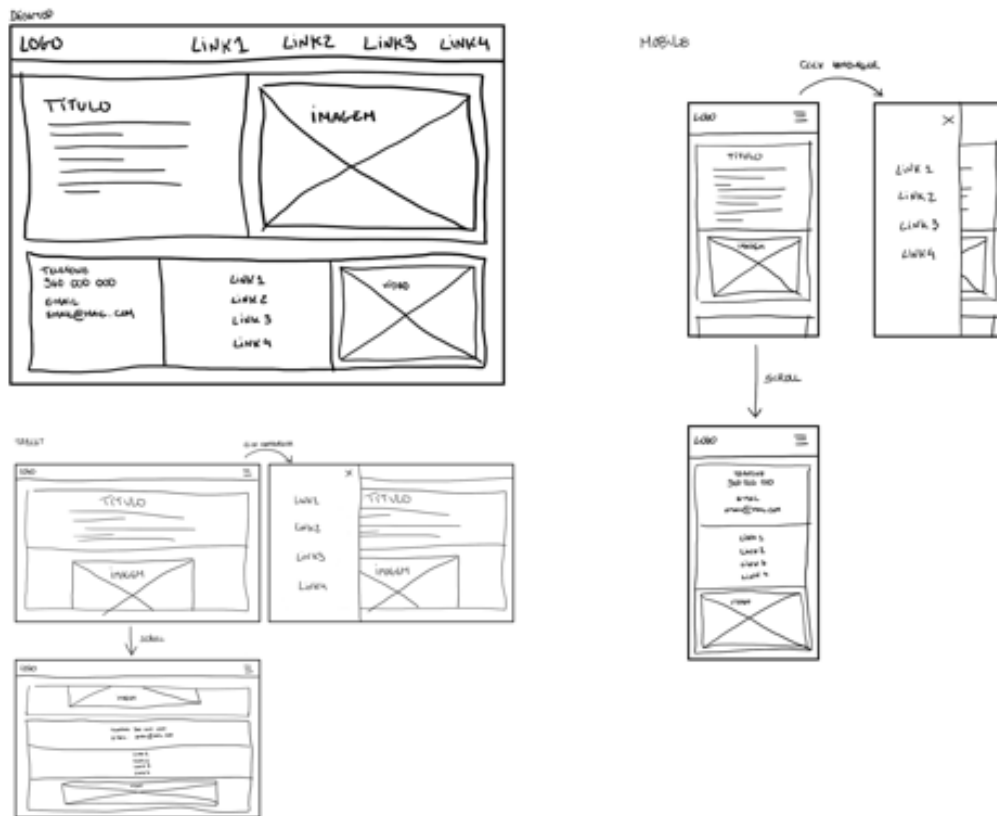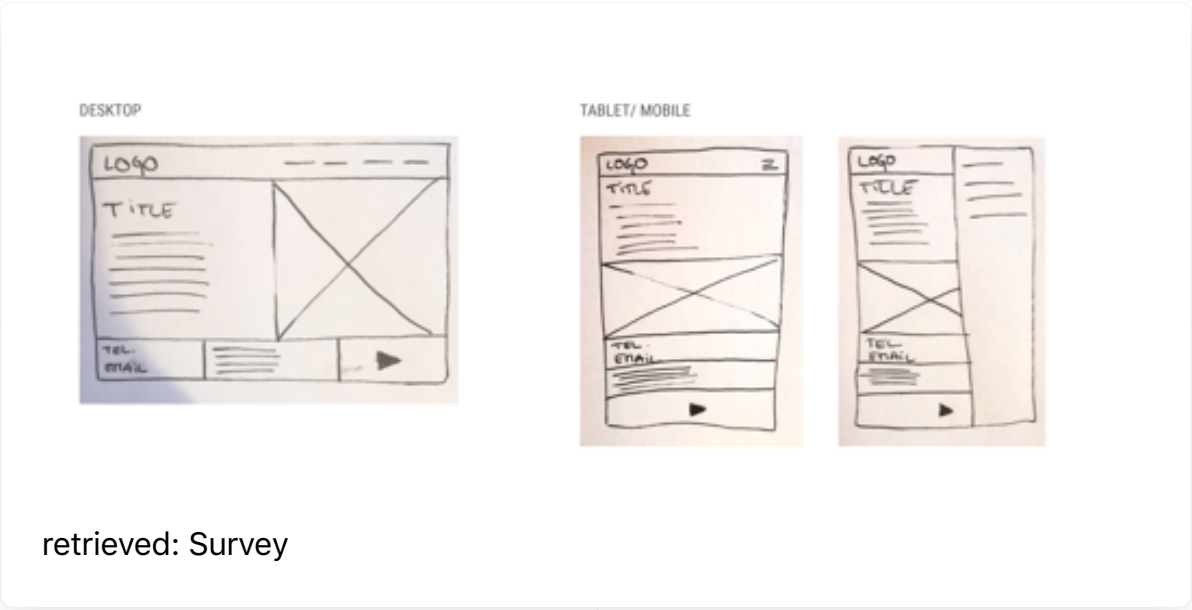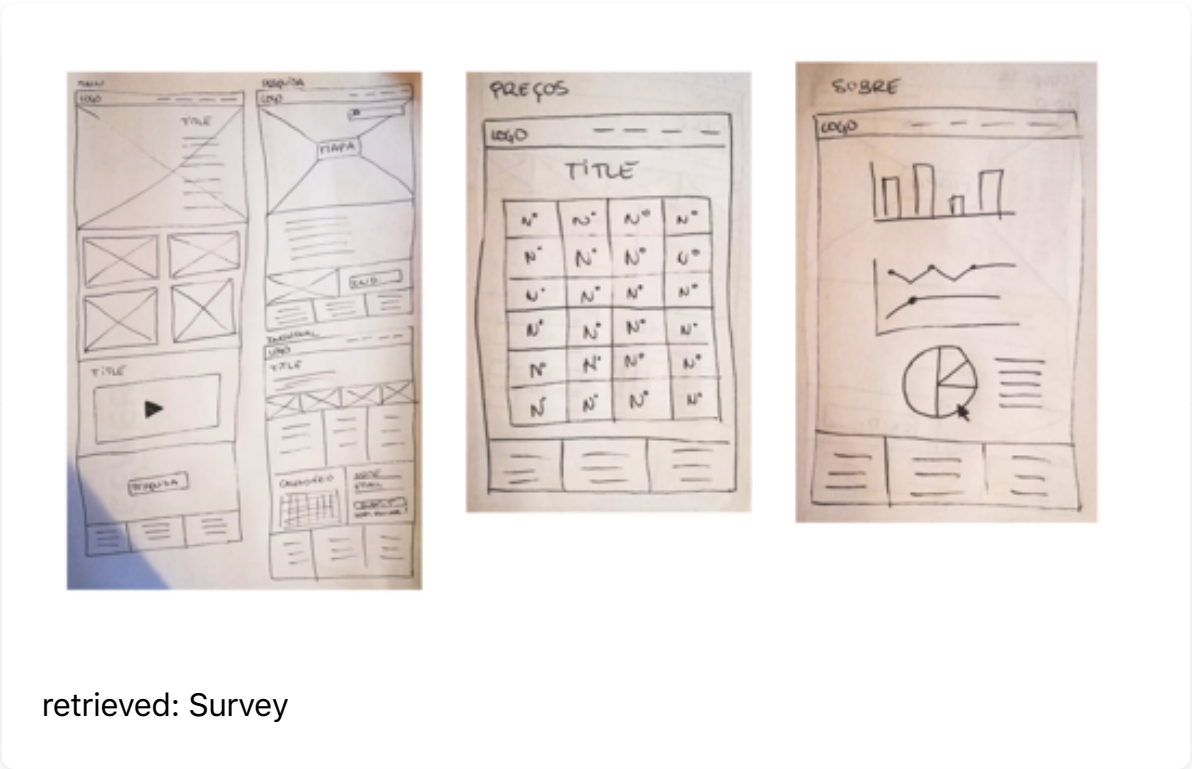
Current software
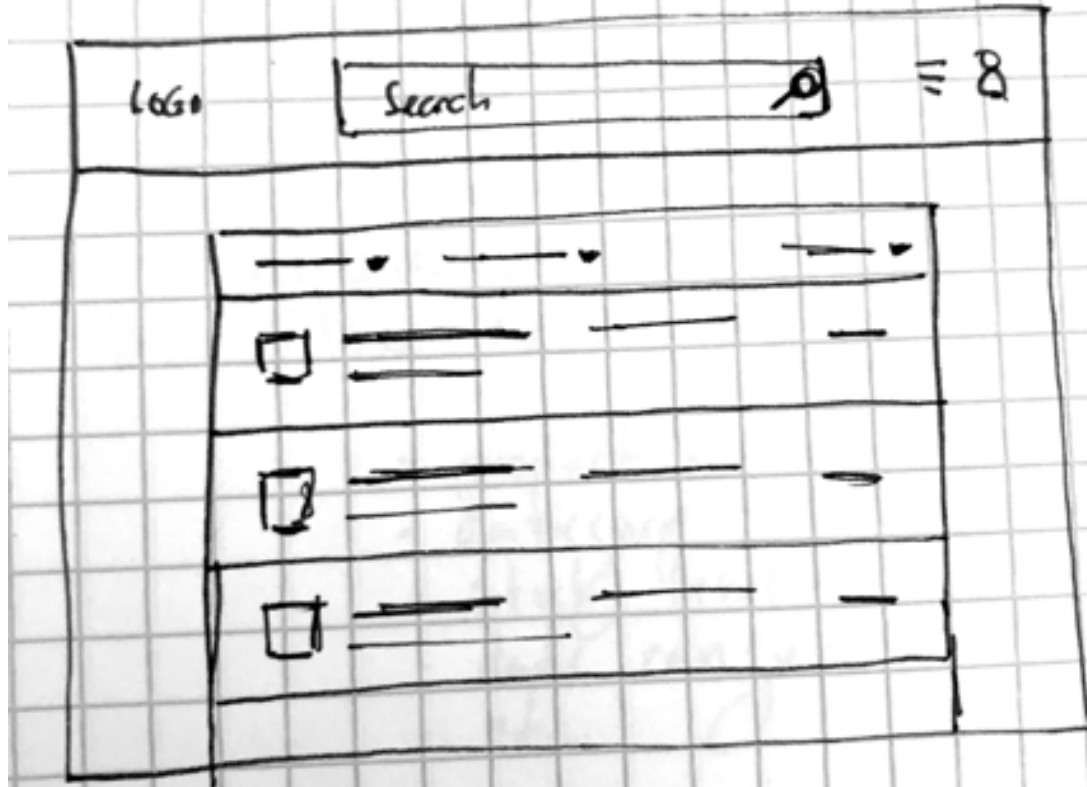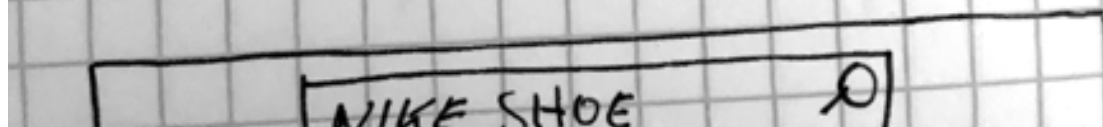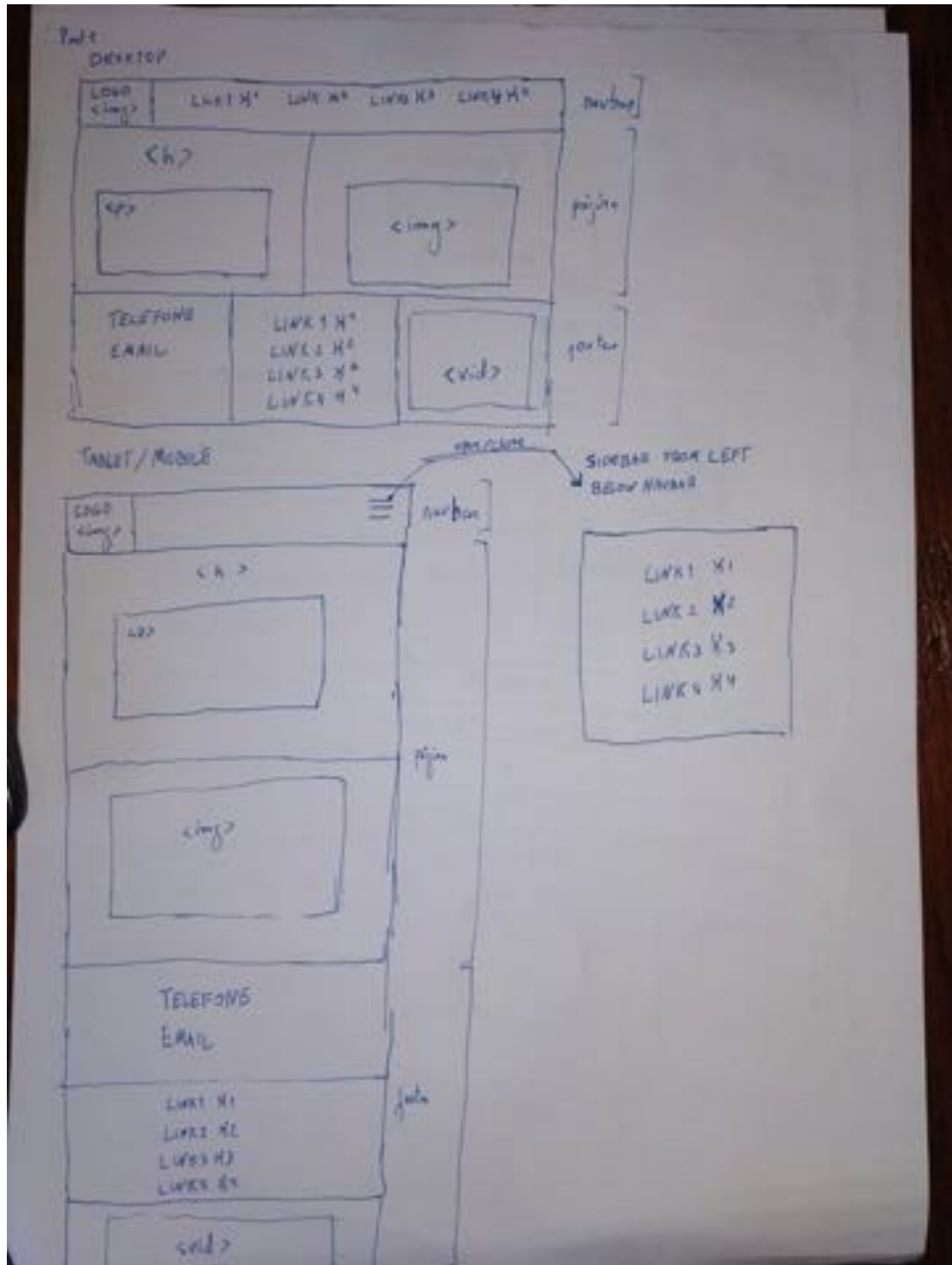
retrieved: Professional

retrieved: Survey
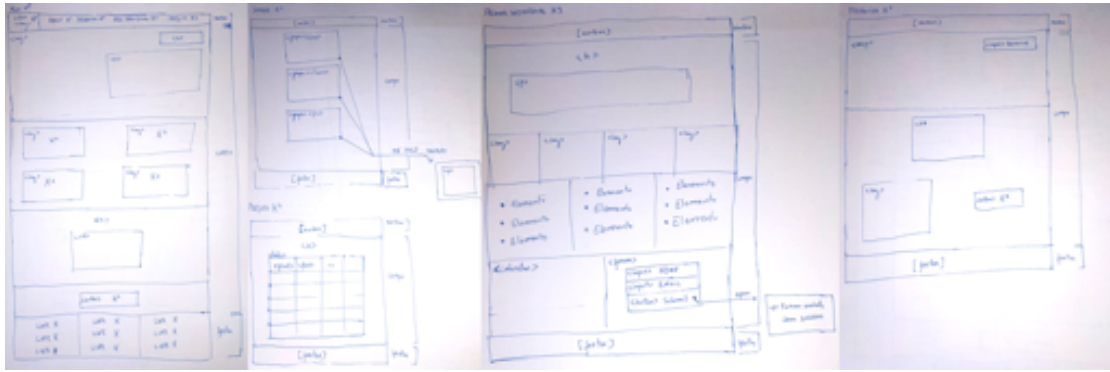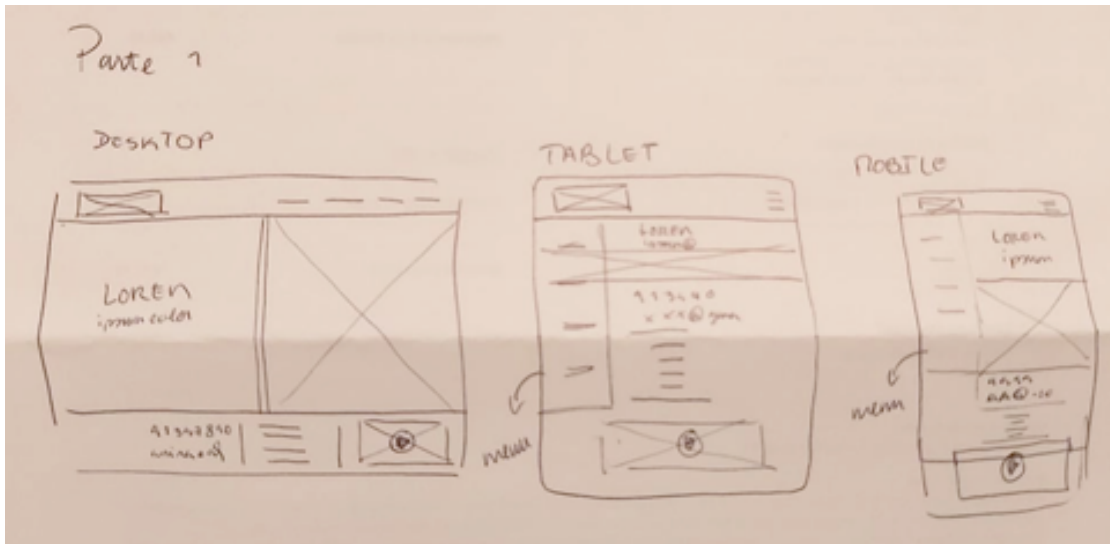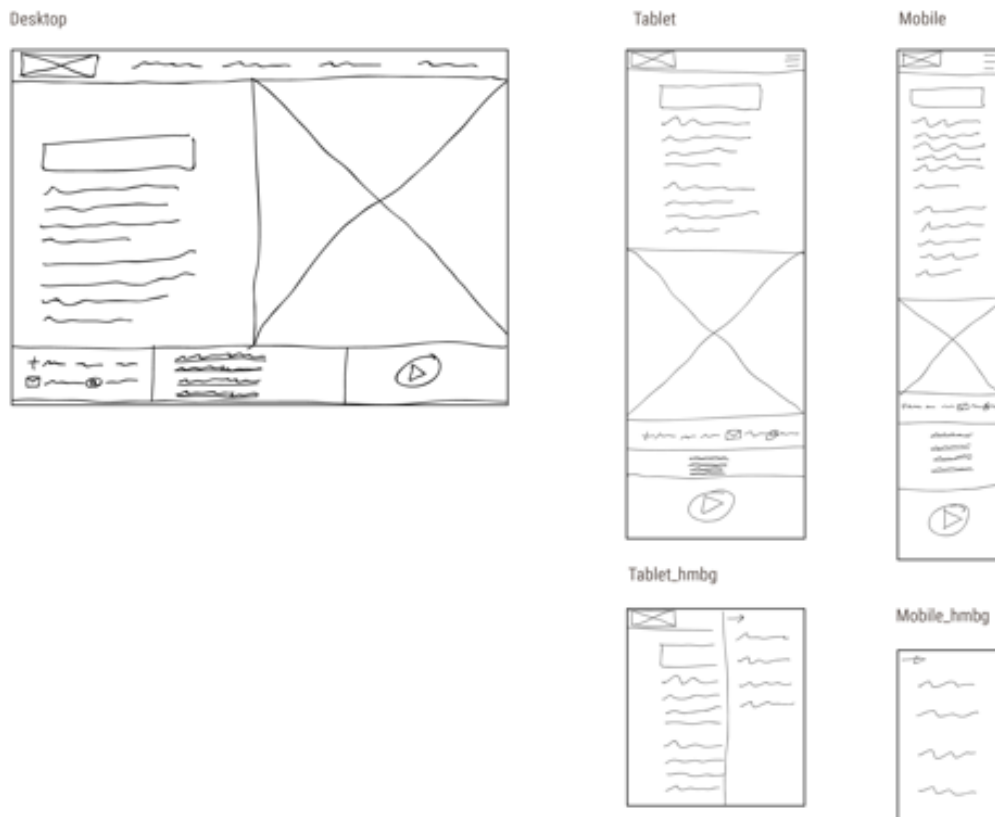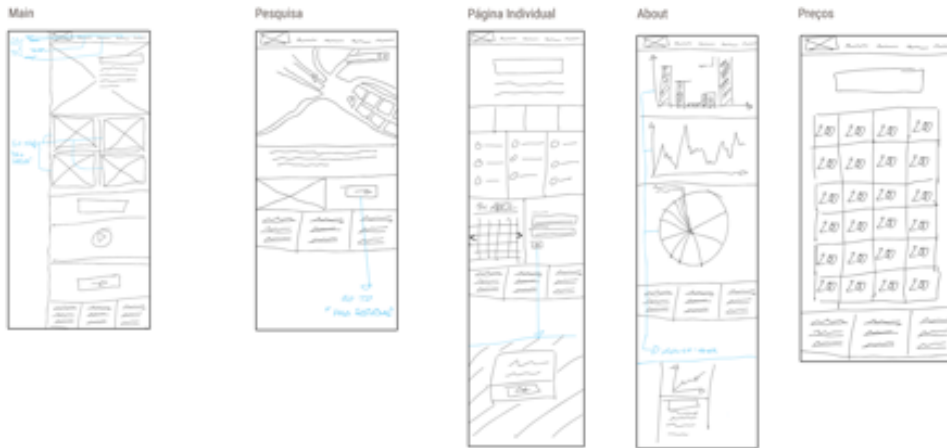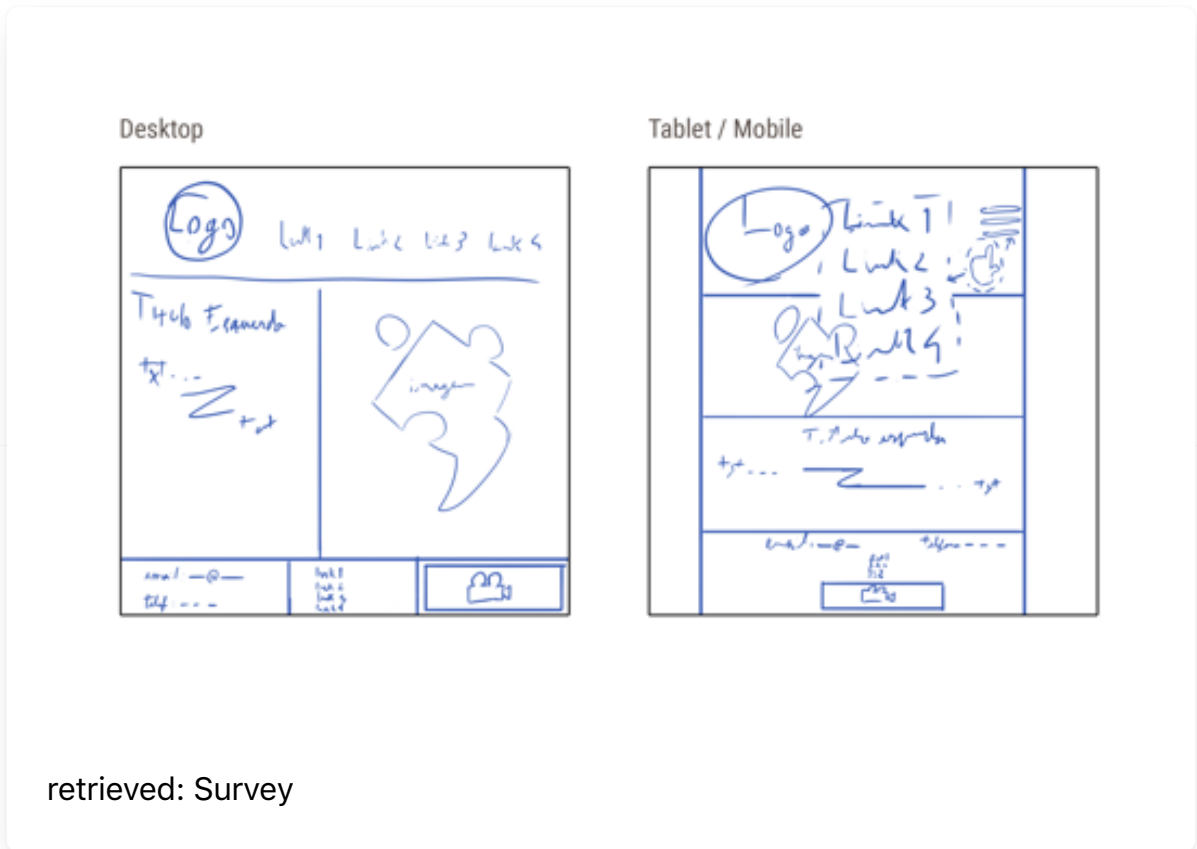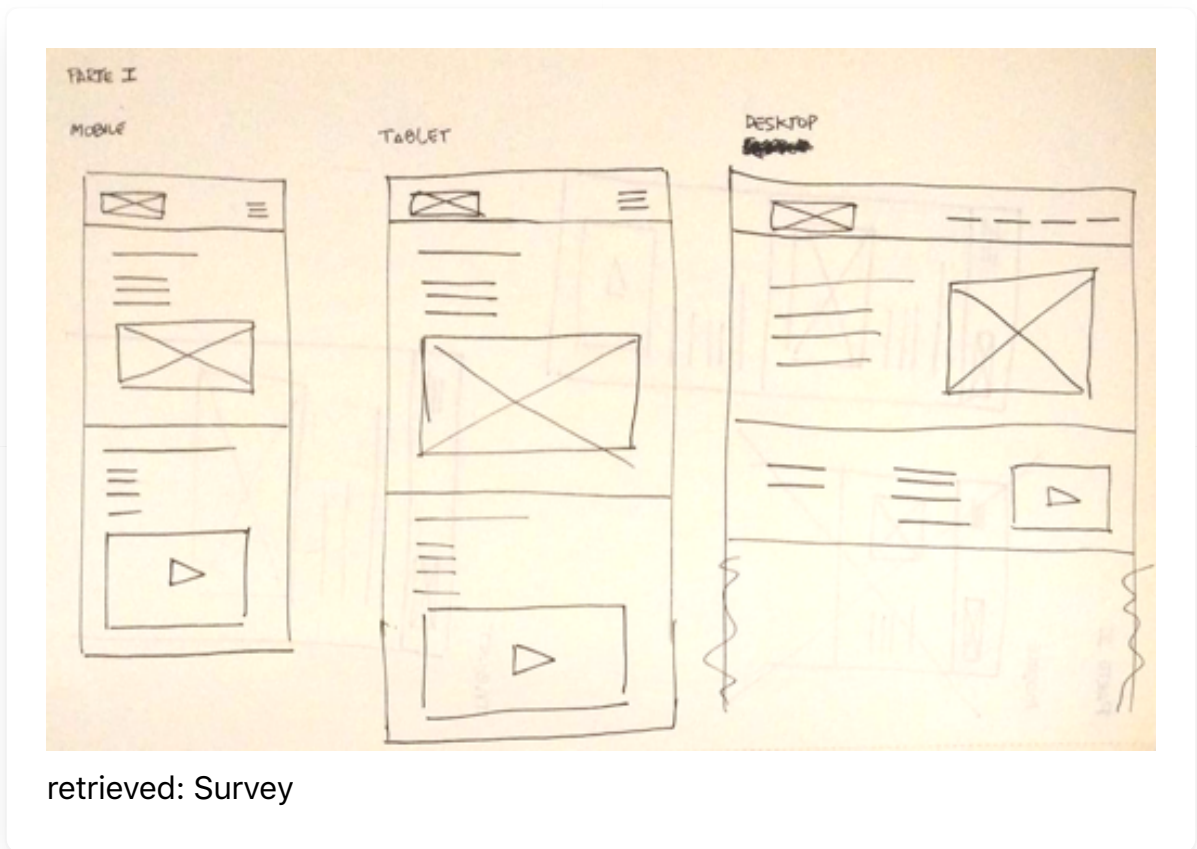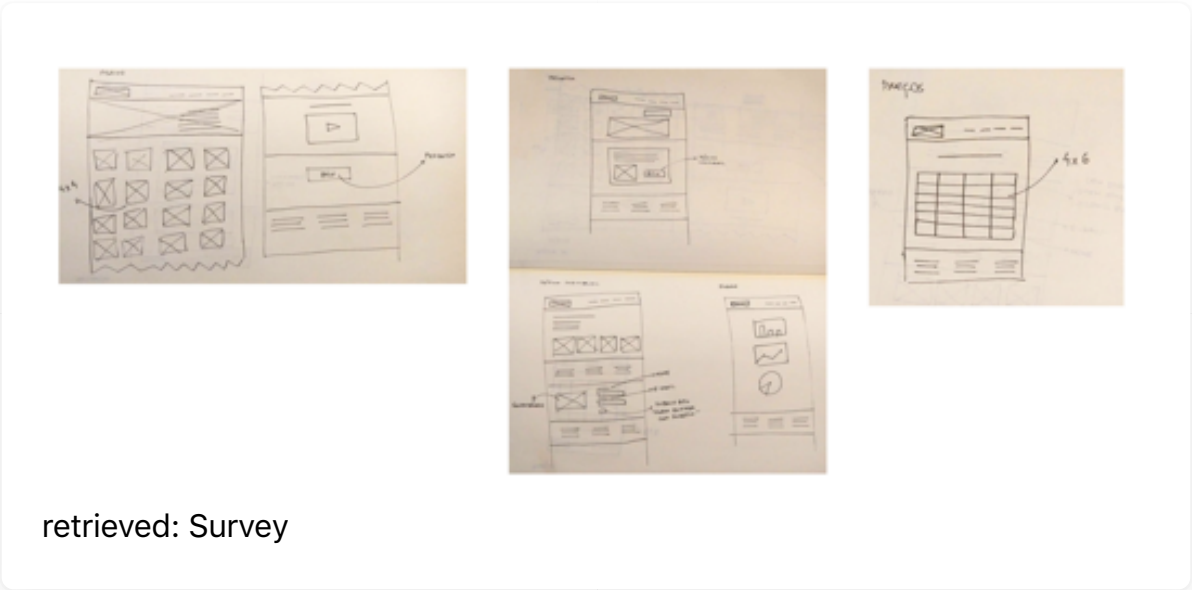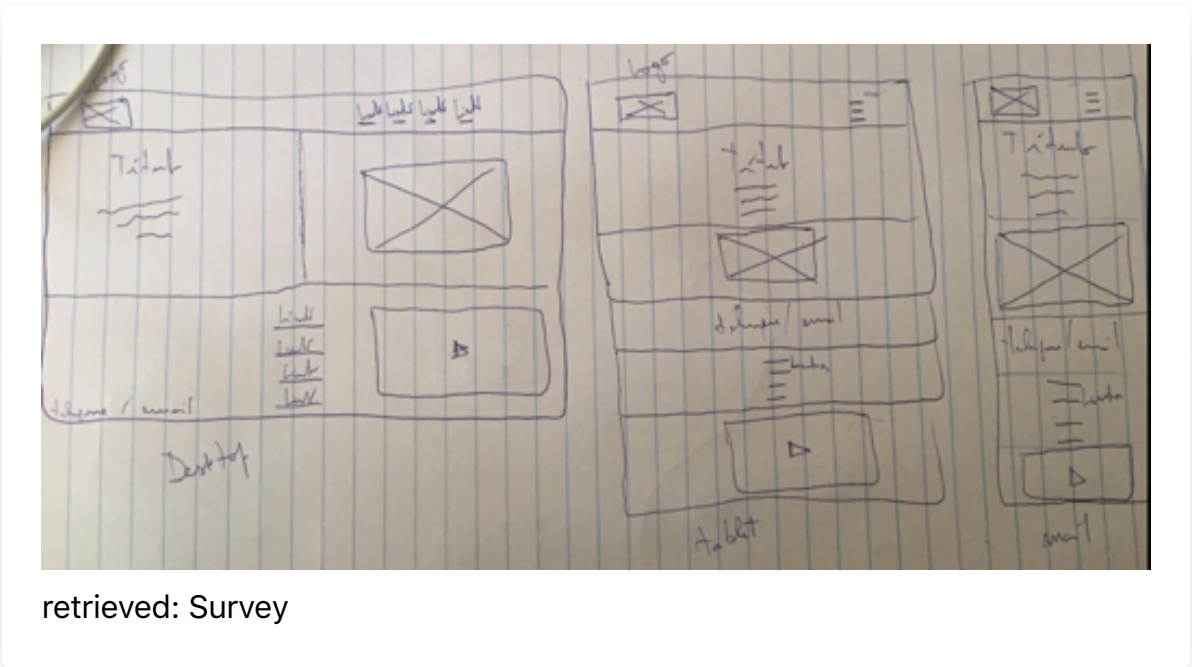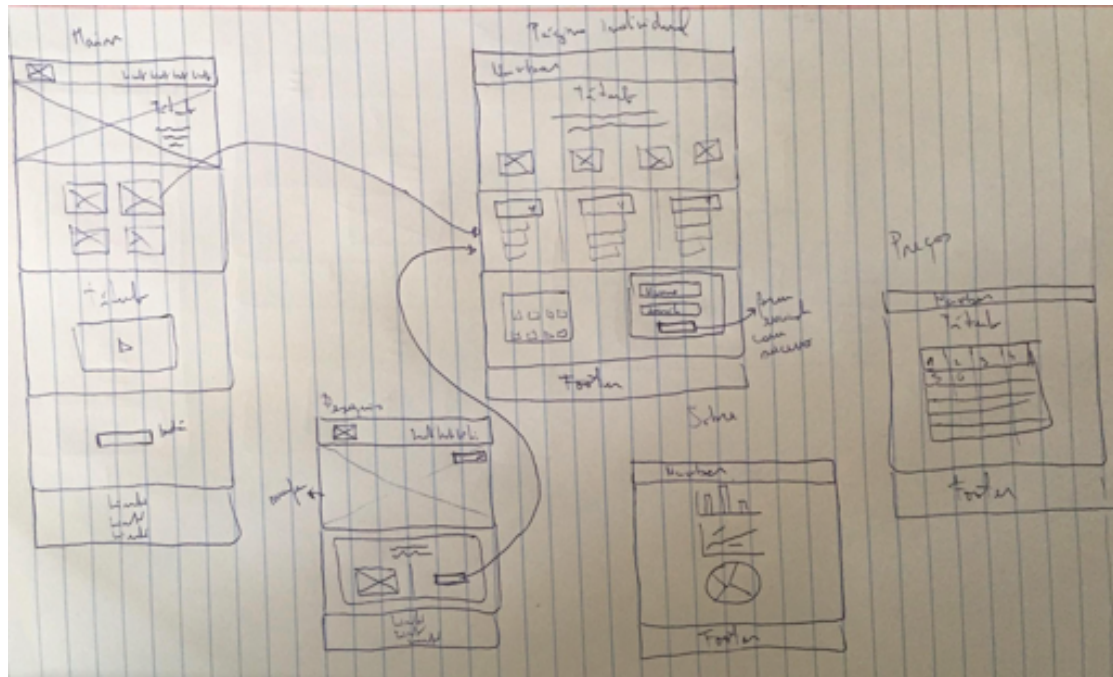
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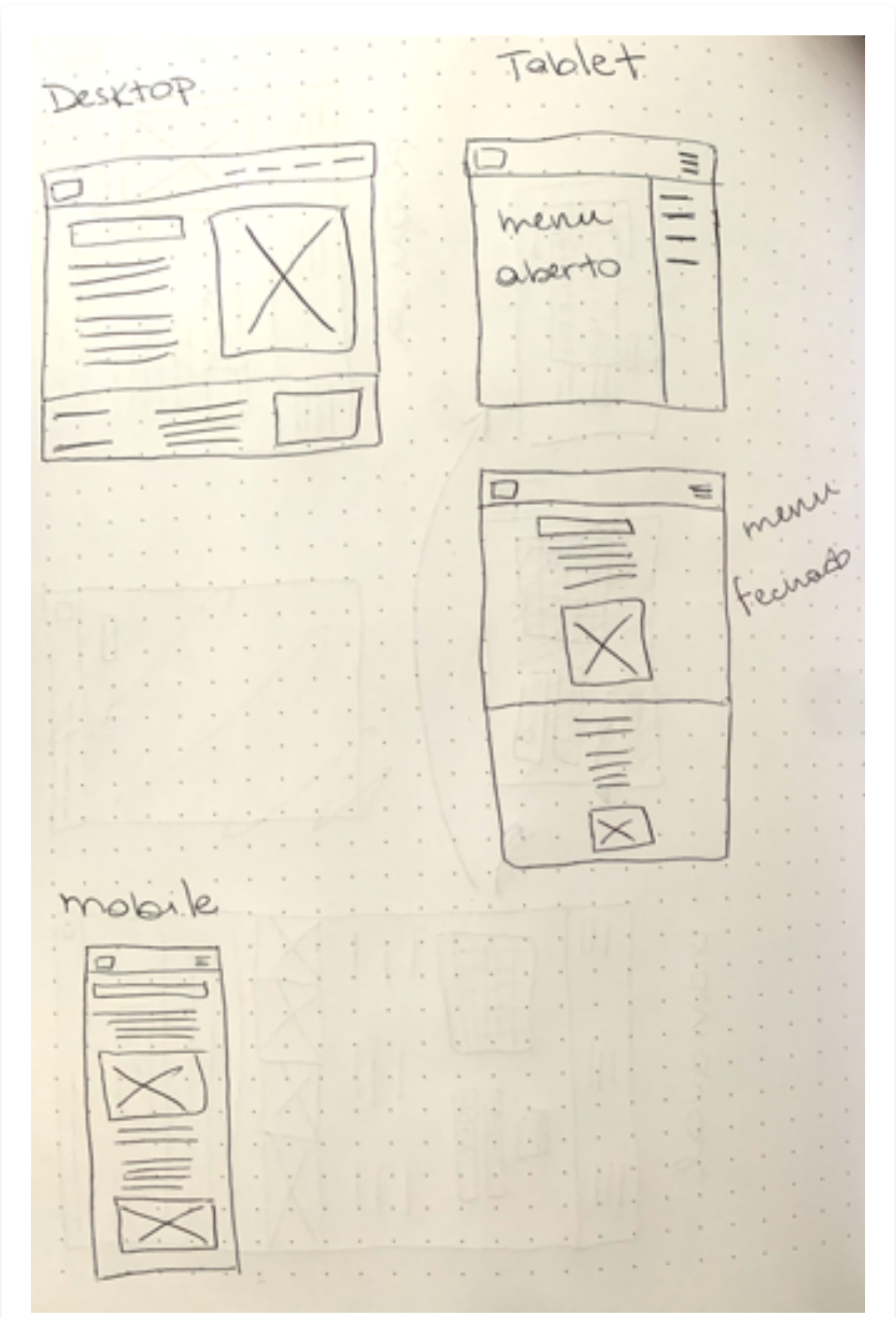

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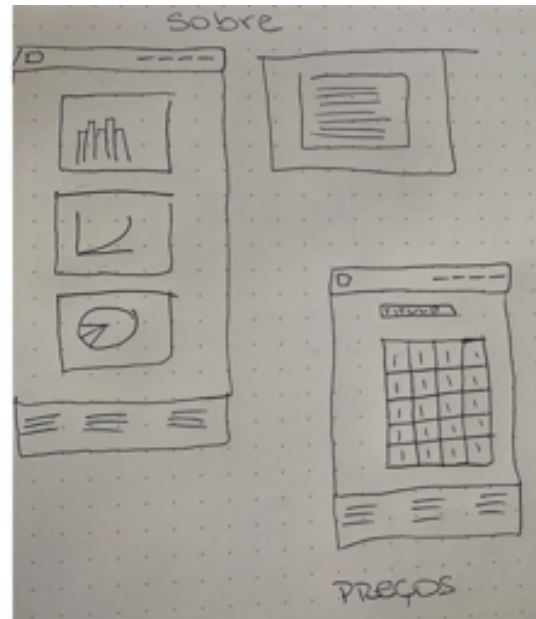
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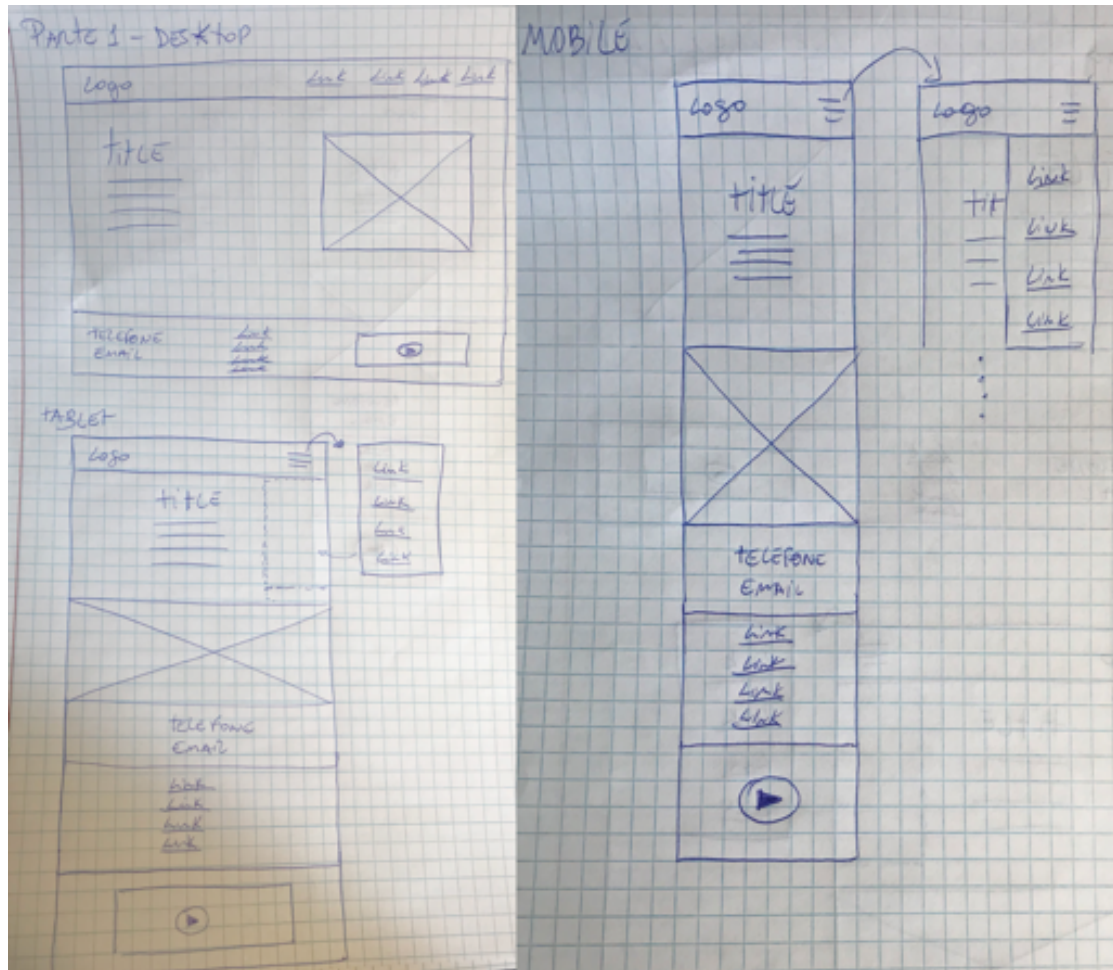
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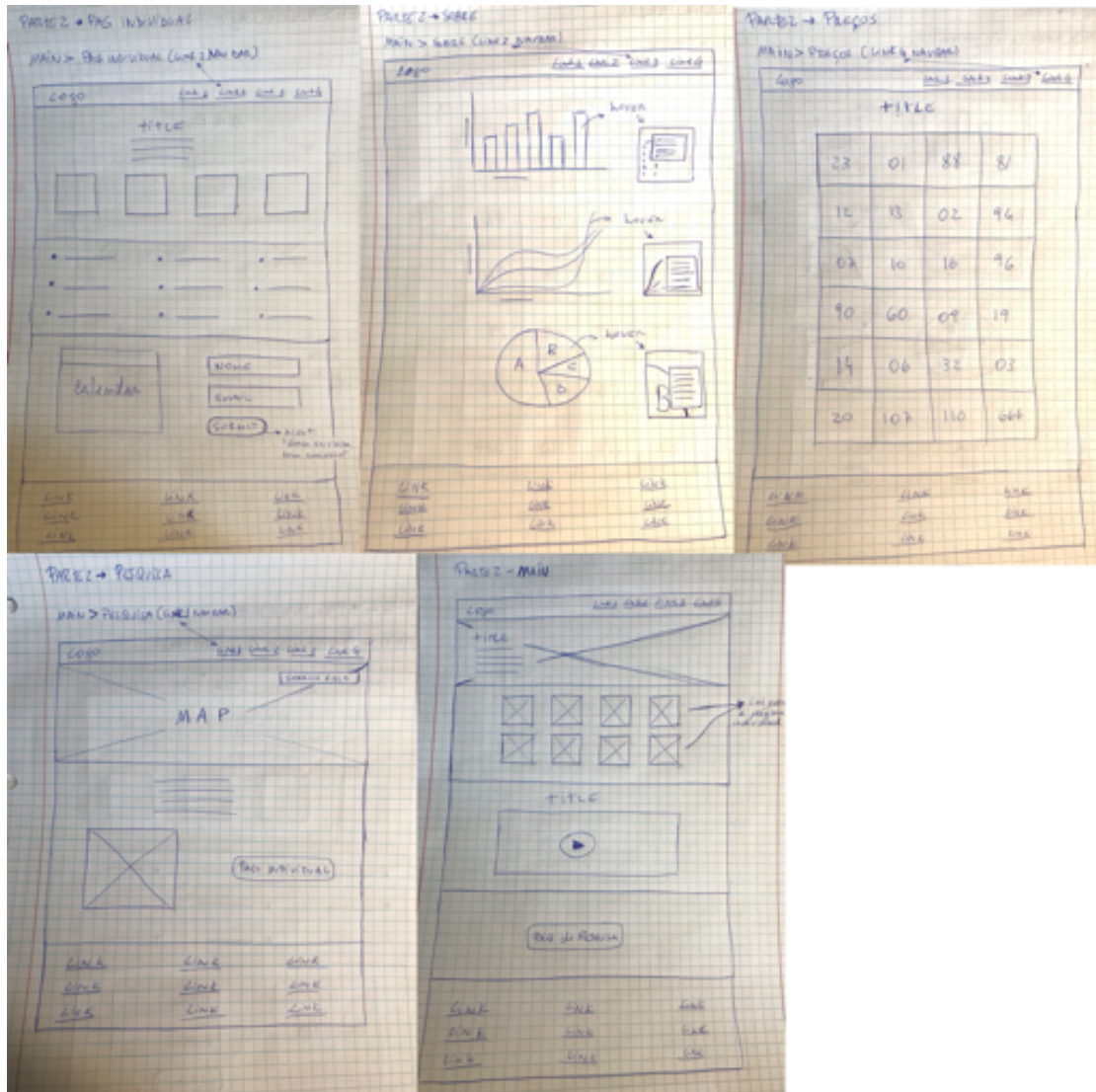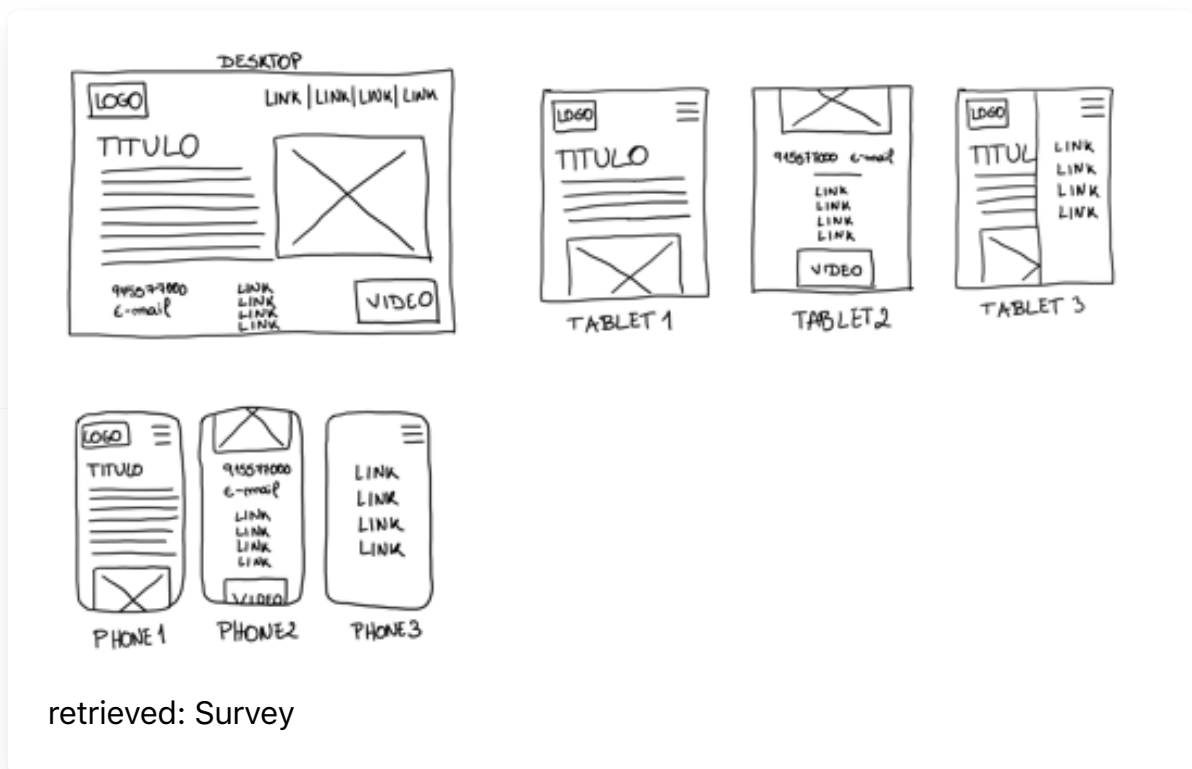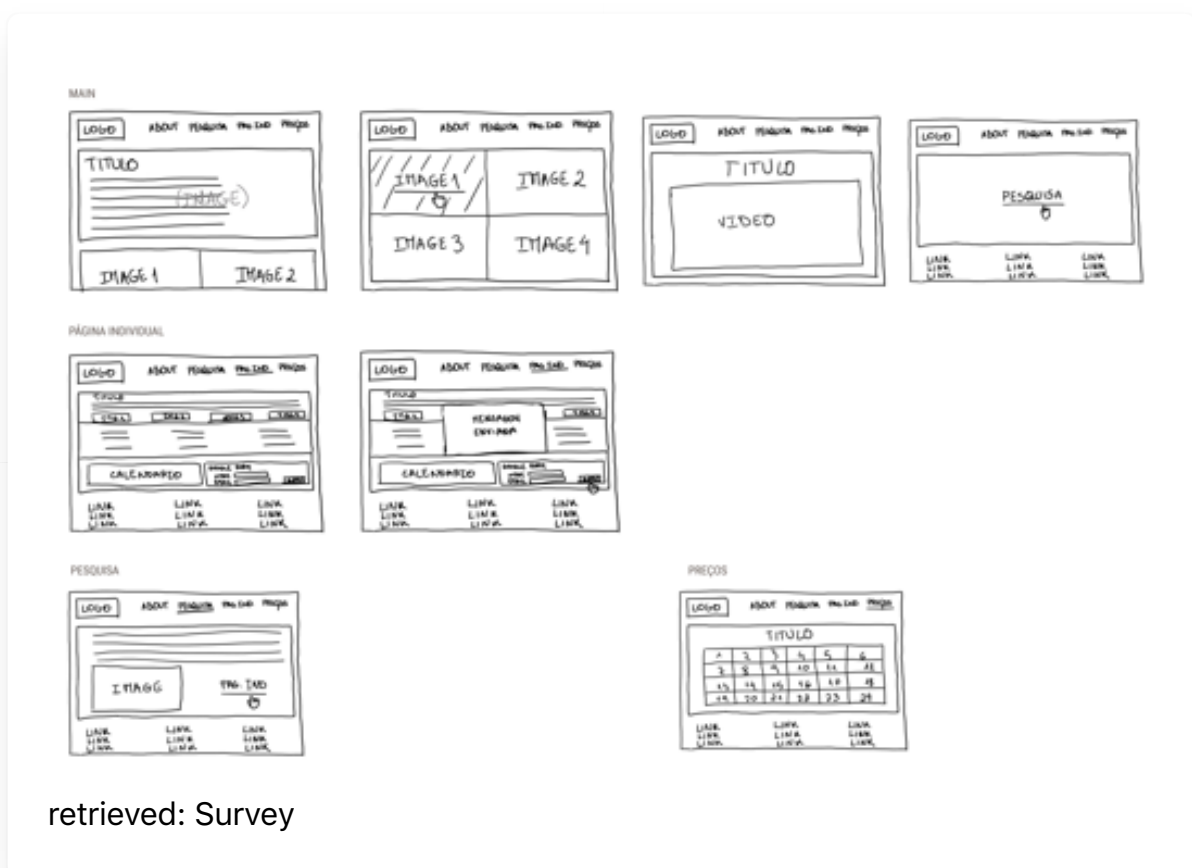retrieved: Survey

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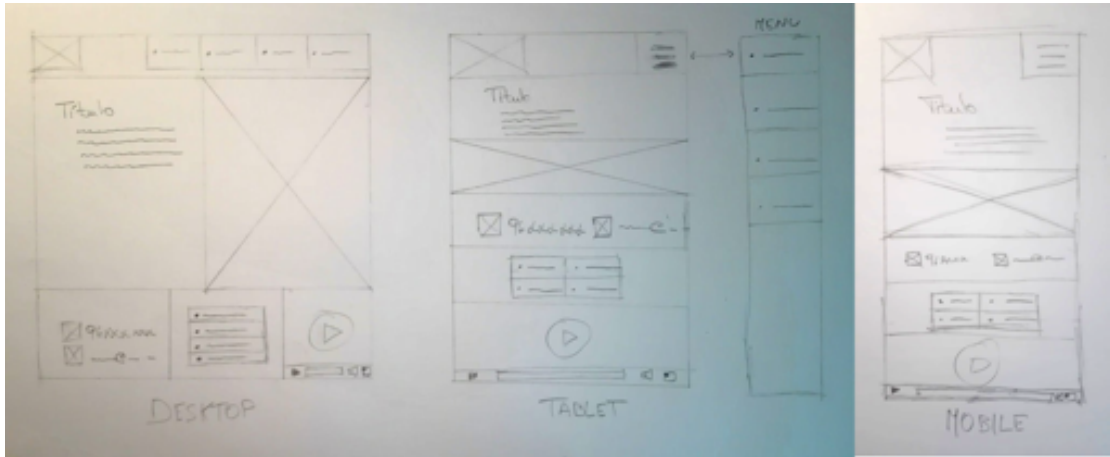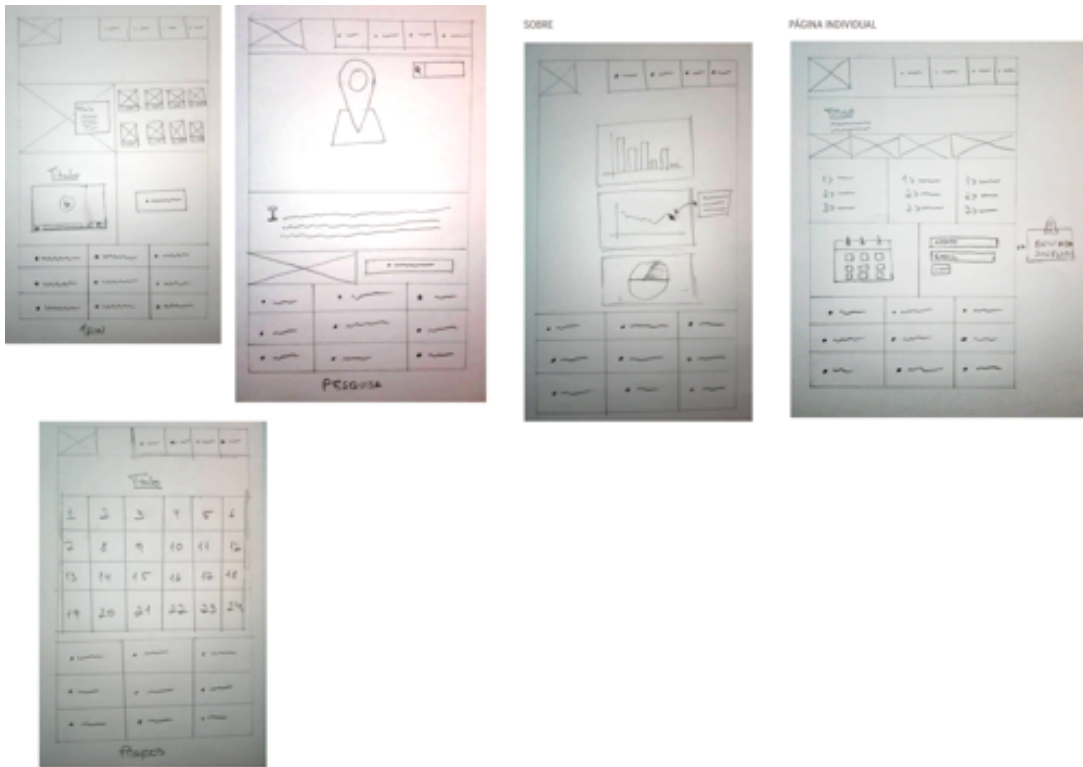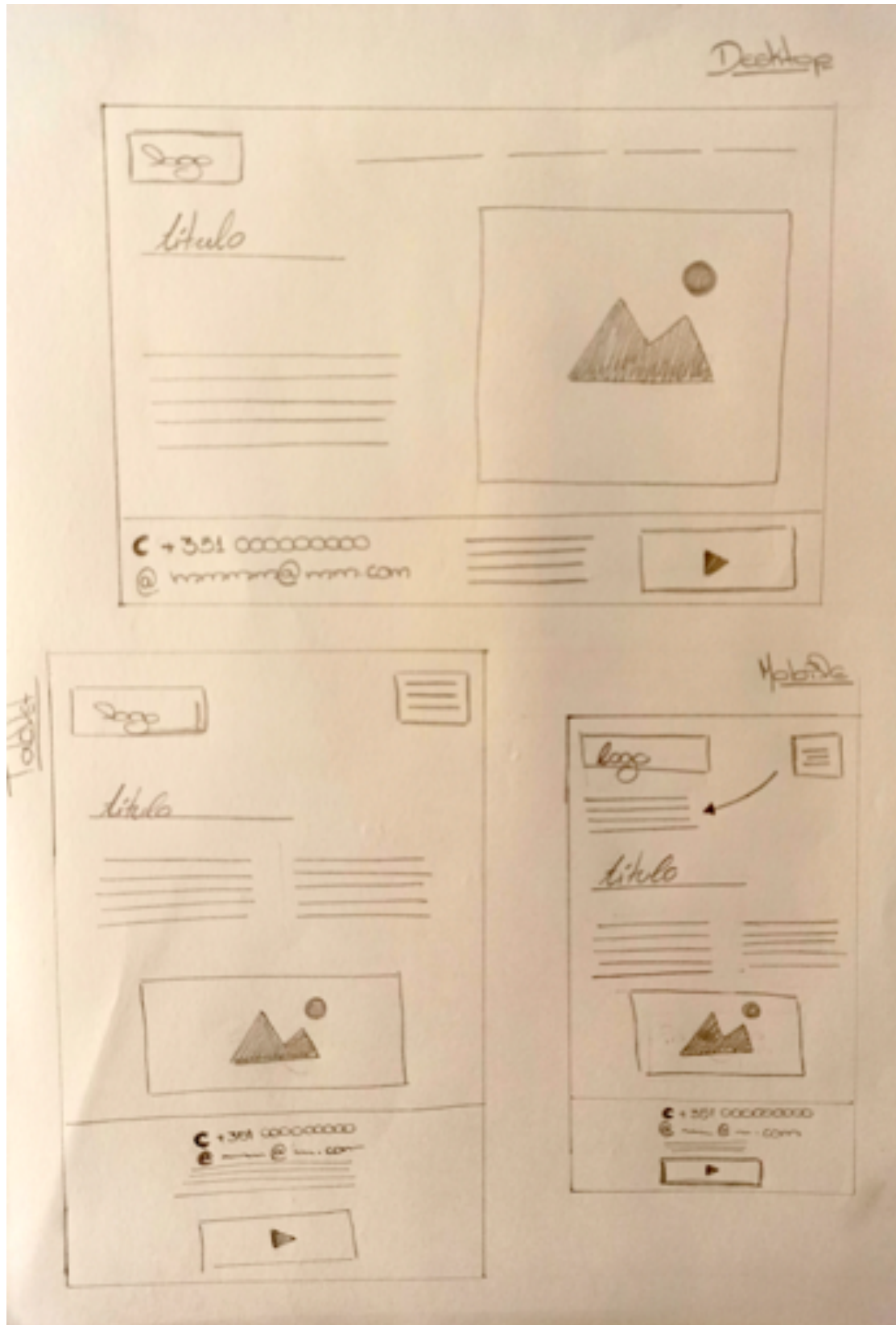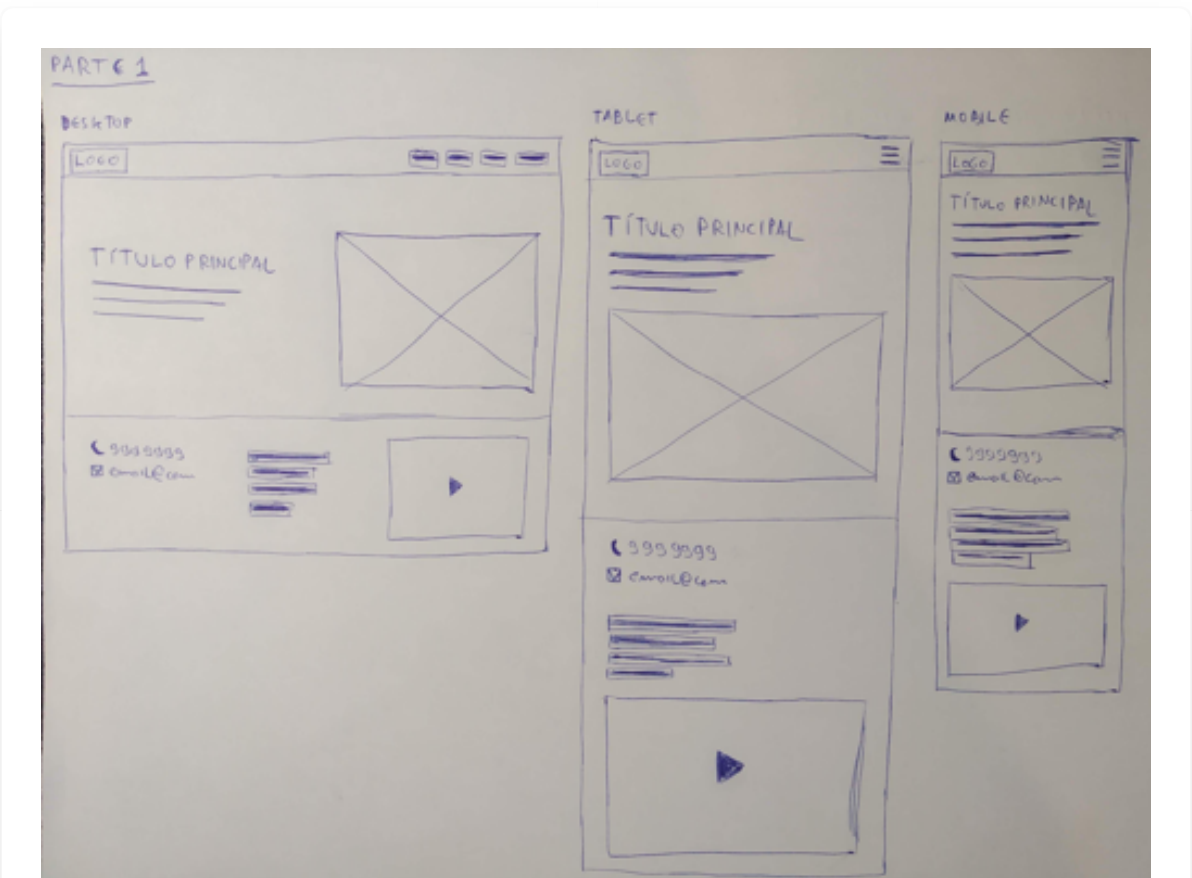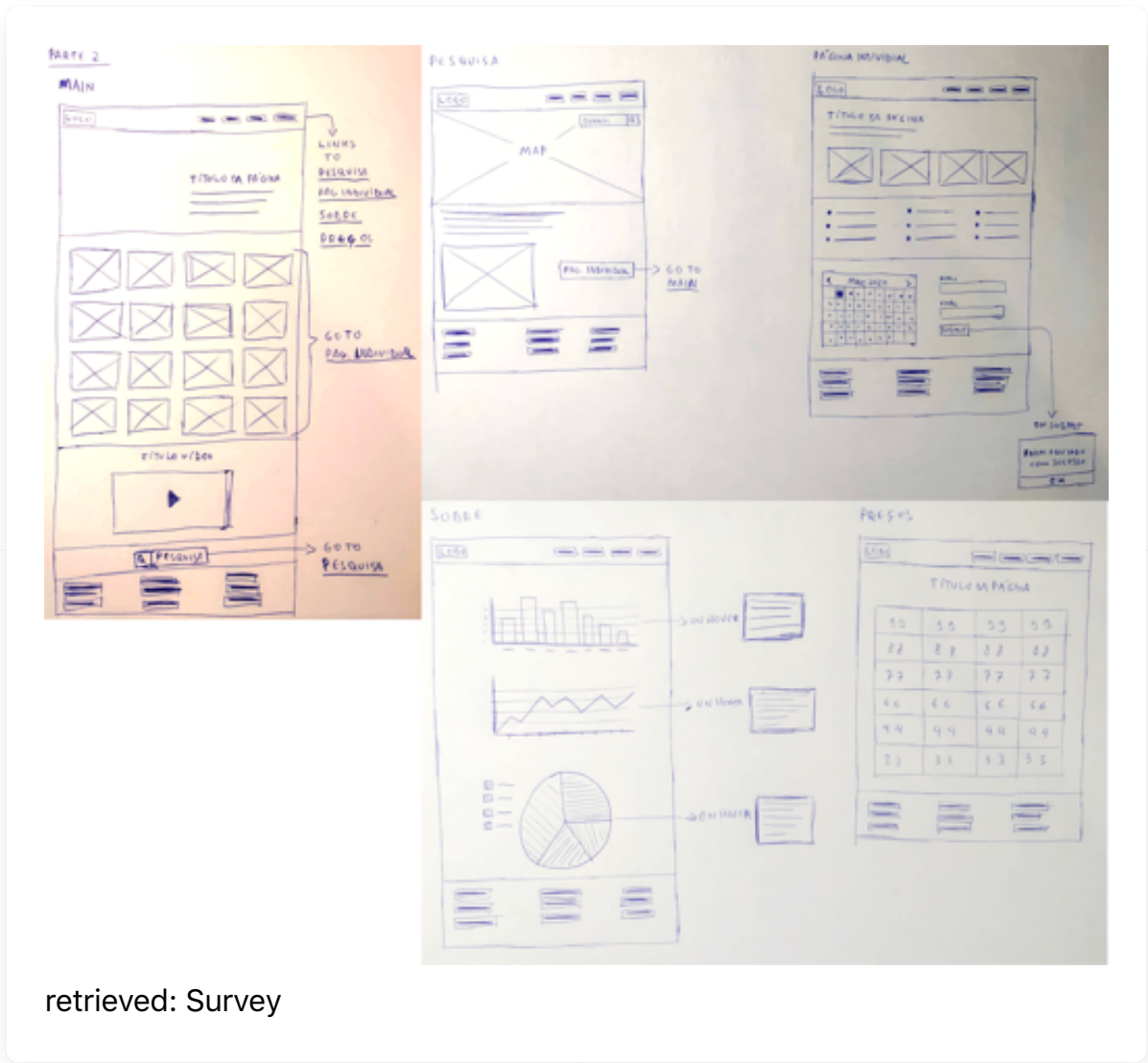
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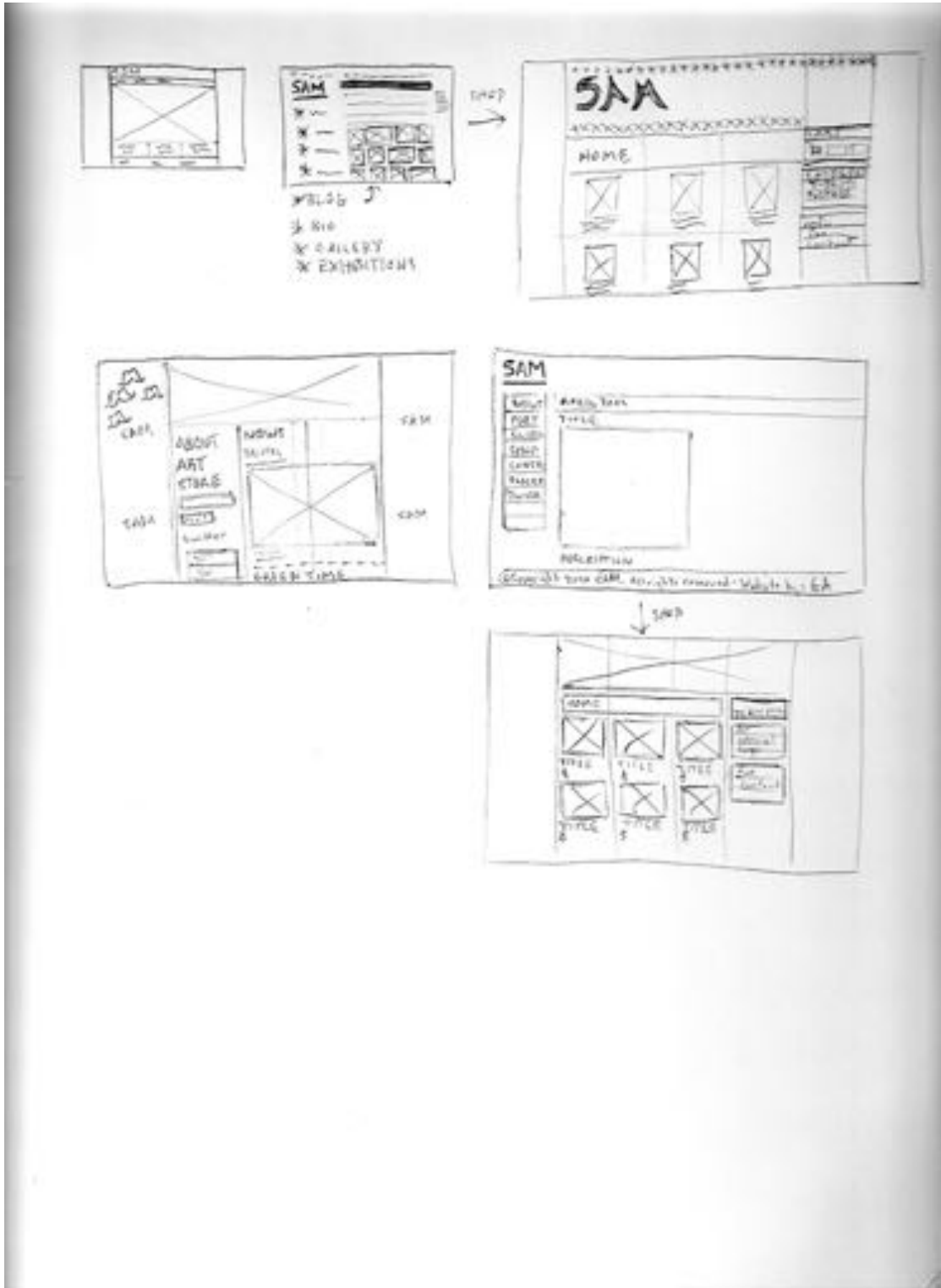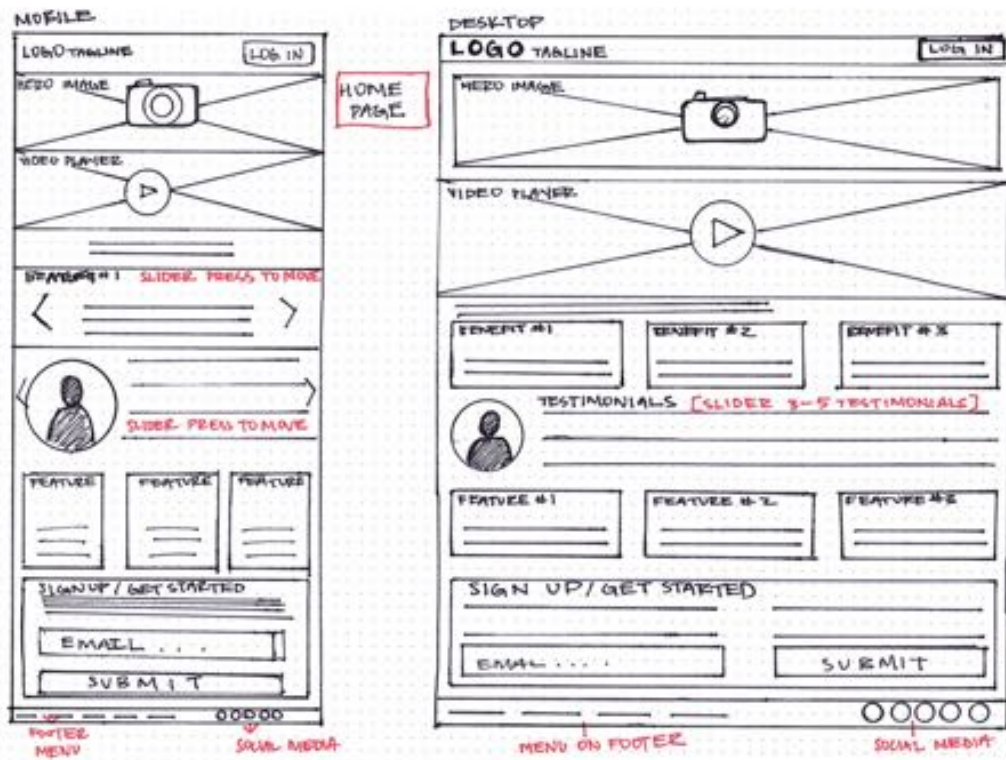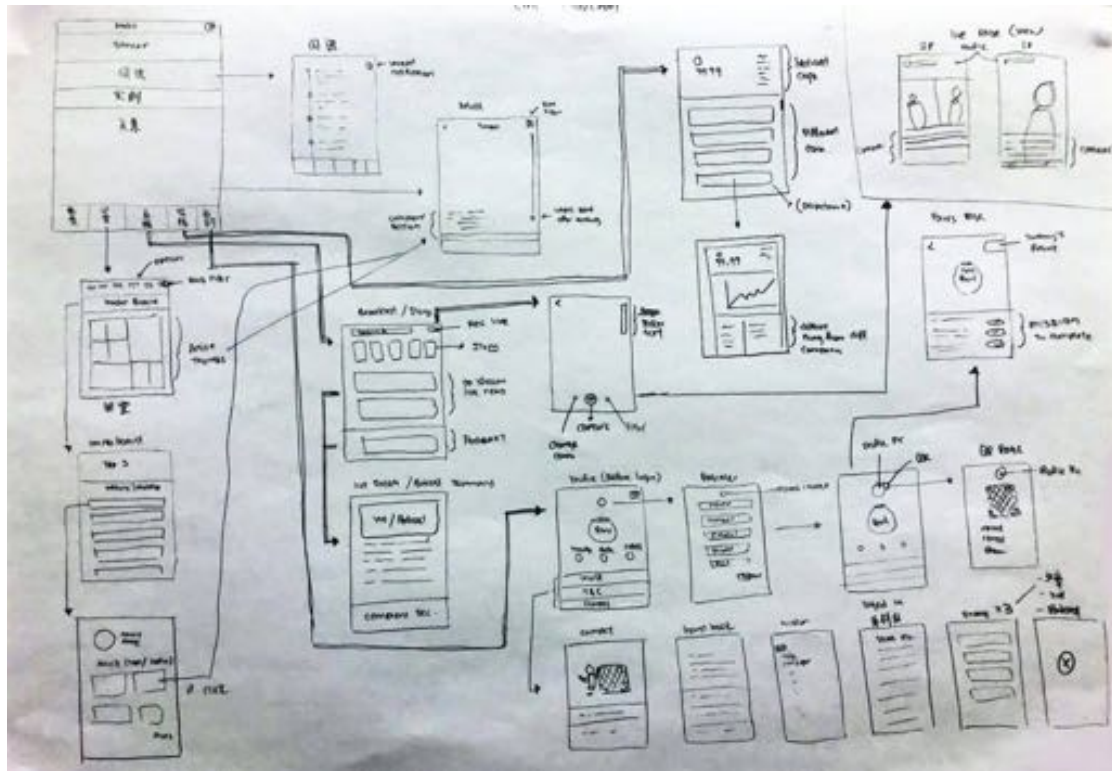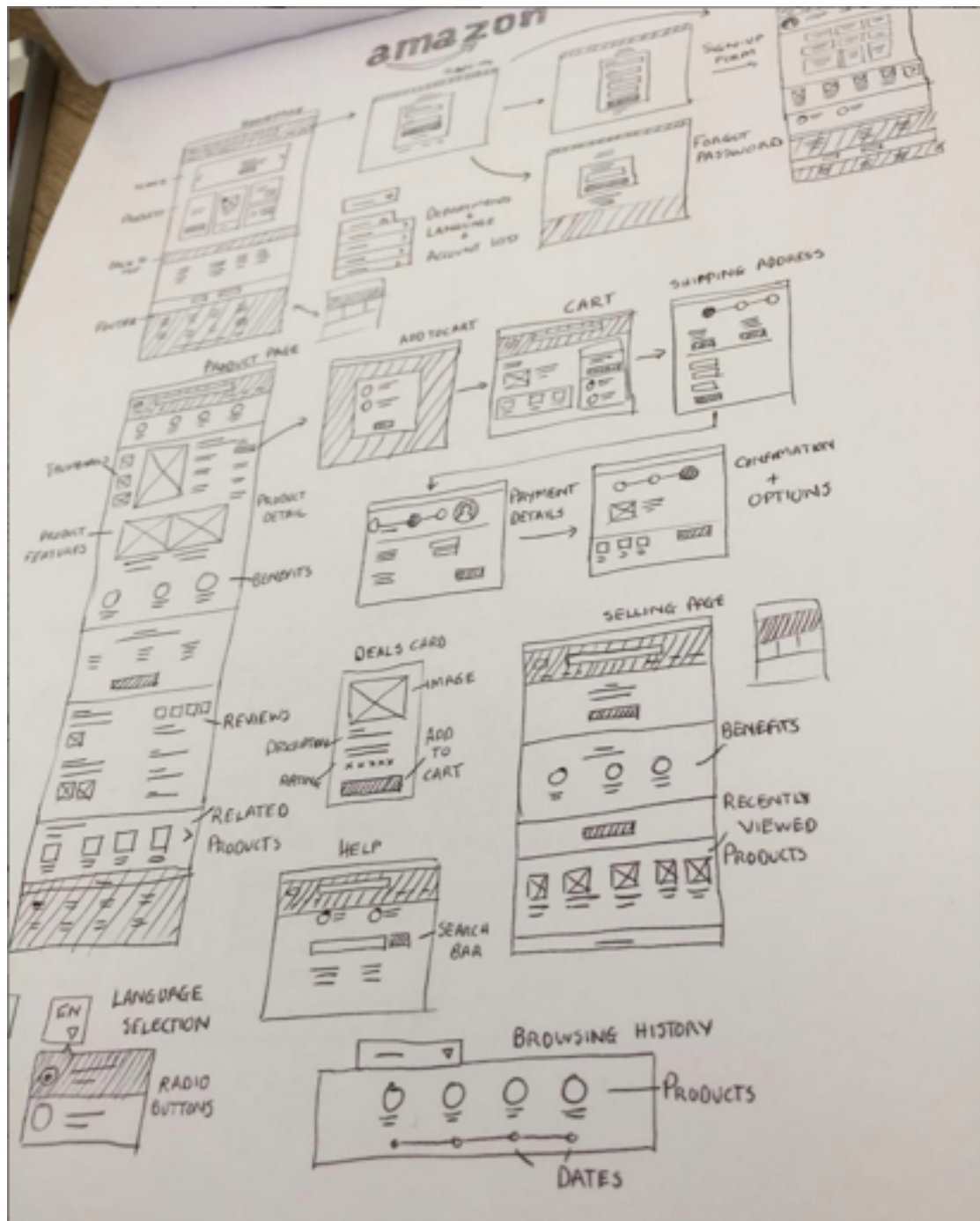

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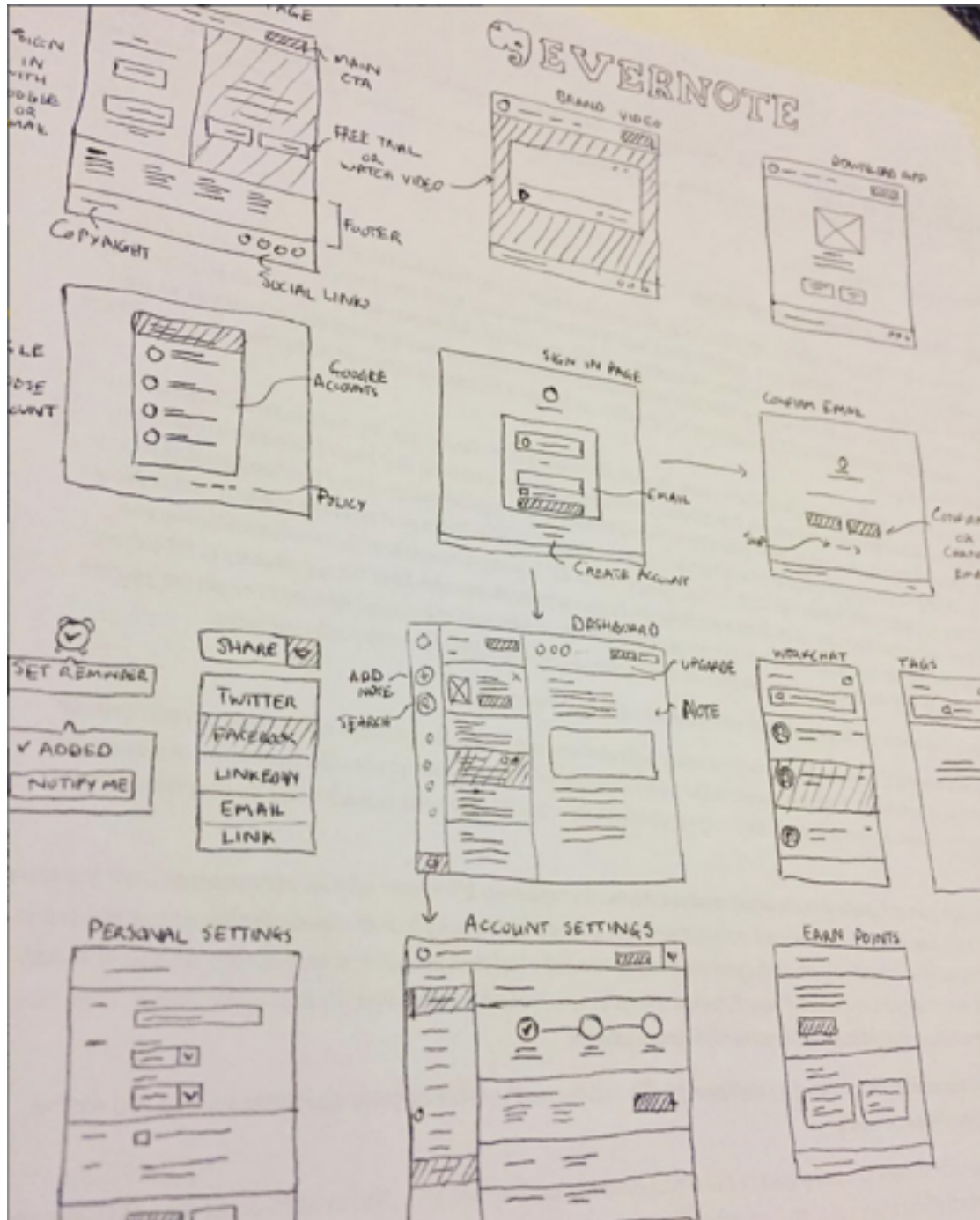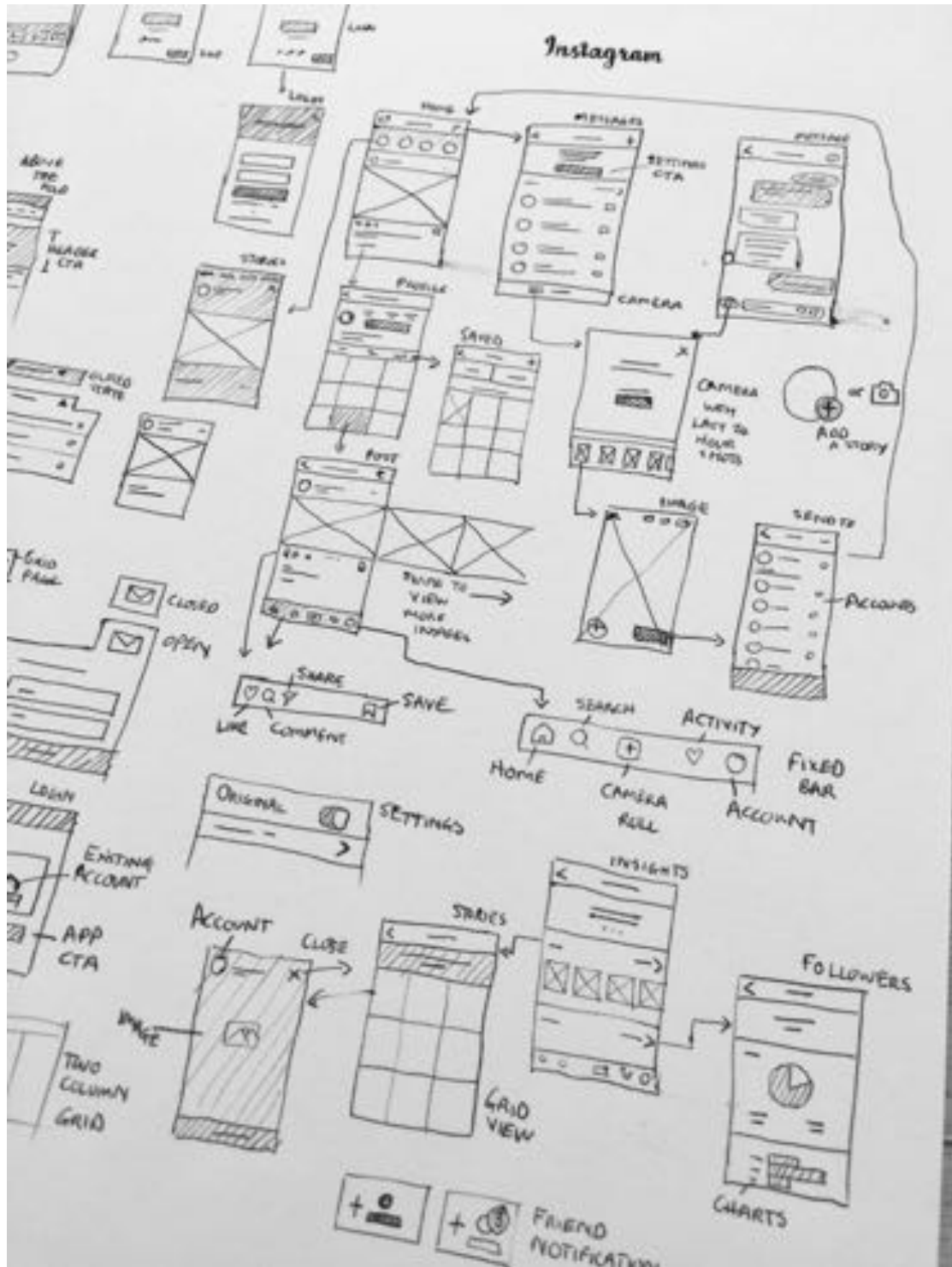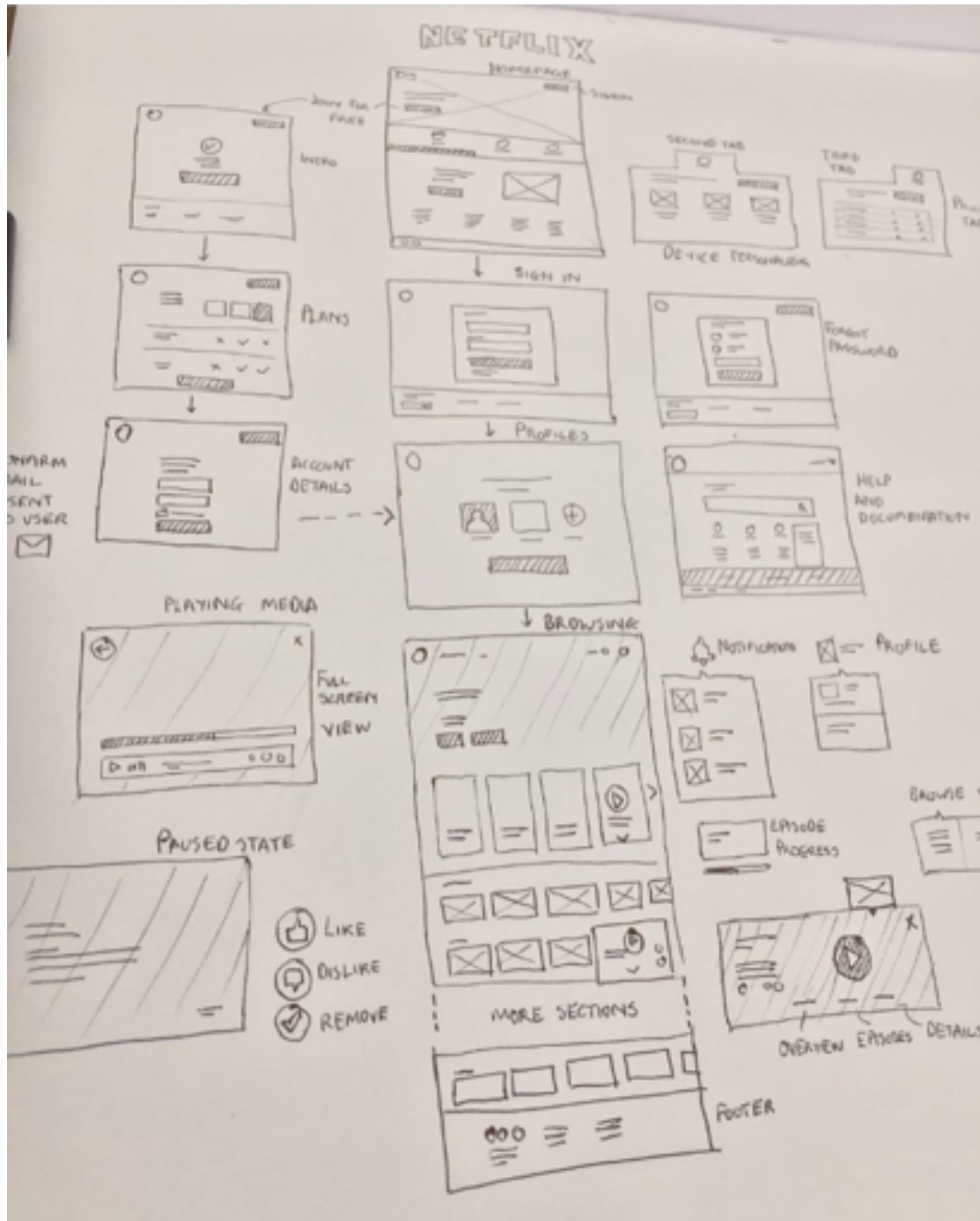retrieved: Online

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Work Documents

Appendix B

Validation Documents

B.1   Raw Data

RAW DATA OF THE VALIDATION

PART 1 - Number of people

C / L	Image	Map	Text	Button	Calendar	Chart	Form	Input	Link	List	Table	Video	Navbar	Footer	Total
1- Image	96		2	1			1				1	1			102
2- Map		102													102
3- Text			102												102
4- Button				90			3	4	4			1			102
5- Calendar				1	100			1							102
6- Chart			1			99					1			1	102
7- Form			1	10			87	1			2		1		102
8- Input				2	1		9	71	2		2		15		102
9- Link							1	6	93	1	1				102
10- List								9		92	1				102
11- Table							2	2		4	90	2	2		102
12- Video									1			101			102
13- Navbar							1	1	1	1			97	1	102
14- Footer							9	9	1	9			4	75	102

C) First column represent the question number and the the intended answer.

L) First line represent all possible answers.

PART 1 - Percentage of people

C / L	Image	Map	Text	Button	Calendar	Chart	Form	Input	Link	List	Table	Video	Navbar	Footer	Total
1- Image	94,12%		1,96%	0,98%			0,98%				0,98%	0,98%			100,00%
2- Map		100,00%													100,00%
3- Text			100,00%												100,00%
4- Button				88,24%			2,94%	3,92%	3,92%			0,98%			100,00%
5- Calendar				0,98%	98,04%			0,98%							100,00%
6- Chart			0,98%			97,06%					0,98%			0,98%	100,00%
7- Form			0,98%	9,80%			85,29%	0,98%			1,96%		0,98%		100,00%
8- Input				1,96%	0,98%		8,82%	69,61%	1,96%		1,96%		14,71%		100,00%
9- Link							0,98%	5,88%	91,18%	0,98%	0,98%				100,00%
10- List								8,82%		90,20%	0,98%				100,00%
11- Table							1,96%	1,96%		3,92%	88,24%	1,96%	1,96%		100,00%
12- Video									0,98%			99,02%			100,00%
13- Navbar							0,98%	0,98%	0,98%	0,98%			95,10%	0,98%	100,00%
14- Footer							8,82%	8,82%	0,98%	8,82%			3,92%	73,53%	100,00%

C) First column represent the question number and the the intended answer.

L) First line represent all possible answers.

1 - What is the screen size of these pages?

Correct Answer: Desktop

Answers	% of people	nº of people
Desktop	72,55%	74
Tablet	9,80%	10
Mobile	17,65%	18
Total	100,00%	102

2 - What happens when you click on the Button at the bottom of "C1"?

Correct Answer: A pop up will appear showing a message

Answers	% of people	nº of people
A pop up will appear showing a message	70,59%	72
I am redirected to another page	21,57%	22
Nothing	7,84%	8
Total	100,00%	102

3 - On the Home page, what happens if you click on "E1"?

Correct Answer: I will go to a specific part of the Games page

Answers	% of people	nº of people
I will go to a specific part of the Games page	74,51%	76
I will go to the Games page	21,57%	22
I will go to the About page	3,92%	4
Total	100,00%	102

4 - How many sections does the About page have?

Correct Answer: 3

Answers	% of people	nº of people
4	48,04%	49
3	32,35%	33
6	19,61%	20
Total	100,00%	102

5 - How many columns does "A1" have?

Correct Answer: 4

Answers	% of people	nº of people
4	95,10%	97
3	4,90%	5
2	0,00%	0
Total	100,00%	102

6 - How many rows does "D1" have?

Correct Answer: 2

Answers	% of people	nº of people
2	83,33%	85
4	14,71%	15
1	1,96%	2
Total	100,00%	102

7 - On the Games page, is "B1" a container ?

Correct Answer: No

Answers	% of people	nº of people
No	41,18%	42
Maybe	33,33%	34
Yes	25,49%	26
Total	100,00%	102

8 - On the "Games" page do you see ...

Correct Answer: a Grid

Answers	% of people	nº of people
a Grid	83,33%	85
Columns	16,67%	17
Total	100,00%	102

9 - On the "Home" how many links do you see?

Correct Answer: 4

Answers	%	nº of people
1	0,98%	1
2	23,53%	24
3	5,88%	6
4	39,22%	40
5	7,84%	8
6	4,90%	5
7	1,96%	2
8	0,98%	1
9	1,96%	2
10	1,96%	2
12	0,98%	1
14	1,96%	2
20	1,96%	2
22	0,98%	1
23	0,98%	1
44	0,98%	1
>=5	0,98%	1
around 16	0,98%	1
a)	0,98%	1
Total	100,00%	102

a) visible (as in, with the symbol), there are four. But could be more it is not clear

10 - How many buttons exist on the "About" page ?

Correct Answer: 2

Answers	%	nº of people
0	0,98%	1
1	4,90%	5
2	70,59%	72
3	2,94%	3
4	9,80%	10
5	4,90%	5
6	1,96%	2
8	0,98%	1
10	1,96%	2
23	0,98%	1
TOTAL	100,00%	102

11 - In how many ways can you get from the "Home" page to the "Games" pages ?

Correct Answer: 3

Answers	%	nº of people
1	1,96%	2
2	34,31%	35
3	55,88%	57
4	3,92%	4
5	0,98%	1
6	0,98%	1
7	1,96%	2
TOTAL	100,00%	102

B.2   Validation Form

Visual Language Validation

Hi, I'm Ivo a student of the multimedia master, and I'm currently finishing my thesis.
I would like it if you could take some time to answer this form about a visual language for sketch web interfaces.
The visual language was developed along this month accordingly to data retrieved from interface designers and the idea now is to understand if it works in this anonymous survey.

The survey is divided in two parts:
In the first part, an image will be shown to contextualize the following questions. In the questions, you will have to identify what is represented according to a multiple-choice and it is possible to return to the initial image, if necessary, to understand where that element is within the system.
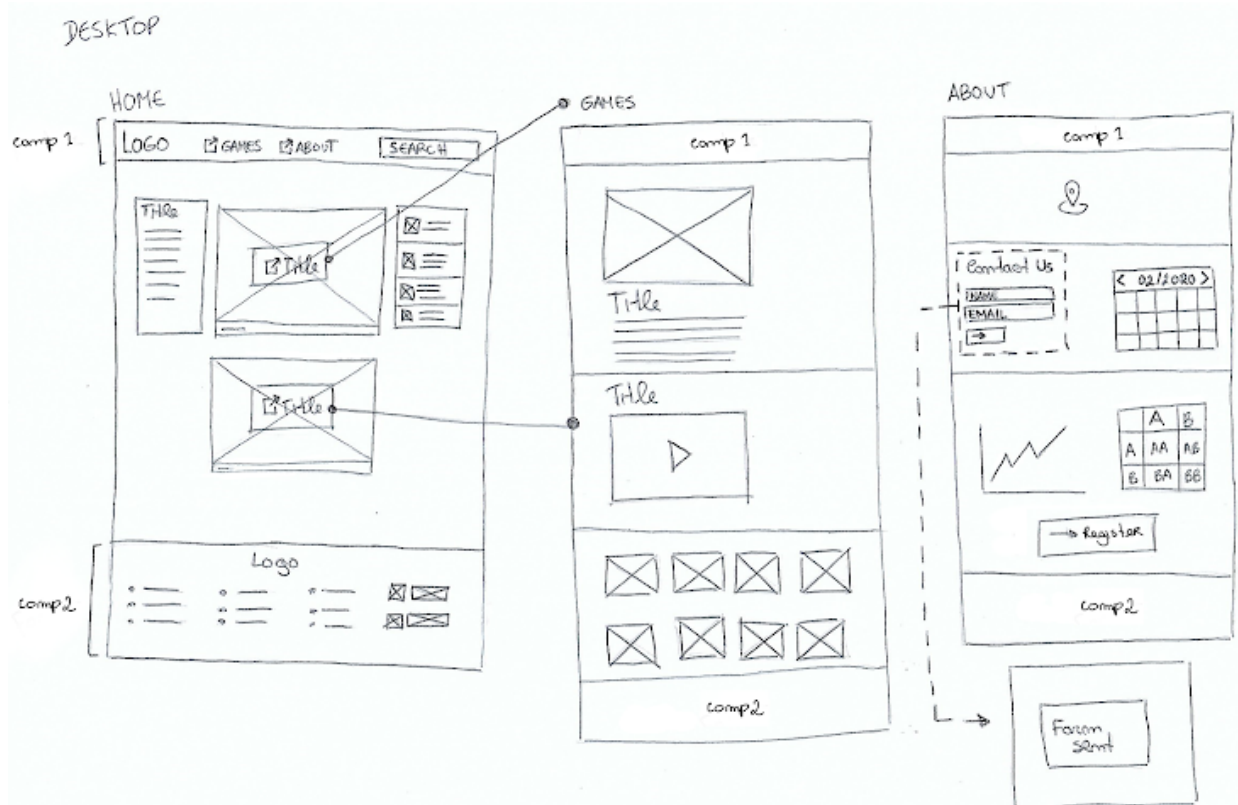
In the second part the same image will be shown but this time other questions will be asked to understand if mechanisms that are not shown visually in the image are understood
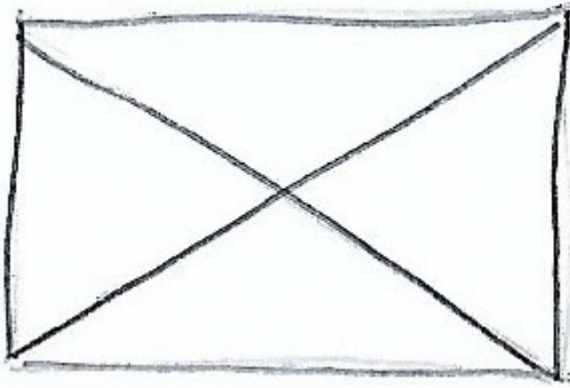
THANKS IN ADVANCE FOR THE TIME TO ANSWER IT
*Obrigatório

Look at the Following Image
After familiarize with it, please answer questions

1.　What is being represented on the image? *

Marcar apenas uma oval.

- ◯ Text
- ◯ Video
- ◯ Link
- ◯ Input
- ◯ Image
- ◯ Table
- ◯ Button
- ◯ Calendar
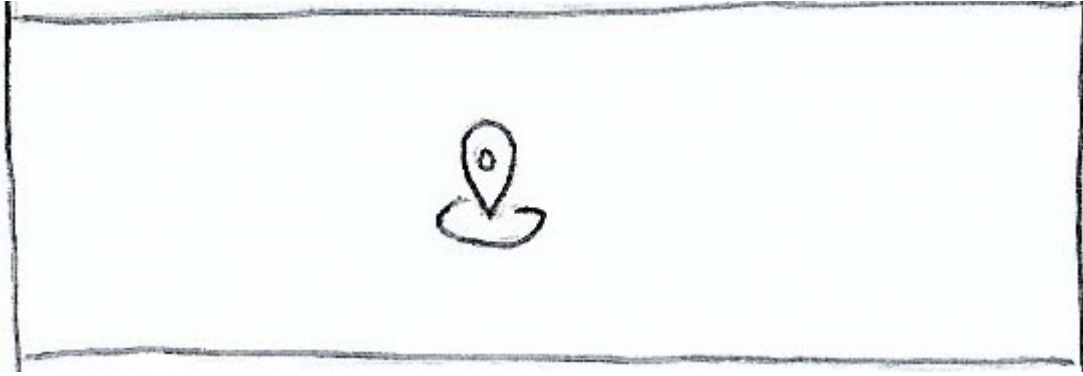- ◯ Chart
- ◯ Map
- ◯ Navbar
- ◯ List
- ◯ Footer
- ◯ Form

2. What is being represented on the image? *

Marcar apenas uma oval.

- Text
- Video
- Link
- Input
- Image
- Table
- Button
- Calendar
- Chart
- Map
- Navbar
- List
- Footer
- Form
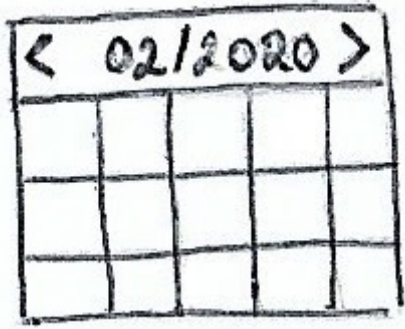
3. What is being represented on the image? *

Marcar apenas uma oval.

- ( ) Text
- ( ) Video
- ( ) Link
- ( ) Input
- ( ) Image
- ( ) Table
- ( ) Button
- ( ) Calendar
- ( ) Chart
- ( ) Map
- ( ) Navbar
- ( ) List
- ( ) Footer
- ( ) Form

4.   What is being represented on the image? *

Marcar apenas uma oval.

- ◯ Text
- ◯ Video
- ◯ Link
- ◯ Input
- ◯ Image
- ◯ Table
- ◯ Button
- ◯ Calendar
- ◯ Chart
- ◯ Map
- ◯ Navbar
- ◯ List
- ◯ Footer
- ◯ Form

5. What is being represented on the image? *

Marcar apenas uma oval.

- ( ) Text
- ( ) Video
- ( ) Link
- ( ) Input
- ( ) Image
- ( ) Table
- ( ) Button
- ( ) Calendar
- ( ) Chart
- ( ) Map
- ( ) Navbar
- ( ) List
- ( ) Footer
- ( ) Form

6.   What is being represented on the image? *

Marcar apenas uma oval.

○ Text

○ Video

○ Link

○ Input

○ Image

○ Table

○ Button

○ Calendar

○ Chart

○ Map

○ Navbar

○ List

○ Footer

○ Form

7. What is being represented on the image? *

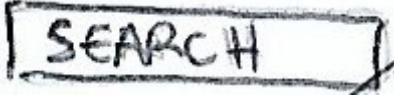*Marcar apenas uma oval.*

- Text
- Video
- Link
- Input
- Image
- Table
- Button
- Calendar
- Chart
- Map
- Navbar
- List
- Footer
- Form

8.   What is being represented on the image? *

Marcar apenas uma oval.

- ◯ Text
- ◯ Video
- ◯ Link
- ◯ Input
- ◯ Image
- ◯ Table
- ◯ Button
- ◯ Calendar
- ◯ Chart
- ◯ Map
- ◯ Navbar
- ◯ List
- ◯ Footer
- ◯ Form

9. What is being represented on the image? *

Marcar apenas uma oval.

- ( ) Text
- ( ) Video
- ( ) Link
- ( ) Input
- ( ) Image
- ( ) Table
- ( ) Button
- ( ) Calendar
- ( ) Chart
- ( ) Map
- ( ) Navbar
- ( ) List
- ( ) Footer
- ( ) Form

10. What is being represented on the image? *

Marcar apenas uma oval.

- ( ) Text
- ( ) Video
- ( ) Link
- ( ) Input
- ( ) Image
- ( ) Table
- ( ) Button
- ( ) Calendar
- ( ) Chart
- ( ) Map
- ( ) Navbar
- ( ) List
- ( ) Footer
- ( ) Form

11. What is being represented on the image? *

Marcar apenas uma oval.

○ Text

○ Video

○ Link

○ Input

○ Image

○ Table

○ Button

○ Calendar

○ Chart

○ Map

○ Navbar

○ List

○ Footer
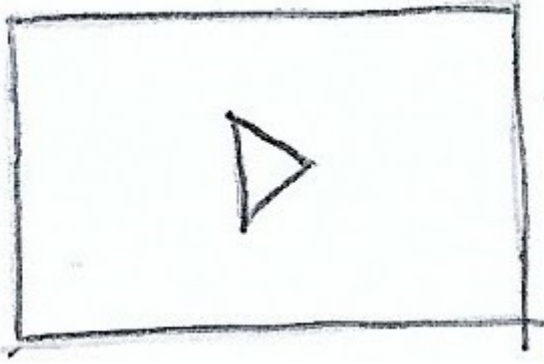
○ Form

12.   What is being represented on the image? *

Marcar apenas uma oval.

◯ Text

◯ Video

◯ Link

◯ Input

◯ Image

◯ Table

◯ Button

◯ Calendar

◯ Chart

◯ Map

◯ Navbar

◯ List

◯ Footer

◯ Form

13. What is being represented on the image? *

Marcar apenas uma oval.

- Text
- Video
- Link
- Input
- Image
- Table
- Button
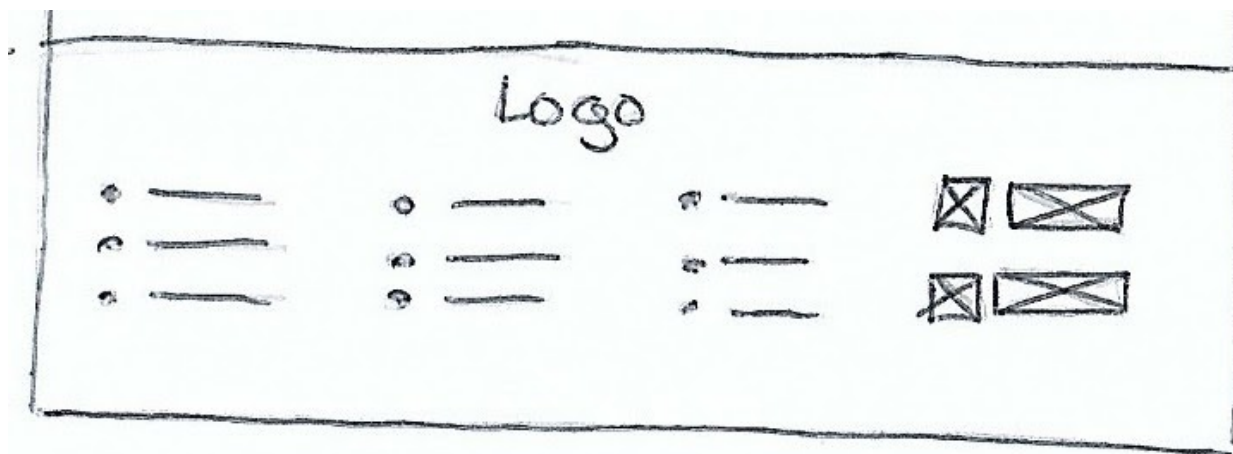- Calendar
- Chart
- Map
- Navbar
- List
- Footer
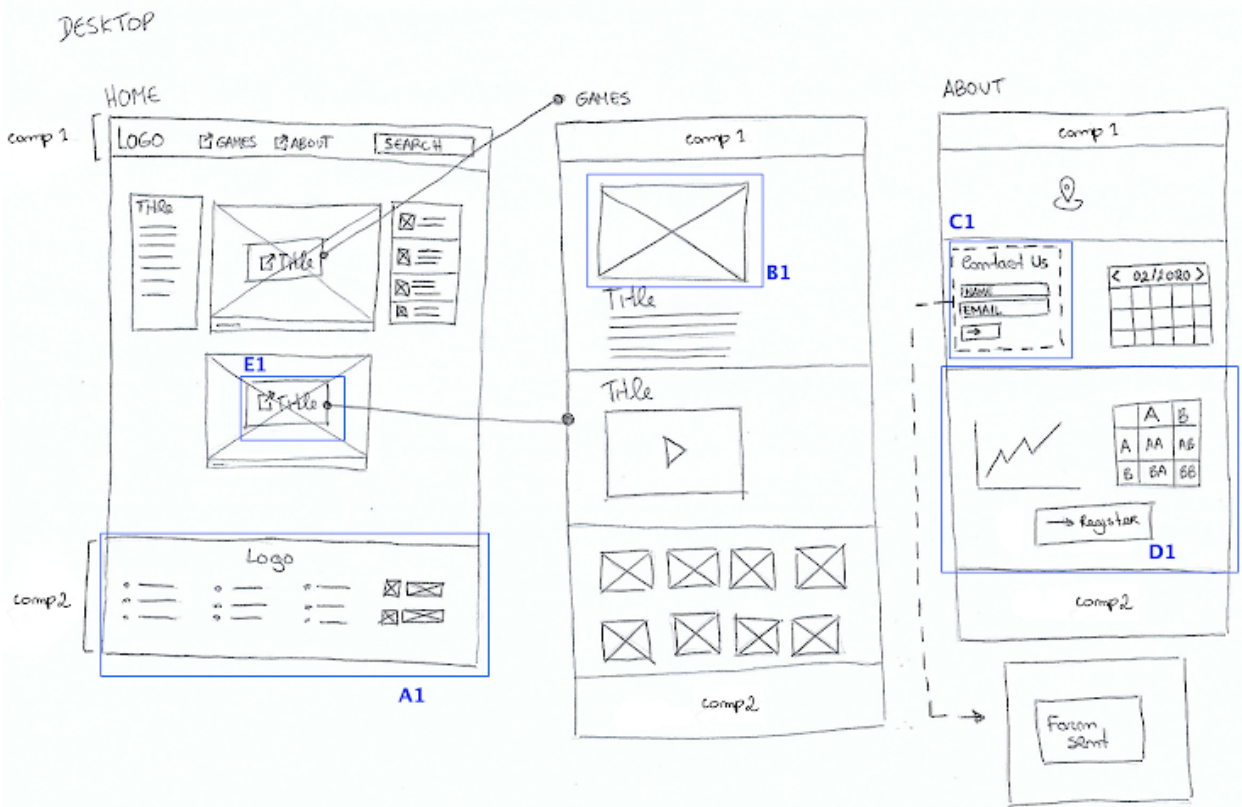- Form

14.   What is being represented on the image? *

Marcar apenas uma oval.

◯ Text

◯ Video

◯ Link

◯ Input

◯ Image

◯ Table

◯ Button

◯ Calendar

◯ Chart

◯ Map

◯ Navbar

◯ List

◯ Footer

◯ Form

Part 2

Look at the fallowing image and answer the questions

15. What is the screen size of these pages? *

Marcar apenas uma oval.

◯ Mobile

◯ Desktop

◯ Tablet

16. What happens when you click on the Button at the bottom of "C1"? *

Marcar apenas uma oval.

◯ Nothing

◯ A pop up with appears showing a message

◯ I am redirected to another page

17. On the Home page, what happens if you click on "E1"? *

Marcar apenas uma oval.

◯ I will go to the Games Page

◯ I will go to the About Page

◯ i will go to a specific part of the Games Page

18. How many sections does the About page have? *

Marcar apenas uma oval.

◯ 6

◯ 3

◯ 4

19. How many columns does "A1" have? *

Marcar apenas uma oval.

◯ 4

◯ 2

◯ 3

20. How many rows does "D1" have? *

Marcar apenas uma oval.

◯ 4

◯ 2

◯ 1

21.   On the Games page, is "B1" a container ? *

Marcar apenas uma oval.

○ Yes

○ No

○ Maybe

22.   On the "Games" page do you see ... *

Marcar apenas uma oval.

○ A Grid

○ Columns

23.   On the "Home" how many links do you see? *

_____

24.   How many buttons exist on the "About" page ? *

_____

25.   In how many ways can you get from the "Home" page to the "Games" pages ? *

_____

Thank you For your Time

Google Formulários

Validation Documents