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Browsing Issues in Large Displays

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ABSTRACT

The internet access is increasingly shifting from the traditional desktop displays to high-resolution giant screen displays. While websites are not optimized for such giant screens, it often delivers a distorted, disconnected and annoying user experience. The challenge in a large display is related to content scaling and placing them on the predictable places to gain visibility. There is a limited research done in this area and we attempted a series of studies in establishing the challenges a user faces while browsing on a large display. We conducted 3 independent pilot studies to understand the problem and discussed the need to create web design guidelines for large displays.

Keywords: *User Centered Design Issues; Large Displays; User Experience Guidelines.*

1. INTRODUCTION

The human visual system has two visual pathways, central and peripheral. Central vision pinpoint objects and peripheral vision draws a gist of surroundings. In web browsing, peripheral vision provides a synopsis of the web page and central vision pinpoint objects guiding the user to initiate actions. For example to initiate a click a call-to-action button is placed within the range of the central vision. A designer constructs visual cues to guide user's vision to different parts of the web page. In order to gain prominence visual weights are assigned to important page components. Since large displays are set to a higher resolution by default, incorrect design considerations lead to two distinct style of displaying webpages further leading to browsing difficulties. A) At higher resolution the page components and fonts do not magnify proportionately in line with the resolution. Consequently, due to the inability to scale the page components gets scattered apparently leaving a ton of whitespaces around them. While designing for large displays designers normally follow the concept of "space is there to be filled" [21]. B) To curb the problem of extra whitespaces sometime the page accommodates extra information leading to a clutter and information overload. Further to this problem users viewing distance affects the browsing experience. If users sit closer to the monitor they miss out information due to a reduced peripheral scope. At this juncture, objects falling within the peripheral area becomes obscure. There are extreme eye excursions, head movement, and postural discomfort. Conversely, if the user is farther no doubt the peripheral scope widens but users encounter problems like information overload and readability issues.

Large displays are becoming popular due to its immersive nature resulting in a greater feeling of presence or a sense of "being there" [3]. As per IDC Worldwide Quarterly PC Monitor Tracker, June 2015, a screen size of 21.5-inches wide has held the largest worldwide share for the last ten quarters. W3Cs research report on the screen resolution statistics says that on Jan 2016 18% of users were using 1920*1080 resolution monitor and 36% users were using 1366*768 resolution monitor [5]. However, monitor resolution and screen size are not alike, even a small screen display (for example a 15inch monitor) can have a high-resolution display capability. At optimal resolution, every pixel in the PC maps to one pixel on the screen. At a lower resolution, every pixel in the PC maps to multiple pixels on the screen. This make object appears blurry [18]. In this paper, we explore few design issues and suggest design guidelines for large displays.

The human eyesight that actually sees the sharp image is called "foveal vision", this is a small part of the eyesight about 1.5-2 cm circle. The rest of it is the peripheral vision which has not so great resolution [14]. The spatial resolution of the human visual field drops greatly from the center to the edges [13]. Casimir Ludwig, J. Rhys Davies, and Miguel Eckstein's research (2014) suggests it is the peripheral vision what it sees, and how that information is processed in the brain. The peripheral vision tells the central vision where to focus next. This is a largely unconscious process [19]. So, for easy access, essential page elements should fall within the visual field of a user.

According to EN 894 industrial standard, the optimal viewing angle lies between 0 and 15º and 0 and -15º (area A in Figure1). The acceptable viewing angle lies between 0 and 30º and 0 and -30º (area B). Area C is not easily visible [4]. Users fail to notice important cues due to the low acuity of peripheral vision [13]. While browsing when a user clicks a button or a link that is usually where his or her fovea is positioned [13]. The rest of the page components are in the peripheral vision where the resolution is low. A person might fail to notice anything that appears in the periphery after a click [13].

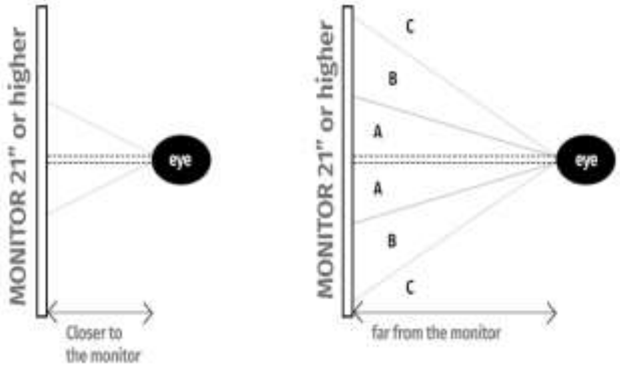

Figure 1. Peripheral & Central view

There is a direct correlation between large display size & the screen resolution, the larger the monitor the higher is the screen resolution. W3counter suggests that large displays have a default resolution of 1920x1080 pixels. In this paper, we define large display as a monitor which is 21 inch & above.

It is evident from user studies that working on a large monitor can augment the benefit of multitasking by adjusting multiple windows running in parallel. But, when it comes to the web browsing large displays throw certain challenges. In movie theaters, the front seats are less expensive than the rear ones. Rear seating is preferred as it gives the audience a full view of the screen. When seated at the back the entire movie screen falls within the peripheral range. This idea echoes back to web browsing. While working with PCs or laptops a user naturally adjusts the viewing distance. In the context of web browsing to get the full view of the webpage, the user prefers sitting at a distance which makes the browsing experience comfortable. Both monitor size & resolution is the key influencer in setting up a comfortable distance.

While working with large displays a sitting arrangement at the farther distance broadens the peripheral scope of the vision. While this is an ideal thing to do but due to the application of incorrect User Interface design patterns, large resolution monitor accommodates additional information into the wider viewport. The page becomes overloaded with information. Overloading of information can further lead to a state of decision paralysis, a phenomenon where the user has difficulty in deciding on the next navigation path. The problem of too many choices is discussed in Barry Schwartz's book The Paradox of Choice: Why More Is Less. Hick's law states that as the number of choices increases it further increases the time to make a decision.

The comfortable distance as set by the user may not hold good for cases where the page components and the font do not magnify proportionately posing challenges to the users in scanning the page from a distance. Everything looks tiny. While the page objects look tiny, it forces the user to get closer to the monitor for a better clarity. At this juncture the peripheral scope reduces, thereby expanding the likelihood of missing important cues. To achieve visual comfort, it forces users to twist the neck towards the visual object. Generally, horizontal head movement occurs when eye excursions are greater than 6 to 8 degrees. It leads to better visual comfort at the expense of postural discomfort [1]. Getting closer to the monitor is suited for low vision users for legibility and clarity.

Figure 2. A popular online e-commerce store showing additional products when viewed on a 30" monitor with a resolution of 2560x1600

2. RELATED WORK

Research projects have independently drawn similar conclusions on how large displays can improve efficiency for normal office work. Those independent findings outlines that the more screen real estate is available (i.e. the larger the display size) the greater amount of information and applications can be visible at once [7]. Jeff Atwood describes a paradox where large displays can increase productivity up to a certain size, but the productivity drops after a certain point because users spend more time managing the space [11]. The Pfeiffer Group (2005), claims that high-resolution displays such as the 30-inch Apple Cinema HD Display results in measurable productivity and efficiency gains. The paper claims that productivity gains were present in professional design and publishing, digital imaging and digital video. The gains are also in general productivity and office applications such as word processors and spreadsheets [8]. However, there is no concrete evidence that large displays can advance the web browsing experience. There is hardly any research done on how to design pages better for bigger screens. Veland (no year) states there is no relevant design guidelines and specific knowledge of the area of large screens [9]. It is seen that the traditional screens are just copied to the large screen. Today, big-screen web users typically utilize their extra space for multiple windows and parallel browsing [15].

To prove the fact that peripheral vision guides central vision Adam Larson and Lester loschky (2009) showed photographs of kitchen and living room to survey respondents. In some of these photos the outside of the picture was obscured, and in others, the central part of the picture was obscured. The images were purposely shown with a gray filter for a short duration so it is hard to see. The research participants were asked to identify what they are looking at. They found if the central part of the photo was missing, people could still identify the image. But when the peripheral part of the image was missing, then they couldn't say whether the image was a living room or a kitchen. They concluded that central vision is critical for specific object recognition. Peripheral vision is used to get the gist of a scene [19].

In 2006, researcher Jakob Nielsen found that on the average, users browse the web in a predictable pattern. Nielsen found that user follows F- pattern in browsing a webpage. However, there is no evidence on what display size and at what monitor resolution the research was conducted. In large displays, the "F" pattern would likely to break due to scattered visual targets and information overload.

Researchers Shin and Hegde (2010) in a research concluded through an experiment that average preferred viewing distance increased as the size of the monitor increased [6]. When users look at a close object, the eyes accommodate and converge, both of which can contribute to eye strain (Fischer, 19777, Collins, O'Meara and Scott, 1975). The eyes adapt to maintain clear focus as visual targets get closer. This process is called accommodation. Computer users generally have more accommodative disorders than the rest of the population (Sheedy, 1990). A closer screen requires more accommodation. To reduce the load on accommodation computer screen should be moved backward. The researcher suggests that placing the monitor farther away reduces the demand on accommodation and convergence. The farther away a visual target is, the less convergence is required. While using large displays George Robertson, Mary Czerwinski, in their paper "The Large-Display User Experience" highlighted usability issues like losing track of the cursor, bezel problems, window management problems and distal access to information [17].

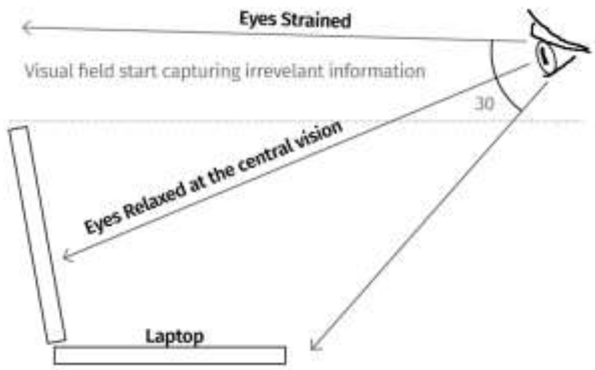

Figure 3. Eyes are relaxed when looking downwards

3. THE STUDY

We conducted 3 independent pilot studies to in the view of establishing an association between the distinct problems a user experience while browsing on large displays. The intent was to discover the significance of the human visual system in outlining a website page, what are the prevailing browsing issues on large displays at an optimal resolution and what ergonomics considerations a user undertakes while browsing on computers. Our perception caught that the issues are interconnected and would require an inside and out approach in handling the issues.

Study1

Brief Problem Statement

The intent of the study is to discover the connection between the workstation ergonomics and how it impacts web browsing on desktop and laptops. While looking at a subject if the physical distance between the subject and the vision is far the periphery gets a wider scope. At this juncture, the vision captures every object falling within the visual field. With a wider peripheral scope the human eye captures assortment of objects including the main subject. Prioritizing an area with the visual field by selectively processing the visual information is known as spatial attention. To gain prominence each subject is assigned with a visual weight to stand separated from the group. But in case the visual weights are identical the consideration is spread over and the whole range of objects are caught in the attention. Further, these extraneous subjects which are caught in the visual field create distractions thereby causing inattentiveness. Even if the user is under the state of full concentration subliminal distraction captures movement & sound around them. To avoid that movies and television are watched under low lighting conditions or complete darkness. It confines the peripheral vision inside the limit of the screen and travels within it to avoid distractions. We analyzed an IT infrastructure management application in context to the application of the human visual system in Web Design. We found one usability issue relating to an information bar obscurity. The thin light blue colored information bar is placed at the top edge of the browser window to notify users. While the intent of the message bar is to educate users on the next steps there has been complaints from the user about the message bar obscurity which resulted in further overlooking the same and making an error.

Sample

Four participants (N=4) who were IT support engineers having an average work experience of 5+ years participated in the experiment on a voluntary basis.

Setup

We conducted a workplace observation with the users while there were engaged in internet browsing. Out of the 4 users 2 were using 16.3" inch monitor laptop and other 2 were using a 19" inch monitor desktops.

Method

The intention of the study was to capture the region of the computer monitor where there is a maximum point of gaze while using different types of workstations.

Results

We observed a variation in the viewing distance for the 2 user groups. The desktop users were comparatively farther from the screen than the laptop users. There was no workstation ergonomics for the laptop users compared to desktop users. The central vision was found to be gazing at the bottom part of the monitor most of the time. User preferred scrolling the content to the bottom part of the screen to facilitate the vision. The same was not the case for desktop users and the eye was able to focus on different parts of the screen with increased peripheral scope

Formative Discussion

Laptop design has inherent problems which makes the ergonomic guidelines for laptop use difficult. At the point when the screen is at a comfortable height and distance the keyboard is not, and the other way around [10]. Research claims that human eyes are relaxed when looking downwards and are strained when looked up (Figure 2). A user has preferences for the vertical position of the visual objects. User prefers computer screen to be significantly lower compared to the horizontal sight line (eye-ear line). As gaze angle tilts downward the resting point of vergence moves inward (Heuer and Owens, 1989). The eyes are simply better at focusing as gaze angles tilt downward. It reduces stress on the eye muscles and improves the ability to accommodate [1]. We concluded that point of gaze of the central vision on a computer monitor is largely dependent on factors like workstation ergonomics, monitor size and the type of workstations users are dealing with. For laptop user head is tilted downwards and the central vision is found to be gazing around the center part of the screen (Refer Figure 3).

Study2

Brief Problem Statement

In continuation of the earlier problem our view was to get user's opinion on which information bar placement option would work better for users, we conducted an online survey with 31 users (N=31).

Sample

We used a convenience sampling technique and involved users who were IT professionals with experience ranging from 2 – 12 years.

Setup

We launched an online survey with 2 prototypes. Prototype A with information bar placed in the center of the page and Prototype B with information bar placed on the top edge of the browser window as is in the application. The survey URL was shared with the users over an email.

Method
The two HTML prototypes were shown to the users. The users were asked to vote for the best choice and state the reason behind the selection. Out of the 31 participants, there were 22 laptop users and 10 desktop users.

Results
Amongst the laptop users 14 chose option A and 8 chose option B. From the 9 desktop users, 5 chose option A and 4 chose option B. There were supporting reasons in selecting Option A which says "it immediately create attention", "it is more visible and accessible", "focus on the message box is lost when it's on top".

Formative Discussion
Human visual system largely dictates the design of a webpage. We concluded our research with two distinct findings. We accumulated the results from the findings of Study 1 and clubbed with Study 2. There were two distinct findings. A) While the focal vision is tied up around the center to the bottom part of the screen the information bar is receiving low prominence. It is placed on the area where the periphery is low for laptop users. To view the information bar eyes needed to gaze upwards further increasing the chance of causing an eye strain. B) The top bar looks muddled due to the browser properties (bookmark bar, extensions etc.) showing up as a part of the browser window. The light blue colored information bar was receiving low prominence and getting weakened with the color of the window. It was getting submerged with the color of the application and never recognized as an individual piece. Instead it was perceived as an assortment of objects. To tackle the issue, we prescribed placing the information bar at the vertical center of the page.

Figure 4. Laptop users found to be not following workstation ergonomics

Figure 5. Desktop users found to be following workstation ergonomics

Figure 6. Screen shot of the application with message bar appearing on the top

Study 3

Brief Problem Statement
In order to gather user insights we launched an online survey to understand the dominant browsing issues with large displays. 31 (N=31) participants responded to the survey.

Sample
The participants were aged between 20 - 70 years with a mean age of 35.80 and SD = 8.38. There were 26 male participants and 5 female participants. 74% of the respondents reported using laptop computer & 26% using a desktop computer.

Setup
An online survey was floated using google forms. Social channels like Facebook & LinkedIn were used to broadcast the survey link. In the survey we started with common demographic questions asking participants about their age, height gender, followed by more specific ones. Does user have a low vision problem, what is the average time spent on the computer, what monitor type, size, and resolution users are working with?

Method
Along with the generic demographic questionnaire we shared an URL with the participants with a query string. The user were supposed to click on the URL and record the number of images appearing in a row on their computer monitor. In our study monitor screen resolution was the independent variable and how many images fits into a single row was the dependent variable. The objective was to see how many images fits in a single row at a certain screen resolution. On another instance, we showed the participants the below image to take an opinion on how much of eye movement or head movement is involved in reaching from point A to Point B.

Figure 7. Image shown to the survey participants asking to check eye & head movement in reaching point A to point B

Results
We observed as the resolution of the screen increased the number of images in the row increased proportionately. A user using a resolution of 2880 x1800 and 5120x2880 reported 10 images were seen in a row. We presented a bar graph to display the survey results (Fig.7) which show an upward trend line with the no. of images increasing in relation to the monitor resolution.

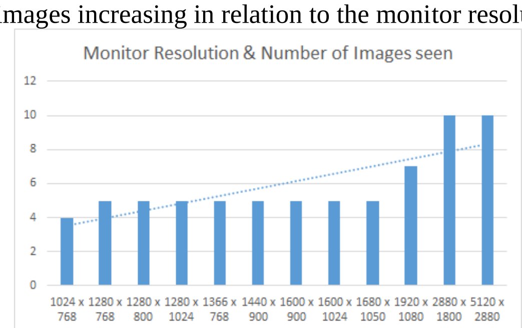

Figure 8. Graph displaying a directly proportional relationship between numbers of images displayed with the screen resolution of the computer

Table 1. Survey results showing mode responses to the question on a Likert scale.

Survey Questionnaire	Mode	Likert Scale
Does a web page look scattered in your monitor?	3	Neutral
Do you find lot of information on your monitor during web browsing	3	Neutral
Do you feel comfortable reading text during web browsing?	2	Uncomfortable

43.8% of the users reported that there is too much of eye movement while 15.6 % said that both eye and head movement is involved (Fig. 9). To reduce eye excursions and head movement users tend to move away from the monitor and try to adjust the viewing distance so that the entire screen is visible in one shot. When asked if the viewing distance varies based on the monitor size. 71.9% reported that viewing distance varies based on the monitor size while 28.1 % reported that the viewing distance remains constant. A longer viewing distance leads to legibility issues. When asked if users are comfortable reading text in website 34% reported not comfortable (Table.1).

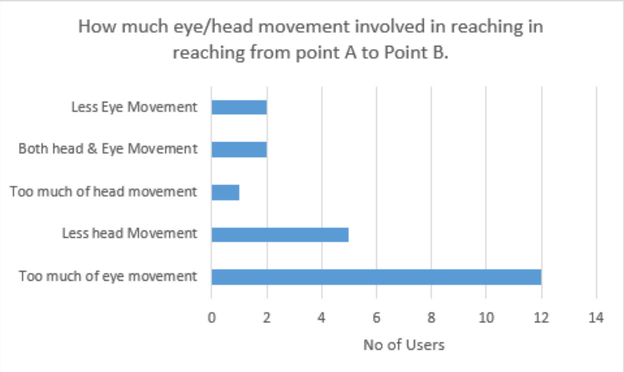

Figure 9. Graph displaying the breakup of parameters if the viewing distance varies.

When asked if the user has difficulty with small display sizes they reported the below-listed problems

- Difficult to take information if the website is too busy.
- Too much information packed in a small area
- Visibility issues
- Content Size

One user reported "It depends on the work I am doing. Sometimes I might simply increase font size or zoom the images." When asked about the browsing experience in 27inch Apple Display one user responded saying "I have to run every website at 200% and half the screen width to be able to read stuff, apps are not optimized for large display...so you have multiple windows running...and attention shifts". When asked if the user has difficulty with large display sizes they reported the below-listed problems

- Scattered Layout & Fatigue
- Head movements
- Website fonts are usually blurry unless I zoom in on most webpages.

Formative discussion

Our study revealed issues with content legibility eye excursions and head movements. The problems observed in small displays are recurrent in a large displays due to lack of design guidelines. The study concluded that while browsing websites users tend to adjust the viewing distance based on the display size and monitor resolution. A large display with a higher resolution set as default at times accommodates extra information within the available viewport. This leads to information overload. The font size does not adjust proportionately leading to legibility issues. It is evident that there is a scope to improve the experience of web browsing in large monitors and the need to set up design guidelines for the same.

Limitations of the study

As this research is not funded our study was limited and we adopted online survey and workplace observation as a method of collecting data. Our study was not conducted in a lab environment, where we could invite participants for a contextual communication and use bigger screens to browse websites and record the challenges involved. This arrangement would have allowed us to measure the impact and come out with concrete findings with empirical values.

4. DISCUSSION

Traditionally large displays are used for various purposes like displaying content while imparting training, they are used in the nuclear control room, entertainment industries, betting shops, airport lounge, stock exchange etc. Due to increased affordability users are using it for personal computing which further prompts the necessity to create design guidelines for large displays. Research claims that user expects tailored experience across form factors. It is because each form factor is used in diverse context for different reasons. Users evidently have different expectations for their phones, tablets, and desktops that must inform our design and UI decisions [16].

Web users have formed certain mental models while dealing with websites over the years. These models guide them to focus on respective parts of the page to look for information. They act as invisible navigators. For example, online shoppers using amazon.com frequently use the search field, when the screen loads users will look right at the search field [20]. While browsing, certain actions does not require any real effort instead, they become automated and originate naturally. These are called as browsing patterns. However, when patterns decompose to form a new one it also carries a steep learning curve. Some of the commonly formed browsing patterns are as follows

- A user always looks out for the logout button at the top right corner of the webpage.
- To update profile user clock on the profile photo that triggers a drop-down menu with update profile link
- To close a modal dialog user unconsciously move the mouse to the top right corner of the modal window or press escape button or click outside of the modal dialog.
- After entering the keyword in the search input box user presses "ENTER" rather clicking on the search icon.

It is expected that certain browsing patterns will remain constant irrespective of display size. Keeping these constants intact design guidelines ought to advance for larger displays. It is a known fact that large displays can be configured to a lesser resolution. However, with an LCD, using a lower resolution will result in inferior image quality. In the lower resolution, each pixel in the computer maps to multiple pixels on the screen. [18] We attempt to institute few design considerations for large displays based on the findings of our study. A series of ergonomics research was conducted by Dr.-Ing. Wolfgang Jaschinski which suggests shorter viewing distance of about 50 cm leads to a stronger visual fatigue than longer viewing distance like 100 cm. To take into consideration more prominent eye-to-screen distance, we require programming software & application that permit text dimensions to be expanded effortlessly. We require rules that don't compel individuals to sit nearer to their screens than the distance at which they are agreeable [2].

As screen size increases, people move their mouse faster and select higher mouse acceleration settings to quickly traverse the screen. The faster the mouse cursor moves, the more likely users are to lose track of it [17]. Fitts's Law states "the time to acquire a target is a function of the distance to and size of the target" [12]. Visual targets should be bigger so that it is easily accessible & reachable with the mouse pointer. As the distance between objects increases, the movement takes longer and as the size decreases selection again takes longer. The aim of user interface design should be to reduce the distance from one point to the next and make the target object large enough to enable prompt detection and selection of interactive elements without sacrificing accuracy [12]. Therefore, it is advisable that all page components including fonts should scale proportionality in line with the resolution in large displays.

In an effort to kill whitespace sometimes large displays accommodate additional content all over the screen. Too much of information leads to decision paralysis, a state where users lack the ability to decide on further actions. Avoiding information overload and providing minimal content would make easier for the user to scan the page. Therefore, extra whitespaces can be filled with bigger content rather than additional content.

Put it where users are looking - People focus in predictable places when interacting with graphical user interfaces [13].
For example top pane and the left is mostly reserved for navigation. Similarly right pane is reserved for sponsored content. The center pane is the room for the main content. In large displays while the content does not scale up proportionality the entire website sits in the center of the screen leaving a large chunk of whitespace on both the sides.

This make content looks tiny and inaccessible, the volume of the content is pressed into a relatively little space makes it troublesome for the eye to know where to focus Therefore, it is advisable to make content available and spread out in the entire viewport.

5. CONCLUSION & FUTURE WORK

Today, responsive UI frameworks allow websites efficiently transform from small to large displays. By applying CSS 3 media queries a single set of code can adapt to multiple form factors. However, responsive UI framework does not provide adequate customization options for large displays. Web pages in 1200 resolution monitors and above look similar. Because of growing mobile users, design guidelines for larger displays is completely ignored. Research says in the future there would a sharp rise in users switching to large displays. We aim to throw light on this topic and plan to establish design guidelines through user research in the next phase of our project. Our next action would be to build a prototype optimized for large displays and test them with end-users. Post testing & analysis we also intend to establish web design best practices for large displays within the user experience community.

6. TIPS FOR USABILITY PRACTIONEERS

While browsing experience is shifting to large displays it becomes important for designers to create UI for higher resolutions. Following are some tips for the Designers

- Since there has been a huge shift from smaller monitors to large monitors it is recommended to keep the base resolution between 1280 -1440px.
- If a larger viewport is available it is recommended not to force fit content. More content on a page can cause usability issues such as information overload which can further lead to a decision paralysis.
- Ensure that the important elements are placed in the periphery with minimal eye or head movement.

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