CS6750 Human-Computer Interactions
Summer 2021 Assignment M5
Split-Screen Feature on Ultrawide Monitor

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Abstract—Samsung's 34" ultrawide monitor with 21:9 wide screen has a great size and nice colors. However, the current interface is not convenient for users to partition the screen on this large monitor based on users' needs. Through the M assignments, I will discuss the problems of the current interface and define the user types. Then I will propose a new interface by performing needfinding, discovering design alternatives, creating prototypes, and conducting evaluations. The new interface should offer more flexibility for users to display multiple screens of different sizes on a single large monitor for business and personal use.

1. QUALITATIVE EVALUATION

1.1 Method and prototype

I was using online surveys to collect data for the qualitative evaluation on wireframe prototype. You can find more information about the wireframe prototype in *4.1 Appendix: Wireframe prototype used in qualitative evaluation*. I created a survey with 7 qualitative questions on peersurvey.cc.gatech.edu. Because the split-screen feature is mainly designed for students and working professionals, I recruited 25 OMS students to complete the survey. The order of the questions shown on the survey is same for each participant.

1.2 Survey results

The raw results are listed in *4.2 Appendix: Survey responses for qualitative evaluation*. Below is the summary of the responses for each question.

Q1. After you click the Menu button, you will see a menu screen like what it shows in Figure 1. Based on your understanding, please briefly describe the actions that you will take to split the screen into 3 windows.

I only provided the figure of the wireframe in my survey and intentionally didn't tell participants the detailed steps to use split-screen feature on the interface. Amazingly, all 25 participants were able to figure out the right steps to perform the split-screen task.

Q2. F1, F2, and F3 are 3 quick access buttons. They can be used to save your 3 favorite screen layouts. And can also be used to quickly split the screen based on the saved settings. Can you guess how those buttons work? For example, how to save the current layout as a favorite and next time how to quickly pull out that layout?

Again, I didn't provide any instructions to participants about how to save their favorite layouts. Only 1/3 of participants were able to provide the correct answer – press and hold the button for 3 seconds to save the current layout as a favroite.

Q3. Can you remember all the necessary steps to perform the split-screen task after using this interface 3 times? Please list some reasons why you can or you cannot remember the steps.

80% participants responded Yes. The rest of the participants said no because they were unclear about if their steps are correct without given any instructions.

Q4. Please comment on this interface in terms of convenience and efficiency of using the screen-split feature. What designs make you feel convenient/inconvenient and efficient/inefficient of using this interface to perform the split-screen task?

88% of participants thought the interface is convenient and efficient. The rest of the participants had concerns that it might not be convenient for novice users.

Q5. Please comment on this interface in terms of usability. For example, it allows users to save the favorite layouts. After you select how many windows you want, it provides a few popular pre-defined layouts to choose. Do you like these functions? Please list the reasons why you like or don't like them.

80% of participants expressed that the interface was highly usable. The rest of the participants didn't think split-screen feature was useful because they barely had need to split the screen.

Q6. Please comment on this interface in terms accessibility. There are physical menu button and quick access buttons to help you perform the task. Do you like them? Please list the reasons why you like or don't like them.

85% of participants thought this interface had high accessibility. The rest of the participants indicated that they preferred to use keyboard shortcuts to invoke the split-screen feature.

Q7. Overall, do you satisfy with this prototype? Do you have any additional suggestions or comments for improvement?

All participants were satisfied with this prototype. Some of them also provided the recommendations for improvements.

1.3 Analyze the feedback from participants

Q1 and Q2 assessed the learnability of the interface. The responses from participants indicate they need some instructions of how to save the favorite layouts. Q3 assessed the memorability of the interface. The responses show that as long as the user knows how to use split-screen feature, it is easy to remember the steps to perform the task. Q4 assessed the guarding functionality. The results show that it is convenient and efficient to use the split-screen feature on this interface. Q5 assessed the usability. The interface has high usability for people who have the need for split-screen. Q6 assessed the accessibility. The interface is easy to access. Some participants provide recommendations for additional features to improve the accessibility. Q7 assessed the overall satisfaction. Participates are satisfied with the design of the interface. They also provide useful suggestions on improvements.

Some insights that I get from feedbacks for improvements are making the split-screen interface easier for novice users to use, making the buttons more intuitive, and improving the accessibility.

1.4 Changes that might result from the qualitative evaluation

In Q2, many participants responded that couldn't figure out how to save the favorite layouts. In Q3, some participants said they cannot remember the steps to perform the task because they didn't know if their steps were correct. To solve these two problems, I am going to add a Help button. So novice users can quickly learn how to use the interface by clicking the Help button to look for references

and instructions. To make buttons are more intuitive, I am thinking about re-naming the buttons. I may allow users to use hotkeys on the keyboard to invoke the layouts as some of them don't like the physical buttons.

2. EMPIRICAL EVALUATION

2.1 Testing process

I am conducting empirical evaluation on card prototype. For more details about card prototype, see 4.3 Appendix: Card prototype.

In this experiment, I have two treatments.

- Treatment 1: Display a Menu button in the lower right corner.
- Treatment 2: Display a Split Screen button in the lower right corner.

This is the only difference on the interface. I kept everything else same in both treatments.

I created 4 webpages. The first web page includes the instruction and a Start button. The instruction says once the Start button is clicked, the timer starts and it will jump to a page show the card prototype for one of the treatments. The treatment on this page is randomly assigned. The participant needs to find the right button to click to perform the split-screen task. Once the right button is clicked, the timer will stop and it will jump to another instruction page with a Start button. When the Start button is clicked, the timer starts and it will jump to a page show the card prototype for the other treatment group. The timer will end when the participant clicks the right button to perform split-screen feature. Then the experiment is done.

For this experiment, I recruited 10 participants from OMS students. I am using within-subjects method. So each participant was assigned to both treatments. The order of the treatments that a participant received was assigned randomly.

I was a little surprised that some participants took more time to complete the experiment than I expected. Because this was the first time they interacted with the split-screen interface. It took them a few seconds to think then click the button. Next time, I will include one more lurking variable – levels of user experience in the study. Another problem is due to the time limit, I was only able to recruit 10 participants. The sample size is small. The problem of small sample

size for a t-test is it has low statistical power. Ideally, for this kind of experiment, it should recruit at least 50 participants in order to get more statistical power.

2.2 Results of the statistical test

Table 1 — Times to click the right button (in seconds).

Participants	Menu Btn	Split Screen Btn	Diff (D_i)	D_i^2	$(D_i - \bar{D})^2$
1	8.5	5.3	3.2	10.24	2.40
2	3.9	3.5	0.4	0.16	1.56
3	11.6	6.2	5.4	29.16	14.06
4	5.2	2.4	2.8	7.84	1.32
5	3.3	2.8	0.5	0.25	1.32
6	6.9	7.8	-0.9	0.81	6.50
7	8.4	9.5	-1.1	1.21	7.56
8	9.8	8.6	1.2	1.44	0.20
9	7.1	4.2	2.9	8.41	1.56
10	5.8	3.7	2.1	4.41	0.20
Mean:	**7.05**	**Mean:** **5.4**	**Total: 16.5**	**63.93**	**36.71**

The results of the experiments are shown in Table 1. It includes the information of the amount of time each participant took to click the Menu button and the Split Screen button, the paired differences, the squared paired differences, etc.

2.2.1 *Paired-difference t-test*

The goal is to find out by changing the label of the button to Split Screen, does it take less time to find and click the right button to start the split-screen task. I am using μ_{Menu} to denote the mean response time to click the Menu button and $\mu_{Split-screen}$ to denote the mean response time to click the Split Screen button.

I have the following null hypothesis and alternative hypothesis for the t-test.

- The null hypothesis: $\mu_{Menu} = \mu_{Split-screen}$ (The means are equal).
- The alternative hypothesis: $\mu_{Menu} \neq \mu_{Split-screen}$ (The means are not equal).

$$t - statistic\ value = \frac{\frac{\sum_{i=1}^{n} D_i}{n}}{\sqrt{\frac{\sum_{i=1}^{n} D_i^2 - \frac{\left(\sum_{i=1}^{n} D_i\right)^2}{n}}{n(n-1)}}} = \frac{\frac{16.5}{10}}{\sqrt{\frac{63.93 - \frac{16.5^2}{10}}{10(10-1)}}} = 2.584$$

For α level of 0.05 and degree of freedom of 9, the critical value $t_{0.025,9} = 2.262$.

Since the t-statistic value is greater than the t-critical value, the null hypothesis is rejected. We accept the alternate hypothesis that the means are not equal.

2.2.2 Paired-difference confidence interval

$$Sample\ Mean\ \overline{D} \equiv \frac{1}{n} \sum_{i=1}^{n} D_i \ = \ \frac{16.5}{10} = 1.65$$

$$Sample\ Variance\ S_D^2 \equiv \frac{1}{n-1} \sum_{i=1}^{n} (D_i - \overline{D})^2 \ = \ \frac{36.71}{9} = 4.08$$

$$Paired\ CI\ \mu_D \in \overline{D} \ \pm \ t_{\alpha/2, n-1} \sqrt{\frac{S_D^2}{n}} = \ 1.65 \pm 2.262 \sqrt{\frac{4.08}{10}} = 1.65 \pm 1.44$$

The 95% two-sided paired-difference interval is [0.21, 3.09]. This interval is entirely to the right of zero, indicating $\mu_D > 0$. Thus, on average, it takes longer to find and click the Menu button than the Split Screen button.

2.3 Analyze the results

The goal of the experiment is to test if the change in the label of the button can make users more quickly to find and click the right button to start the split-screen task. The test results indicate the Split Screen button is more effective than the Menu button. It takes less time to find and click the Split Screen button to start the task. This is exactly the result I expected.

I believe this result reflects the real differences. The Split Screen button directly indicates the function of the button. Being direct is great. It's easier for users especially the novice users to understand what the button can do. While for a Menu button, it's not clear to users if it is used for adjusting brightness of the monitor, adjusting the contrast, or splitting the screen. So it takes longer to response.

I used within-subjects design and randomly assigned the order of the treatments to the participants. I got paired data from 10 participants, did a paired difference t-test, and computed the confidence interval for the difference of paired means. The t-test is designed for working with small samples. So the test is valid even if the data are not approximately normally distributed or the sample size is not large enough. As I've stated before, recruiting more participants can definitely increase the statistical power. But the t-test result for this experiment is still valid.

2.4 Changes I would make to the interface

Based on the test results, I would use the Split Screen button instead of the Menu button in my original prototype. I also noticed that it took more time for novice users to find the right button to perform the split-screen task. So I will add a Help button next to the Split Screen Button. That way novice users can read the descriptions and instructions by pressing Help button. This could narrow the gulf of executions in the process.

3.EVALUATION SUMMARY

3.1 Information for additional needfinding exercises

I am going to do a survey for additional needfinding exercises.

In the survey, I would try to gather the following information to understand about the user more fully.

- What are the special needs for novice users?
- What information do uses want to see after press the Help button?
- Is it better to use hotkeys on the keyboard to invoke split-screen feature or press the physical buttons? Or provide both options to users?

The questions arose based on the evaluation that need further investigation separate from the prototypes are -

- In qualitative evaluation, some survey participants reported they couldn't figure out the right process to save the favorite layouts to the quick access buttons without receiving any instructions. And it was hard for them to remember the entire process of performing the split-screen task. The question is how to make the interface become invisible by design and by learning?
- In empirical evaluation, the average response time to find and click the Menu buttons is 7.05 seconds. And it took 5.4 seconds to click the Split Screen button on average. How can I reduce the execution time to narrow the gulf of execution?

3.2 Additional design alternatives

Based on the results of qualitative evaluation and empirical evaluation, I have the following design alternatives that I want to explore in a second iteration

through the design life cycle. All the changes will be made to the existing proto-types.

- Replace the Menu button with the Split Screen button to facilitate the direct manipulation.
- Add a Help button which allows novice users to quickly learn how to use the interface.
- Enable an option of using hotkeys on the keyboard to invoke the split-screen feature so as to narrow the gulf of execution. Normally it is quicker to click the hotkeys than press a physical button.

3.3 Revisions to the prototypes

I will implement the ideas from design alternatives to the prototypes. On both wireframe prototype and card prototype, replace the Menu button with the Split Screen button. On the card prototype, I will add a Help button. This would be helpful for novice uses to learn how to save their favorite layouts to the quick access buttons. And for both prototypes, I will enable an option of using hotkeys on the keyboard to invoke the split-screen feature. I will raise them to the next level of fidelity. For example, I will change the size, shape and color of buttons and make it a clickable wireframe/card prototype.

I will use high fidelity prototypes that add some interactive elements in wireframe and card prototypes to make it look close to the real product in terms of details and functionality. So participants don't have to guess what the screen will look like after they press a button. They can also provide information of whether they get the expected feedback from the interface after pressing a but-ton. This can be evaluated by a survey in next round of evaluation.

3.4 Types of evaluation I would employ next

The types of evaluation I would employ next are qualitative evaluation and em-pirical evaluation. For qualitative evaluation, I will create a survey with some qualitative questions to evaluate the learnability, memorability, accessibility, us-ability, and users' satisfactions of the revised prototypes. For empirical evalua-tion, I will conduct A/B testing on different sizes, shapes, and colors of buttons as these elements play an important role in helping users effectively complete the task. I will recruit more participants for the experiment and control the biases by randomly assigning the order of treatments to the participants.

4. APPENDICES

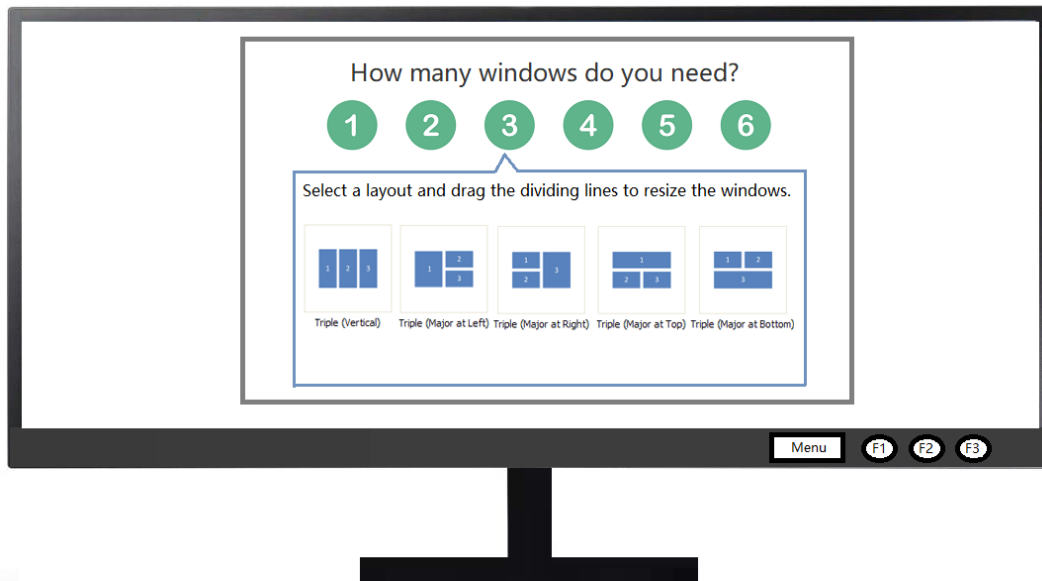### 4.1 Appendix: Wireframe prototype used in qualitative evaluation

Figure 1 — Wireframe. Source: photo created by the author.

Press the Menu button will bring up the menu. On the top section of the menu, it asks users how many windows they need. If a user moves mouse over the selected number of windows, it will display the available layouts in bottom section of the menu. For example, in *Figure 1*, a user chooses 3, then it shows all available options for splitting the monitor into 3 windows. Once a specific layout is selected, a user can also drag the dividing lines to resize the size of each window.

There are three quick access buttons F1, F2 and F3 in the lower right corner of the monitor. Once a layout has been selected, a user can save the current settings by pressing one of the quick access buttons and holding for three seconds. Next time, if a user press that quick access button, it will split the screen using the saved settings.

4.2 Appendix: Survey responses for qualitative evaluation

Q1. After you click the Menu button, you will see a menu screen like what it shows in the Figure 1. Based on your understanding, please briefly describe the actions that you will take to split the screen into 3 windows.

1. Click on the number 3 and then click on the layout I want

2. I would click 3 and then select the layout I want

3. Select the circle with a three and then select the image with the configuration that matches my desired use

4. Per my understanding, I need to click on Menu button and choose number of windows I need. Then select the layout I want from the available options.

5. click on 3

6. I would click on the desired layout to resize my screen accordingly

7. Click menu, click 3, select the desired layout

8. It looks like you would have to select the number of windows that you want and then select which layout works best. I don't see a submit button or anything so that makes me think that if you select it then maybe it previews it for you?

9. Click 3, Click my preference - option 2

10. I'll need to select one of the "Triple" layouts shown on the picture. Then I'm assuming something will show up where I can drag dividing lines. However I'm a bit confused - am I using the mouse? Is this a touch screen? Usually when I do stuff from the buttons that are physically on my screen (which is what looks like the buttons in the diagram are), I can't control that interface with the mouse, so I'm not sure how I'm supposed to resize this. Unless I've misunderstood something?

11. Read the screen, select the 3rd circle with a "3", and select my preferred configuration of screens

12. I will first click on one of the green circles ("3"). Then, I will choose one of the layout options

13. I'd click on the 3 and then choose one of the options that is relevant.

14. Click on the round button that says "3". Then click on one of the layouts shown in the pop up window.

15. press menu button, select 3, select configuratoin

16. Yes

17. click the 3 and select an option

18. Click the three button and select a layout configuration.

19. Click Menu -> select 3 -> click which layout you want

20. click the green circle with number 3 and select what I need below in the pop up

21. I usually use the Triple(Major at left) layout. I place the script/code to the left. Result window is usually to the top right. And output at the bottom right.

22. Click on three and then triple vertical

23. click 3

24. I will select one of the squares and expect the screen will be split to the preset.

25. Click on one of the options

Q2. F1, F2, and F3 are 3 quick access buttons. They can be used to save your 3 favorite screen layouts. And can also be used to quickly split the screen based on the saved settings. Can you guess how those buttons work? For example, how to save the current layout as a favorite and next time how to quickly pull out that layout?

1. Once I select the number of windows and arrangement, I click on the F1/F2/F3 button on the screen.

2. Not sure how to save them to the hot buttons but I guess pressing these buttons would make the layout immediately

3. I have a mac so this would not work for me - i have no experience with those buttons

4. To save the current layout, I guess if I hold one of the quick access button for probably 3 seconds, then it will get saved. When I want to pull out the layout, I just need to click the quick access button.

5. use the menu button? it's not very intuitive.

6. Maybe pressing the buttons for a couple of seconds until there is prompt confirming the new setting

7. F1 is for 1 screen, F2 for 2, F3 for 3.

8. My guess is that once you select a layout it would ask if you want to save it to an F key. Then I'm guessing you just need to click one of these buttons to switch it for you.

9. I would guess you choose a layout and then click F1 if you wanted to save it to F1. Then to bring it up, click F1

10. No idea - maybe if I hold down F1 it will save as a favourite, and if I quick press, it will load what's currently saved?

11. No

12. F1: one screen (revert back from other settings). F2: two screen layout. F3: three screen layout.

13. No clue on how to save, but it'd be easy to choose the layout once it has already been saved.

14. No, when I press one of those buttons, I don't know if it will overwrite the saved favorite to the current layout, or if it will pull out the saved layout.

15. selection configuration and press f-key?

16. Favorite 1 saved as F1 to recall later and so on

17. F1 would be favorite, then F2, then F3

18. Probably have to go to the menu to save current layout as a favorite. Just selecting a quick access button should bring up that layout

19. Press F1 to go to layout 1; same with 2 and 3. Unclear on how to save the current layout as favorite. Maybe hold the F1 button

20. I guess, F1 for the favorite one, and F2 for the second favorite one

21. To save the current layout - select "menu", select "layout" and press "F1". To pull out the layout - press "F1".

22. Yes

23. click it then click F1 at the bottom for F1

24. Since F1, F2, and F3 are quick access buttons, my intuition is that if I hold onto one of the F buttons, it'll save the current layout.

25. Click the Fn button on the lower right of the screen and then click the layout you want to associate with it.

Q3. Can you remember all the necessary steps to perform the split-screen task after using this interface 3 times? Please list some reasons why you can or you cannot remember the steps.

1. Yes. There are only 3 actions (menu, click number, click layout)

2. After 3 times I should be able to remember. It is relatively straightforward

3. menu - select number - select configuration diagram, these steps are easy to remember

4. Yes, I can remember all the necessary steps to perform the split-screen task after using this interface 3 times. It's easy to follow.

5. the prototype itself does not give enough detail for a new user to figure it out

6. No, the set up is not ideal for novice users

7. Maybe change name of "menu" button, otherwise it is very clear

8. I guess I'm not sure what the necessary steps are because I am guessing but I could remember what I thought it should do.

9. I think so, but it would be nice to have a more direct way of saving to the button. I have to guess.

10. I have no idea because I can't use this interface once, never mind 3 times. I think I'm supposed to press menu, somehow navigate to the number of screens, then somehow choose one of the layouts then drag to resize but I'm still not very sure what my input methods are.

11. This feature is not visible or apparent to me, so I may forget what it is set to or forget how to use/access it

12. Yes, there are only a couple intuitive steps.

13. Yes. I still don't know how to save though.

14. Yes. Not a lot of steps are needed.

15. yes, number icons are intuitive

16. Yes. Simply to remember

17. No, not sure the steps are clear

18. Yep, seems really simple.

19. Yes, the instructions are listed as soon as you press the menu button.

20. Yes, it is straight forward

21. If I use the interface 3 times I will remember the steps. However, if it is not used on a daily basis, I will probably not remember the steps.

22. I think so. The quick access buttons should make it easy

23. yes

24. I will likely NOT remember because screen splitting is done probably once on the initial setup.

25. I think I can. Reason: it seems simple enough

Q4. Please comment on this interface in terms of convenience and efficiency of using the screen-split feature. What designs make you feel convenient/inconvenient and efficient/inefficient of using this interface to perform the split-screen task?

1. This is great. The top-down nature of the design seems nice and easy.

2. It's nice to be able to have preset options

3. I think this is great although I'm not familiar with how it works currently so I cant judge the level of improvement

4. Overall I think this is convenient and efficient. It gives me a variety layout options to choose from and after I choose one I can use the quick access button to save it for later.

5. convenient - able to select the options instead of dragging the windows

6. It might be convenient for expert users, for novice users that are two many steps involved.

7. It would be very convenient to partition the monitor with a hotkey. However, F1/F2/F3 are sometimes used, particularly in applications with their own hotkeys. You may want to add "alt" or something

8. Efficiency seems to be there if the f keys switch which screen layout is out there. The convenience of getting to this screen is probably there as well if all you have to do is hit menu and maybe select one thing like display settings.

9. I think saving a layout would be inconvenient

10. It seems like once I understand how to do it, it should be easy enough.

11. I like that it shows me what will occur with each option. I am less likely to make a slip as a result

12. I think the design is efficient and convenient.

13. Very convenient and efficient to have baseline splits and allow me to adjust as needed.

14. It's more convenient and efficient than manually arrange windows in a screen. The fact that there is a dedicated button to open up the menu and buttons to instantly pull up favorited layouts makes it convenient.

15. i think it appears intuitive and i think the idea of configuration shortcuts

16. Great design

17. convenient, I would probably do the 2nd or 3rd design

18. The simplistic nature of it makes it very convenient to use.

19. Splitting the screen is definitely convenient, and the programmable buttons make it efficient.

20. It is straight forward, however I only have 2 screens now so I am not sure how current interface is like for >2 screens

21. It is great to have the option to automatically have the screen split in many ways. However, there are too many templates to choose from. It is better to just

have the user defined templates. As the users usually only use some specific types of layout.

22. I'm not sure I want a pop-up over my windows. I currently use Magnet to accomplish the same thing, and it just lets me drag windows around, which is a bit more natural.

23. It's efficient to use the Fn buttons but I'm not sure how often I'd need to change the screen layout

24. The presets or usage of lines doesn't feel direct. Therefore, I may consider it inconvenient. The drag-and-drop convention, as they currently exists, works well.

25. Fn buttons are easy to access

Q5. Please comment on this interface in terms of usability. For example, it allows users to save the favorite layouts. After you select how many windows you want, it provides a few popular predefined layouts to choose. Do you like these functions? Please list the reasons why you like or don't like them.

1. Good usability. It was not obvious you could save favorites though. I only know since Q2 mentions it.

2. I like this feature, it gives the user ideas on how to layout their screen

3. I always like being able to set my favorites, but it needs to be easy to initiate them

4. I do like these functions. Easy to use and accessible.

5. Good functions but perhaps for people that want more customization, they will want to have their own options, instead of the preset options.

6. Yes, it will improve usability for individuals that only have a single monitor but still need to split the screen layout

7. Extremely usable, might duplicate a hotkey.

8. The functions are useful but I think having a computer take care of the switching between the displays would allow for more choices(if you actually needed one).

9. Overall, it's good, but should allow you to save a custom layout.

10. I think saving favourite layouts will be very nice. Picking from predefined layouts makes sense but it seems like a few too many steps - maybe just have a list of 6 common predefined layouts instead of having a different menu for each number of windows and several predefined layouts under that?

11. Yes, predefined or common layouts would be useful to reduce cognitive load

12. I don't think there's a need for screen-split shortcut buttons since the action isn't frequently performed by most users.

13. Yes. More convenient because I'm usually doing similar tasks on the computer.

14. I like the function to save some favorite layouts and access them quickly later. Makes process very easy because you just need to press a button.

15. i like them. minimizes the decisions i have to make and does a good job of communicating the layout visually

16. Like them. Easy to use

17. I don't think I split my screen that often

18. Yep, I like the pre-defined option. It makes it easier then setting it from scratch.

19. it's unclear based on the prototype which window is 1, 2, or 3 in the triple splitting menu. What happens if I want to split between windows 1, 4, and 5?

20. yes saving as favorite is good as it can save a lot time for unnecessary clicking, best even the default one should just be the favorite one saved by the user

21. yes I like how it lets me select the number of windows and then select the layout. It would be better if the predefined layout is customized by the user. For ex. I rarely use three triple vertical windows. It is better not have it listed for me. But it could be important for other users.

22. Yes, it makes it easy for both novice and expert users.

23. Yeah it's cool that it gives pre-defined splits and you can drag to change the sizes

24. These functions are not preferable mostly because I would hardly change my screen setup.

25. I don't know

Q6. *Please comment on this interface in terms accessibility. There are physical menu button and quick access buttons to help you perform the task. Do you like them? Please list the reasons why you like or don't like them.*

1. Yes. I like quick buttons for expert/advanced users. Great redesign.

2. Pretty good on accessibility. I like the physical menu button

3. I believe this is accessible. Perhaps voice selection might be helpful as well for macs using Siri

4. I like those buttons it's very easy to use and access, especially when I want to switch between layouts.

5. perhaps make it pop up a little more

6. No, there is still room for improvement there. These buttons are not intuitive and they are very similar to the traditional monitor set up

7. Menu should be renamed. Otherwise, this is clear.

8. The quick access buttons are nice but as I said before I think maybe letting the computer have some hot keys or a quick interface would allow for more setups.

9. The physical buttons are fine. What if a user has shorter arms though? Could there be a command on the keyboard to invoke the layouts instead?

10. That should be fine but I'm confused about whether you use the mouse or not to navigate between options, or whether you're restricted to those physical buttons.

11. Yes, although they are not visible (I almost didn't see them) and maybe you can incorporate hover-text to support the user's thinking

12. I think it has good accessibility.

13. Don't like physical buttons on the front because they get stuck or accidentally pressed.

14. I would prefer if the buttons were on the computer or have keyboard shortcuts for performing the tasks, instead of having buttons on the monitor. The monitor is sometimes placed further on the desk and is harder to reach.

15. i like the layout, but i don't have accessibility issues

16. Like them. Useful

17. the menu buttons seem easy to use. I would notice them more if they were along the top.

18. I'd just as rather use hotkeys.

19. Having a physical menu button is nice.

20. I like it, it is simple to use

21. I like physical buttons and quick access buttons. They are very convenient to use, easy to find and save time.

22. Yes, this seems accessible.

23. The menu buttons are pretty

24. Wouldn't mind having them, but would not like them if it takes up a key on the keyboard. Again, screen setup is a one-time deal for me.

25. I don't know

Q7. Overall, do you satisfy with this prototype? Do you have any additional suggestions or comments for improvement?

1. Very satisfied.

2. Could use help on discoverability. User wouldn't know what the hot buttons mean

3. Yes!

4. Overall, I am satisfy with this prototype. The only suggestion I have is that if there are some instruction or explanation on how this prototype should work that will be much easier to use, instead of user guessing how to use it and how it suppose to work.

5. see comments above.

6. Same as above

7. Yes, I actually think this is a great idea!

8. What if the interface based on what is displayed automatically tried to switch the screens for you or suggested them and a user could click yes or no. That way depending on what was going on you could maybe have email, a video call, and take some notes all on one screen and the system recognizes it.

9. I think it's a good idea, but needs to be worked on some more.

10. More clarification would be helpful!

11. Yes, it would be a good implementation

12. Each monitor is different and may not have three buttons at the bottom right...

13. Very nice

14. Overall, the interface presented in the prototype is very useful.

15. i think it looks great

16. Satisfied

17. overall satisfied.

18. I like it a look, but how does it handing changing focus and minimizing windows, etc?

19. I am confused on whether the window splitting happens on the OS of the computer (ie: chrome/word/outlook) or is split between different inputs on the monitor (ie: HDMI 1/HDMI 2/DisplayPort)

20. Yes, similar to Q5 I would like the default one displayed as the one saved as favorite by me

21. Yes, this prototype is well-designed.

22. I like the idea, but I think that it could be made more natural by incorporating natural movement like Magnet does.

23. looks good

24. Wouldn't the OS autodetect the number of screens available for split at the hardware level? If so, you can perhaps omit the number of screens to split selection and jump straight to the layouts. Again, I would prefer a more direct interaction.

25. The prototype seems fine, but this survey should have been more multiple choice and less short answer.

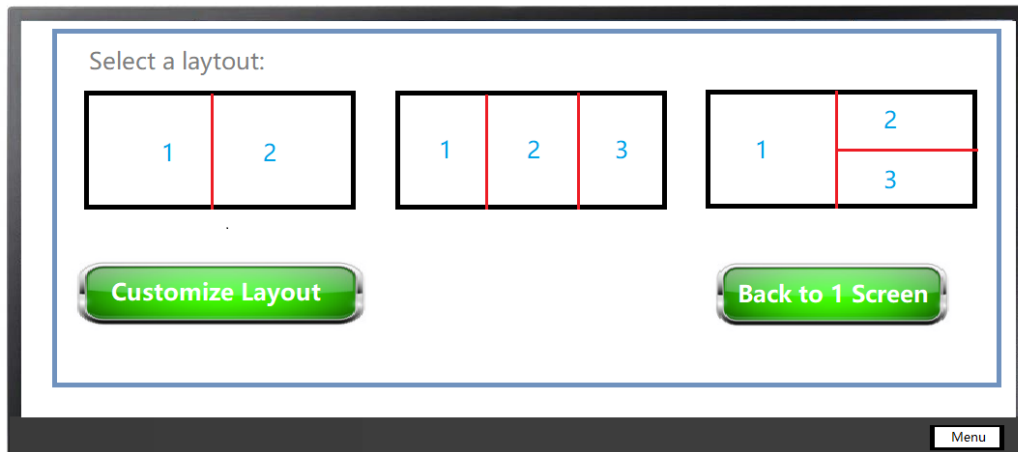## 4.3 Appendix: Card prototype used in empirical evaluation

Figure 2 — Main menu. Source: photo created by the author.

Clicking the menu button will display the menu screen as shown in the figure above. The 3 layout options on the top section come from my survey results. These are 3 most popular layouts selected by the survey participants. If a user doesn't want to use any of these 3 layouts, clicking on Customize Layout button will allow a user to design a new layout.

21

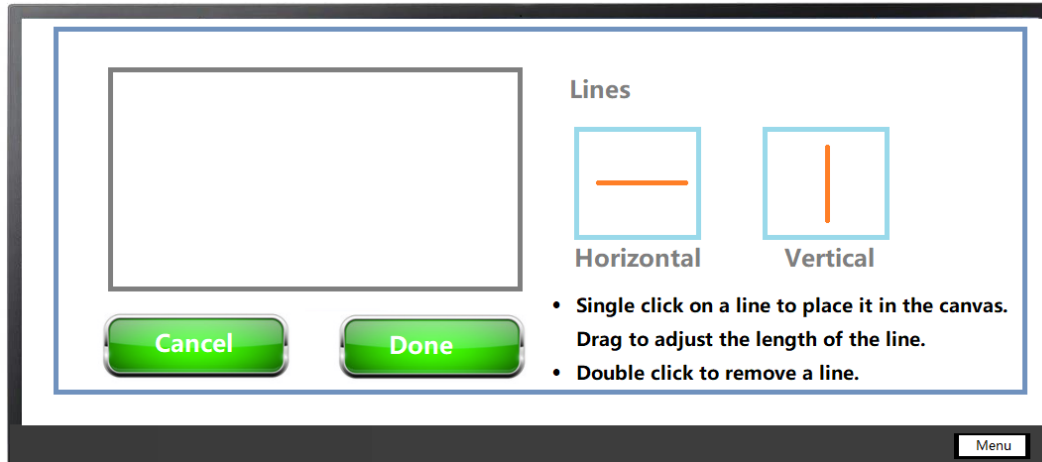Click on Customize Layout button will show a screen as below.

Figure 3 — Menu screen. Source: photo created by the author.

Below is an example of a user places a horizontal line and a vertical line in the canvas to split the screen into 4 windows.
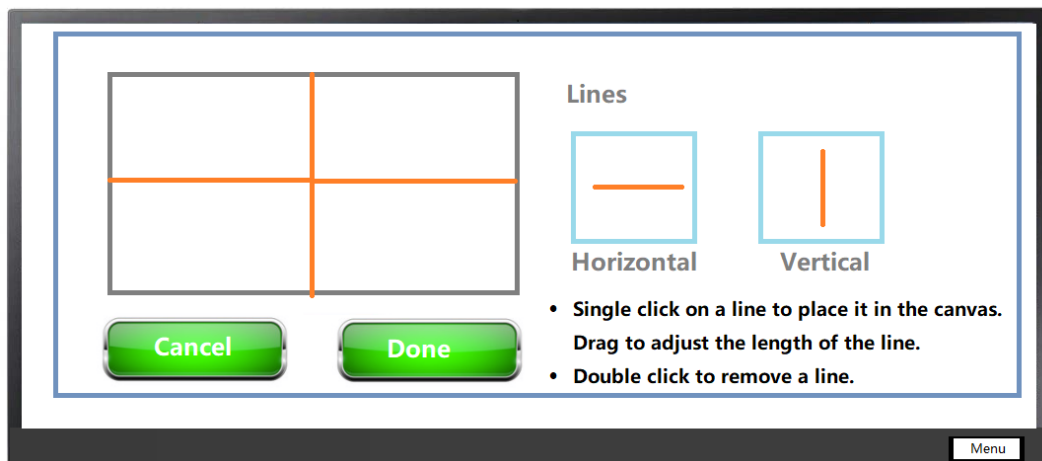

Figure 4 — Custom layout. Source: photo created by the author.