Groups 32: SFWR ENG 4HC3 System Design

Karim Guirguis
001307668
Hamilton, Canada
guirguk@mcmaster.ca

Marko Laban
001300989
Hamilton, Canada
labanm@mcmaster.ca

Curtis Milo
001305877
Hamilton, Canada
milocj@mcmaster.ca

Alexandra Rahman
001305735
Hamilton, Canada
rahmaa25@mcmaster.ca

ABSTRACT
UPDATED—5 December 2017. This paper outlines the design of a car media control panel. The control panel was designed based off of Don Norman's design principles and the successes and pitfalls of four other systems. A usability test was performed on the design and the results of such tests are included as well a discussion as to what the results might mean in terms of the current design and future iterations.

Author Keywords
hard controls, soft controls, A/C, modes, GPS, CD, phone-pairing

ACM Classification Keywords
B.4.2 Input/ Output Devices; B.1 Control Structures and Microprogramming; B.4.4 Performance Analysis and Design Aids; B.4.5 Reliability, Testing, and Fault-Tolerance; G.1.6 Optimization; H.1.2 User / Machine Systems

INTRODUCTION

Installation Instructions

Windows 10 OS and a resolution of 1920x1080 are required to run the application. If the user would like to utilize the voice command features a microphone is required.

1. Select the windows key and search for "Use Developer Features".
2. Select the developer mode, followed by yes to the pop-up.
3. Right-click the Add-DevPackage.ps1 and select "Run with Windows PowerShell".
4. Follow the terminal instructions to ensure the application is properly installed.
5. Select the Windows key and search for "CarInterface".

Milestone 2 Background

A car media dashboard has been redesigned based on the critiques of multiple different systems. Four systems have been reviewed and critiqued based on Don Norman's design principles: discoverability, mappings, constraints, conceptual models, feedback, signifiers and constraints. The four systems under review were the Sylvania SRCD243 Portable CD Player, 2017 Dodge Ram Media Control Panel, 2008 Toyota Corolla Media Control Panel and 2016 Nissan Murano Media Control Panel.

Though the four systems vary in more ways than one, the focus was on features that could either be improved in the redesign or features that could be used as cornerstone in the redesign. The features that were found to be the most problematic or most enlightening were the volume adjustment, phone connectivity, tuning music settings and programming GPS location.

The Sylvania SRCD243 Portable CD Player was shown to have very good mapping and signifiers, which led the user to familiarity and control. They expertly used universally accepted symbols when appropriate and labels to ensure that there was no miscommunication between the user and the model. Unfortunately, the portable CD player solely relied on hard controls that were found to be less ideal in a car media control panel. Such was the case with the 2008 Toyota Corolla media control panel.

The Toyota Corolla's control panel was comprised of a single line display screen, and hard controls such as knobs and buttons. Though said hard controls provided immediate feedback to the user and lend themselves well discoverability and affordances they fall short in terms of discoverability. Dashboards have limited space, and it would be counterintuitive to have a button for every control and therefor the introduction of multiple buttons with different modes. Depending on the sequence in which buttons are pressed, as well as their duration, the functionality is likely to change. Thus leading to poor discoverability. This issue was easily solved by the integration of soft controls as seen in both the 2017 Dodge Ram Media Control Panel and the 2016 Nissan Murano Media Control Panel.

Both the 2017 Dodge Ram and the 2016 Nissan Murano have a mix if hard controls and soft controls. The soft controls are used for the commands that have multiple modes or multiple menus. Unlike the hard controls in the previous two systems, soft controls provide a better conceptual model and discoverability. The drawback with soft controls is that they do not provide tactile feedback, though this can be avoided by providing both audial and visual feedback.

Milestone 4 Design

The basis of the design was to keep the hard controls that proved to enhance the designs of the Sylvania Portable CD Player and the 2008 Toyota Corolla control panel but also include soft controls that do not constrain the user or impair their discoverability, much like the designs of the 2017 Dodge Ram and 2016 Nissan Murano.

The hard controls in the new design are the knobs on either side of the display that control the volume, and radio tuning. The volume knob can be pushed, like a button, to turn on or turn off the power. There are also hard control buttons at the bottom of the display screen for the A/C settings in the car. There are LED for some of the buttons as signifiers indicating they have been pressed.

The rest of the controls are soft controls and are split into screens. There are multiple screens within the system but a few are of note: the call screen, the air screen, the navigation screen, the media screen and the settings screen. The call allows the user to dial a number using the number pad or to call a frequently used contact. The air screen gives the user a choice to use either the hard controls or the soft controls to direct the airflow of the car and regulate the temperature. The navigation screen allows the user to set a new destination on the GPS and will give the corresponding instructions. The media screen allows the user to filter through multiple preset radio stations or listen to playlists off of the connected mobile device. Finally the settings screen allows the user to pair their phone to the media system as well as tune the music settings such as bass and fade.

Milestone 4 Design Assumptions

In this implementation, due to budget and time constraints, the knobs are implemented as soft controls; as opposed to in a physical one. The same can be said for all the buttons along the bottom of the display screen, they are all meant to be implemented as physical buttons and not the soft controls they currently are.

Pressing a knob was not feasible due to a constraint set by the technology used. Thus, a mute button was added below the volume knob to simulate clicking on the volume knob.

In the phone-pairing screen, the prompt for whether the connecting phone is the user's phone will only be shown once the action is initiated from the user's phone. However, for the sake of the simulation, it was shown by default in that screen.

Finally, in the navigation tab, once the voice command is activated by the user, only the command "navigate gas" will be processed. The same can be said for the call screen, the only recognized command is "call Kevin".

USABILITY TESTS

To ensure that the design was a sound one, certain usability tests were done in which five participants completed a series of tasks with little to no instructions as to how the tasks are to be accomplished. The speed in which each task was completed determined the success of the task. A survey was also provided to the user at the end of the test to further validate that the implemented design was justified.

Each user was subjected to the same test conditions. All users were to perform the test on the same laptop, at a desk with moderate ambient noise and visual distractions. This was to better simulate the visual and audial distractions present while driving, seeing as the model was to be used while operating a motorized vehicle.

All participants were provided a mouse as a medium between them and the interface. This was a conscious decision made because track pads do not provide the same control as a mouse. There was also the added concern that track pads have a certain learning effect, whether there are physical buttons for the left and right click or they are integrated in the pad, whereas mouses are more universal.

None of the participants had interaction with each other prior to the tests, ensuring that no information was passed between participants, which would ultimately lead to inconclusive results.

The participants were asked to complete the following five tasks in succession without prior knowledge of the interface. The tasks were as follows:

1. Connect a phone to the interface and make a phone call to one of the predetermined contacts.
2. Increase or decrease the volume by 10, increase the base settings by 2 and decrease the fade settings for the back right corner of the car.
3. Set a new destination on the GPS to the closest gas station using a voice command.
4. Change from the current radio station to Playlist 2 through the media settings.
5. Change the A/C setting to blow air to the feet and increase the temperature for the left side of the car by 5 degrees Celsius.

A survey was provided to the participants at the end of the test. The survey consisted of fifteen simple questions that are based on the difficulty of the each task on a scale of 1 to 5, 1 being easy and 5 being difficult. There were also a couple questions asking the user to compare the design to the current one they are using.

Each task was considered to be properly designed and a success if they were completed within the desired time constraint.

Tasks	Time that constitutes success:
Task 1	Under 45 seconds
Task 2	Under 45 seconds
Task 3	Under 20 seconds
Task 4	Under 10 seconds
Task 5	Under 30 seconds

Table 1: Times that constitute success for each task in the usability tests

RESULTS

Given that each on the tasks within the usability study were timed, the data collected could be displayed in a graph as seen in Figure 1. Each participant and task was given a

label such as P# or T#, where # ranged from 1 to 5. Each task was displayed along the x-axis and the necessary time required in completing each task along the y-axis.

From this graph an average can clearly be seen for the time required to complete each task, though there are a few outliers. Such outliers are present in tasks 1,2 and 5, which indicate the presence of issues in the design.

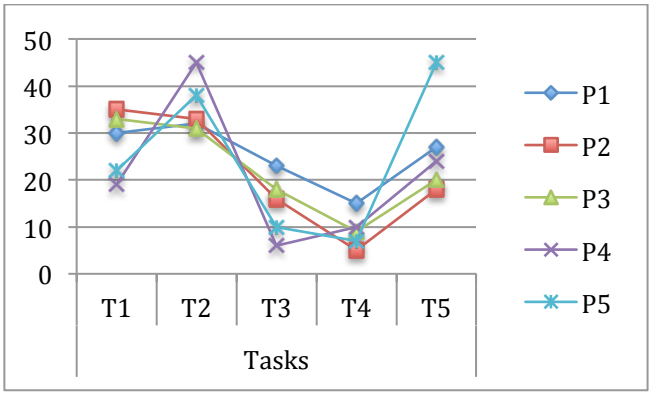

Figure 1: Time required by each participant to complete tasks in the usability tests

A survey or questionnaire was supplied to the participants after completing the usability test. The survey consisted of 15 questions that assess the difficulty of each task as well as the layout of the screen and the functionality of the feature. A score of 5 determined the task to be very difficult whereas a score of 1 determined it to be fairly simple. On average each task received a standardized score of 2. The survey also prompted the user to compare this new system to the current system they are using. Each response was weighted out of 5 as previously mentioned, and the lower the score the lower the difficulty level of each task. The results are displayed in Table 2.

Task	Total Possible Score	Actual Score	Better or worse than existing model?
Task 1	50	23	Better
Task 2	50	21	Better
Task 3	50	20	Better
Task 4	50	24	Same
Task 5	50	24	Same

Table 2: The results of the survey given to participants after the usability tests

DISCUSSION

The overall consensus between the participants was that most features were simple to use, though often times, a participant struggled with one of the tasks within the usability test. However, the task that proved most challenging was not consistent between participants, this in part is due to the varied backgrounds of the subjects. This was most evident with a particular subject that drove a 1999 truck who struggled with tasks that include connecting the phone to the media system. More specifically, dealing with the voice commands within the navigation section. The participant went to multiple different screens before arriving on the correct one because they did not easily identify the voice command symbol. This could also be attributed to the lack of signifiers in the design. In future designs and additional label will be placed below universal symbols so as to avoid ambiguity and misconceptions.

Participants that were driving more modern cars found the navigation task to be a simple one and such a task was completed in approximately 8 seconds, compared to the 15 seconds by the other participant. Due to the integration of this new technology in most modern cars there is a considerable learning curve for users that are not familiar with the system. That being said, it has become a task that many user rely upon and will not be removed in future implementation, though the addition of signifiers will be considered.

Another interesting aspect to note was the thought process used when participants were asked to connect their mobile device to the system. The participants would immediately navigate to the call screen or the media screen. Although this action could be found on the settings screen, it is of note that in future implementation there would be an additional button on either of the two screens that would navigate the user to the phone pairing settings screen if a phone has not already been connected. This is a simple addition to the design that would help improve the discoverability and the conceptual model.

It was unclear to many participants where the fan will circulate the air based on the soft controls in the air settings screen. The button in question would switch between three modes; circulation to the feet, circulation to the face, or both. A participant in particular was confused about the functionality of the button and began to modify the amount that the fan was blowing before looking at changing the mode of the soft controls. This may be an area to be improved in future implementations, one that can be resolved by adding a hard control such as a knob instead of the current soft control.

When given the choice between smaller hard controls, for temperature settings, or larger soft controls, many of the users chose to use the soft controls. One can assume that the reason behind this is the size of the buttons and not a preference of soft controls over hard controls. Though this was of note and may be considered as viable research in future implementations.

There was also proof indicating ambiguity with the temperature indicator displayed as a slider. A participant mistakenly tried to change the temperature with the slider indicator. Due to the unfortunate design of the temperature indicator being a slider the conceptual model relayed to the

user was misleading. This is an error in the design that would be remedied in future implementation by adding the functionality to the slider which will invoke the affordance of the slider sliding up and down instead of just being a nice visual feature.

One aspect that was found to be successful among all participants was the calling feature. All participants were able to preform the task with ease. The addition of a frequently called list of contacts proved to be very beneficial for the user. Participants agreed that there were only a handful of people that they frequently called and that this would vastly improve their existing car models.

CONCLUSION

Although the participants agree that the redesigned car media control panel is better than their existing model, there is evidence that suggest that the design is not perfect in term of Don Norman's design principles. The data collected proves that there are tasks that can be improved and some of the decisions made by the participants only further prove thus. In future implementations the temperature indicator that closely resembles a slider will be implemented as both a slider and an indicator. Additional signifiers will be added to buttons so as there is no misconception between the user and the design. The size of the hard controls at the bottom of the display will be enlarged so that the user does not feel constrained to use the soft controls and finally additional buttons would be added to the media and call screen to allow the user to easily connect their phones.

REFERENCES

1. Don Norman. 2013. *The Design of Everyday Things* (Revised and Expanded Edition). Basic Books, A member of the Perseus Book Group
2. Stickers, i. and AI, I. (2017). *Material Design Icons - 4,300 Free Icons*. [online] Icons8. Available at: https://icons8.com/android-icons/ [Accessed 15 Nov. 2017].
3. Shareicon.net. (2017). *Share Icon - more than 250.000 free icons*. [online] Available at: https://www.shareicon.net [Accessed 18 Nov. 2017].