Prospectus

General Use FM Transmitter
(Technical Topic)

Apple's Error 53 Controversy as an Attempt to Constrain Users
(STS Topic)

By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

Almost every car model today comes with Bluetooth capabilities that allow the driver or passengers to play any song they want through their car speakers; Bluetooth, however, did not start appearing in cars until 2010 (Hamel, 2019). So, the people still driving a car that was manufactured before the early 2000s are forced to listen to what is currently being played on the local radio stations or a few outdated CDs using the built in CD player. Studies show that music can positively impact a person's mood while driving or doing any repetitive task (Zwagg, Dijksterhui, Waard, Mulder, Westerink, & Brookhuis, 2011). The limited selection for those driving older models makes it more difficult for the driver to listen to the music he or she wants, so there is less opportunity for the music to create a positive atmosphere. This is an issue because everyone deserves to have the ability to make the monotonous task of driving more enjoyable through music.

The technical solution to this issue is to design an FM transmitter that takes the audio output playing from a phone and broadcasts it to an open channel. Then once the car stereo is tuned to this channel, the phone audio starts playing through the car speakers. This simulates Bluetooth's ability to freely choose songs on the driver's phone and only adds a single step to tune to the specified radio station on the device. However, a technical solution alone is insufficient because there also needs to be a better understanding of how designers embed ideas about users into their product and how these ideas may end up constraining the product from being used in a particular way. By addressing both the technical and social aspects of the problem, it allows the final designed product to not only work but also appeal to the greatest amount of people. Instead of constraining users to only use the device in the car, the transmitter

could be designed to use the USB power port to allow users the freedom to use the device anywhere.

To fully resolve this issue, a solution that meets both technical and social aspects is necessary to produce a fully effective and appealing device. Below I outline the technical process for designing and building an FM transmitter that is capable of transmitting audio from one device to a radio frequency to be heard, one that is not limited to use inside a car and gives users the freedom to play music in any way they see fit. I will then use the STS framework of user configuration to analyze how Apple created the iPhone with the intent to constrain the user from using it in certain ways.

Technical Problem

Older car models were made without Bluetooth or auxiliary ports that provide the opportunity to stream any music at any time and limit the driver to listen only to music on the radio or on available CDs. Currently, there are multiple Frequency Modulation (FM) transmitters on the market that solve this issue by taking audio output from a phone and broadcasting it to an open FM band (radio frequency such as 99.5); once the car radio is tuned to this band, the audio can be heard playing through the car's speakers. However, most of these are powered through the car's cigarette lighter port, which limits users to broadcasting their music in a car and does not provide users an alternative option to manually select the band to which they wish to broadcast. The development of a new FM transmitter that is powered by general USB allows the possibility to broadcast from any auxiliary port to any device that has a radio in any location with USB Power. This allows the device to be used for more than just listening to music in the car. For example, one might plug in an electric guitar to hear the chords played on a house radio. Similarly, adding the ability to manually choose which band to broadcast to adds versatility in

using more frequencies than just the one chosen automatically by the device and allows the user to continue using the device if the automatic scanning function stops working.

The new FM transmitter will be a general use device that can take input from any device broadcasting audio from an auxiliary port and send that audio to an open FM band, powered through a USB connection. This device can be broken down into three main sections: power, transmission, and encasing. For a USB port to work properly, there will be a power regulator to limit the incoming voltage level to the correct 5 volts necessary to power the device. So, whether the device is plugged into the USB port of a car receiving 5 volts or attached to a wall adapter cube and plugged into a wall outlet receiving 120 volts, it will only send 5 volts to the device. Transmission of the audio from the phone to the radio frequency will be done by programming an MSP430G225 microcontroller to communicate with a software-defined-radio chip. This chip can scan multiple frequency bands to find which band is the least noisy (nothing else being transmitted on that frequency) and then transmit the audio input to the chosen frequency. Finally, the device will be encased in a small aluminum box to allow for adequate heat dissipation. The box will have an LED screen that displays the frequency the user needs to turn the radio to and a rotary encoder knob that allows the user to manually override the automatic scanning and choose a frequency themselves.

There will be three main tests. First, we will develop a test to determine whether the prototype is able to take audio playing from an Android phone, search for an open FM band, broadcast the audio to that FM band, and if tuned to the frequency shown on the LED screen, music should be heard playing through the car's speakers. Second, the same test will be repeated as before but with the device plugged into a wall outlet, rather than a car, to ensure that the product supports as many different user activities as possible. Finally, the third test will

determine whether turning the rotary encoder is able to make the chip broadcast to whichever frequency is displayed on the screen. If all these tests work, then we have created a successful technical solution, one which is more versatile and appealing to the user.

STS Problem

As technology grows and becomes more complex, companies are making it more difficult for consumers to make repairs and modifications themselves. Apple is notoriously known for limiting the ability of consumers to modify and repair its products due to its extensive use of adhesive and small, proprietary components (Clover, 2019). This forces consumers to go directly to Apple for all repairs (Shah, 2018). This desire for control was taken a step further in Apple's "Error 53" controversy. After the release of a new software update, people who had repaired or modified their phones with products not directly from Apple suddenly lost all access to everything on their phones, with nothing showing up besides the message "Error 53" (Wiens & Gordon-Byrne, 2017). Apple defended this update as simply a security measure meant to protect consumers (Julier, Munch, & Folkman, 2019; Svensson, Richter, Maitre-Ekern, Pihlajarinne, Maigret, & Dalhammar, 2018). By some accounts, this update, as well as Apple's refusal to allow repairs outside of its company, was actually designed to squeeze out independent repairers so Apple could monopolize the repair of its products (Brignall, 2016). While this was likely the case, this explanation, overlooks Apple's attempt to not only control who can repair its phones but also to control what its consumers can and cannot do with the phone. Considering this argument highlights the importance of how companies design their products around who and what they want their users to be and not simply around just getting the technology to work.

I argue that Apple's action in the Error 53 case was an attempt to further constrain users from modifying their phones rather than letting users co-construct the product by having free

reign. Apple's actions suggest that it views the users as passive recipients of the iPhone who simply interact with the device exactly how it comes out of the package. Apple does not desire users that wish to modify or repair the phone, instead they prefer users who are less tech savvy and not interested in tinkering or repairing their phones. In addition to being passive recipients, Apple's users are envisioned to be affluent in the sense that, if their phones break, they have the money to pay the expensive Apple repair fees or to buy a new phone rather than try to fix it themselves to save money.

My analysis of the Apple Error 53 case draws on the science, technology, and society (STS) concept of co-construction, which in this case means that users and technology are co-constructed (Oudschoorn & Pinch, 2003). Specifically, I will use Woolgar's concept of user configuration, which details how designers have preconceived notions about theirs users which get embedded into the product itself. (Woolgar, 1991). So, once designers have a user in mind, they can set constraints by opening certain paths for users and closing others. In this case, users' ability to repair the iPhone was closed off by Apple.

Conclusion

In this paper, the technical report delivers a design for a new device to allow drivers of older cars to enjoy the ability of streaming the songs they want from their phones directly to their car speakers. The design also makes sure that its use is not limited to inside a car but instead can be used in whatever music-playing ways the user chooses. Drawing on the concept of user configuration, the STS research paper seeks to provide further insight into Apple's Error 53 controversy by examining how Apple's designers constrained the users of the iPhone. This analysis provides support for why it is important for the technical device to empower users,

without necessarily constraining them, which will enable our technology to appeal to a broader range of consumers.

The results of this technical report help resolve the socio-technical problem of providing all drivers the ability to play the music they desire with the design of a device that simulates the ease of Bluetooth without needing the car to be Bluetooth capable. The findings from the STS paper can be used to resolve this issue by shedding light on how designers constrain the abilities of their users, which can limit the technology from growing to its full potential by allowing users to co-construct it.

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References

Brignall, M. (2016, February 5). 'Error 53' fury mounts as Apple software update threatens to kill your iPhone 6. Retrieved from https://www.theguardian.com/money/2016/feb/05/error-53-apple-iphone-software-update-handset-worthless-third-party-repair.

Clover, J. (2019, April 30). Apple fights proposed right to repair legislation with warnings of consumer harm. Retrieved from https://www.macrumors.com/2019/04/30/apple-right-to-repair-consumer-harm/

Hamel, J. (2019, January 10). What cars have Bluetooth capabilities*?* Retrieved from https://itstillruns.com/cars-bluetooth-capabilities-5669426.html

Julier, G., Munch, A. V., & Folkmann, M. N. (2019). *Design culture: objects and approaches*. London, England: Bloomsbury. Retrieved from http://books.google.com

Oudschoorn, N., Pinch, T. J. (2003). *How users matter.* Cambridge, Massachusetts: Massachusetts Institute of Technology.

Shah, A. (2018). Can You Repair What You Own? *Mechanical Engineering,* 140(09), 37-41. Retrieved from https://asmedigitalcollection.asme.org/memagazineselect/article/140/09/37/366630/Can-You-Repair-What-You-Own-For-Many-People-who

Svensson, S., Richter, J. L., Maitre-Ekern, E., Pihlajarinne, T., Maigret, A., & Dalhammar, C. (2018). The Emerging ‘Right to Repair’ legislation in the EU and the U.S., presented at Going Green, CARE INNOVATION 2018, Vienna, Austria.

Wiens, K., & Gordon-Byrne, G. (2017). The fight to fix it. *IEEE Spectrum,* 54(11), 24-29. doi: 10.1109/mspec.2017.8093797

Woolgar, S. (1991). Configuring the user: the case of usability trials. In J. Law(Ed), *A Sociology of Monster: Essays on Power, Technology and Domination* (pp 57-99). London, England: Routledge.

Zwaag, M. D. V. D., Dijksterhuis, C., Waard, D. D., Mulder, B. L., Westerink, J. H., & Brookhuis, K. A. (2011). The influence of music on mood and performance while driving. *Ergonomics*, *55*(1), 12–22. doi: 10.1080/00140139.2011.638403