Analyzing and Implementing Codesign Benefits and Trading Zone Challenges to Conversational Agent Feasibility Study

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Disha Patel

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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

Advisor

Sean M. Ferguson, Department of Engineering and Society

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Introduction

There evidently has been and currently exists a mental health crisis in America, sourcing from a huge range of age groups and backgrounds. Approximately half the U.S. population experiences serious mental health problems during their lifetime, including 29% with an anxiety disorder, yet more than two thirds will not receive treatment ("U.S. Department of Health and Human Services", n.d.). With this level of mental illness burden, it is clear that treating people one-on-one in a clinical setting will never meet the existing needs. Mental health is a topic that is very important and prevalent in the world today, especially as we as a nation face issues like the COVID-19 pandemic, Black Lives Matter movement, and divides in the political climate (Panchal et al., 2021). In efforts to minimize the toll being taken from events like the ones listed, the increase of mental health interventions are crucial. However, given the high magnitude of mental health seeking patients, digital mental health measures must come into play to allow for accessibility of resources to large and diverse population groups.

Actions Being Taken: MindTrails

My interest in digital mental health piqued as I became involved with the MindTrails team at UVa through my capstone project, which aims to research and design innovative techniques to embed in digital mental health interventions, specifically through the use of a virtual conversational agent. The team collaborates with members of MindTrails, an existing UVa digital program to reduce anxiety through a cognitive bias intervention method, to create a conversational agent that replaces a human coach during a session. MindTrails is created through the Program for Anxiety, Cognition, and Treatment (PACT) Lab in the Psychology department. The goal of the conversational agent is to provide feasible and useful insights to keep users engaged in MindTrails and minimize attrition rates throughout the study. Thus, I will be using

MindTrails and analyzing my experiences working with the team as a case study throughout this paper.

My STS research will directly revolve around a MindTrails case study from my capstone project as there exists an overlap between the technical aspects and frameworks discussed in class. As previously mentioned, the team I am a part of is working directly with members of the Psychology department to engineer an effective conversational agent. With this crucial collaboration process I will focus on analyzing features from the codesign framework being implemented in the MindTrails case study to assess what is effectively being done versus not. To successfully make this analysis, I will investigate existing cases and projects in which codesign methodologies are being implemented and what successes or challenges can be applied to improve my capstone work. I will also explain what trading zones are in engineering and how they play into the design process to reflect on whether or not successful steps have been taken in investigating the current MindTrails study.

Background: MindTrails Case Study

Digital mental health strategies have significantly increased and played a huge role in providing care for those who are unable to do so in person. However, attrition is a problem for users who desire to complete mental health interventions but find that they are not able to do so (Bremer, et al., 2020). This is a problem in all behavior-change technologies, including MindTrails. As a capstone group, we will work on creating a way to keep users engaged in MindTrails. Human coaches were initially used in MindTrails to increase engagement among participants. Due to availability issues, alternative engagement methods have been researched by our team. A conclusion reached was the potential solution of a conversational agent - an automated agent that can respond to closed or open-ended responses from the user at

predetermined or open times. A digital conversational agent during MindTrails is beneficial as it will allow for non-human interactions which is preferred by those with social anxiety, consistent service at any hour of the day, user familiarity to chatbots creates ease of use, exposure to unfamiliar people can be avoided (exposure can trigger anxious feelings and the fear of being judged), and a digital agent is cheaper to run due to reduction of MindTrails staff.

The main goal involving my participation with MindTrails entails researching existing virtual conversational agents and their features to design the best chatbot so that users stay active in their MindTrails sessions. We used a software called Juji to design our agent based on what effective designs currently exist.

Toolkits: Codesign and Trading Zones

As a group, we advanced through our plan to create the conversational agent, but we also faced many issues that can be explained by poor design and collaboration methods. Before diving into specifics, I hope to lay out the important toolkits that will be used in analyzing capstone progress: codesign and trading zones.

The main focus of codesign includes collaborative work, but there are so many more aspects to consider in order to fully grasp what makes the framework so impactful. A project between a group of engineers working to build culturally inspired, sustainable housing for the Pinoleville Pomo Nation (PPN) uses a codesign process to gain a better understanding of the needs of the people who will live there. The effective codesign aspect of this project intends to "engage an array of stakeholders and actors with different knowledge, skills, and experiences, as well as different resources, sources of power and prestige, and interests in the project" (Edmunds, et. al, 2013). In my capstone project, there exists a codesign relationship between our

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group of engineers and members from the Psychology department that work for MindTrails, which makes a large impact on the other stakeholders in the project like the anxious population that actually uses the technology implemented through the study. The issue that lies without this collaboration is the inability to appropriately design a conversational agent so that it is engaging and feasible for participants. We as engineers are able to control the software that produces the responses from the agent, but the knowledge from another stakeholder (psychology department) is crucial in assuring the chatbot responses will be impactful to the user. This is being done as my team consistently meets with the Psychology department working with MindTrails and gains input based on what experiences and background knowledge they have.

As mentioned, there lie some issues, especially with communication, while working with our team of engineers and the psychologists who have prior experience with the MindTrails program. To assess these issues, some interactional expertise was drawn to exemplify and analyze the creation and results of trading zones. Trading zones are a concept that tie in very well with impacts of the codesigning framework and the process of building my capstone project. The concept of trading zones, explained in a paper by scholars Harry Collins, Robert Evans, and Mike Gorman, were introduced by Peter Galison, and can be defined as "locations in which communities with a deep problem of communication manage to communicate. If there is no problem of communication there is simply 'trade' not a 'trading zone'" (Collins et al., 2007). The authors elaborate on this topic and describe that there are two dimensions varying the type of trading zone that exists. These two dimensions include collaboration-coercion and homogeneity-heterogeneity, creating four general quadrants of types of trading zones. The first axis, collaboration-coercion, is determined by the amount of power used to enforce trade, in which collaboration reduces power used while coercion results in a group or person with higher

power to make important decisions. The second axis, homogeneity-heterogeneity is determined

by the extent a trade leads to a homogenous new culture, in which homogeneity results in a

collective shared belief or opinion, and heterogeneity does the opposite in which the

collaboration results in many differing or opposing views. The inter-language quadrant is the

ideal quadrant to fit into because "they involve mutual agreement to trade rather than coercion,

and they tend toward homogeneity in a merged culture" (Collins et al., 2007). There are

instances throughout the course of our project in which some of these quadrants are exemplified.

A better visualization of this model can be seen in Table 1 below:

	Homogeneous	Heterogeneous
Collaboration	Inter-language	Fractionated
Coercion	Subversive	Enforced

Table 1. Trading zone quadrants (Collins et al., 2007)

Given the amount of required communication between our capstone team and the

MindTrails psychology team, there definitely are some problems with communication which will

be discussed later in the paper, creating trading zones that fit many of these quadrants. As I walk

through the task of implementing our capstone goals, the issues creating trading zones will be

addressed as well as what codesign methodologies were attempted to be implemented in working

to prevent these obstacles.

Case Studies Analyses

One crucial step in our project was to interview a participant (with a generalized form of

anxiety) to get their feedback before and after using the designed conversational agent. A

successful existing codesign project involves working with the elderly population whose goal of

helping people to better and more actively participate in their social networks aimed to develop and evaluate new service concepts. The study involved understanding how the elderly population lives their day-to-day life in order to gain a better understanding on how social networks develop as one gets older. The researchers made sure to have the participant pool remain diverse within the elderly population, specifically including an age range of elders that live in different environments (rural vs urban). One main codesign technique used in this study was directly interviewing the main stakeholder group (elderly population) to gain a better understanding of their existing knowledge and views regarding the development of their social networks as they grow older. "Through co-design, we engaged in an ongoing dialogue with the elderly people that participated, which enabled us to jointly develop, verify and further develop ideas and themes, which helped us to generate valuable and validated concepts— more valuable and validated than concepts that would have been developed without interacting with users" (Steen, et al., 2011). This study clearly shows the positive impacts of using interviewing in the codesign process which include gaining a better understanding of the affected groups of the study, specifically, the authors mention that the researchers "...engaged in an ongoing dialogue with the elderly people that participated, which enabled [them] to jointly develop, verify and further develop ideas and themes, which helped us to generate valuable and validated concepts" (Steen, et al., 2011). In the case of my capstone project, this exact method is being used to understand what reactions participants have since they will be the primary group using the final technology design. However, this method could easily result in a subversive trading zone in which the collaboration between the parties skews from collaborative to a more coercive approach in favor of the researchers and against the elderly population. As explained earlier, the original group of participants was diverse in where they reside (rural vs urban) to gain a better understanding of

discrepancies between the groups. However, if they were to only gain knowledge from only urban participants. This could result in a new homogenous culture, but it's geared solely towards those who live in urban areas. Though there is interaction and collaboration being done within the team of engineers and members of the psychology department, there is still no way to know exactly how participants react to new technologies like the conversational agent without getting direct feedback.

While getting to know how beneficial techniques of codesign in existing studies can be pinpointed in my capstone project, it is equally important to be aware of potential challenges that exist in the framework. One of the challenges for codesign facilitators is responding to pressures related to resource and time constraints that could compromise the process (Moll, et al., 2020). This obstacle exists in my capstone work as there are time and resource limitations in the process of creating and testing the feasibility of a conversational agent. Time is a huge factor that creates pressure in two ways -- the overall timeline pressure of the technical work (only until Spring 2022) and the time constraints of each codesign group, possibly preventing regular collaborative meetings. Resources are also limitations, specifically in a health related study like MindTrails due to existing rules like HIPAA that prevent thorough analysis of the study. These are challenges that may result in collaborative trading zones, but understanding that they are present and applying the codesign framework effectively can help minimize the negative impacts from them.

Trading Zones Along the Process

Since we are not perfect humans, it is almost impossible for there to be a perfect collaboration and codesign project without any problems. As the semester continued, I worked to

document our progress in a journal, especially when more issues began to arise in our efforts. After analyzing what went wrong, I was able to group each issue into one of the trading zone quadrants discussed as a toolkit for analysis in the beginning of this paper. With the acknowledgement of these issues, our group did the best of our ability to ensure there was equal codesigning going forward and preventing the same situation from happening again.

One challenge also briefly explained at the beginning of the paper was that there were discrepancies between our team of engineers and the psychology team of MindTrails in terms of how the virtual conversational agent would be designed. Specifically, we as engineers were not fully aware or knowledgeable on what verbiage would psychologically be the most assuring and encouraging for the users. However, we were able to successfully fall into the interlanguage trading zone as we implemented positive codesign frameworks. In order to get to this point, codesigning and collaboration was heavily used as we produced a script for the chatbot and got feedback from the MindTrails psychology team as we made updates. To exemplify this, one instance while getting feedback from the MindTrails team was that the initial script's verbiage was trying too quickly to get to the technical points rather than embedding sympathetic responses that say phrases like, "I'm sorry to hear that…" or "I hear you, that can be difficult." This feedback was taken very well by our team and we began to consider those aspects when continuing our design. This interaction fit into the interlanguage quadrant of trading zones as the MindTrails team went through and color coded our script in terms of what changes they suggested. This resulted in an effective means of collaboration rather than coercion and also resulting in a homogeneous outcome as the group was able to implement effective codesign and collaboration methods to reach a shared outcome. They highlighted phrases that needed to be updated to sound less "robotlike" in yellow and phrases or words that had technically incorrect

dialogue in pink. The codesign efforts were positively reciprocated as ideas continued to be pinballed back and forth and built to the satisfaction of both parties.

Like I briefly touched on in the beginning of the paper, we planned to assess the feasibility of our virtual conversational agent using an interview with questions written by our team. Our capstone team met during our usual Thursday meeting time in which we worked with our System's Engineering advisors to formulate types of questions to ask in the exit interview. After researching and talking through the reasoning behind different types of questionnaires, we decided it would be most beneficial to use the Post-Study System Usability Questionnaire (PSSUQ) which consist of multiple statements in which the participant would select their response on a scale from "strongly disagree" to "strongly agree" ("PSSUQ (Post-Study System Usability questionnaire)," 2021). This was a general consensus within our group, however, we knew it would be important for the psychology team of MindTrails to look over our decisions and provide feedback so we could continue to codesign that aspect of our project.

In the meeting with the MindTrails team, we presented the questionnaire we had created using qualtrics, with the PSSUQ questions previously discussed. There was discussion about what we had created, but the main conversation point was that the MindTrails team suggested that the interview to be primarily free-response questions. Though this is ideal, given other constraints like time and resources, a free-response only survey was not feasible. This created a fractioned trading zone as there was collaboration between both teams, but there were differing results. This is similar to a study of a diverse group of scientists, trappers, amateur collectors, and university administrators successfully collaborating in providing and cataloging specimens for the Museum of Vertebrate Zoology at the University of California, Berkeley. Each group was given a map of California to design however they wanted. The results showed that "the maps of

California created by the amateur collectors and the conservationists resembled traditional roadmaps familiar to us all…maps created by the professional biologists, however, shared the same outline of the state (with the same geo-political boundaries), but were filled in with a highly abstract, ecologically-based series of shaded areas representing 'life zones', an ecological concept" (Star & Griesemer, 1989). In this case, the collaboration created a fractioned trading zone, but specifically, there existed a boundary object – the state of California. Each party was on the same common agreement that the specimens should be collected from California. In the case of our interview, though there were disagreements, there was a common boundary object which was that we wanted to conduct some sort of feedback survey on the Qualtrics platform. After assessing each team's views and collaborating accordingly, we were able to result in a homogeneous consensus of an equal mix of likert scaled questions and a few overall free response questions that we would still be able to analyze and sift through in the given time frame.

As it came closer to time for us to actually conduct the experiment, we worked to get IRB approval to run the study after spring break. The participants being brought in for the study were supposed to consist of undergraduate psychology students who are required to participate in a certain number of hours worth of psychology studies at UVA. However, at one of the Friday meetings on Zoom with MindTrails before break, we shared our deployed chatbot with the team. After providing feedback on many parts of a chatbot that we deemed ready, the head of the psychology department brought up a completely new idea moving forward. She suggested that in order to avoid the IRB process and since our chatbot was "not ready" that we should change the interview process to having different people on the MindTrails team try out our software and provide feedback to be used in future studies after we graduate. It's important to note that I was

the only person from my capstone group who could make it to the meeting, so this suggestion induced a lot of stress as I felt the need to be able to talk it through with my group members. However, my capstone advisor agreed with her idea and they continued on with the new changes. This, in my opinion, resulted in an enforced trading zone as the outcome of the meeting was more coercive and the consequence of the change would be a much more heterogeneous culture. An example of an enforced trading zone is the way that central planners came to dominate architecture and agriculture in some parts of the world, with a resulting negative impact on agricultural production as there was a heterogeneous outcome of opposing agricultural methods between the two opposing groups – the central planners and the groups who were already in the area (Scott, 1998). This new turnaround was definitely very difficult to deal with as I had to update the rest of my team who wasn't aware or present during the change, but we pushed through, trying to circle back and work on making the new changes. Through positive codesign and collaboration we were able to figure out a new tentative plan and hopefully turn our trading zone into a positive trade of ideas. Our new efforts included physically writing out everything that needed to be done to make the changes as well as verifying that with all parties working on this project. Though frustrating, everyone was content with the end result and became motivated once again to finish off a strong project.

Conclusion:

To conclude, there were many takeaways from my experience and analyzing the MindTrails case study and its relation to other researched cases. Specifically, the biggest takeaway from this analysis is that almost every team or group is going to face issues in collaboration, resulting in negative trading zones. A successful codesign process from beginning to end is rare, but it's very important to note the beauty and success that follow these efforts.

Trading zones root from failed collaboration, followed by a forced homogeneous culture or opposing heterogeneous views. However, a key framework as highlighted throughout this paper is codesign and analyzing how effective it is to overcome obstacles. Many instances, as shown through the case studies in my paper, show the process of collaboration and design, whether it's initially a great methodology, or if it involves recovery through cooperation and design. I also had the advantage of applying my knowledge of the codesign and trading zone toolkit while working through my capstone project with the MindTrails team. Through case studies and immersing myself in a year-long group project, it is clear how essential these frameworks are to achieve success in all types of joint efforts.

Works Cited

Bremer, V., Chow, P. I., Funk, B., Thorndike, F. P., & Ritterband, L. M. (2020, October 28). Developing a process for the analysis of user journeys and the prediction of dropout in Digital Health Interventions: Machine Learning Approach. Journal of Medical Internet Research. Retrieved November 3, 2021, from https://www.jmir.org/2020/10/e17738.

Collins, H., Evans, R., & Gorman, M. (2007). Trading zones and interactional expertise. ScienceDirect. Retrieved March 16, 2022, from https://worldpece.org/sites/default/files/artifacts/media/pdf/collins_et_al._-_2007_-_trading_zone s_and_interactional_expertise.pdf

Edmunds, D. S., Shelby, R., James, A., Steele, L., Baker, M., Perez, Y. V., & TallBear, K. (2013). Tribal Housing, codesign, and cultural sovereignty. Science, Technology, & Human Values, 38(6), 801–828. https://doi.org/10.1177/0162243913490812

Moll, S., Wyndham-West, M., Mulvale, G., Park, S., Buettgen, A., Phoenix, M., Fleisig, R., & Bruce, E. (2020, November 1). Are you really doing 'codesign'? critical reflections when working with vulnerable populations. BMJ Open. Retrieved November 3, 2021, from https://bmjopen.bmj.com/content/10/11/e038339.

Panchal, N., Kamal, R., Cox, C., & Garfield, R. (2021, February 20). The implications of COVID-19 for mental health and substance use. The Implications of COVID-19 for Mental Health and Substance Use. Retrieved November 3, 2021, from https://www.kff.org/coronavirus-covid-19/issue-brief/the-implications-of-covid-19-for-mental-he

alth-and-substance-use/#:~:text=The%20KFF%20Health%20Tracking%20Poll,eating%2C%20in

creases%20in%20alcohol%20consumption.

PSSUQ (Post-Study System Usability questionnaire). UIUX Trend. (2021, February 9).

Retrieved March 16, 2022, from

https://uiuxtrend.com/pssuq-post-study-system-usability-questionnaire/

Scott, J. C. (1998). Seeing like a state: How certain schemes to improve the human

condition have failed. New Haven: Yale University Press.

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, 'translations' and boundary

objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39.

Social Studies of Science, 19(3), 387–420.

Steen, M., Manschot, M., & De Koning, N. (2011, August 15). Benefits of co-design in

Service Design projects. International Journal of Dsign. Retrieved November 3, 2021, from

http://www.ijdesign.org/index.php/IJDesign/article/view/890/346.

U.S. Department of Health and Human Services. (n.d.). NIMH " mental illness. National

Institute of Mental Health. Retrieved November 3, 2021, from

https://www.nimh.nih.gov/health/statistics/mental-illness#part_2539.