Inclusion by Design: A 75-Minute Crash Course on Accessible Design

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The community of researchers supporting instruction on design thinking has a significant body of materials to help students understand and master the process of creative problem solving in design. Missing, we argue are materials and processes which directly support the design of inclusive technologies for persons with disabilities. We present ‘Inclusion by Design’, an interactive and participative crash course designed to introduce students to techniques that may be useful in an inclusive design process. In a single 75-minute session, students explore the inclusive design of a transportation technology for a visually impaired persona. We report on our findings from a single pilot of the crash course involving six diverse students within a graduate course on Inclusive Design. Our findings suggest that the course may be effective in introducing techniques like storyboarding, scenario creation, and low fidelity prototyping to students using an approach that may be effective for various learning styles.

INTRODUCTION

Design thinking is an increasingly utilized iterative process that seeks to foster a deep understanding of the user, their needs, and perspectives (Cross, 2007; Razzouk & Shute, 2012). The process itself is both a way of thinking and a collection of processes designed to foster creativity while challenging assumptions. From a practical perspective, design thinking may be defined as, “a discipline that uses the designer’s sensibility and methods to match people’s needs with what is technologically feasible” (Brown, 2008). But, while design thinking broadly supports the design of technologies intended to meet the needs of end users with a range of abilities, it is arguable that many of the materials intended to teach this process do not go far enough in training students to fully explore the needs of persons with disabilities and older adults (65+). ‘Inclusion by Design’ is an interactive and participative crash course design to introduce students to techniques that might prove useful in designing technologies specifically intended to be accessible for users with disabilities. These de facto assistive technologies (AT) may include technologies intended to satisfy the often-different experiential needs of end users who may be blind or visually impaired (BVI), may be deaf or hard of hearing (DHH) or who may have age-related declines in physical or cognitive abilities. The course, which is loosely based on the crash course in design thinking from Stanford’s Design School, provides students with a hands-on exploration of user needs analysis, affinity diagramming, scenario creation, storyboarding and low fidelity prototyping in a 75-80 minute workshop (Stanford University Design School, n.d.). The activities are specifically geared towards those interested in the design of inclusive technologies and AT as well as those with limited experience in design generally.

Within this work we present ‘Inclusion by Design’, provide a detailed explanation of the process, present findings from a pilot study and critically reflect on the process as a whole. We argue that the process itself may prove beneficial for both the design thinking and inclusive design communities and may contribute to the effort to aide students in the mastery of design for end users with varying abilities. Further, this work may benefit researchers interested in universal and inclusive design broadly.

INCLUSION BY DESIGN

The ‘Inclusion by Design’ crash course is delivered by a main facilitator who controls the flow of the experience, regulates the activities, keeps track of time and provides prompts to assist participants in completing the defined tasks. The activities of the course are sequential in nature, beginning with a kickoff activity and problem description and concluding with a low-fidelity prototyping activity. The crash course was intentionally designed around a challenging problem of inclusive design that has real world implications; designing a shared autonomous vehicle (SAV) (Alam & Habib, 2018; SAE International, 2018) used as part of a ridesharing service like Uber or Lyft, that is accessible for blind or visually impaired end users. The approximately 57 million people in the United States with visual, hearing, cognitive and mobility disabilities often face significant barriers to personal mobility and transportation (Claypool, Bin-Nun, & Gerlach, 2017). Recent research, for instance, suggest that as many as 20% of the disabled in the US face transportation barriers, with 45% of this group lacking access to a personal passenger vehicle (U.S. Department of Transportation, n.d.). This problem may be especially pronounced for persons with significant visual disabilities who, unlike amputees or persons with partial paralysis, have no legal means of operating a conventional motor vehicle in a non-experimental sense(National Federation of the Blind, n.d.; Sucu & Folmer, 2014).

Emerging transportation technologies like fully autonomous or “self-driving” vehicles hold tremendous potential in addressing the multifaceted transportation problems with which the disabled must contend. The combined use of concierge or ridesharing applications (e.g. Uber, Lyft, etc.), self-driving vehicles, light rail, automated shuttles, and conventional buses now provides a conceptualized scheme for enabling the visually impaired to independently travel from a point of origin to a final destination.

In the ‘Inclusion by Design’ crash course we tasked students with designing the SAV user experience to be accessible for a BVI persona. Personas, popularized by Cooper, Reimann, and Dubberly (2003), are fictional people with names, ages,
genders and any number of other characteristics that aide designers in grounding their design decisions around user needs. Typically these characters are accompanied by a picture and a textual narrative that is written to make the persona seem like a real person while also providing a story that relates the specific needs and personal goals of the persona in the context of the product being designed (Cooper, 2004). The use of personas has been integrated into the design process of many Fortune 500 companies (Nielsen, 2013) and according to Cooper et al. (2003), persona use during the design process can ultimately improve the usability of a final product. Within the ‘Inclusion by Design’ course we introduced participants to a persona called Walter, a 48-year-old technology reporter who has been blind since birth. The Walter persona is based on user needs gleaned from related literature on visually impaired persons and their use of self-driving vehicles and surface transportation technologies (Brewer & Kameswaran, 2018; Brinkley, Daily, & Gilbert, 2018, 2019; Brinkley et al., 2020; Brinkley, Posadas, Sherman, Daily, & Gilbert, 2019; Brinkley, Posadas, Woodward, & Gilbert, 2017; Kameswaran et al., 2018).

Activity 1: Introduction (5 minutes)

As a first step in the ‘Inclusion by Design’ crash course participants pair up with a partner, are informed about the end goals of their design process (e.g. the design of an accessible SAV experience) and are introduced to the Walter persona. To add to the believability of the character and the scenario, participants are played an audio recording of the character introducing himself, voiced by a professional voice actor, and provided with a populated persona template based on a general template by Nielsen (2013). The provided template extends the general and technology characteristics of Nielsen (e.g. computer skills, educational level, description of daily life, etc.) with characteristics that focus on disability and domain specific transportation characteristics.

Activity 2: Affinity Diagram (15 minutes)

In activity two, participants begin the process of understanding Walter’s needs from an SAV accessed via a ridesharing service. Participants are provided with sticky notes and instructed to, as a team, brainstorm and document factors that might affect Walter’s experience with a shared autonomous vehicle used as part of a ridesharing service; participants are given seven minutes for this activity. We instruct them to refer to the documents provided about Walter which include a one-page narrative and the described persona template. Participants are told to aim for at least 25 notes. Participants are then given four minutes to group items together from the end user’s perspective using a different color sticky note to label groupings and identify themes (Figure 1). As a final aspect of this activity, participants are given four minutes to individually read through groupings and items individually. Participants are asked to write down questions or blind spots in the data and post these in different colored notes next to the location in the diagram that they relate to.

Activity 3: Frame the Problem (2 minutes)

In activity three, participants are given three minutes to synthesize findings into two groups; goals and pain points. We ask participants individually to think about and write down Walter’s biggest pain points or obstacles with his current mode of transportation, based only on the information that has been provided, while also considering what he hopes to accomplish in his use of an SAV.

Activity 4: Scenario Creation (5 minutes)

In activity four, participants are provided with a scenario template and are asked to individually create a scenario that explains how Walter will use the shared autonomous vehicle. Participants are provided with a snippet that sets the stage for the scenario:

Walter takes the bus five days out of the week to get to work. He’s happy that the bus is available, but his long commute is time consuming and takes time away from his family. He would prefer the ability to drive a car but is blind and cannot operate a conventional motor vehicle…

Activity 5: Ideation (10 minutes)

In activity five, participants are asked to individually identify solutions to the problems that they identified, referencing activities two through four. Participants are prompted by the facilitator to sketch at least five radical ways to meet Walter’s needs with the SAV. Participants are encouraged to opt for volume, quantity over quality, and to be visual.

Activity 6: Feedback (8 minutes)

In activity six participants share their ideas with their partner and receive feedback. Participants are encouraged to listen to their partner’s reactions and questions and to take note of what they learned.

Activity 7: Synthesis (5 minutes)

In activity seven participants reflect on the feedback from their partner then individually combine their best ideas into a single solution. Participants are then asked to depict Walter’s use of this solution in context using a narrative storyboard. Participants are instructed that the storyboard should highlight both the interface(s) and the overall context of use.
Activity 8: Prototyping (5 minutes)

As a final activity, participants are asked to create a physical prototype from a collection of materials that includes construction paper, tape, pipe cleaners, scissors, glue, felt balls and popsicle sticks. Participants are then challenged to physically create an aspect of their experience that, in theory, they would present to Walter to interact with. They are further encouraged to physically and emotionally release the prototype to the class for feedback by placing the prototype in the center of the room.

Discussion and Reflection (15-20 minutes)

To conclude, participants are given 15 to 20 minutes as a group to present, reflect, and comment on their work and the work of their classmates. Participants are asked to reflect on the process itself through a written reflection journal.

INCLUSION BY DESIGN PILOT

To conduct an initial assessment of the concept and approach as well as its practical value, we conducted a pilot study with six students in a graduate course called, 'Inclusive Design and Accessible Technology'. The course is listed as an 8000-level special topics computer science graduate course at Clemson University. The course is a 3-credit hour introduction to the concept of inclusive design that explores the use of inclusive design processes in the development of accessible technology. Topics included Design for User Empowerment (Ladner, 2015), User Sensitive Inclusive Design (Newell & Gregor, 2000), Universal Design (Bigelow, 2012), Ability-Based Design (Wobbrock, Kane, Gajos, Harada, & Froehlich, 2011), the ethics of accessibility, the legality of inaccessibility, disability-related terminology and assistive technologies (e.g. screen readers, refreshable braille displays, etc.).

Students within the course (3 males and 3 females) came from diverse backgrounds both personally and educationally (Table 1); no student had more than four years of experience in design. Three students within the course were first year Human-Centered Computing doctoral students, one student was a final year Human Factors Psychology PhD Candidate, one student was a second year Computer Science Master’s student and the final student was a second-year graduate student in the university’s Education department.

We conducted the ‘Inclusion by Design’ pilot at week seven after students received instruction on inclusive design and technologies that assist people with disabilities, visual impairment and blindness, motor impairment, auditory impairment, and cognitive impairment. Modules one through six were comprised of lectures on specific user experience design topics. the Clemson University Institutional Review Board approved all study-related activities and we did not compensate student participants, monetarily or otherwise. We also did not grade any artifacts produced as part of the pilot study.

Framing of the Problem

Participant attempts to frame the problem yielded responses which, in general, were similar for all. Participants indicated that Walter’s goals were to commute independently without relying on others, to have reliable transportation, to maximize time with his family, all while minimizing his transportation costs. Walter’s pain points with his current mode of transportation, public buses, were identified as the time and financial costs of his commute, lack of flexibility, over reliance on others and the loss of opportunities due to issues with personal transportation. All participants were able to frame the problem and identify pain points in the two minutes allotted for that activity.

Scenario Creation

The scenario creation process produced a range of responses from participants which were similar in the sense that they followed the same structure but were otherwise different from one another. Participant 3 for instance, using the provided template, created the following scenario for an SA V service called Tim’s Autonomous Car Oligarchy (TACO):

Walter’s primary need from the SA V is to be able to swiftly and easily travel from multiple locations at his own time requirements throughout the day. TACO allows Walter to request an autonomous vehicle at any time of the day or night, and to quickly and efficiently travel to any requested destination without the assistance of another person. The TACO in-vehicle human-machine interface allows Walter to enter his route and destination information using voice commands or an accessible smartphone application. Walter is now able to take any job that he desires, spends more time with his family and travel independently to any destination he chooses at any time of day or night.

While the scenario creation activity yielded diverse responses only half of the student participants were able to fully complete the scenario in the five minutes provided.

Ideation

In the ten-minute ideation activity participants were asked to visually document at least five radical ways to meet Walter’s needs with the SA V. While one participant generated four ideas, the remaining participants were all successful in producing at least five different solutions to Walter’s problems involving the SA V and encompassing a description of the vehicle’s human-machine interface. Participant 1, for instance, described a vehicle seating arrangement where occupants were placed in rows and interacted with an in-vehicle infotainment system embedded in the seat in front of them. This intelligent seat would alert the vehicle occupant to when he or she had arrived at a desired location using vibrations, included an interactive system with built in screen reader and a large, tactile, emergency stop button (Figure 2). Participant 5, however, envisioned an in-vehicle interior replete with tactile maps paired with constant auditory feedback coupled with doors handles that would change temperature to indicate when it was safe to exit the vehicle.

Storyboarding

In the idea synthesis and storyboarding activity participants had five minutes to individually combine aspects of their disparate ideas into a single solution. Participants were then asked
Table 1. Pilot Study Student Participant Demographics

<table>
<thead>
<tr>
<th>Participant No.</th>
<th>Gender</th>
<th>Degree Program</th>
<th>Years of Design Experience</th>
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</thead>
<tbody>
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<td>M</td>
<td>Computer Science</td>
<td>2</td>
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<tr>
<td>2</td>
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to create a narrative storyboard that depicted Walter’s use of the designed technology in context. The resulting storyboards depicted a wide variety of features for the shared autonomous vehicle and included a range of internal and external HMI. Participant 5 for instance illustrated a tactile interface integrated into the SAV to enable Walter to identify, upon vehicle arrival, that the vehicle is in fact his requested ridesharing vehicle non-visualy. Participant 6, however, focused on vehicle ingress and egress and described a vibro-tactile-based system that would alert the occupant regarding arrival at the desired final destination while also providing an indicator to indicate when it was safe to exit in light of any oncoming traffic.

Prototyping

Participants produced a range of low fidelity prototypes in the five minutes that was allotted for this activity. The prototypes were intended to provide a tangible means of enabling the group to engage with the solutions that were developed through the design activity.

Figure 2. Autonomous Vehicle “Smart Seat” low fidelity prototype with tangible stop button, in-seat display and haptic feedback

DISCUSSION

Generally, participants were successful in completing the individual activities of the ‘Inclusion by Design’ process. This success was reflected in the ability of all participants to develop a tangible artifact for the group to engage with and interact with as the final activity of the design process. Time constraints in the processes challenged the participant, however, these challenges were not significant enough to minimize, we argue, the overall effectiveness of the process. In evaluating the effectiveness of the crash course, we looked to the completion percentage of all activities as well as participant feedback as reflected in the written reflections journal submitted by students three days after the process. In the analysis of participant crash course packets, collected at the conclusion of the activity, we determined that participants completed over 80% of all assigned activities during the crash course. This suggests that while the limited time may have been a factor in the depth with which participants were able to explore specific activities, it did not serve as a significant hinderance.

TAKEAWAYS

To support others interested in implementing a similar crash course or using directly the materials we will make available for ‘Inclusion by Design’, we make the following suggestions:

- When possible, an audio recording of the persona providing a personal narrative should be used as a kick-off/introduction activity. This type of recording increases the believability of the entire process.
- To supplement the personal narrative recording a populated persona template should be provided for participants to refer to throughout the design process.
- A template should be provided for the scenario creation activity with examples drawn from the design context.
- The facilitator should be very strict on sticking to the time allotted for each activity even if its clear that not all participants have completed the described task.
- A range of materials should be made available to participants for prototyping to avoid placing de facto limitations on participant creativity.

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REFERENCES
