Accessible Technology Design:
Assessment of problem-solving approaches
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All citizens have the right to vote privately and independently. In 2002, new legislation in the United States required that voting systems "be accessible for individuals with disabilities". Despite this progress in reducing the participation gap between citizens with and without disabilities, many Americans with disabilities still face obstacles to participating in elections—from registering to casting their ballot. These obstacles include systems that are cumbersome to use and polling places where accessible systems are not set up. Recognizing that solutions to the plethora and diversity of problems require innovative problem-solving approaches, representing an array of expertise and interests, a series of workshops were held to bring together experts from a variety of backgrounds to engage in a design-focused approach to collaborative problem solving. This paper describes the structure, outcomes and impact of the workshops. A particular emphasis is placed on how these workshops were designed and conducted as a model for integrating accessible and universal design practices in the design of everyday technologies, products and systems.

Keywords: Universal design, Voting technologies, Design workshops

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Chaque citoyen a le droit de voter seul, sans aide et de manière confidentielle. Depuis 2002, la législation américaine exige que les dispositifs destinés au vote « soient accessibles aux personnes handicapées ». En dépit des progrès réalisés pour réduire l’écart en termes de participation entre citoyens handicapés ou non, de nombreux Américains handicapés rencontrent encore des difficultés lors du parcours électoral allant de l’inscription au vote lui-même. Ces problèmes sont dus au fait que les dispositifs destinés au vote restent difficiles à utiliser et que de nombreux bureaux de vote ne sont pas équipés de dispositifs accessibles aux personnes handicapées. Trouver des solutions à ces problématiques aussi nombreuses que variées nécessitait donc une approche innovante et concrète couvrant un large éventail de compétences et d’intervenants. C’est dans cette optique qu’une série d’ateliers réunissant des experts de divers horizons a été organisée afin d’adopter une démarche axée sur le design permettant de trouver ensemble des solutions concrètes à ces difficultés. Ce document évoque l’organisation de ces ateliers ainsi que leur impact et les résultats obtenus. Il y est notamment fait mention de la manière dont ces ateliers ont été conçus et menés afin de constituer un modèle d’intégration de pratiques accessibles et universelles à la conception des technologies, produits et systèmes que nous utilisons au quotidien.

**Mots-clés :** Design universel, technologies de vote électronique, ateliers de design
Introduction

In 2002, new legislation in the United States required that voting systems “be accessible for individuals with disabilities, including nonvisual accessibility for the blind and visually impaired, in a manner that provides the same opportunity for access and participation (including privacy and independence) as for other voters” (Help America Vote Act, 2002). In the ten years since the Help America Vote Act (HAVA) was passed, there has been progress. Polling places are required to have some form of accessible voting system available (Verified Voting, 2012), and new Federal guidelines (Election Assistance Commission, 2005) set standards for usability and accessibility in certifying new systems.

Despite this progress, Americans with disabilities still face many obstacles to participating in elections, from registering to vote to casting their ballot (Hall & Alvarez, 2012). For example, the size, complexity, and diversity of ballots across the United States add challenges as well as confusing ballot design and instructions (Redish et al, 2008; Norden et al, 2008; Runyan & Tobias, 2007). The Accessible Voting Technology Initiative (AVTI) was established with a goal to better understand the barriers and facilitators for designing new voting technologies for people with disabilities and to bring about new accessible voting technology solutions (Information Technology & Innovation Foundation, 2012). Informal interviews with manufacturers and designers suggested that one reason for the poor design of current voting systems is a lack of access to voters, especially voters with disabilities, for design research and usability or accessibility testing. Furthermore, lack of understanding on how to meet the broad range of accessibility requirements for voters with vision, hearing, mobility, dexterity and cognitive disabilities is a focal reason. An additional barrier to accessible design is that disability advocates with expert design knowledge are often focused on specific disabilities, making it hard to reach a synthesis in design requirements. Based on this analysis of the current landscape for designing voting systems, the ITIF AVTI decided to hold two workshops to see if a more design-focused approach would be effective in both helping individuals interested in election technologies gain a better understanding of the design challenges, and producing new concepts for accessible election technologies, processes or other solutions. As such, two design workshops were held in two consecutive months. The workshops focused on developing new concepts for accessible elections. This paper describes the structure, outcomes and impact of the workshops.
Voting technologies

Voting technology in the United States has evolved substantially since the introduction of the secret ballot in the late 1800s. Over the years, a variety of new systems from lever machines to punch card systems were introduced to improve elections. However, it was not until the debacle of the 2000 U.S. presidential election, when voters witnessed a systematic and widespread failure in the election system, that a serious effort began to replace inaccurate and inconsistent paper ballots with electronic voting systems. As part of the HAVA in 2002, Congress authorized nearly $4 billion for states to replace their aging collection of voting systems with more modern systems so that the problems from the 2000 election would not be repeated.

HAVA also included provisions mandating that voting systems be fully accessible for people with disabilities. As a result of these requirements and the availability of federal funding, state and local election officials began to widely adopt the use of Direct Recording Electronic (DRE) voting machines.

DRE voting machines are electronic machines, similar to Automatic Teller Machines (ATMs) that enable voters to view ballots on a screen and make selections using an input device such as tactile buttons or a touchscreen. These systems also typically include optional audio-based features (and headphones) so that individuals who cannot see the screen can listen to and then mark their ballots. Many DRE voting systems also support some integration with assistive technology. For example, these systems may allow sip-and-puff controls or jelly bean switches to accommodate voters with certain mobility or dexterity disabilities.

Universal design implications

Some of the challenges presented by voting technology could be addressed if greater attention were paid to usability and accessibility as part of their design. Traditionally, add-on assistive technologies have been used to compensate for accessibility barriers after a system has already been designed (Sanford, 2012). For voting machines, such an approach requires that assistive technologies be on-site and set-up, and that voters and poll workers already know how to use them. More importantly, reactive attempts to provide accessibility through assistive technology may not be effective, or may provide an awkward solution to accessibility problems.

Universal Design (UD), which is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design (Story et al, 1998), offers an alternative proactive approach that considers usability and inclusivity for all people in the design of voting systems. UD is based on seven principles (The Center for Universal Design, 1997): equitable use, flexibility in use, simple and intuitive use, perceptible information tolerance for error, low physical effort, and size and space for approach and use.
The principles serve as a guide to help designers develop and evaluate their concepts. The principles are particularly relevant to some of the challenges with voting technologies. For example, the barriers faced by voters who have low vision would be addressed by attention to the UD principle of “perceptible information,” which might include the use of adequate contrast and maximized legibility, differentiated elements, and the use of different presentation modes (pictorial, verbal, tactile). Moreover, a UD approach not only benefits voters with disabilities, but it also makes the technologies “more usable by all people.” For example, features designed around the principle of “simple and intuitive use” not only benefit voters with cognitive disabilities, but also voters with low literacy, those for whom English is a second language, and first-time voters who are unfamiliar with the equipment. Similarly, many features designed around the principle of “size and space for approach and use” not only accommodate a voter who uses a wheelchair, but also a voter who is accompanied by his or her children.

**Workshop Needs**

In order to make voting more accessible to people with disabilities, a universal design-oriented process of participatory workshops was used to gather input, insights and ideas and empower the key stakeholders, including individuals with disabilities and their advocates, election officials and voting system vendors. As a result, the workshops provided the context to create an understanding of the needs and perspectives of all stakeholders, identify barriers to current and potential innovations in voting systems, and develop new comprehensive voting solutions to overcome the barriers. The goals of the workshops were therefore not just to develop new technological solutions, but also to apply new conceptual ideas for voting systems based on the Principles of UD so that they are: Usable: supporting all voters to participate independently and privately; Inclusive: enabling all voters to utilize the same voting systems; Flexible: compatible with election management practices from traditional polling places to vote centers and vote-by-mail; Secure and auditable: making it possible to recount and audit elections; Affordable and robust: cost effective for even the smallest election districts.

**Workshop Structure**

The one-and-a-half day workshops were structured as a design charrette (Martin & Hanington, 2012). A charrette consists of an intense period of design activities. It is a highly collaborative and participatory method in which groups of people work together to collaborate in envisioning solutions to specific problems, in this case accessibility of voting systems. This process provided a way of quickly generating design solutions while integrating the expertise and experiences of a diverse group of people.
Workshop Participants

A total of 35 people participated in each workshop. The workshop participants represented a broad spectrum of experiences and viewpoints, including individuals who make decisions about the design of voting technologies, the selection of voting technologies and polling places and training in the use of voting technologies as well as those who use voting systems. As such, people with disabilities, accessibility advocates, election officials, election workers, voting technology experts and voting system designers, as well as designers and researchers from technology, interaction, information, usability, graphics, architecture and other design fields were involved. Overall, participants were categorized by four of expertise areas: people with disabilities and accessibility advocates, election officials, voting technology experts, and designers.

Workshop Overview

The workshop was divided into four group areas representing the different themes of the voting process: preparing to vote, voting in person, voting remotely, and marking the ballot. Initially, participants were assigned to one of the groups based on their type of expertise and to guarantee heterogeneous and balanced representation across teams. However, later, participants were allowed to change groups at designated times during the workshop.

To help participants best achieve these goals, the workshop was designed to engage them through a variety of different problem-solving activities. The workshop followed a structure with the use of various analytical and creative methods (Higgins, 1994; Martin & Hanington, 2012). Those methods included scenario based design (Carroll, 2000), personas, and Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis. Integral to all of these methods was the grounding in the Principles of UD.

Participants were encouraged to have an open mind, positive thinking and enthusiasm and to be focused on the activities. A workbook was given to all participants to guide all activities (see figure 1). The group activities moved from defining accessibility barriers, to sketching ideas for how to overcome them, refining those concepts into viable solutions, and presenting those solutions.
Workshop Methods

The first task of the workshop was based on identifying barriers. “Scenario-based design” was utilized to identify barriers to voting (Carroll, 2000). This method uses a problem identification and problem solving technique where new products are designed by addressing problems in the activity in which the product is used. Scenarios evoke a task-oriented reflection by the designer through a process of thinking about the tasks to be done and the requirements to accomplish the task. During the workshop, participants were given a set of scenarios and tasks to reflect on, such as: “Your voter is trying to prepare for an upcoming election. He uses the newspaper and Internet for learning about the candidates. He knows that he will need to use the accessibility features on the new voting systems for this year’s elections, and would like to learn how to use them ahead of time.” Participants engaged in conversations and story sharing within their group to identify barriers for designing accessible elections.

In addition to the scenarios, personas were given to each team. Personas are fabricated research-based archetypes, or models, of end users intended to be a singular icon that are representative of an entire group (Visocky O’Grady, 2006). For example, “Tasha is a woman in her 30’s who runs her own business. She has been blind since birth. She employs a “reader” who reads print materials to her. However, she uses a computer independently and prefers that method for accessing information.” The personas created for the workshop were based on the needs, abilities and experiences of actual voters with disabilities who were interviewed as
part of the larger project. Workshop teams used the different personas to evaluate the voting context of a scenario through the lens of a variety of user experiences. After identifying barriers experienced by voters in the voting process, teams were asked to brainstorm ideas and generate concepts to overcome those barriers (Higgins, 1994). Brainstorming combines a relaxed, informal approach to problem-solving that helps people break out of traditional patterns of thinking. The teams used rules of brainstorming developed by IDEO, which included: deferring judgment, encouraging wild ideas, building on the ideas of others, staying focused on the topic, having one conversation at a time, creating rich images and going for quantity (Willerer, 2009). With this method, participants generated a vast amount of varied ideas and solutions to the identified barriers.

![Figure 2. Concept visualizations.](image)

The next step was to continue the work towards a developed solution. As such, all participants were tasked to “vote” on the best ideas from all work developed by each team. All work was pinned up for review, giving participants a chance to see all of the ideas produced by each team. Each participant was given a limited number of “votes” using color-coded stickers to represent a vote. The sticker color represented the participant background (see figure 3). This allowed participants to recognize patterns of interest in concepts based on expertise. The votes were ultimately used to select the best concepts to be further developed by different teams.
After selecting the best concepts, each team worked to refine them. The teams used the UD Assessment Tool (The Center for Universal Design, 2002) as a framework for validating the concepts (see figure 4) through a SWOT analysis. The UD assessment tool forced teams to refine the accessibility of the concept by answering specific questions related to the UD principles, such as: “Can the concept be effectively used in a variety of ways?” Teams wrote down the strengths and weaknesses of the concepts according to each of the Principles of UD. The SWOT analysis method helped uncover design opportunities that were not immediately obvious (Higgins, 1994). By understanding the weaknesses, there was a new opportunity to eliminate unpredicted threats. Combining the universal design assessment with a SWOT analysis allowed teams to identify the goals for refining the concepts from which a final concept would emerge.
Visualization

Figure 4. SWOT analysis

Workshop synthesis

At the end of two workshops, the groups had created eleven diverse concepts addressing different aspects of elections, from learning about participation to concepts for how to cast a ballot. Each team created a final detailed design concept showcased in a poster (see figure 6). The posters summarized the concept, identi-
fied the barrier being addressed, and documented how it incorporated universal
design principles. The process of preparing the posters enabled the teams to
synthesize their ideas.

Teams presented the posters to the entire workshop. At the end of each presenta-
tion, the presenting team was tasked with asking the other workshop participants
five questions about their concept that they felt still needed to be answered, such
as how weaknesses in the design might be overcome or how a concept might
be applied or adopted. Audience responses were used to refine the concept one
more time.

Figure 6. Workshop Posters

**Evaluation and Outcomes**

Overall, the workshop methods facilitated the development of concepts that could
improve election accessibility. In addition, it allowed the application of participatory
design and the studio practices of design thinking to a civic process like elections.
Although concepts of participatory design, design thinking and planning charrettes
are common ideas in other domains (Brown, 2008, Kroll & Chisnell, 2011, Ungar
& White, 2008), they have received little attention in elections in governmental and
civic projects. Especially where political advocacy has made it difficult to bring all
of the parties together for collaborative work. As such, the workshops were novel,
in both the mix of participants and in the structure of the activities.

Both informal follow-up and input on an anonymous survey gathered comments
about the value of the workshop. The response to the overall workshop was over-
whelmingly positive with all of the ratings above average on a 4-point Likert scale.
All (n = 41) but 1 respondent rated the workshop good or better, with, 63.4% (n =
26) rating it “Excellent” and 12.2% (n = 5) rating it as “Good to Excellent.”
The qualitative comments reflected the goals of the workshop in promoting a col-
laborative environment in which people coming to a challenge with different pers-
pectives could work together to find solutions.
It was successful because we brainstormed new ideas and were able to see everyone’s viewpoints, needs and wants and are all walking away better informed.

[The best thing about the workshop was] getting people out of their normal modes of thinking and communicating ideas about how to address challenges.

What I enjoyed the most was the entire end-to-end design process -- concept to end product. This process is sorely missing in the accessibility community.

Many respondents expressed enthusiasm for the process and potential outcomes of improved elections.

[I] felt we generated actionable reform designs that will enhance access for most voters, not just those with disabilities.

Greatest gift - leaving with learning more than I was able to contribute.

More importantly, 95% indicated that the workshop was useful. Only 26% of the participants cited the development of new concepts a primary value; instead, the opportunity to hear the viewpoints of different stakeholder groups was most cited (53%) as a success, and 18% cited the contacts or “new allies” that they met.

Conclusion

The workshop methods presented in this paper are intended to help individuals interested in designing accessible products, especially in a civic context with many stakeholders, perspectives, and requirements. They included a set of creative methods for identifying and overcoming barriers for designing products to be used by all. Scenario-based design, brainstorming, SWOT analysis and Universal Design assessment tool were among the methods utilized in a design workshop. Overall, these methods helped teams bring the diverse experiences of the group’s members into play during problem identification and problem solving activities. Each workshop brought together 32 multidisciplinary participants divided in teams to imagine new solutions to make the voting process more accessible to every citizen. An innovative aspect of the workshops was the inclusion of industrial design students who sketched the team’s ideas and created posters of the proposed solutions. Their skills enabled everyone to participate on an equal basis, regardless of their prior experience with design and visual communication.

It would be unrealistic to think that one project could completely change how
elections are designed, but the results of these workshops showed that it is possible to bring together people with a wide variety of perspectives to work on a difficult civic design challenge. These workshops also validated the idea that it is possible to engage non-designers—advocates, officials, and policy-makers in a successful design process. Making the workshops a success took careful planning of the activities, a balanced group of participants, and staff to support the group in practicing new design skills.

By the end, the concepts were varied, but all provided unique ideas and insights to advance the design of the next generation of accessible voting technologies. Through a collaborative design process, the workshops produced solutions that have the potential to make the entire voting process more accessible for every citizen. This project showed the value of the design process in solving complex problems with diverse stakeholders.

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