Figure 1: Land.Info interface is close to simulation games, as it allows users to interact with 3D objects based implemented with higher graphic quality

Figure 2: Land.Info provides estimated costs and several environmental parameter impacts based on applied design

Land.Info: Interactive 3D Visualization for Public Space Design Ideation in Neighborhood Planning

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ABSTRACT

In the contemporary practice of participatory neighborhood planning, planners leverage digital support tools with realistic, interactive 3D visualization to support perception processing and to increase engagement among diverse public stakeholders. However, capturing the aspirations of a community lacking design and planning expertise requires a more thorough evaluation and considered design of support tools. We present Land.Info, a proof-of-concept software that allows users to design open spaces with 3D visualization and see the subsequent costs and environmental consequences. To assess how the public engages in design discussion with 3D visualization, we organized three community design workshops for developing a vacant lot. We found that 3D visualization 1) promotes public ideation of user stories around objects, and 2) prohibits ideas beyond spatial design elements. Future research will investigate whether it is possible to aggregate more diverse public aspirations, whether or not visual realism sets expectations for designs, and the potential impacts of expanding the software user base for neighborhood planning cases.

KEYWORDS

Interactive 3D visualization; public space design; participatory design; neighborhood planning

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INTRODUCTION

One of the key challenges in neighborhood planning is incorporating and translating complex, diverse public wishes into an implementable design [2, 16]. Recent neighborhood planning emphasizes citizen engagement to gain local knowledge, legitimate the design, and support community development [7]. Conventionally, planners acquire public opinions for design through formal meetings and field interactions [8, 16]. To support these practices, there has been increasing interests in the HCI sub-fields of data visualization [1], mixed reality [4, 18], and gamification [6]. Extending on this work, using interactive, realistic 3D visualization in space design discussion provides several benefits that HCI scholars can further explore. In particular, our research aims to see how graphic realism and interactivity in 3D visualization can facilitate public design discussion.

We present Land.Info, a proof-of-concept software that simulates planning sites in the 3D virtual space and allows users to interact with 3D objects and examine the related cost and environment indicators. (see Figure 1, 2) While the software has been developed based on a number of the past

Figure 3: For each design session, we organized design teams with different participants to design the space for 30 minutes

Figure 4: Each design group has a facilitator that handles software control, as well as several graphics for assistance

workshop cases, here we focus on the reporting of a preliminary investigation of how interactive 3D visualization in the software can facilitate public face-to-face group design discussion. We organized three community design workshops for 18 residents of Detroit, Michigan. The results suggest that the software supports yielding user stories around objects; however, it constrains participants' ideas by anchoring them to visible objects. We contribute to CHI as we design and evaluate a novel software that can support the current practice of participatory neighborhood planning.

RELATED WORK

A participatory neighborhood planning process depends on mutual design communication between community members and designers [5]. To yield stories and meanings from the members in a holistic manner, planners leverage diverse facilitation methods to communicate how community members perceive and aspire for their neighborhood [8, 16]. Furthermore, recent trends of HCI for development focus not on immediate needs, but persistent, self-defined aspirations of community members [17]. Therefore, researchers have explored how ICT can support collecting data from the public for planning [3, 10]. More recently, Mahyar et al.'s study presents a web-based civic design platform to collect design ideas directly from the public, which generated more than 300 contributions for open space ideas [11]. However, these studies tend not to allow participants to engage with the costs of various environmental and social elements that should be considered, which means that they cannot make informed cost-based tradeoffs as they contribute ideas.

Meanwhile, appropriate geospatial visualization supports space design communication between stakeholders with different design expertise. Researchers have long discussed the appropriate level of abstraction in 3D space visualization [2, 9]. In addition to these studies, several recent case studies show that technologies that utilize novel 3D visualization technologies can clarify complex spatial information [13, 15], increase accessibility for remote stakeholders [12], and promote more engagement in the process [18]. However, most studies in 3D visualization support for planning are expert-oriented and case-specific. To sum, our software Land.Info aims to develop more participatory, effective planning support with its realistic 3D visualization and interactivity for environmental cost analysis. Developing and evaluating the software with the public in diverse design discussion will bring interesting research opportunities for HCI.

METHODOLOGY

Land.Info is a Unity3D-based software developed by a research group of a Midwestern university concerned about sustainability. The software provides two main functionalities distinguishing it from other 3D planning software: 1) users can place natural (terrain, trees, green infrastructure) and man-made (road, benches, playground) 3D modeled objects in the virtual space (Figure 1); 2) users can

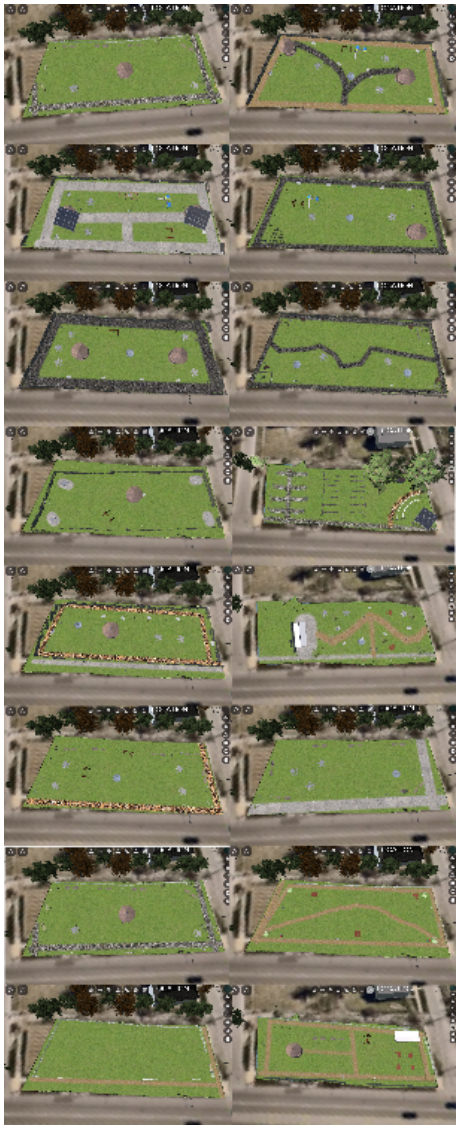

Figure 5: Final designs from the workshops

check the estimated construction and environmental costs (For example, carbon-dioxide absorption rates of trees) of the objects (Figure 2).

Participants. With a partnered community-based organization in Detroit, Michigan, we recruited a total of 18 resident participants (8:10 male to female, 61 age average). All participants in the workshops were African-American and had more than 3 years living in the neighborhood (Mean 26.7 years). While we designed workshops to have the same number of participants, there was some variation: Workshop 1–15 people, workshop 2–13 people, workshop 3–9 people.

Workshop Design. We held the three community design workshops (3 hours each) with the organization responsible for redesigning a vacant lot in the neighborhood between September - October 2018. For the first control workshop, the participants visited the site for planning and had a paper-based group design discussion. Based on the results, the developer team added 3D objects mentioned in the discussion in the software (see Figure 3, 4). For the second and third workshops, we grouped the participants in teams of three participants to design the site with the software. Each team had a facilitator for managing the software controls. We also instructed facilitators to facilitate group discussion.

Data Collection and Analysis. The data we collected included pre- and post-session questionnaires, written and drawn design profiles, 20 design outcomes created in the software, video analysis of the screen-recordings, and researcher observations. We analyzed the data using iterative thematic clustering and summarization, at each step attempting to succinctly, but precisely, articulate what the underlying data suggested. The findings below represent discussions of the most novel of the high-level themes that emerged.

PRELIMINARY FINDINGS

3D visualization can promote user stories around objects. The participants created a total of 20 designs from group design sessions (see Figure 5, 6). Overall, participants could directly initiate discussion by engaging with the software. Most saliently, the software assisted the participants to situate themselves in the space and imagine usage scenarios. The facilitators in de-briefing reported that different user stories emerged from the discussion and 3D visualization enabled users to be more space- and object-specific when they described the stories. For instance, a participant during the design session explained the site design with a scene of a wedding event in the design. She situated herself in the event and described the scene from walking down the aisle, interacting with other people, and sitting on the chair for the event. Likewise, many participants explained the objects (gazebo, fence/road around within the area, bike racks, signage) through stories with the software as the visual reference. This shows the potential effectiveness of the software in engaging an inexpert public.

Figure 6: Final designs from the workshops (Continued)

3D visualization can constrain ideas beyond spatial design elements. Compared to lower-fidelity ideation, 3D visualization in the software limited participant ideation by providing a fixed space and interactable objects. This can be either a guideline or a limitation. For example, in the paper-based ideation session, we observed that some participants hesitated to draw their own designs due to lack of experiences or understanding of the site. Furthermore, some drawings focused on coming up with objects, which had no information about the location. In comparison, the software let the participants have an understanding of the space, and the accurate measurement allows the participants to be more confident in choosing where the objects will be placed. On the other hand, the software has functionalities (simulating the aging of trees, showing the environmental benefits) that can show their design consequences. However, we could not observe many cases in which the participants interacted with the numeric analysis features for their discussion.

DISCUSSION AND CONCLUSION

Based on what we found from the workshops, we present next steps for research.

Narratives are crucial parts of participatory planning to understand what community members like, dislike, and desire for their neighborhood [8, 16]. We find that 3D visualization in the software may support contextualization and enable participants to ideate stories that are attached to spatial elements in the software. The software also showed that objectivity and spatiality could allow participants without design expertise to participate in the design discussion. We will further investigate how different community members and stakeholders express their ideas through the software and how visual realism in the software impact their ideas.

Furthermore, while the software can provide more interactivity to allow participants to see social and environmental consequences in their designs, this should be achieved with more consideration of each design cases as well as diverse public knowledge. Neighborhood planning is a process of solving community problems; public space design should consider not only beautification but also long-term social and environmental problems [7, 14]. We will improve visibility and interactivity of parameters and validate more the software's effectiveness if people change their design ideas when showing the long-term social and environmental consequences. For this, we will evaluate our software with the participants, building on previous studies in 3D visual realism perception and empirical studies in environmental data visualization.

In conclusion, this paper presents a first step towards designing an interactive 3D visualization support tool, Land.Info, for participatory neighborhood planning. From the preliminary results, we identified its effectiveness in public group design discussion. In addition to technical software improvements, future research should investigate further whether it is possible to aggregate more diverse public aspirations, whether visual realism sets any negative or positive expectations, and the impact of expanding the user base of the software for neighborhood planning cases.

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