A Multi-Display Environment for Community Planning

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ABSTRACT

We describe an integrated, tabletop-centered multi-display environment for engaging the public in collaborative community planning. Activities are anchored in a multi-touch tabletop display augmented with multiple large-screen displays and smaller hand-held displays to foster collaborative co-creation. To make the tool accessible for non-technical users, we provide familiar visualizations and intuitive interactions. We discuss the latest version of our user-centered iterative design, the different roles of the three types of displays, and preliminary results of an observational study.

Index Terms: H.5.2 [User Interfaces]: evaluation—; H.5.3 [Group and Organization Interfaces]: CSCW—

1 OVERVIEW

Our research examines how visualization and collaboration technology can support civic engagement, improve decision-making outcomes, and promote sustainability of the built environment in the public consultation phase of urban community planning. Our goal is making complex and abstract urban planning data accessible to a diverse range of stakeholders using simple and familiar visualization and interaction techniques to support the social processes underlying discussions among stakeholders. We achieve this through the dual lenses of computer-supported collaborative work and visual analytics.

Traditional urban planning uses a variety of visual and physical artifacts to support collaborative discussion: small, medium, and large-scale 2D drawings and 3D renderings, miniature physical models of a site, and film and video-based narratives of the rationale and anticipated outcomes. Public engagement especially is often through one or more of these artifacts. In modern society, the increased complexity of the urban planning process brought on by concern for the environment and desire for more sustainable development practices requires professionals to utilize sophisticated computational models and analytics. This creates a knowledge gap between professionals and lay people that makes it difficult to fully engage lay people in planning and decision-making. To bridge this gap, digital tools are increasingly used to facilitate collaborative planning. Planning Support Systems (PSS) link and visualize complex information so non-professional stakeholders can better engage and understand long-range consequences of decisions. However, most of these digital tools are designed for a single user and are expert-intensive.

Perhaps the best known previous work on digital collaborative systems for urban planning is the MIT Media Lab's pioneering Urp system [5], a tangible interactive tabletop that allowed users to explore light properties and air flows of an architectural scene. ColorTable [3] is a more recent tangible user interface for collaborative urban planning. Similar to Maquil [3], we take into account the overall workflow and the full context of collaborative urban planning and we employ both tabletop and auxiliary displays to support the design, presentation, and evaluation cycle for urban planning without requiring complex desktop rendering tools. Our system is a multi-display environment centred on a multi-touch tabletop augmented both with wall displays for 3D renderings and hand-held displays for examining sustainability metrics. Our current iteration is the result of design, development, and refinement over six years based on lessons learned in several field studies and close collaboration with domain experts [2].

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2 ITERATIVE DESIGN AND DEPLOYMENT

There had been two previous major design iterations prior to our recent work, a single-display, interactive tabletop [1], to which an auxiliary wall display was later added to provide 3D views [4] and custom visualizations of sustainability metrics [6]. The system was then deployed in the field and refined in a series of five community-based workshops (the city of Revelstoke and the Marpole district of Vancouver, both in BC) with over eighty participants during a 27-month period. Workshop sessions were video taped and data gathered through questionnaires and focus groups, yielding insights about the system design, collaborative interactivity, and the value of immediate live feedback during the planning process. The system received positive stakeholder responses for *being fun*, *easy to understand and interact with*, *encouraging*, and *instructive about the consequences of planning decisions* [2, 6].

One of the best features of the system, as reported by users, was *fast and early feedback* through the 3D visualization and the metrics. Surprisingly, the system was well received by professional planners, even though we had thought it would be mainly of interest only to non-experts. Eight professionals who used our system in a half-day workshop subsequently requested to use our system for their own planning activities because they found it very useful for collaborative planning by a diverse set of professional disciplines. They believed the immediate feedback our system provides is essential for quickly creating a variety of alternatives and relevant data for decision-making. Visualization tools they normally used did not provide a multi-user environment in which they could simultaneously check 2D, 3D, and sustainability metrics in real time.

Analysis of videos, questionnaires and focus groups indicated some important limitations: lack of personal work spaces, difficulty interacting in parallel with the 3D view on the wall display, and low user engagement with the sustainability metrics that were on the wall display. In our third iteration of the system, we addressed these issues by integrating hand-held devices for controlling the 3D view and for inspecting the sustainability metrics.

3 THE CURRENT VERSION OF THE SYSTEM

Our integrated multi-display environment (Fig. 1) has its activities anchored in a multi-touch tabletop workspace augmented with both large-screen wall displays for shared viewing and smaller hand-held displays to foster collaborative co-creation. The system integrates

Figure 1: Users viewing a neighborhood plan on the touch table. A 3D aerial view of the neighborhood is shown on the wall display and indicators for sustainability metrics are shown on iPads.

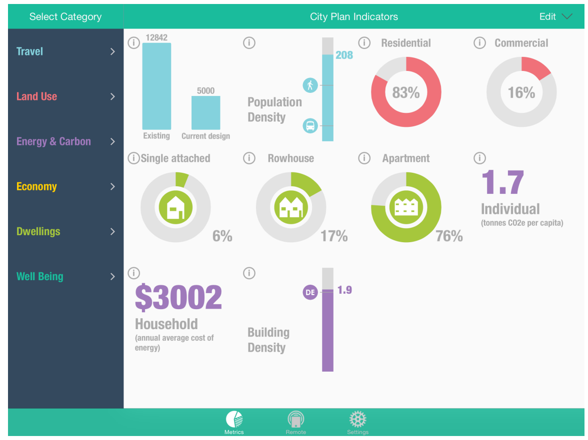

Figure 2: iPad indicator app. The left side is a toolbox of color-coded indicator categories, the right side is the set of selected widgets. Other widgets in a dashboard are accessed by "swiping" left or right.

three independent applications: Google Maps for the 2D tabletop background, live access to the *elementsdb* database where "cases" (such as buildings and parks) can be added to the 2D plan, and Google Earth for a 3D view of the community plan with 3D views of the cases in their actual locations. The Google Earth API is used to render 3D models of each case at the appropriate location.

Tabletop Display. The interface has a 2D map onto which multiple users can simultaneously drag, rotate, or scale cases and associated data to create a "pattern" (a spatial layout of cases). The tabletop's horizontal display provides a natural collaborative platform where everyone can contribute. It also provides an opportunity for individuals to explore options individually by providing a case bar along each edge of the display, each with a full set of building types colour-coded based on their use (residential, commercial, green spaces, etc.). As users browse through the case bar, they can tap on a case to view detailed information in a pop-up window (floor area, number of bedrooms, alternate views of a building, etc.).

Wall Display. A 3D aerial view of the planning site shown on a wall display provides real-time feedback about spatial layout of the cases. Because 3D content has a natural up-down orientation, it is more appropriate for a vertical display. Parameters such as viewing angle, zoom level, and elevation can be dynamically controlled. Auxiliary wall displays allow the limited tabletop screen real estate to be devoted to the 2D map and the case bar interaction.

Individual Hand-held Displays. Two iPad applications improve interaction with the wall display by remotely manipulating the 3D view and they allow individuals to configure custom indicator dashboards. The apps use WiFi to communicate with a server that manages the tabletop and the 3D displays. Hand-held devices offer individual work spaces for parallel investigation of sustainability metrics and remote manipulation of the 3D view.

iPad 3D view control. A direct manipulation multi-touch tabletop widget initially sets the location of a virtual camera and its direction of view and elevation relative to a "look-at" point. The custom remote control iPad app then allows pan and scroll of the look-at point by one-finger movement, camera distance and orientation by two-finger pinch-expand and twist gestures, and camera elevation by two-finger virtual sliding. Ubiquitous experience with personal computers, hand-held smart phones, and tablets has created a level of sophistication in the general public that allows us to assume gestures such as zoom and pinch are familiar to many people.

iPad sustainability indicators. Dashboard indicators give users visual feedback about sustainability metrics for the current plan. Indicators can be dragged from a toolbox to build custom widget sets (Fig. 2). Indicators are updated automatically whenever a change takes place on the tabletop, so widgets always show current data to everyone. Indicators such as total dwellings and population, housing density, projected energy use, and a neighborhood walkability index are drawn from computational models in an urban design database.

4 Preliminary Results of an Observational Study

We evaluated usability through hands-on tests by three experts and refined the system based on their feedback. We are conducting an observational study of our latest system and of the traditional paper-based approach still widely in use. We believe the features in our system, with its use of accessible and familiar visualization and interaction techniques, provides more engagement and helps users better learn about the process and complexity of community planning compared to a traditional paper-based approach. Preliminary results indicate that groups using our system had more equity in terms of collaborative contributions and co-creation of plans, more parallel activities through use of iPad applications, and more fine-grained discussion about features of the design such as look and alignment of buildings because of the 3D view and the real-time metrics. Feedback to date from participants has corroborated the positive value of adding individual displays to engage people and allow them to explore and customize data based on personal needs.

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