Touching Buildings – A Tangible Interface for Architecture Visualization

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Abstract. The process of architectural design and urban planning has been fundamentally transformed through digital media. While providing the opportunity to make the process more flexible and open to realize an extensive public participation, they also pose specific problems. *Touching Buildings* is a prototype for a multimodal, collaborative interface that integrates the various aspects of the planning and communication process through a platform for tangible interaction with an open communication system. This paper presents the results of a first implementation of this prototype.

Keywords: Urban planning, visualization, touch interfaces, natural user interface, tangible interaction.

1 Introduction

Contemporary architectural design and urban planning is fundamentally transformed through the impact of digital media. Not only the architectural form finding but also the planning and decision-making structures are significantly altered by digital tools and communication media. Less concerned with questions of form finding, this study analyses the role of new media in the process of urban planning and communication and proposes a new approach to utilize digital interactive media to facilitate these processes while at the same time avoiding some of the pitfalls that might arise from them. Urban planning has become an increasingly complex process having to take into account complex information layers. Digital media have both complicated this process and opened new ways of structuring it and achieving new and so far unprecedented degrees of flexibility and democratic involvement. After a brief analysis of some of the positive and negative aspects of digital media on the planning and communication process we will discuss a prototype for a new multimodal digital interface that can serve as an efficient tool for both planning as well as the communication of planned interventions.

1.1 Urban Planning and Digital Media

Historically urban planning is marked by increasing complexity and while until the mid 1960s it was mostly undertaken by centralized institutional bodies formulating a

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master-plan based on surveys and analysis of the surveyed data it has grown to involve more stakeholders, participants and require a more complex and dynamic structure. The master-plan was a fixed goal to work towards, and once formulated it was intended to determine the future development over an extensive period of time. Since the late 1960s the planning methods have changed and become more flexible and open ended. As Hall and Tewdwr-Jones describe [1], in the late 1960s and early 1970s urban planning moved from the "blueprint to systems planning". Inspired by cybernetics [2] and the notion of an ongoing feedback loop urban planning started to be conceived as an ongoing process that was open to revision and adjustment. The fixed blueprint gave way to an understanding of the urban space as a dynamic system. Equally in the late 1960s and early 1970s new theories of analyzing places such as those of Henri Lefebvre [3] introduced a more complex and layered understanding of space integrating a physical, mental and social perspective.

With online media the dynamism and complexity of urban planning processes has further increased. The influences of the internet on the development and our understanding of places are manifold. Through the creation of a communication and resource distribution structure that is largely independent from the geographic reality that it connects to, the internet has introduced a secondary layer that completely evades traditional methods of geographic surveying and observation. Nevertheless, it has a strong impact on the development and the active forces determining the dynamics of the geographic reality through the physical reality of cables as well as through the resource flows of this secondary information infrastructure, which alters traditional patterns of consumption, work and general social interaction [4]. On the other hand social media provide many opportunities to involve the public into the planning process and establish sustainable forms of participatory interaction to implement the public process, which in many states is called for by law [5]. An example of city planning employing participatory mechanisms is the Future Melbourne project, which used a wiki platform to establish open public engagement [6]. The online-enabled participatory process can become so active that it can pose obstacles to the decision making process as the mayor of New York City, Michael Bloomberg, states: "We are basically having a referendum on every single thing that we do every day, […] And it's very hard for people to stand up to that and say, 'No, no, this is what we're going to do,' when there's constant criticism, and an election process that you have to look forward to and face periodically." [7].

1.2 Spatial Imagination

While the engagement enabled through online social media has great potential to establish a collaborative and democratic planning process, we also hear in concerns like the one of Bloomberg the fear that decision making gets prolonged with possible failure to make any decisions as they could go against the opinion of at least part of the constituents. Another related concern is that online media allow for comments and criticism to be formulated remotely and in dissociation from the actual geographic site and its immediate dynamics. This abstraction from the actual locality may be increased by the inability to fully anticipate the planned intervention, since being offsite the information flow in online participation has to rely foremost on maps, textual

descriptions, and visualizations. These are rather specialized communication tools specific to the domains of planning, architecture, statistics etc., which are not always readily understood by non-specialists. In general, in order to criticize and judge a planned intervention the commentator has to be able to gain a comprehensive understanding of it. This normally involves a mental representation of the planned and thus not yet existent structures integrating the various aspects of information available.

Various newspaper articles [8] and studies [9] suggest that it is exactly this ability to imagine spatial structures that is hampered by digital media. Our reliance on digital tools like GPS and navigation systems seem to have a negative effect on the ability to navigate space and to create mental maps. It is expected that this decrease in spatial ability will lead to a loss of cultural literacy, as the British Cartographic Society warns [10]. While some of the impacts on the spatial ability of users of navigation devices can be attributed to design issues of the device [11] it is important to note that direct experience of a space is most conducive for the formation of mental representations of the space.

The aid of navigation systems seems to reduce the exposure and the degree of mental processing of the space, thus hampering the creation of a mental map of the place. Meanwhile traditional maps, even though they provide a helpful overview knowledge of the space, introduce the problem of harmonizing the internal perspective (the overview knowledge provided by a map of by surveys) and the external perspective (the spatial knowledge gained from directly navigating the space). The task of harmonizing the two perspectives poses specific cognitive challenges [12]. Conclusively we can say that the direct experience of a space contributes most to the formation of mental representations and the understanding of the complex set of characteristics of this space. Even though digital representations such as 3d modeling and simulations can be efficient tools to support the understanding, direct experience is the most informative and efficient way to form mental representations of a space. In addition to purely visual information it also makes vestibular and kinesthetic information available to form a mental representation of the space traversed. This makes it easier to integrate the different aspects of the space and form a more coherent and rich representation [13].

2 Methodological Considerations

2.1 A Multimodal Approach to Planning Communication

The core question of our project was to find ways to realize the benefits of direct experience and digital media already in the planning communication while avoiding the potential problems associated with them. Obviously in the planning phase direct experience is limited to exploring the site where the intervention is planned, all other aspects need to be communicated through media representations. In the project Touching Buildings we are exploring technologies to integrate information visualization, documentary film, 3d computer-visualization, computer-based simulation, and haptic modeling into one system that is built around touch- and gesture based interaction with tangible objects. The development hypothesis for Touching Buildings is that within the framework of an interactive multimodal interface it will be possible to

integrate the main modalities of urban planning communication leading to a comprehensive understanding of the planned intervention and a platform of participatory communication.

The research for an urban planning project comprises a plethora of different layers of information, which all have their own ways or language of communication and which are not seamlessly integrated into a standard framework or generic methodology [14]. Wang and Groat identify seven groups of significantly different vantage points: interpretive-historical, qualitative, correlational, experimental and quasi-experimental research, simulation and modeling, logical argumentation and finally case studies. The results of these research layers can come in the form of texts, diagrams, plans and information visualization, audio-visual testimonies and observations, computer-generated 3d graphics and animated simulations. For the non-specialist observer these layers of information can create challenges in terms of understanding and readability as well as in terms of integration into a comprehensive and coherent picture. Our strategy to address these challenges is to create a framework using interactive digital media that can hold all of these layers and keep them in a structure grouped into understandable categories and in a coherent aesthetic treatment so that they can be easily related to each other. In order to keep the cognitive load of parsing the information in an accessible range we are using various categories and present specific details on demand, i.e. more detailed information is available upon active request (interface widgets that allow to call up the information) but does otherwise not clutter the display.

2.2 A Shared Tool for Planning and Communication

Touching Buildings is conceived as both a tool for planning and discussion among those involved into the planning process as well as a communication tool for a larger audience of non-specialist users. The requirements for these two usage scenarios are quite different and our aim is to integrate both processes in order to accommodate an open and ongoing planning process that does not hermetically seal the planning phase from the phase of communicating the planned results to the public. Adopting the notion of systems planning we are creating a framework that can access a flexible database with a growing information repository containing survey results, planning decisions, public feedback etc. This database can have an online interface to actively call for participation and thus make the public process an integral part of the system. Despite the online possibility the main notion of the Touching Buildings project is to work as an interactive installation which serves at the same time as an elaborate display as well as a meeting point and a location for discussion. It is meant to foster face to face discussion and the constructive interaction among the users and with the system through a multi-user interface. For the team of people involved into the planning process such a shared physical system fosters collaboration and active exchange for which the normal computer workplace is not conducive. Earlier studies have shown that such multi-user systems can enable collaboration and can be helpful in particular for the domain of urban planning [15]. For the participant in the public process the installation-type system functions similar to an information kiosk but with an open two-way communication, in the future potentially removing the boundary between

on-site and off-site online interaction. For both scenarios the physical situatedness of the system provides a physical and tangible context in relation to the planned intervention. In this way it roots both the content and the interaction in a shared discursive context. Our hypothesis is that this rooting within a shared discursive context with a physical location and tangible interactions with discourse-partners will foster a sustainable and problem oriented decision-making process rather than the prolonged and unfocused exchange criticized by Bloomberg.

In the current state Touching Buildings is realized as a prototype that implements a subset of the possible functionality as a lab-version, and currently does not implement a structure for online interaction.

3 Realization of the *Touching Buildings* Project

3.1 Architectural Model as Tangible Interface Device

The prototype implementation of Touching Buildings examines a part of Downtown Los Angeles which will be the location of a planned transit-hub of the Los Angeles Metro system. The core of the project is a physical model that represents the area in question. The model is touch sensitive and allows users to interact with it by touching its different parts. The model itself is made of laser-cut multiplex and thus sufficiently robust so that it can withstand the interactions of a larger audience. The represented area measures several blocks around the metro station including major landmarks such a LA-Live and the Staples Center and focuses more on the overall city layout rather than on realistic details which would make the model too fragile to be interacted with. The model is plain white and serves as the surface for a projection. In this way the model itself becomes one of two screens that can function as interactive displays. The projection on the model uses projection mapping to display various layers of information ranging from satellite images delivering an arial perspective of the area all the way to animated traffic simulations.

The interaction is tracked with a Microsoft Kinect depth camera that can locate the hands of the viewers in various positions. This set-up allows us to not only implement a direct touch sensitivity of the model surface, but the hands can also be tracked while floating above certain parts of the model, effectively implementing a “hover”-state in the touch interface. Pointing gestures are one of the basic categories of spatial communication and direction assessment plays generally an important role in the formation of mental representations of space and the testing of spatial ability. We intuitively communicate by pointing to things and integrating this aspect of gestural expression into our interface concept seemed vital. Normally touch interfaces can only react to physical contact and are thus missing the “hover” or “roll-over”-state that traditional mouse-based interfaces have. Adding this layer in its full significance as a form of spatial communication is an important aspect of the creation of an intuitive and natural user experience in the Touching Buildings project. Different layers of information can thus be accessed through “hover”-states and through touching.

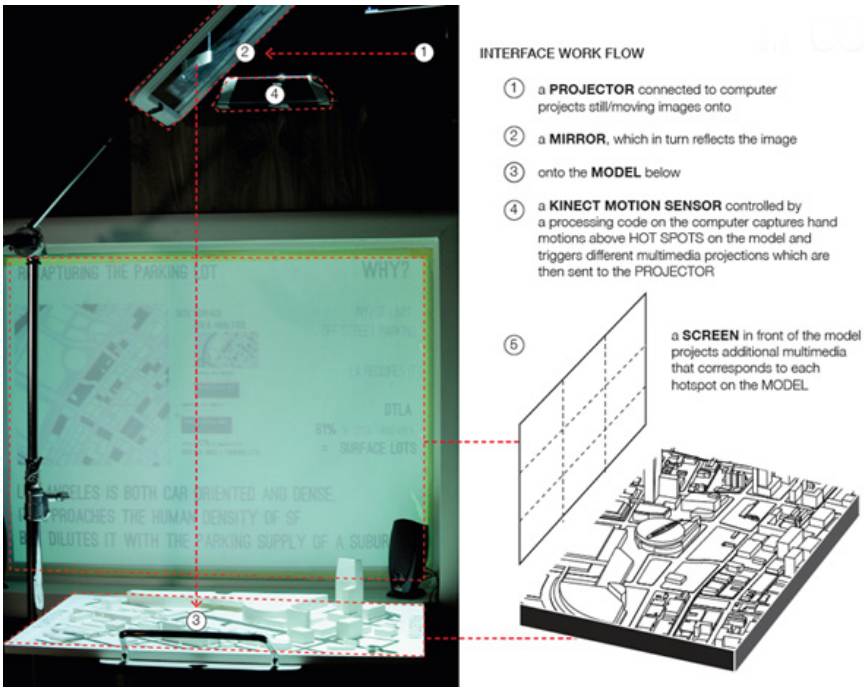

Fig. 1. Key elements of the *Touching Buildings* installation set-up

This kind of physical involvement with the model makes a contribution to establishing some of the benefits of direct experience for the formation of a cognitive map of the area. The added modalities of tactile and kinesthetic sensation contribute to the formation of a more nuanced mental representation of the planned intervention even though they are taking place in a scale model. Pointing to certain aspects of the area and quasi-exploring it with a finger delivers a stronger experience quality than what could be achieved through audio-visual information delivery alone.

3.2 Video-Mapping to Reduce Cognitive Load of Information Integration

The scale model serves in conjunction with a calibrated projection system as the center piece of the installation where all the information layers come together. The projection mapping allows to "skin" the model in different ways and thus display current states and planned states in a compelling way. It can also serve to localize survey data, simulation data and other information directly in the corresponding place of the model. This centralized approach makes it easier for the viewer to relate the different information layers to each other and to integrate them into a comprehensive understanding and mental representation of the planned intervention. The information layers projected onto the model are always connected through their geographic relationship. Rather than looking at visualizations, charts and diagrams the viewer can see the data attached to the localities that they refer to.

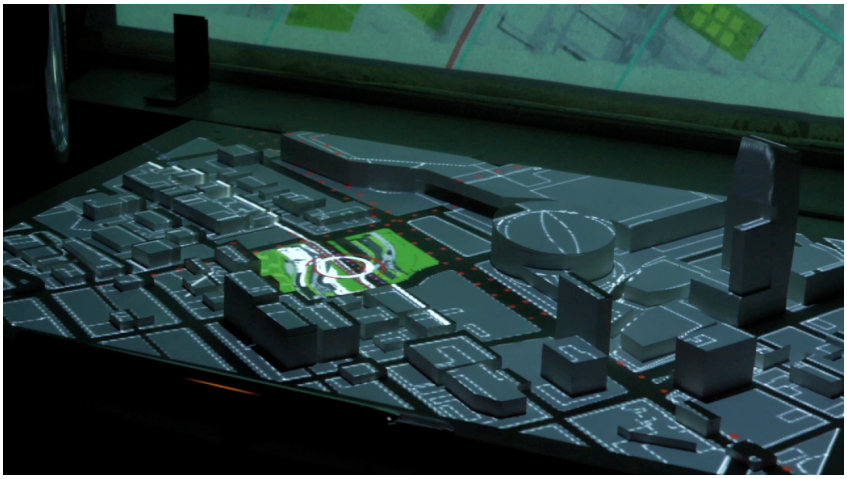

Fig. 2. Animated traffic simulation projected onto the architectural model

The model-screen is one of a set of two screens arranged perpendicular to each other. The second screen can be used to show information that is not pertaining to exact spots on the model, such as interviews and documentary sequences, historical and other background information. We use the second screen further to display information that would be obscured by the pointing gestures or that would be overloading the display capacity of the model-screen. The two screens can also be used in conjunction with each other to give large format overview information similar to the high resolution display of traditional maps. The close relationship of the two screens allows also to support the integration of internal (overview) and external perspective (stemming from direct experience). The flat vertical screen delivers overview information, which can be directly linked to the detailed and quasi-on-the-ground information displayed on the model screen.

Fig. 3. Double screen projection with a combination of overview and detail information (left) and with documentary film and locational information (right)

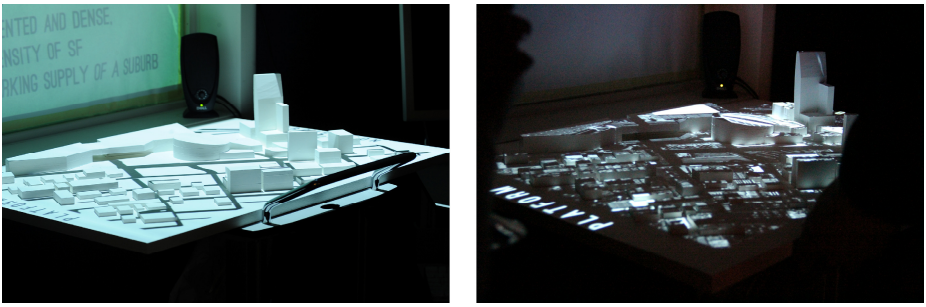

Fig. 4. Images projected onto the architectural model

4 Conclusions

Touching Buildings is a prototype that implements the core functionalities of our concept. The installation was shown to a group of approximately 50 people both female and male, in an age group ranging from 20 to ca. 65. Our aim in this first presentation was to get a general feeling for how the concepts and technologies work with a mixed audience and how well they are accepted. With varying subsets of the group members we conducted exit interviews and think-aloud observations; all members were part of a general observational study. We looked at criteria such as ease of use and the accessibility of the interface, as well as the efficiency of the communication flow. Further we looked at time spent in the installation, which was conceived without any restrictions on the extent of a session, users could walk away whenever they wanted. Another area of interest for us was the level of enjoyability of the experience.

We found that most of the participants judged the experience engaging and spent enough time in it to go through all major aspects. The majority of the participants lived in Los Angeles and was able to get a good understanding of the general setting of the planned intervention that was presented in the project. A few occasional textual prompts on the screens were used to invite people to touch the surface of the model and most of the users had no problem engaging into the touch interaction. A small number of participants stood back without directly operating the interface, instead observing others use the system. Through the large format double projection the appearance of the system had an informative and pleasurable quality from a distance as we understood from those participants. This behavior was mostly observed when a group of people such as a family or a group of friends was using the system and only one member of the group was the one to operate it while the others stood by.

In general people were not hesitant to touch the model, which was perceived as solid enough to not be concerned about its fragility. The possibility to directly touch buildings, blocks and streets was perceived as entertaining and pleasurable. The ease of acceptance is related to the widespread familiarity with touch interfaces combined with a novelty aspect of the fact that the touched surface is modeled. Participants easily discovered and used the “hover”-states resulting in a two-layer exploration consisting of the direct touch and the “hover”-states. Finding what kind of information was attached to “the air” above the model seemed to be an engaging activity.

All audience members showed and expressed an appreciation for the displayed materials and their aesthetic appearance.

In the current set-up we used just one depth camera to track the model, which worked well with the structure of the model. The particular area of Los Angeles has mainly low buildings and large open spaces such as parking lots etc., resulting in a rather flat model. For other model types we anticipate problems with occlusion in the tracking system where high buildings create 'shadows' in which the interaction cannot be tracked. For such cases probably a second depth camera would need to be used.

As in this first prototype we only observed high-level aspects of the interaction and communication associated with the system, a series of more specific and quantitative evaluation will be necessary to determine the actual degree of influence of the implemented physical interaction on the formation of a mental image of the site and the understanding of the planned intervention as well as the influence on the planning process as a whole. The system therefore should also to be tested with an audience of people less familiar with the general setting of the area.

Further research will have to explore different ways of model making and touch integration and the online participatory component will have to be tested with a larger audience. After having had a rather positive outcome of the first feasibility study it is now the task to build the system out into a solid and flexible platform for collaborative planning.

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