The Phoenix Tactile Urban Interface System

RUTH RON
University of Florida

YOSHIHIRO KOBAYASHI
Arizona State University

INTRODUCTION

The design studio is at the heart of architectural education. Architecture students and faculty often propose design solutions to local problems at sites that are in close proximity to schools themselves. For example, the entire undergraduate third year studio at the University of Florida in Gainesville is devoted to the exploration of north Florida's natural and man-made environment. Some of the ecologically related research themes include high-density development as alternatives to sprawl, relationships between the built environment and the natural landscape, and sustainable development that takes into consideration local climate, materials, and culture. Such ideas demonstrate the commitment of architectural education to the improvement of its surrounding and may be of interest to the local community. The students' projects are presented at the end of each semester to fellow students and a panel of critics. Occasionally, they are also displayed at the school gallery, in a newsletter, or even in academic publications. Usually, however, they do not reach beyond the school's walls. Faculty research projects often do not fare better. Even a design charrette that involves local developers, politicians, and representatives from the community may not reach the general public. A school (or part of it) may be, therefore, physically located right at the center of concern, but still only reach a limited audience.

At the same time that architecture schools are recognizing the need to connect more with local communities, new technology has become available that can facilitate this interaction. Traditionally, architects represented three-dimensional designed spaces with two dimensional plans, sections, elevations, and rendered views. Today, three-dimensional (3D) computer modeling is a common design tool. The presentation of the design, however, is more often than not two-dimensional (2D), in the form of printed documents or PowerPoint files. While this process is for construction documents, it may not be ideal for presentation purposes. If the process and the final designs are already visualized in 3D, it makes sense to present them in an appropriate medium, preserving their properties, rather than reducing them to 2D drawings and renderings. Schools of architecture, as leading educational institutions, should be the first to embrace a 'natural' medium in which to publish design work. Navigable 3D virtual models, on or off-line, can be used not only for gaming or entertainment, but also for presentation, visualization, research, and outreach. Nonetheless, many architecture schools' websites still look much like the old printed catalog, with added links to university resources. It may indicate that we (i.e., architecture schools) are slow to respond to communication technology developments. We are not capitalizing on the use of new technology, especially for outreach and education.

The question, therefore, is how architecture schools can take advantage of these new communications techniques to distribute their ideas, get feedback from the public, and to improve the connection between academic and local communities. This paper suggests one possible avenue, presenting an attempt to employ these ideas in a specific context.

PHOENIX URBAN RESEARCH LAB

The Phoenix Urban Research Lab (PURL) is a recent extension of the Arizona State University College of Design, located in Tempe, AZ, into downtown Phoenix. The lab is centrally located on a top floor, with panoramic views of downtown. It houses a large 20' x 20' physical model of the downtown area, and was envisioned as a welcoming place for information exchange. PURL accommodates research studios, exhibitions, and local governance meetings.

PURL is "an information-rich environment for researchers, decision makers, industry professionals, and students to debate, collaborate, and seek new solutions to the most pressing design problems facing cities today.

Fig. 1. Phoenix Urban Research Lab

Part think-tank, part advocacy center, part project development office, PURL speaks to local, regional, and national issues confronting the development of vibrant and sustainable cities, and Phoenix in particular. PURL is a connector linking academic, professional, political, civic, and business interests in pursuit of new answers to pressing problems. In short, it is the goal of PURL to drive the discussion of downtown development in the most progressive manner possible, to be the locus of long-range planning efforts and to provide all interested parties with comprehensive information upon which to base decisions."[1]

The facility brings the presence of ASU architecture students into downtown Phoenix. It provides pleasant presentation and meeting spaces that are well situated in the urban context, for discussions of local planning and design matters. Despite its convenient central location and stylish design, PURL's large physical model is not used to its fullest potential and has only minimal web presence. In fact, after opening PURL, many people, such as real estates brokers, governmental project managers, architects and developers inquired about seeing the model. Though computer rendering and modeling technologies are available to them, it is easier for them to use the big physical model when discussing urban and city matters, demonstrating the need for 3D tools in planning and design. However, there is a limitation to the information that can be extracted from this model. A computer-based device and an interface between the physical model and a database, that would enable the visitors to make better use of the large physical model and make their discussions more effective, are missing.

THE PROPOSAL

The "Phoenix Tactile Urban Interface System" is a collaborative effort that brings together researchers from various academic departments of the university[2] to explore possible extensions of the large PURL physical model. The team proposes an interface[3] between PURL and the College of Design resources for two main aspects. First, enhance PURL's meeting place by making the 20' x 20' model "smart." Making the large PURL physical model "smart" means connecting it to a virtual 3D model of downtown Phoenix and a local information database through a custom-made tactile interface. When the models are linked, one can quarry a database that provides a variety of design, environmental, planning, and urban data. The database can contain photos, text, web links, movie clips, sound, and more. While a physical model usually displays the current state of an urban environment, a virtual model can also include historical phases and potential future development. In a second phase, we propose to extend PURL's presence onto the web, using an online 3D virtual model. The same virtual model that is linked to the large physical model can be formatted to a navigable online 3D model. It allows the viewer to fly around, zoom, and link to the database. It can also include an "input" interface that collects data from the public. For example, members of the public could provide personal experiences in specific locations or responses to suggested development.

THE PROTOTYPES

A working prototype of the first phase of the proposal was realized and presented at SIGGRAPH Boston 2006 conference[4]. The haptic system is based on a prototype of a landscape model of the Lower Colorado River area and entitled, "The Lower Colorado Tactile Topographic Interface."[5]

A virtual model of downtown Phoenix was automatically generated with a 3DMax plug-in, using a commercial photogrammetry package that utilizes multiple angle aerial photos.[6] The result was a high quality virtual 3D model with good precision and high-resolution texture maps. To link the physical and the virtual models we developed a tactile interface. Since the 20' x 20' model is too large for a person to reach and touch each point, a small 16" x 16" version of the model was converted from the virtual 3D model and printed out by a Rapid Prototyping machine in PRISM's[7] lab.

It was connected to the virtual model with a digitizer stylus[8]: a pen-like sensor that can track the position and angle of its tip. A custom program reads the location of the stylus' tip over the smaller physical model and synchronizes its location with the position of a "character" on the virtual model. The database then provides information specific to the position of the stylus' tip. The database can contain 2D maps, photos, text, videos, sounds and more.

A basic web-based prototype of the second phase was also realized in 2006 to demonstrate the capacity of the interface. It was presented at the "Hyperpolis – Really Useful Media" conference at Polytechnic University, Brooklyn NY.[9]

In this version, there was no stylus-based tangible input; instead, the computer mouse was used to interact with the virtual model. Using custom programming, the virtual model was interactively displayed on screen, allowing the viewer to fly around, zoom, and to connect to the database (the prototype is available online at http://ruthron.com/purl/[10]).

THE POTENTIAL

The prototypes bring together several forms of abstraction to describe an urban landscape: a large physical model you can see, a smaller tactile model you can touch, a virtual 3D model you can fly around and zoom into, and a database of 2D maps, plans and text on a computer screen or projected. Information can be also projected back onto the large physical model, to highlight related areas or overlay design proposals. On top of that, the actual city views are available through PURL's large windows. The interface allows a user to see and feel a physical model and make the cognitive connection to the virtual tool. Bringing together different types of data united by geographic lo-

Large 20'x20' physical model of dowtown Phoenix

Digitizer stylus: a pen-like sensor that can track the position and angle of its tip

Small 16" x 16" version of the model was printed out by a Rapid Prototyping machine

A computer-based database can contain photos, text, web links, movie clips, sound, and more

A high quality virtual 3D model of downtown Phoenix.

Fig. 2. Components of the interface system proposal

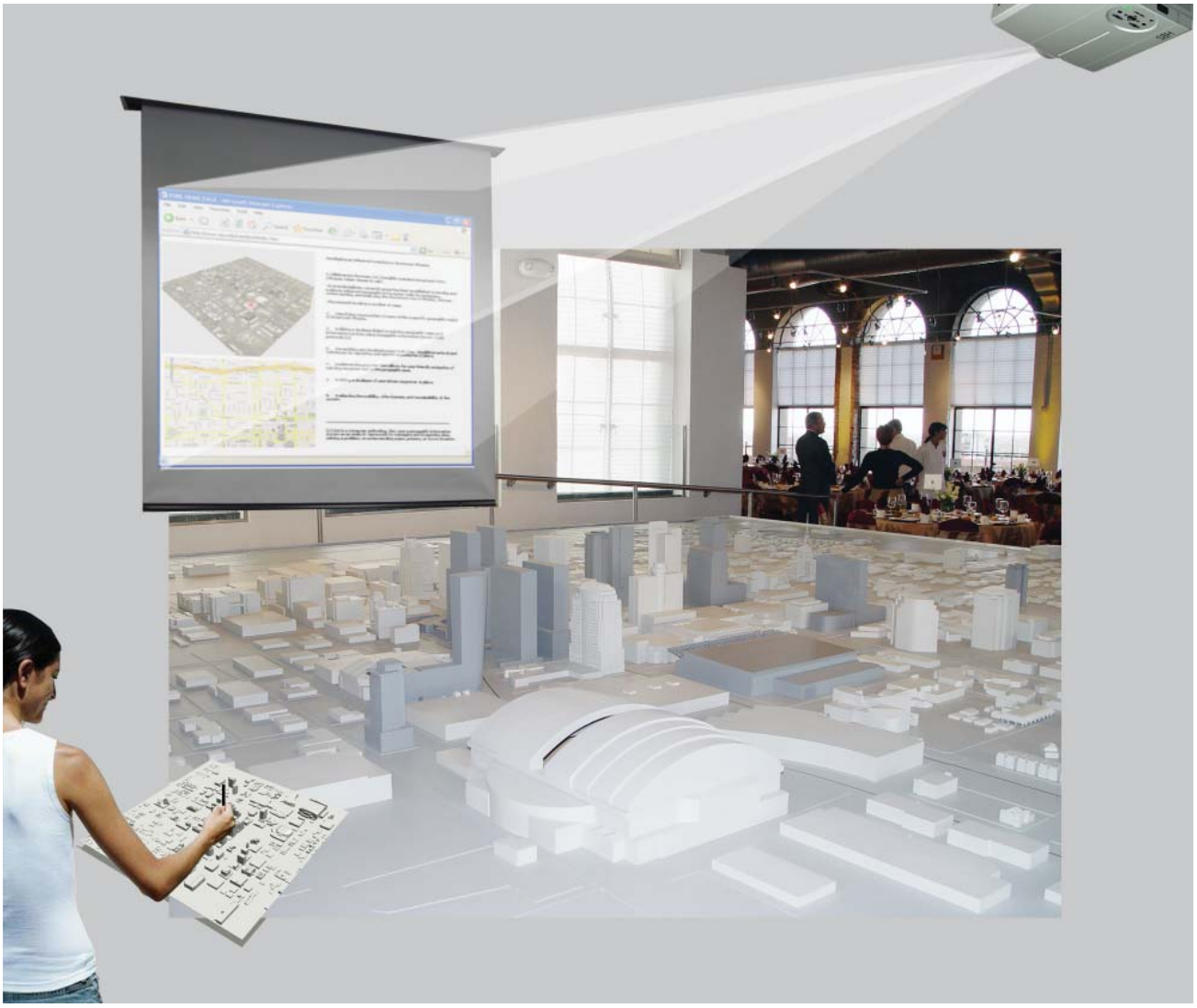

Fig. 3. Interface system proposal in PURL's space, with the 3D virtual model and database projected

cation helps a larger portion of potential users "connect" with the content. Each person can find her own way to perceive the information and may find one of the displays more useful or intuitive than the others. This project investigates different ways to browse through information in connection with place, reflecting various possibilities for human-computer interactions.

Brief analysis of existing products for online mapping, such as ESRI "ArcGIS Online," ESRI "ArcWeb," and "Google Earth", can assist in evaluating our proposal. Today, ESRI's tools may be criticized because they are expensive, require extensive training, have limited 3D and web capability, and have an uninviting Graphic User Interface (GUI). They seem better as geography and planning research tools than an architectural design and 3D visualization tool. "Google Earth" is a commercial platform. While very powerful, it is not truly online because it requires the download and installation of the software and the models onto the user's computer. It allows a user to share 3D "Sketchup" models using the "3D Warehouse" website. When a user wants to view a 3D model, he or she needs to download the file and open it with the "Google Earth" software on the computer.
On the other hand, the 3D virtual model we used in our proposal has higher resolution and better texture-maps. The complete virtual model is

hosted online and does not require the user to save it on a local computer. In short, our model is developed to be used as an architectural design and visualization tool. It has a user-friendly user interface and is more accessible to the general-public.

The proposal of a web-based 3D model and database can also be examined in relation to development of virtual 3D urban models. New trends in urban planning, especially in environmentally-oriented analysis of such things as noise, air pollution, and urban climate make new demands on urban officials and planners. Due to increasing availability of information systems and 3D data, planners and municipalities emphasize the importance and usefulness of modeling urban space in three dimensions. Many examples of 3D models of cities exist today. They are created by commercial companies, academic research labs, and municipal authorities. The models vary from early basic volumes to realistic vast metropolitan area models and can be used in a variety of ways. A commercial website, such as the San Francisco-based company "Planet 9 Studios,"[11] sells more than forty city models for the purpose of game development, movie production, architectural simulation, and military use. Academic research centers have been using such models for simulation and prediction of urban growth. In addition, these types of models have been used for scientific visualization of complex data sets, such as local water management and urban growth impact on global warming. Examples of local authorities' use of 3D urban models include mapping infrastructure and promoting local tourism and attractions. Advanced applications of 3D models can employ

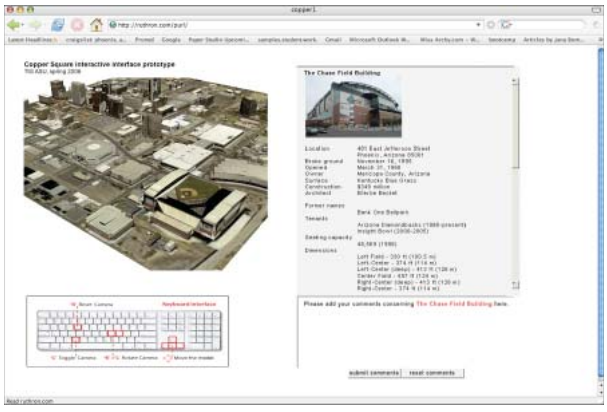

Fig. 4. The proposed web-based interface with virtual 3D model and display of related data (image+ text)

multi-user platforms to allow a collaborative planning process.

In our project, connecting the 3D virtual model to a database allows for additional advanced applications for a variety of interesting uses. In the article "A Real Time Visualization System for Large Scale Urban Environments,"[12] Professors William Jepson and Scott Friedman discuss the advantages of having a 3D virtual model in which each piece of geometry is also part of a database. For example, a building will have a street address, number of floors, and year it was constructed. In this case, it is possible to quarry the components of the model or to replace them in order to research possible future scenarios. The 3D model thus becomes a research tool, similar to Geographical Information System (GIS), rather than a group of vertices in space.

Advanced research using the 3D virtual model of downtown Phoenix focused on visualization of future traffic patterns.[13] Traffic is one of the most important issues in urban and city planning. However, it is difficult to visualize in Virtual Reality (VR) environment because it requires creating traffic objects including all lane conditions for each street and intersection; geometry and driving rules of automobiles such as cars, trucks, and buses; and, lastly, traffic signals with timed schedules for red, yellow, and green lights. In the traffic project, "UC-win/road", a commercial off-the-shelf VR package[14] was used because of the user-friendly interface to generate 3D agent automobile objects. Once the traffic volume per hour for each street was inputted, 3D objects that can behave like real automobiles are generated and driven on the streets of the VR environment.

Due to space constraints, the traffic modeling process is explained briefly. First, the future patterns of housing and employment locations were predicted with an urban simulator, called "UrbanSims.[15]" This software uses demographic data and various simulated scenarios. Next, travel patterns of all people in Phoenix metropolitan area were calculated using "TRANSIMS,[16]" which is a micro traffic simulation package developed by Los Alamos Laboratory. Finally, the number of automobile for each street is extracted from the result of simulation, and 3D automobile objects as many as the results are generated in the VR 3D city model.

Fig. 5. The following images are screen-shots of running traffics in the VR model.

Since each automobile is defined as an intelligent agent object, they can stop at red traffic signals, reduce the speed near the front of other automobiles, and made left and right turns. By visualizing all of the automobiles at downtown Phoenix in the future, new problems and new solutions on urban developments are expected to be recognized.

FUTURE EXTENSIONS

The concept of public participation has become important in promoting more representative planning decisions. In its various forms, participatory planning has been prompted by different institutions and within the context of many different agendas. These range from political manipulation to redistribution of power among marginalized communities. The idea of citizen participation took form in the United States from the advocacy planning movement during the 1960s and, over the past few decades, has continued to be reshaped and redefined by many planning professionals, politicians, developers, activists and citizens.[17] This concept was introduced to the Phoenix Tactile Interface System project as an extended web-based interactive display named "tagging the city" described next.

The web is a powerful space for sharing information.[18] None of the existing online 3D urban models are publicly available as an "open source" for the community to browse and use as a new type of public space. Our 3D urban browser of the second phase prototype can be transformed into a "public space" for local communities on the web. It can become an interactive bulletin board and a virtual gathering place.

A project called "tagging the city,"[19] takes the Phoenix Interface project public. The "tagging the city" portal includes a 3D model, a blog, a database that collects local information, and a "tagging" system that makes this information more useful and easy to find. "tagging the city" is not an information site published by authorities, but a bottom-up community resource that collects information and displays it to the public. It allows users to bookmark and comment on specific places in the neighborhoods, such as the website "del.icio.us,"[20] but in the real world. It makes information accessible, organized, handy, and links it in an intuitive way for the user. The idea is to allow the user to find both the location of the information and the content itself. It eliminates the need to open a separate link to a map and brings together practical information on one main 3D map.

The traffic research described above can be further developed to include visualization of traffic and humans in 3D city models for day-to-day and emergency conditions. In addition, it may be beneficial to develop a more interactive control system that allows a user to change all the city components such as streets, signals, signs, houses, and buildings at the same time.

CONCLUSION

By enhancing a physical urban model, one can browse for knowledge about a place. Using virtual assets the real is extended beyond its physical limitations. New media is applied to render architecture with an embedded layer of information.

This paper discusses how 3D models of the city of Phoenix can create a new type of public space. Academic research into a 3D urban browser can be used by local communities and serve as an interactive bulletin board and a virtual gathering place. The research can also advance topics such

as public education and bottom-up community resources, and make architectural design more accessible to the general public.

This paper is promoting an inclusive approach to media and presentation in which new tools should not push away old technology, but rather add a layer, an alternative, and a viewpoint. The wider the variety of representation there is, the wider the audience it may capture.

ACKNOWLEDGMENTS

Project websites:

http://www.ruthron.com/digiphoenix/ and http://ruthron.com/purl/

[‘Shockwave’ player is required: http://www.adobe.com/shockwave/download/alternates/#sp]

The projects presented in this paper are collaborative works. We would like to thank our colleagues:

“The Phoenix Tactile Urban Interface System”

Yoshihiro Kobayashi http://www.public.asu.edu/~ykobaya/Personal/

Ruth Ron http://www.ruthron.com/

Dan Collins http://www.asu.edu/cfa/art/people/faculty/collins/

Dianne Hansford http://www.farinhansford.com/dianne/

and John McIntosh, Karen Bullis, Jacob Fisher, Al Simmon

“Visualization of future traffic patterns in downtown Phoenix”

Yoshihiro Kobayashi

“The Lower Colorado Tactile Topographic Interface”

Ruth Ron, Dan Collins and Dianne Hansford

“tagging the city”

Ruth Ron and Karen Bullis

ENDNOTES

1. PURL’s website: http://design.asu.edu/purl/

2. Dan Collins, Dr. Dianne Hansford and Alan Simmon from PRISM, John McIntosh and Karen Bullis from PURL, and Dr. Yoshihiro Kobayashi, Jacob Fisher, and Ruth Ron from the College of Design, all at Arizona State University.

3. The term interface “has existed for over a century, describing the place at which independent ‘systems’ (such as humane/machine) meet and the navigational tool that allows one system to communicate with the other. The interface serves as a navigational device and as translator between two parties, making each of them perceptible to the other.” Christian Paul, *Digital Art* (London: Thames & Hudson Ltd. 2003), 70.

4. SIGGRAPH Boston 2006 conference. http://www.siggraph.org/s2006/.

5. “The Tactile Topographic Interface” was developed by Dan Collins, Dianne Hansford and Ruth Ron at PRISM in 2005. http://ruthron.com/tactiletopo/index.htm.

6. The model was created using *Nverse Photo* plug-in of *‘Precision Lightworks.’* Custom made aerial photos of downtown Phoenix from about 6000 feet high were used to extract 3D modeling data, including texture maps and a terrain model. http://www.precisionlightworks.com/new/Products.html.

7. PRISM - Partnership for Research in Spatial Modeling, Arizona State University. http://prism.asu.edu/.

8. The stylus sensor by Polhemus. http://www.polhemus.com/?page=News_Rhino_Plugin.

9. “Hyperpolis – Really Useful Media” conference. http://idmi.poly.edu/hyper.

10. Shockwave player is required to view the 3D model. http://www.adobe.com/shockwave/download/.

11. “planet9” Company. http://www.planet9.com/.

12. Jepson, William, Scott Friedman. “A Real-time Visualization System for Large Scale Urban Environments.” UCLA Urban Simulation Team, Los Angeles, http://www.ust.ucla.edu/~bill/./UST.html.

13. Research by Assistant Professor Yoshihiro Kobayashi.

14. “UC-win/road” is a package developed by the company *Forum8.* http//:www.forum8.co.jp

15. http://www.urbansim.org/

16. http://transims.tsasa.lanl.gov/

17. Can, Roy, “Urban Simulation: A Revolutionary Tool for Participatory Planning.” Urban Simulation Specialist, MultiGen Paradigm, Inc., www.multigen.com/support/dc_files/Urban_Sim_White_Paper_participate.doc.

18. De Kerchove, Derrick. *The Architecture of Intelligence* (Basel: Birkhäuser, 2001).

19. “tagging the city” was proposed by Karen Bullis and Ruth Ron, project website: http://www.ruthron.com/html/20.html.

20. “*del.icio.us* is a collection of favorite links - yours and everyone else’s. *del.icio.us* can be used to keep links to your favorite articles, blogs, music, restaurant reviews, and more on *del.icio.us* website and access them from any computer on the web” See website: http://del.icio.us.