technology

Tangible Infoscapes

Multi-layered manipulative platforms that integrate digital and physical representations will provide a major discourse in design and planning processes. **By Eran Ben-Joseph**

In a brightly lit room, a few planners are huddling around a glowing tabletop. Several are holding and moving blocks that look like building models.

Others are molding and reshaping the surface with their hands. As one gets closer, a three-dimensional projection of a city's neighborhood is revealed: fluid, ever-changing images and objects that respond to the actions made by the users; a setting where biomass and infomass intersect in effective combinations; a setting where physical actions invoke computational processes and where computational processes manifest themselves physically. As the interaction increases and the level of excitement rises, the nature of the setting is revealed—an interactive deliberation about the future of an urban site. It is not just a simple interchange but one where data input, discussion, manipulation, and delivery are shaped and configured in real time—where knowledge and tangible delivery occurs, allowing for new forms of information delivery that are direct and easily understood by laypersons as well as professionals.

The infrastructure of data and digital models describing our world is growing rapidly. Local monitoring, aerial images, and remote sensing produce an almost endless flow of real-time data. Sophisticated models allow the simulation and computation of the most varied city and landscape parameters, from traffic conditions to wind velocity and air quality. As urbanist–architect Rem Koolhaas puts it, "No longer is the city visualized or composed as much as it is empirically computed."

Top left and right, The Luminous Table is one of the first prototypes of a tangible computerized design and planning interface. Lower left and right, Illuminating Clay provides a collaborative, immediate, and seamless platform for landscape analysis.

Despite this progress, there has been relatively little development in the interface through which this information is presented and manipulated. Few platforms exist that allow immediate, real-time, and seamless changes in response to public or professional inputs. Often several different modes of representation must be used for a project to convey different kinds of information and aspects of the design. It is

DEPARTMENT OF URBAN STUDIES AND PLANNING, MIT, ALL this separation between various representative forms that increases the cognitive load on both the designer and the audience, who must draw relationships among dislocated pieces of information.

If our aim is to let the public become more involved in the planning and design of physical spaces, better methods and tools of urban simulation have to be developed. Ideally, these tools would communicate changes that are proposed so that non–design professionals could easily understand the impact of the proposed changes. These systems could be used not only as tools for design professionals but also as an interactive application to enrich communication and learning within the design process. The integration of such envisioning tools into the decision-making process will allow for better professional judgments while incorporating various stakeholders' expectations.

Responding to the challenge, faculty and students at MIT's School of Architecture and Planning Tangible Media Group and the City Design and Development program have been developing such systems. The Luminous Table, for example, is composed of projectors and cameras hanging above a table, enabling an attached computer to see the changing positions of different physical objects. The system computes a variety of features that are associated with these objects and projects them back on the table's surface, moving and changing the features as the objects are shifted or manipulated. For example, models of proposed buildings placed on the table generate projected data such as shadows, ground wind patterns, reflective glare, and view corridors. These projections are immediately changed and updated as one moves the buildings around on the table. Because of its dynamic nature, the system can also show the movement of shadows across a site as a day progresses in winter, summer, or any time of the year; or show prevailing winds as they change by seasons, or the increase of traffic at rush hour on surrounding streets. Additionally, two or more tables at different locations may be electronically interconnected, enabling individuals to participate in the design or analysis of a three-dimensional project simultaneously over a distance as a group.

The Luminous Table integrates the currently separate activity of viewing physical models and the viewing of animation and computerized simulations. As stated by Bill Mitchell, dean of the School of Architecture and Planning at MIT, "Biomass and infomass are intersected, in some effective combination...where physical actions invoke computational processes, and where computational processes manifest themselves physically."

Another system, Illuminating Clay, allows designers to manipulate 3-D models of landforms and objects upon which visual data is projected as the shape is formed. A 3-D laser scanner continuously scans the three-dimensional model and calculates differences in shape. As the clay surface changes its shape, data such as topography, slope, aspect, cut and fill, or travel time are calculated and projected on the surface. A perspective window screen also allows users to explore the clay model from a person's height. The result is a powerful simulation tool that provides access to a full efficacy of computational resources in a manner that is comfortable and intuitive.

For more information

on Illuminated Clay, visit *web.media.mit.edu/~ben piper/ILLCLAY/ILLCLAY01.htm,* which includes the text of a research paper, downloadable in PDF format.
For more information on the Luminous Planning Table, including a slide show and movie, visit *web.mit.edu/ebj/ www/research.html.* *http://tangible.media.mit. edu/projects.htm.*

Consider the following scenario: A civil engineer, a landscape architect, and an environmental planner stand at an ordinary table on which is placed a clay model of a site in the landscape. Their task is to plan a new research park and access roads. Using her fingers, the engineer flattens out the side of a hill in the model to represent a graded parking lot and an access road. As she does so, various colors illuminate the surface from green to yellow. The landscape architect points out that the red colors along the newly created road indicate that it exceeds the allowable slope. They try various configurations by working the clay model. As they shape the terrain, projected colors indicate the resulting impacts—blockage of drainage, erosion susceptibility, and undesirable visual exposure. Finally, as a solution is agreed upon, the landscape architect performs a scan of the model to calculate the cut and fill. When the scan is projected on the clay surface in various colors, the participants can clearly see both the location and the amount of earth to be moved or excavated.

Next they unroll onto a large table an enlarged map showing the portion of the site that will contain the entrance plaza. They place an architectural model of one of the site's buildings onto the map. Immediately a long shadow appears, registered precisely to the base of the model, and follows along with it as it is moved. They bring a second building model to the table and position it on the opposite side of a large fountain from the first building; it too casts an accurate shadow. "Try noontime on December 15," requests the landscape architect. The engineer places a simple clock on the map; a glowing "8:00 am" appears on the clock's face. The colleague rotates the hour hand around to 12:00 o'clock, and as "8:00

am" changes to a luminous "12:00 pm," the shadows cast by the two models swing around. It is now apparent that in the winter at lunchtime the fountain is entirely shadowed by one of the buildings. They try moving the building and fountain locations, and upon doing so can immediately see the responding shadow patterns. The landscape architect positions a third building, near and at an angle to the first. They deposit a wind-generating tool on the table, orienting it toward the northeast (the prevalent wind direction for the part of the city in question). Immediately a graphical representation of the wind, flowing from southwest to northeast, is overlaid on the site; the simulation that creates the visual flow takes into account the building structures present, around which airflow is now clearly being diverted. In fact, it seems that the wind velocity between the two adjacent buildings is quite high. They verify this with a probelike tool at whose tip the instantaneous speed is shown. Indeed, between the buildings the wind speed hovers at roughly 20 miles per hour. They slightly rotate the third building and can immediately see more of the wind being diverted to its other side; the flow between the two structures subsides.

The integration of digital and tangible interfaces provided by the Luminous Table and the Illuminating Clay are unique in the presentation of urban simulation, where the activity of viewing physical models and the viewing of animation and computerized simulations are separate. Along with offering a missing link between the palpable and the digital, the promise of these systems may also be in shaping a plural planning process. Typically, during public planning reviews, suggestions and input cannot be immediately simulated and explored, often requiring repeated meetings and presentations. These tools, on the other hand, offer a seamless input/output planning and design process. Ideas, changes, and suggestions and their resulting impacts can be seen and explored in real time allowing the public to be better informed and involved. **LA**

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PROJECT CREDITS

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RESOURCES

Web sites at MIT have additional information about the technologies discussed in this article.

Tangible Media Group's site at *tangible.media.mit.edu* includes information on some of the projects they're working on, downloadable PDF versions of research papers, and a discussion of their vision, Tangible Bits (quoted below from the web site):

"People have developed sophisticated skills for sensing and manipulating our physical environments. However, most of these skills are not employed by traditional GUI (Graphical User Interface). Tangible Bits seeks to build upon these skills by giving physical form to digital information, seamlessly coupling the dual worlds of bits and atoms.

"Guided by the Tangible Bits vision, the landscape designers and researchers at MIT are designing 'tangible user interfaces' which employ physical objects, surfaces, and spaces as tangible embodiments of digital information. These include foreground interactions with graspable objects and augmented surfaces, exploiting the human senses of touch and kinesthesia. They are also exploring background information displays that use 'ambient media' —ambient light, sound, airflow, and water movement. The goal is to communicate digitally-mediated senses of activity and presence at the periphery of human awareness.

"Specifically, the researchers are attempting to change the 'painted bits' of GUIs (Graphical User Interfaces) to 'tangible bits,' taking advantage of the richness of multimodal human senses and skills developed through our lifetime of interaction with the physical world."

Below is a sample of the research papers available at *http://tangible.media.mit.edu/papers.htm.*

Patten, J., Ishii, H., Hines, J., Pangaro, G., Sensetable: A Wireless Object Tracking Platform for Tangible User Interfaces, in Proceedings of Conference on Human Factors in Computing Systems (CHI '01), (Seattle, Washington, USA, March 31–April 5, 2001), ACM Press, pp. 253–260.

Ishii, H., Ren, S. and Frei, P., Pinwheels: Visualizing Information Flow in an Architectural Space (short paper), in Extended Abstracts of Conference on Human Factors in Computing Systems (CHI '01), (Seattle, Washington, USA, March 31–April 5, 2001), ACM Press, pp. 111–112.

Ishii, H., Mazalek, A., Lee, J., Bottles as a Minimal Interface to Access Digital Information (short paper), in Extended Abstracts of Conference on Human Factors in Computing Systems (CHI '01), (Seattle, Washington, USA, March 31–April 5, 2001), ACM Press, pp. 187–188.

Piper, B., Hwang, R., The HomeBox: A Web Content Creation Tool for The Developing World (short paper), in Extended Abstracts of Conference on Human Factors in Computing Systems (CHI '01), (Seattle, Washington, USA, March 31–April 5, 2001), ACM Press, pp. 145–146.

Ullmer, B., Kim, E., Kilian, A., Gray, S. and Ishii, H., Strata/ICC: Physical Models as Computational Interfaces (short paper), in Extended Abstracts of Conference on Human Factors in Computing Systems (CHI '01), (Seattle, Washington, USA, March 31–April 5, 2001), ACM Press, pp. 373–374.

Chang, A., Resner, B., Koerner B., Wang, X and Ishii, H., LumiTouch: An Emotional Communication Device (short paper), in Extended Abstracts of Conference on Human Factors in Computing Systems (CHI '01), (Seattle, Washington, USA, March 31–April 5, 2001), ACM Press, pp. 313–314.