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# Visual Simulation in Urban Design

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# VISUAL SIMULATION IN URBAN DESIGN

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This essay is about the use of visual simulation by urban designers and planners. We explore briefly the history of simulation from its origins in the 1960s in the United States, explain guidelines for its application in urban design and planning projects, and discuss how simulation might be applied in a country like Japan.

The essay was written at the Center for Advanced Science and Technology at the University of Tokyo, where I had been invited to join Professor Osamu Koide and the Urban Development Engineering Groups (GC 5).

During my five-month stay I have lectured about simulation and urban design, and as expected, architects and engineers in Japan needed little introduction to this subject. I found simulation technology as advanced in Japan as it is in the United States. In fact, computer image recording and display technology was far superior to any I have seen in the U.S. or in Europe. However, in Japan, the application of visual simulation was most advanced as a tool of promoting urban development proposals and was not frequently employed as a urban design research tool. For example, simulation has rarely been used in the analysis of visual impacts, or as a tool in soliciting community response to controversial urban planning projects.

In response to my lecturers to professional organizations and planning agencies, including a number of lectures to University students, members of the audience frequently commented on the uniquely North American practice of public discussion concerning large urban design projects. It was said that in Japan the public rarely participated in planning decisions. Judging from the questions asked, the professionals in the audience showed considerable interest in methods and techniques designed to improve public communication. Members of the audience also commented on the need to raise public awareness about the urban environment, and the need for a more informed discussion regarding the effects of development and for improvements to the decision-making process in urban planning.

Therefore, in the following essay I have only briefly discussed matters of simulation technology, but have instead emphasized how simulation came about and have concentrated on issues related to its application.

## The Search for Visual Language in Design

In Japan, as in most countries, architects make up the largest contingent of urban designers; and about architects, the late Spiro Kostof wrote: "Theirs is a special skill that is called upon to provide concrete images of structures so others can decide whether to build them and yet others can actually construct them." Providing images, then, is all that designers do. Although some designers function as builders, generally architects do not construct their designs, nor do they operate as clients of their designs. As creators of images, they are concerned about how well their images communicate to those who build and to those who decide. It follows that images— chiefly drawings as the primary means of professional expression— have a profound effect on the quality of the urban environment.

Fundamentally, there are two opposite methods of representation. Buildings or environments can be expressed conceptually or experientially. The conceptual method emphasizes layout and structure; the experiential form of representation explains how environments are perceived by the human senses.

Both methods are abstractions of reality. No method is available to recreate reality as it exists.

Among architecture design professionals, including engineers and physical planners, the conceptual method of communication is dominant. Internationally, designers in different parts of the world might not understand each other's language, but they do understand each other's conceptual drawings. The general public does not. Few people outside the design and engineering field can read two-dimensional drawings and understand what it would be like to walk alongside a building shown thus.

The general public understands the experiential form of representations. Professionals use renderings and eye-level sketches to communicate with non-professionals. Chiefly used as a method to promote design or planning proposals, artists' renderings might show the designer's intent but might not be truthful in explaining what is likely to result if the design shown were approved and built.

Designers not only use representations as a means of communications, but in the process of design, they use them as a tool for spatial analysis and for design development. Here the shortcomings of conceptual representations are felt most severely.

Throughout the history of the profession, designers have searched for new graphic languages of design. Among the professionals in the field of architecture, engineering, and urban planning, urban designers have searched most actively. Frequently asked to visualize the effects of development over long periods of time, they found their task impossible to perform without the aid of improved visual tools. In North America and in Europe this search for new visual forms of communication intensified when public awareness about planning and engineering projects, and criticism of such projects, demanded professional attention.

In North America, during the early 1960s, citizen groups started to rebel against large-scale urban renewal projects and against the completion of the urban freeways. Citizens had become involved politically because the physical changes that affected their neighborhoods had come about without their involvement. Designers invented new types of imagery so community groups could better understand how planning and design proposals might affect the mental image of their city or neighborhood.

Few single publications of that period had a more profound influence on the field of Architecture and Urban Planning than Kevin Lynch's "Image of the City." Professionals in the U.S. employed Lynch's ideas not necessarily to appease citizens or to facilitate consensus building of controversial proposals; the main aim was to better understand the qualities of physical urban environments. Lynch developed a graphic design language for analyzing the experience of urban places. The visual analysis made it possible to evaluate how future changes might affect the experience of cities. This evaluation improved public discussion and led to a better informed decision-making process.

Ironically, much of the new graphic imagery invented in the early 1960s was idiosyncratic, relying on notation systems that were difficult, if not impossible, to understand.

The search for understandable imagery received an official mandate in the United States with the passage of the National Environmental Protection Act of 1968. Passed by the U.S. Congress and adopted by most states during the early 1970s, the act required that all large engineering, architecture, and planning projects had to be analyzed as to their impact on the existing natural and man-made environment. The analysis had to be prepared neutrally and accurately, and fully disclosed to the public. Included in the new law was a call for analysis of the visual effects of future developments. Again, the profession was forced to respond with new graphic design tools. No truthful, easy-to-understand method of portraying environmental change existed. The National Science Foundation, an agency of the Federal government, had started to fund research in the area of environmental analysis and specifically, in 1972, set aside funding for an Environmental Simulation Laboratory housed at the University of California at Berkeley. In establishing the new facility, the Science Foundation insisted that the imagery produced here had to be validated. If simulations were to be used as a decision-making tool, then the reactions people would have in response to seeing a simulation had to be equivalent to reactions the same person might have after visiting or viewing reality.

Only with such response equivalence would simulation be valid as a tool in impact assessment. From person to person the judgement regarding the proposed development might differ, but the same person would be expected to react identically to simulated scenes as to a real-world experience.

The validation was made possible by comparing a large existing environment with simulated scenes of the same place. Using special effects technology invented by Hollywood's feature film-makers, a simulated drive was recorded in motion through a simulated environment. The film was shown to large groups of people randomly selected, and they were asked to compare the experience of watching the film with the first-hand experience of driving through the same area in reality, or with a film recorded of the identical route in the real world.

With the validation successfully completed in 1972, the laboratory was ready to take on urban design work and to conduct analysis in the new field of environmental impact assessment.

This brief history explains the events that led to the establishment of the Berkeley Environmental Simulation Laboratory (ESL). Before we explore how such a facility might function in a city like Tokyo in the 1990s, we need to explain how the Laboratory was applied to a number of professional projects and clarify some issues related to technology.

## Users of Simulation —A City Planning Department

Consistent with the mandate from the National Science Foundation, ESL has made its services available to city governments, community groups, or to private developers.

For six years, from 1979 to 1985, ESL was involved in the work on San Francisco's Downtown Plan, a master plan amendment to guide and control downtown development in San Francisco. ESL contributed to three aspects of the planning work: to simulate future development, to test new planning ordinances, and to communicate the plan to the public.

First, the laboratory provided San Francisco planning staff with simulations that showed how future development under alternative planning strategies would affect the scale and character of the city as a whole and specifically the neighborhoods adjacent to downtown. Images from a large model of the city were recorded on videotape and animated to show incremental developments that might take place if new planning controls were adopted. The animations allowed the viewer to register his eyes on a scene and distinguish the lasting from the changing, existing buildings from future buildings. New development did not appear at once but incrementally, giving the viewer a chance to make out trends of future growth and how these trends might be influenced by planning law. Then the model was changed and another set of planning controls tested. Chiefly, the controls evaluated in this manner included building height limits and other land use restrictions such as floor area ratios, building bulk limitations, transfer development rights, and historic preservation ordinances. Later in the process, sun access requirements to parks and open spaces and wind tunnel analysis were also evaluated.

The city had been taken into the laboratory. Images of the city skyline and of areas adjacent to downtown became the basis for discussion among planners, politicians, and the real estate development community, and with groups in opposition to downtown development. Many individuals made the 30-minute trip to Berkeley to watch planners at work, voice their concerns, and watch the reaction of others to scenes that showed how San Francisco might develop in the future.

Second, the laboratory became a place where specific ordinances were prepared that later became part of San Francisco's planning law. They included sunlight access standards for open spaces and streets and wind velocity standards to protect pedestrians from the mechanical force of winds produced by tall structures.

The third contribution made by the Laboratory included the preparation of images for use by the news media and for public communication of the downtown plan.

The work was funded partly by the City of San Francisco, partly by local private foundations and by the National Endowment for the Arts, an agency of the Federal Government.

## Community Groups as Users of Simulation

Community groups have frequently requested simulation; for example, a citizens group in New York's Upper East Side commissioned the laboratory to prepare simulations of development trends in their district. The group had been dissatisfied with the response they received from official New York planners when the group complained about the speculative residential towers that had been constructed on the Avenues of the Upper East Side during the real estate boom of the 1980s. The city planners had responded by saying that the buildings in question were built "as of right," meaning, no review of the Planning Department was required and the buildings were outside the environmental review mandated by the state. Dissatisfied with this response, the community rallied for support to change the review procedure. To help illustrate their position, they commissioned simulations that showed the effects of the development on the scale and character of their district. The work included animations of a drive down typical sections of the Upper East Side avenues. The simulations compared existing conditions with conditions that might be experienced in the future, if the development trend continued. In addition, ESL prepared simulations of alternative building configurations that matched the existing character, did not block sky and sun, and continued the existing dimensions of the street facades. The community group asked one of their local residents, the actor Paul Newman, to narrate the film. The planning commission scheduled a showing of the film but held firm to their position. The president of the commission was quoted in the newspapers saying, "nothing was wrong with the land use controls on the Upper East Side."

The group continued to show the film at community meetings, but a response to their concerns could come only after a change of the planning commission following the next local election —or for a turn in the real estate market.

## Developers as Users of Simulations

The third group in need of simulations are developers and their architects.

Developers frequently come to Berkeley, but with some reluctance, for instance the sponsor of a large new shopping mall in a suburban town near San Francisco. His architect, responding to local opposition against the large project, explained to the local city council that the shopping center would be scaled like a European village. Several council members at the public hearing questioned the architect as to exactly what the image of a 'European village' meant. Dissatisfied with the response, they asked the developer to schedule a new presentation with simulations showing a drive or walk alongside the proposed development.

The laboratory produced a simulated walk through the project and simulated a drive through the existing town with the simulated shopping mall in place as proposed. These views were presented at the next public hearing and a more concrete discussion about the scale of the proposed structure resulted.

## Four Guiding Principles: Simulations Should be Representative

Earlier in the explanation of ESL, I have used the word neutrality in describing the role the laboratory should adopt when analyzing planning and design proposals. The reader might question whether it is possible to be neutral when clearly those who commissioned the work are either promoters or opponents of plans and designs.

Realistically, the people who prepare simulations will, of course, have their own opinions about the merits of a project. The crucial question is to what extent will these opinions affect the work they do? Subjective perception of a proposal cannot be excluded, but the work is done with the goal in mind that any person watching the simulation would reliably report the same observation from the same situation in the real world. In other words, the simulations have to be representative of the environment as it exists and of the changes that are proposed. This quality of "representative" simulations can be measured. Simulations should be prepared from representative viewing locations. The views should not only show the most positive angle (or worst), but a range of angles should be shown that is representative of the experience people would have in reality.

The viewer should be drawn into the scene. This is accomplished by showing simulations in motion. Ideally, simulations should show the environment at different times of day or season. The building, streets, and landscaping should be depicted as if experienced in reality, not abstract but realistic. Simulations that are abstract leave open too many interpretations as to what actually might happen if a project is built.

## Accuracy

The second principle is accuracy. Obviously, simulations should be accurate. Equally important is to prepare simulations so that they can be verified through an accuracy test. Anyone questioning the accuracy of what is shown should be able to evaluate simulations through independent tests. The principle of openness to accuracy tests is important because of the adversarial conditions that shroud public discussions of planning and design projects. Obviously, people take positions, and if the information contained in a simulation does not support an individual's position, the parties involved will question the assumptions made in the modeling of the existing or proposed environments and will try to undermine the credibility of the work.

### Neutrality

Third, the neutrality of simulations is questioned if the people preparing the work are actively engaged in negotiations or arbitrations or any other form of decisionmaking regarding a proposed project. The simulators should clearly state that they see their role as providers of information. They have to avoid being perceived as allied with one or another party in a dispute.

### Public Information

Finally, the information contained in the simulations is public property. The information cannot be used selectively but has to remain complete. All simulation work done at Berkeley is owned by the "Regents of the University," a body of trustees appointed by the Governor of the State of California. Everything produced is in the public domain. Anyone can come and ask about the work and it has to be disclosed.

These four principles guide simulation work at Berkeley.

### Technology

So far, very little has been said about technology. The reader expects more because the wave of current interest in visual simulation is fueled by the interest in computer technology.

In the 20 years since the beginning of simulation, technology has changed constantly and will continue to change. At Berkeley, we have used a computer-controlled camera, a robotics system similar to those used by cinematographers in Hollywood's special effects industry. We use stage-set-type model displays made from photographs to realistically simulate eye-level news in motion.

Theatrical lighting is used to illuminate the scenes. Once the initial investment in the equipment is made, this technology is easy to use and inexpensive. The technology allows us to respond quickly to requests for simulations.

Since the mid-1980s, we have employed computer modeling techniques wherever there are accurate data files of an existing environment. Proposed architectural and engineering designs increasingly exist in detailed three-dimensional computer data files, but accurate and detailed data files of existing neighborhoods or urban districts are still rare in the United States.

In 1986 the City of San Francisco commissioned a detailed survey of the downtown area based upon aerial photogrammetry. We developed computer data files for all existing structures and wrote application software for data management and shadow-casting. All buildings and open spaces in the downtown area are portrayed at an accuracy of plus/minus 10 centimeters. This high data accuracy permits shadow-casting algorithms to predict shadows within a range of plus/minus 1.5 meters. (Any less accurate shadow prediction would not have satisfied the analysis mandated by a city ordinance.)

Data files of San Francisco are now used for visual analysis. The advantage of the San Francisco database is that all data comes from a single source, including information regarding topography and building heights. Urban data files in other cities generally assume a flat terrain and the files utilize data from a variety of sources, including data read from existing maps and field checks. The multiple data sources make it difficult, if not impossible, to predict the accuracy of any analysis.

For detailed visual analysis, an accuracy of plus/minus 30 centimeters should be the goal. This will make possible the analysis of building facades, signage, configuration of building entrances, and street-scape designs, including analysis of appropriate tree spacing and tree canopes.

For large-scale visual analysis of urban design proposals, an accuracy of plus/minus one meter is sufficient. This accuracy permits analysis of skyline views and overall views of urban districts.

The lack of realism in computer modeling techniques is of concern. Realism increases if a technique called texture wrapping is employed. Using application software, photographs of building facades can be scanned by computers and "mounted" onto three-dimensional building volumes. This technique improves the otherwise abstract appearance of computer models.

Street trees, sidewalk designs, cars, and people make up the most extensive portion of visual information in urban views. The realism of this information is crucial for good eye-level simulations. Photographed in reality, these details are placed as silhouette into the view. Movement through the simulated scene is made possible with motion control software that animates a walk or drive step by step, frame by frame.

The choice of machines capable of storing complex three-dimensional data files and capable of running the various application software programs is ever-changing. We started with microcomputers by the Digital Equipment Company running MacDonald-Douglass modeling software, changed to Sun Micro Systems to run UNIX-based software, and recently acquired Silicon Graphics Workstations; but IBMs 6000 RS are also very suitable machines. Much of our current work is also done with personal computers using image processing software.

For us, the question of what technology to use is somewhat secondary. Of course, such a statement is easily misunderstood. Clearly and increasingly sophisticated technology is required to produce representative and accurate simulations.

At Berkeley, image quality is important. Images have to be realistic. They must relate to the viewer directly, ideally placing him into the scene. Moving images are better suited than still images. Clearly, accuracy in simulation is important. In general, computer applications are not open to accuracy tests. Few people understand how data files are created, or how assumptions and conventions used in modeling affect the representation of an urban environment. Also, few people know how to access the data in order to verify the accuracy of simulated views.

Technology has to be employed in support of credibility in simulations. Credibility will always be of concern, because, as the Mexican writer Carlos Fuentes wrote: "Reality and Realism of course is a problem as old as the shadow on Plato's grave. It is incessantly proposed anew because we are never at ease with any definition of reality or its derivate rules."

So far I have tried to explain three ideas. First, the origins for a new visual language in urban design; second, I have made an attempt to establish general principles that guide environmental design professionals in the application of simulation work; and finally I have discussed a group of issues related to simulation technology. Now I turn to the task of explaining how urban designers in a city like Tokyo might use a simulation laboratory to evaluate the urban design merits of proposed projects, and how urban designers could use such a facility to explain existing urban design qualities of Tokyo.

Clearly, to attempt such an explanation of Tokyo's urban design is an ambitious task, but work on a city-wide Urban Design Plan is correctly underway by the Metropolitan Planning Office. The discussion that follows highlights how simulation can be used in the process of developing such a plan.

## Tokyo —Urban Design Simulation

At the outset of this task, I must admit to my limited knowledge regarding planning and design practice in Japan. During my five-months' stay, I have met with numerous professionals, and knowledge about urban design in Japan is spreading in the United States, although there is still a very long way to go before professionals in the two countries can say they are truly familiar with each others traditions. The reason for visits and exchanges has been the convergence of professional interests and values. By this I do not mean to say that the planning and urban design practice is becoming identical. On the contrary, the political and economical system in which urban planning takes place remains quite different. But planning in both countries benefits from the same basic democratic rights and freedoms.

Simulation as a tool for public access to information has a strong political dimension. The important question is, how this political dimension might fit into the established planning process in Japan. This process is governed by a central authority, whereas in the United States the authority to plan rests in each individual city's right to self-determination. This right invites periodic debate about planning and about the kind of future that planning should bring.

During my stay, in the first half of 1992, a number of large planning projects were discussed in Tokyo. These included an intensive concentration of large commercial structures on the western perimeter of the Tokyo inner circle, a circle defined by the Yamanote Rail Line. At Ikebukuro in the north, at Shinjuku and Shibuya in the central portion of this western loop, and at Ebisu in the southern portion, in all these station locations large developments were proposed and under construction. Upon first impression it appeared Tokyo's center of economic activities was in the process of moving westward. But in the traditional center of Tokyo, several very large projects were under discussion also. The largest potential development included the Marunouchi area, across the moat from the Imperial Palace, a 100-acre district where government buildings were constructed after Tokyo became the Capital. The district burned down in 1872 and the land was purchased by one large company on order of the Emperor in 1893. The district was destroyed again at the end of World War II. Rebuilt after the war, it houses principal banks and head offices of domestic and foreign companies. Given the large dimension of city blocks in the Marunouchi area, buildings considerably higher than the existing 12-story structures could be built here under the current planning law.

Also in late May, plans for another large project near the center of Tokyo were unveiled. The so-called Shiodome at the Shinbashi Station calls for development of the 75-acre site for office, retail, cultural, and residential facilities.

Limited public discussion took place regarding the effects of these large projects on surrounding areas of Tokyo, with the exception of the last two mentioned. In the case of the Shinbashi Shiodome project, a Japan Times reporter quoted leaders of a community group called "Group for the Democratic Use of the Shiodome District." The leaders and their consultants list a host of concerns reminding the public of the need to preserve the 1872 relics of Japan's first railroad station as well as the remains of samurai dwellings unearthed in recent excavations. The consultants also mentioned the need to develop housing in this area, especially for the elderly. Other consultants voiced environmental concerns: in their view, the influx of businesses and a large new population will increase garbage and air pollution. Yet others are concerned about social issues: it will be difficult to find in such a high-tech area a community filled with the vitality of people as that which exists in the Shitamachi areas of Tokyo. (Shitamachi— the old low-lying downtown areas of Tokyo on both sides of the Sumida River.)

The comments reflected very little specific information about the project, and this lack of information appears to be the main reason for the conflict. "We citizens have the right to know about the impact of development projects on the lives of local residents," the groups said in a petition to the Metropolitan government. The reporter of the May 28 article went on to explain the city planning process to his English-speaking readers.

> Under the City Planning Law, prefectural governments are required to hold public hearings on their draft development plans. After the plans are finalized, they will be open to public inspection for two weeks. At that time local residents can submit opinions or suggestions to the prefecture's city planning council. The council's deliberations are closed to the public.

According to the article, a request for additional information in the Shinbashi Station case was declined. Further details of the plan will be provided after negotiations to facilitate the project are completed with the land owners. The reporter finished his article with yet another quote by a professor of economics, who advises the group: "Open and intensive discussion about how we should develop cities is the first step toward building cities that actually improve our living conditions."

I have selected this newspaper article because the reporter reflected a type of public concern that is not unique to Tokyo or Japan, but can be found in cities everywhere. And it is exactly in projects like these where a simulation laboratory can be of assistance in making all parties involved understand the consequences of a large-scale proposal. Preliminary simulation would explain the amount of floorspace proposed, alternative use of buildings, the massing of building volumes, and possible ways of incorporating historic structures. Simulations would show views of the large complex from various neighborhoods. Later, when the information about the proposed plan is complete, a second round of simulations might take place.

The simulations would be made public, and as a result the discussion among planners, developers, and community groups would be more specific, reflecting the rights of the land owner as well as the needs of the community.

Final decisions regarding approval of the project might consider community concern, but might also go against local views. Regardless of the decision's outcome, a more informed discussion would have taken place and the decisionmakers would have conducted their task with more concrete information in mind. Under ideal conditions, the developer would be asked to commission the simulation work from a facility that can produce the work accurately, neutrally, and publicly. Under present conditions, the developer, however, is under no obligation to sponsor such work. Therefore the local government or even a community group might request simulations. Regardless of the sponsor, the work has to be done independently of the parties involved.

The above example illustrates the use of a simulation facility in the evaluation of controversial urban design proposals. There is another important application of simulation. Simulations can be used prior to the discussion of an actual proposal, in the process of analyzing and explaining urban design qualities that exist in a city like Tokyo. As a planning tool, simulation has great merits because it allows a large audience to fully understand choices about the appearance of the city.

## Urban Design Plan for Tokyo

Currently, the Metropolitan Government has started work on Tokyo's Urban Design Plan. The task is immense. But Tokyo, the biggest city in the world (only Shanghai is more populous), is not as monstrous as some might expect. The 11.5 million people that live in 1,700 $km^2$ (656 sq miles) seem to live in a number of cities grouped together, each with busy shopping areas, parks, and buildings of all shapes and sizes, as well as small private houses, the latter gradually being forced back to the vast residential outskirts. But even in a large and fast-changing city like Tokyo there is an urban design structure of permanence. As in all cities, this structure is expressed partly in the natural and partly in the man-made environment.

To this day, a distinction exist between two historic sections of Tokyo: Shitamachi, the area to the east of the Sumida River towards the Bay of Tokyo, and the Yamanote, the higher-lying plateau to the west, a plane that stretches to the foothills of the mountains. These two geographic areas produced a social distinction in the minds of Tokyoites. Today, the escarpment that marks the plateau from the lower river plan is only occasionally visible. But wherever it is apparent, it serves as a clear demarcation of the two Tokyos. (People of Shitamachi insist that only their part is the real Tokyo.) The geographic form is best viewed above Ueno Station, at Kanda where a small river broke through the escarpment, and at Shiba Park.

An ambitious urban design undertaking would be to encourage an urban form that maintains the sense of the escarpment. Without simulation it is difficult to imagine how such an edge of two areas can be made clear., but the form that would result would have meaning for all the people of Tokyo.

Over the last few years, the many rivers and canals of Tokyo have been discovered by urban designers. Of course, many place names that end with *bashi* remind the visitors of even greater numbers of waterways in Tokyo. Frequently filled, covered, or used for the alignment of roads, railroads, and expressways, the remaining rivers and canals contribute significantly to the structure of the city. In recent years, these waterways have been made accessible. Promenades are under construction along the embankment, and in places where water no longer flows, symbolic gestures have been made to reintroduce water in landscape designs. Many more people can now experience sections of Tokyo from such new embankments. But building designs along these waterways have not responded to this new urban quality. Simulations could help to establish building heights and massing configurations that are oriented towards the rivers and canals. A more impressive experience would result for those many people who can now view Tokyo from the water's edge.

Given the hot, humid summer condition, these water locations would have the added benefit of a relatively greater comfort than the rest of Tokyo at that time of year.

Among the man-made features, the visitor is full of surprise when he finds, in a large inner-city area, the remnants of old villages that existed in the last century and earlier. Frequently, a pattern is found of boundaries and paths designed for agricultural uses. The irregular fields and gardens have become properties with buildings, and today's streets follow a seemingly random order. Often, an old shrine or temple can be found surrounded by mature trees. There are winding commercial streets and frequently a more formal approach to a temple lined with trees and small buildings, as in the Zoshigaya area north of Waseda University. Here, Tokyo's urban form has a fine grain. Simulations could help to explain how buildings built today under current laws could respond to these small dimensions.

The topic of block dimension in Tokyo and how block dimensions effect the character of urban design would be an important subject of systematic simulation studies. Such a study would analyze how density and use restrictions take on different urban form appearances given the range of block and grid formation found in Tokyo.

One of the most impressive experience for a visitor is the street life that takes place on Tokyo streets. The high density of people and the fact that only relatively few people move by car instead of walking creates a level of activity on sidewalks rarely found in western cities. (The ratio of people using cars to trains in Tokyo is three to seven.) Closely spaced trees that line some streets give them a formal character and make them memorable in the experience of the city. Simulations could help to identify other streets that have not been improved as major paths.

Main squares as public places of assembly and used as markets are not common in Japanese town planning. But with the arrival of the railroads, station squares have been created that are important transfer places with large crowds moving through. Some of these squares, at Ueno Station, Shibuya, and East Shinjuku, are impressive because they are framed well by adjacent developments including large billboards and electric signs.

Many good examples of station squares exist, and simulation could help to explain how future buildings can support each square's unique character. Similarly, simulations could explain the alternative development solutions that serve as frames of the many important parks, gardens, and temple areas.

In these examples, simulation can be used to develop a rich urban design plan for Tokyo. I have only used examples from the 12 inner wards of Tokyo and not included examples from the much larger outer areas unfamiliar to me.

The examples mentioned illustrate how urban design could be explained to the people of Tokyo. Even in a fast-changing city like Tokyo, urban form can help to express the permanence of a city's structure and thus contribute to the identity of the city.

The ideas expressed here have triggered some discussion among those people I met during my stay in Japan. Many questions still need to be answered before any one group seriously considers starting an urban design simulation laboratory in Tokyo or elsewhere in Japan. Hopefully, a first step has been made towards that goal.

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*Lectures given in Japan:*

3/11 RCAST. "Representation of Urban Environments."

3/31 Mano Neighborhood Association in Kobe; present were planning and urban design professionals from Kyoto, Kobe, and Osaka. "Identity of a Neighborhood."

4/3 Kyoto. "Environmental Simulation as a Planning Tool."

4/14 Sonic City, Saitama. Think Tank. "Environmental Simulation."

4/18 Kyoto. "Growth Management Policies in San Francisco."

5/8 City Planning Institute of Japan, Tokyo. "Growth Control Policies in San Francisco."

5/12 Tokyo University, Prof. Koide. "Downtown Plan San Francisco."

5/12 Architects Institutes of Japan. "Brunelleschi and Leonardo Da Vinci, Two Forms of Representation"

5/14 Tokyo Metropolitan Government, "Simulations as a Planning Tool."

6/6 Musashino University. Prof. Takejama. Lecture to design students.

6/8 RCAST. "Films and Videos of the Berkeley Simulation Laboratory."

6/16 Chiba University. Professor Kitahara, lecture to Urban Design students.

6/17 Waseda University, Tokyo. Prof. Satoh. "Brunelleschi and Leonardo da Vinci." Methods of Representation.

6/18 Institute of Public Health, Government of Japan, Prof. Murakami, University of Tokyo. "Standards to Protect from Adverse Wind Conditions in San Francisco and Toronto."

6/19 University of Tokyo. Prof. Watanabe Lecture to urban design students.

6/26 Setagaya Ward, city planning department, Akio Hara, city planner. and Yoshimaru Asanoumi, Research Associate.

6/29 Shimizu Corporation. "The use of computer simulation in environmental analysis."

6/29 RCAST. "The Tokyo Landscape."