VISUALIZING URBAN FORM

Peter Bosselmann and Kevin Gilson
University of California
Berkley, USA

This article is about the use of visual simulation by urban designers. 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 in greater detail how new simulation techniques might be integrated into design instruction and practice.

THE SEARCH FOR VISUAL LANGUAGE IN DESIGN

In the introduction to one of his early books, the historian Spiro Kostof (1977) defines the work designers do. Summarized, this definition might read as follows: 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 might 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 physical environment. Fundamentally, there are two opposite methods of representation. Buildings or environments can be described conceptually or experientially. The conceptual method is abstract; it emphasizes layout and structure. The experiential form of representation explains how environments are perceived by the human senses. Both methods treat reality selectively. No method is available to recreate reality as it exists.

Among architecture design professionals, including landscape architects, 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 thus shown.

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, of course, not only use representations as a means of communications, but in the process of design itself. They use images as a tool for spatial analysis and for design development. Here the dominance of conceptual representations has had a major effect on how professionals think about physical space. The graphic conventions used as tools in spatial analysis, and in developing designs, produce abstract diagrams. The mental image of a design is only partially expressed by such graphics. Fewer and less exact graphic conventions exist for expressing the experience of design ideas.

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 urban freeways. Citizens had become involved politically because the physical changes that affected their neighborhoods had come about without their involvement. Some designers invented new types of imagery so the public 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 (1960) "Image of the City". When applied, Lynch's ideas did not necessarily appease citizens or facilitate consensus building of controversial proposals; his aim was to better understand the qualities of physical urban environments. Lynch developed a graphic language for analyzing the experience of urban form, and for evaluating how future changes might affect such an experience. The evaluations, he and others believed, improved public discussions and would, hopefully, lead 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. (Appleyard, 1977.)

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 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. The profession was forced to respond with new graphic 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 there 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. (Craik, 1983.)

Only with such response equivalence could 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 an extensive 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 their responses were compared with those made by people who had been given a first-hand experience of driving through the same area in reality, or with those who had seen a film recorded of the identical route in the real world. Thanks to the skill of the film-makers, audience responses to simulated scenes matched closely to those made by audiences that viewed reality. 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. Before we explore how such a facility functions currently, 20 years later, we need to explain how the Laboratory was applied to a number of professional projects and clarify some issues related to technology.

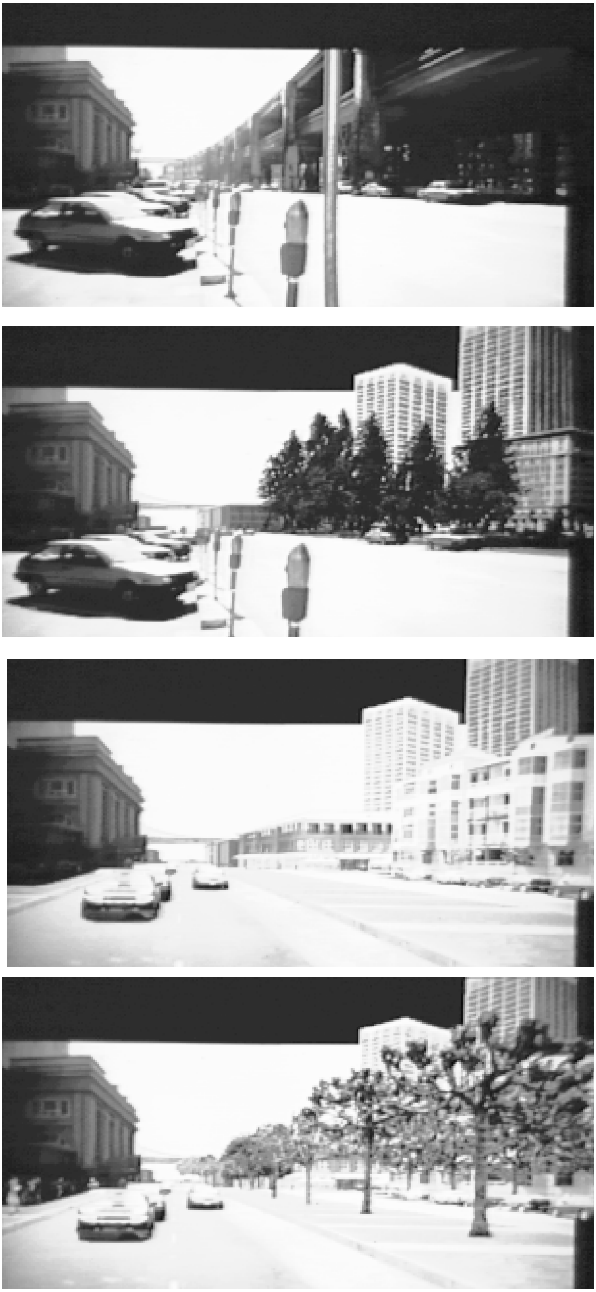
USERS OF SIMULATION – A CITY PLANNING DEPARTMENT

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

For six years, in the early 1980s, the Laboratory was involved in the work on San Francisco's Downtown Plan, a master plan amendment to guide and control downtown development in San Francisco. The lab contributed to three aspects of the planning work: to simulate potential 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 a 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 all at once but incrementally, giving a viewer the opportunities 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 limits to building heights and other restrictions such as floor area ratios, building bulk limitations, transfer development rights, and the effects of historic preservation ordinances. Later in the process, sun access requirements to parks and open spaces and wind tunnel analysis were also evaluated.

Figures 1 - 4
Project in San Francisco on a freeway, which was to be demolished because of a earthquake.
1. Original situation.
2. Computer generated background with existing buildings.
3. and 4. Edited student designs.



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.

Secondly, 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. (Bosselmann, 1987.)

The third contribution made by the Laboratory included the preparation of images for use by the news media and for public communication of the planning document. 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. (Bosselmann, 1987.)

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 building proposals were considered outside the environ-

Figures 5 - 7
Project on Time Square
in New York .

mental 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, the Laboratory 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 and in delivering the narrative the actor dramatized the information contained in the simulation. The planning commission scheduled a showing of the film but held firm to their position not to change land use controls on the Upper East Side.

The group continued to show the film at community meetings, but a response to their concerns would come only after a change of the planning commission following the next local election-or for a turn in the real estate market. (Bosselmann, 1987,1993.)

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, as in the case of a 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 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. (Bosselmann, 1993.)

FOUR GUIDING PRINCIPLES

Earlier in the explanation of the Laboratory, we 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. Based upon our experience with various types of clients, we explain four criteria, or principles, that can be used in judging our independence.

1. Simulations Should be Representative. 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, because if images were abstract they were open to interpretations as to what actually might happen if a project were built.

2. Accuracy. A second principle is accuracy. Obviously, simulations should be accurate. Equally important is to prepare simulations that 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, in the adversarial conditions that shroud public discussions of planning and design projects, 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.

3. 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.

4. Public Information. Finally, the information contained in the simulations is public property. The information cannot be used selectively but has to remain complete, and shall not be distorted (for example, through dramatization). Like all research conducted at Berkeley, simulation work is owned by the "Regents of the University", a body of trustees appointed by the Governor of the State of California. All information produced is in the public domain, and its use is protected by public-record acts. Anyone can approach us and inquire about our work, and the information has to be disclosed.

These four principles have guided our work. They might be obvious statements. In our experience, however, they are not necessarily obvious to those who request work from us.

ISSUES RELATED TO 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 years since the beginning of simulation, technology has changed constantly and will continue to change. At Berkeley, for 25 years, we have used a computer-controlled camera and robotics system similar to those used by cinematographers in Hollywood's special effects industry. We have used stage-set-type model displays made from photographs to realistically simulate eye-level views in motion. Theatrical lighting illuminates 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 an accurate database is available. Proposed architectural and engineering designs increasingly exist as detailed three-dimensional computer data, but accurate and detailed databases of existing neighborhoods or urban districts are still a rarity.

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

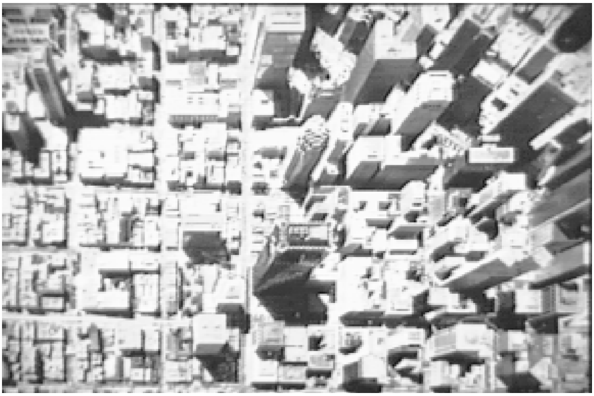


Figure 8
Aerial photograph of the City of San Francisco.

The computer model of San Francisco is now available for visual analysis. The advantage of the San Francisco computer model is that all data came from a single source, including information regarding topography and building heights. Urban databases developed for other cities frequently assume a flat terrain utilizing 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 survey accuracy would provide image accuracy to within one degree of visual angle for a viewer 30 meters from the building. It would make possible the accurate analysis of building facades, signage, configuration of building entrances, and streetscape 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.

For many years the lack of realism in computer modeling techniques was of concern. Modeling applications lacked in their ability to represent textures and materials in a realistically. The time needed to model building details is significant. Using image processing

Figure 9
Photographs of building facades can be scanned and "mounted" onto three dimensional building volumes.

software and a process called texture mapping, photographs of building facades can be scanned and "mounted" onto three dimensional building volumes. The images create a very rich and realistic representation of the building. (This technique is described in detail later.)

Trees, street furniture, cars, and people comprise a significant 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 silhouettes into the view. Likewise, surface textures and landscaping materials are photographed and scanned for use as realistic model surfaces. Movement through the scene is made possible by software which animates a walk or drive through the model one frame at a time. These frames are recorded sequentially onto videotape for playback in real time.

The choice of machines capable of manipulating complex three-dimensional models and of running the various application software is constantly changing. The simulation lab started with Digital Equipment Corporation mini-computers running the VMX operating system and a solids modeling application. We then changed to Sun Micro Systems workstations running UNIX-based software, and later to Silicon Graphics Workstations, also running under UNIX. Much of our current work is done with DOS-based personal computers using computer-aided design applications, image processing hardware and applications, and three-dimensional rendering and animation software that allow us to produce walks or drives through realistic computer-generated environments.

For us, the question of what technology to use is somewhat secondary. Of course, such a statement is easily misunderstood. Clearly, increasingly sophisticated technology and applications are 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 or her into the scene. Moving images are better suited than still images. Accuracy in simulation is important. We are concerned about openness to accuracy tests. Few people understand how data is created, how assumptions and conventions used in modeling affect the representation of an urban environment. Also, few people know how to access 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 we have tried to explain three ideas. First, the origins for a new visual language in urban design; second, we have made an attempt to establish general principles that guide environmental design professionals in the application of simulation work; and finally we have discussed a group of issues related to simulation technology. Now we turn to the task of explaining how urban design students and practitioners might use a simulation laboratory to evaluate the urban design merits of proposed projects.

SAN FRANCISCO, EMBARCADERO

In San Francisco, an elevated freeway ran alongside the water&ont. Initially constructed to connect the city's two bridges, the Oakland Bay Bridge and the Golden Gate Bridge, the freeway had never been completed due to citizens' protests. In the early 1960s, the construction had stopped at the foot of Telegraph Hill, after a mile-long run in front of the financial district. In November of 1989, this elevated structure was damaged in a severe earthquake and demolished in 1991. Prior to the natural disaster, San Francisco's Board of Supervisors had discussed the demolition of the structure more than once, and federal funds had been made available for the replacement of the freeway with a surface roadway of comparable service levels.

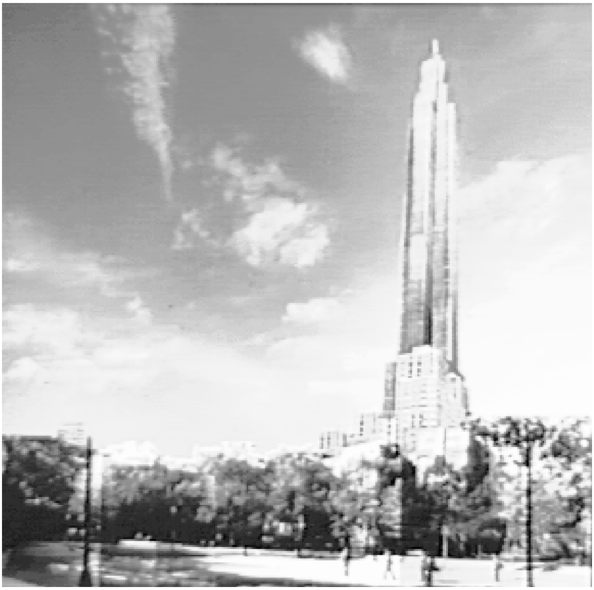
For San Franciscans the removal of the Embarcadero freeway had been a continuous debate with broader concems than the accommodation of moving traffic. When the elevated structure finally came down, the openness of the Embarcadero to sky and bay encouraged office workers, tourists, and residents alike to promenade along the water's edge. Once again the city had its edge at the Bay, and Market Street could end at the Ferry Building. While there was some agreement on the potential qualities of the newly gained urban place at a conceptual level, the character of the place still has to be designed. Should the place in front of the Ferry Building have surface roadways with two or three lanes of traffic in each direction? Should the roadways run below-grade? How should the entire space be structured? In its current size, the dimensions of St. Mark's Square in Venice or the much larger Trafalgar Square in London would fit comfortably into this locale with room to spare. The space in front of the Ferry Building would need to be contained, if not by structures by viable tree plantations. A design would need to consider busy areas with people crossing traffic, stepping on and off streetcars bound for the tourist spots along the Embarcadero. There would also be quiet areas with benches to sit on and views to enjoy — Like the view of General deAnza in larger-than-life bronze on horseback on a concrete pedestal and, nearby, the statue of his King, Carlos III of Spain on foot, who in 1776 gave de Anza the order to start the settlement that became known as San Francisco. Today, these two statues are standing in the shade of the Southern Pacific Buildin, and would have to be incorporated into a new design of a more permanent setting. In the minds of many local designers, the place calls for a formality evoked by the symmetry of the Ferry Building, with its tower on axis with Market Street (although rotated by a few degrees, making visible two aspects of the clocktower's facade). In contrast with any formal design, the free-form geometry of the plaza at the 1970s' Embarcadero center with its dry fountain had to be considered. This section of the space is shaded and frequently made cold and windy due to the tall office towers to the south and west.

COMPUTER MODELING

In order to study possible designs, we constructed a computer model of the area in front of the Ferry Building. Information regarding the surrounding buildings came from our San Francisco database and from computerized plan information compiled by the city's public works department.

Students of Berkeley's College of Environmental Design photographed the buildings with a special lens that produced orthagonal prints or slides. They do so by placing themselves in front of a structure, pointing the camera on a view axis that is perpendicular to the facade of a building. All vertical edges in the scene will register parallel to the edges of the framed view in the viewfinder. Buildings such as the over 600-foot-long Ferry Building would of course require several photographs to record the entire facade. The photographs were then scanned and converted into digital image files. Where necessary, several images can be assembled side-by-side to produce a single image of the entire building facade. A wireframe

Figure 10
The Ferry Building project.



volume constructed to the dimensions of the building serves as a guide in the assembly of the pictures. Objects like mailboxes, cars, trees, etc., located in front of the facades when photographed on location are now removed and the image area is restored. This last step sounds more complicated than in practice. Most building facades have a repetition of textures and openings, and frequently there is symmetry. Elements of facade pictures can be duplicated and applied in areas where the original information was obscured.

Proportions and heights of building details can be scaled directly from the orthagonal images of the facades. Vertical dimensions can be calculated from known horizontal dimensions by measuring directly from the image in pixels.

During the modeling process we have a film script in mind. We decide on the location of walks through the model and on places where we will stop and look around. We determine the locations from which we will compare alternative designs. This script is drawn as a map on a blackboard in the room where we work. We frequently consult it in the assembly of the computer model. The model shown on this map is really more similar to an imaginary stage set than to a complete three-dimensional model. We do not include the backs of buildings, nor do we model distant views. All information beyond one city block's distance from our location is recorded on a two-dimensional cyclorama that wraps around our computer model, allowing us to show views of the Bay Bridge in the distance, or Telegraph Hill and Coit Tower in the opposite direction. The placement of the cyclorama in space is carefully calculated to reveal the distant view of structures accurately when we later move through the scene.

Digital image files of building facades can be quite large. The files used to represent the Ferry Building, for example, use more than 5 megabytes (million bytes) of memory during rendering. We can economize by reducing image resolution and building model complexity for more distant elements in the scene. The aspects of elements in the immediate viewing range of a person walking will change more rapidly; new information is constantly being revealed. Distant elements change less in the view, and can be modeled with less detail and use images scanned at lower resolutions.

Surfaces in the foreground of the scene are created from photographs in the form of bitmaps spread across the groundplane. Beyond certain distances the bitmaps are replaced by a generic computer-generated texture, which, if used in the foreground, would make the scenes look unrealistic.

A DESIGN TOOL

What is described above might strike the reader as complicated. The modeling techniques are derived from our experience with physical, miniature stage sets. The application of these techniques to computers is teachable. It takes our students approximately four weeks to learn the steps, and for most of our graduate students the use of computers as a design tool is still new. But that is where their interest lies. Once the computer model is complete, the students can experiment with their conceptual designs for the site using a variety of landscape elements. The students can experiment with tree spacings, heights, and tree canopies. Using a computer image library of trees, they may select and place trees along the roadway. Or they may create a bosque of trees, and place them in front of existing buildings to help structure the dimensions of the space. The views of an imaginary person driving or walking alongside can now be created and the spacing of trees can be changed. The model and the way it is viewed in motion becomes a reasonably good substitute for reality. The students discuss their designs and everyone is reacting to the same design issues with a concrete image in front of them. The experiential qualities of conceptual ideas are quickly tested and, if so desired, an image of a place can be recalled from the screen and shown as a concept in the conventional form of section and plan.

IMAGES IN MOTION

The images that illustrate this article do not sufficiently well explain what images in motion reveal and how motion pictures pull the viewer into the scene, as if he or she were part of it. Movement allows the eyes to take bearings constantly, judging distance and size of objects relative to other objects passing by. Movement through a computer model is created by placing a ”camera” into the scene at a point in space where the motion will begin. This camera is placed five feet above the ground for a pedestrian and the opening angle of the imaginary lens can be set. We can then define new positions for this camera at further points in time along our walk or drive. The speed of the movement is set by adjusting the timing in which the camera passes through the defined points. We can change the direction the camera is aimed as we move along the defined path, allowing the viewer to pan, or rotate, the camera across the scene.

Figure 11
The model of San Francisco.

THE CITY IN THE LABORATORY

The Berkeley laboratory, as a place where city design could be subjected to systematic testing, had been a unique facility for many years. Computer technology has made possible the existence of other laboratories at other universities, most notably the University of Toronto, the Massachusetts Institute of Technology, the University of Texas, the University of Cincinnati, and others. The most recent new laboratory was constructed by the Berkeley team at the New School for Social Research in New York City. Located on busy 14th Street in a storefront of a former bookstore, the new laboratory invites passersby to stop and look through the windows. The pedestrians might wonder what is on sale here next to virtually everything else imaginable that can be purchased on 14th Street; well, simulations — concrete images of future places represented in a way that makes their designs open to evaluation by many, including all those who might not otherwise understand the consequences of design and planning decisions. They include the general public and decisionmakers, but also the designers and planners themselves.

REFERENCES

Lynch, Kevin 1960. *The Image of the City*. MIT Press, Cambridge, Mass.

Appelyard, Donald 1977 ”Understanding Professional Media.” In *Human Behavior and Environment,* Altman and Wohlwill, eds., Vol. 2, New York, Plenum Press.

Craik, Kenneth 1983 ”The Psychology of the Large Scale Environment.” In *Environmental Psychology, Directions and Perspectives,* N. R. Feimer and E.S. Geller, eds., Praeger, New York.

Bosselmann, Peter 1993. ”Dynamic Simulations of Urban Environment.” In *Environmental Simulation, Research and Policy Issues,* D. Stokols and R. Maraus, eds., Plenum Press.

Bosselmann, Peter 1987. ”Times Square.” *Places, Vol. 4, No. 2,* MIT Press.

Bosselmann, Peter 1987. ”Experiencing Downtown Streets in San Francisco.” In *Public Streets for Public Use, A. V.* Moudon, ed., Van Nostrand Reinhold, New York.