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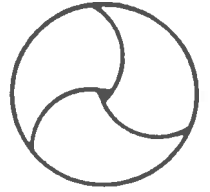
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Toward these ends, current research is directed to the economics of urbanization in the West and in the Third World; techniques of environmental management; effects of using new energy sources; emergent patterns of suburbanization and central area reconstruction; evaluation of alternative modes of transportation; design of effective means for supplying social services; contemporary issues in housing policy; regulation of urban growth and uses of land; determinants of urban livability and the factors shaping urban life; and potential improvements in methods of analysis, evaluation, and planning.

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Berkeley Environmental Simulation Laboratory: A Tool for Transportation Planning

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When an engineer draws a perspective, makes a model, or presents a plan, he or she is simulating a future environment. Too often these simulations are distant from the ultimate reality and remote from the environment as it will be experienced. Plans are difficult for lay people to understand since perspectives and models provide an illusion of reality that is frequently inaccurate. Drawings and perspectives are necessarily selective, and planners choose the viewpoints and features that best communicate their ideas of what the project ought to be like. At best, there is a rich mixture of hope in these presentations; at worst there is downright deception.

The Environmental Simulation Laboratory at the University of California, Berkeley, was designed to improve the general quality of environmental simulation and to carry out basic research on the issues of public communication facing the environmental and planning professions. The laboratory uses a dynamic environmental simulator that enables one to visually walk or drive through small three-dimensional scale models of urban and natural environments. A remote-controlled television camera that is equipped with tiny viewing attachments moves through scale models of the environment and continuously projects eye-level views on closed circuit television screens. Trips through miniature environments can be displayed live to a large television audience. Color films and videotapes can also be made for comparative feedback, permanent records, and later presentation. The laboratory has model- and film-making facilities.

USES OF THE ENVIRONMENTAL SIMULATOR

Currently, five potential uses of the simulator stand out as the most interesting and relevant. The following is a discussion of these uses, which include communication and resolution of environmental issues, planning and

design tool, educational films, technological innovation, and environmental psychology.

Full disclosure of the environmental consequences of plans and projects is becoming mandatory. By communicating the nature of environmental proposals to the public, the simulator can provide a focus for the assessment of environmental impacts and for the resolution of environmental conflicts. The simulator enables plans and designs to be presented to citizen groups through film and television, media that are more familiar and more interesting to the public. Simulations can be displayed at several points in the design process: at the beginning of the process to help generate ideas, at the point at which selections must be made to focus on decisions, and at the end of the process to help communicate a preferred scheme.

A simulation technique that adequately elicits professional or public responses to proposed plans should enable design alternatives, modifications, and testing to become integral decision-making stages in the planning process. The simulator is a resource for the interactive gaming and assessment techniques already being developed in the design methods and community participation fields. It can also be used to provide feedback in the education of environmental professionals. We plan to set up a viewing room at Berkeley equipped with voting switches where schemes can be displayed on closed-circuit television for group voting and discussion.

The simulator can be used to show educational films about environmental problems to the public and professionals. Through the use of animated models and shifts in viewpoint, the growth of communities, the history of development, the processes of ecology, or the chains of environmental impact can be simulated. The effects of typical planning or design decisions on the everyday environment—the visual meaning of such professional abstractions as density, floor area ratio, traffic volumes, or floodplains—might be made more comprehensible. Movies can be produced for use in school, community, and continuing education programs as well as on television.

Toffler (1) pointed out that most people find it difficult to visualize the future. However, future environments that are quite different from any that exist are being con-

ceived in laboratories, on drawing boards, and in imaginative minds around the world. Ocean settlements, floating power stations, megastructures, solar housing, high-speed transit systems, and automated freeways are being proposed. The function of utopias has been to offer complete and detailed images of the future; but rarely if ever have these been presented for public discussion and debate. If simulation can bring these projects closer to the real world, the public may have a clearer idea of whether they are desirable or monstrous. One of our first movies was about travel on an automated highway.

Once the simulator is validated, psychologists will be able to bring into the laboratory models of existing and future environments. Thus, experiments may be carried out with less investment than those undertaken in the real world. The real world is so complex that analysis of the effects of different variables becomes a problem. In simulating the design of a highway or transit, for example, the height and character of the channel, landscaping, street furniture, protective barriers, and type of surrounding development can be varied independently to test responses to appearance by would-be travelers, citizen groups, and public representatives. Reactions by different social classes, age groups, or personality types could also be assessed (2).

Figure 1. Terra Linda model and overhead camera gondola.



Figure 2. Two views of Terra Linda model taken with a 35-mm still camera.



DEVELOPMENT OF REALISTIC SIMULATIONS

One of the first questions asked when we proposed to construct the simulator was whether we could actually produce realistic images. Thus, the project was designed to have an evaluative component. Craik, University of California, Berkeley, designed an elaborate large-scale evaluation to test the psychological effectiveness of the simulator. A large and diverse area of suburban Marin County was chosen as the testing ground. A model [scale: 3.5 m = 1 cm (30 ft = 1 in)] was made of this area [2.4 by 1.6 km (1.5 by 1 mile)] that included a freeway and arterial and residential streets (Figures 1 and 2).

Figure 1 shows the camera gondola with the 1.27-cm ($\frac{1}{2}$ -in) probe and 16-mm camera positioned over the Terra Linda model. Also shown are the gantry structure, support rails, cyclorama background, overhead fluorescent lights, and a quartz-halogen spotlight. Figure 2 shows two views (a and b) of the Terra Linda model. Both of these pictures were taken with a conventional 35-mm still camera that was attached to a 2.54-cm (1-in) probe. Note the wealth of detail, even in black-and-white still photos. The most difficult problem solved on this project was the control of depth of field. In Figure 1a, the car is about 5 cm (2 in) away from the probe, the building on the hill is 0.9 m (3 ft) away, and the background is 1.8 m (6 ft) away.

Four groups of 200 subjects each were randomly selected from Marin County and were taken (a) on a real trip through the area, (b) on a film trip through the area, (c) on a color-film trip through the model, and (d) on a black-and-white video trip through the model. The trip took 25 min, and small groups of 10 to 15 people were invited daily for these presentations. These groups were subsequently given 3 h of recall and attitudinal questions and tests. The psychologists are in the process of concluding their analysis, but preliminary reports show high correlations between responses to all four trips.

These results will confirm the experience of anyone who has viewed our films. The films are not abstract, schematic, or like cartoons that are simulated by computers. The films are sufficiently real that many viewers refuse to believe that models were used. Tribute must be paid to the quality of the model making that used unconventional techniques such as photo montage and brass etchings.

ENVIRONMENTAL QUALITIES

A visual simulation can depict many more issues than those merely aesthetic. The following is a discussion of the environmental qualities that could be simulated.

Safety, Stress, and Pollution

Lay people and professionals interpret levels of safety, noise, overload, and air and water pollution from the appearance of environments. Perceived levels of safety may be affected by the presence of walls, enclosures, and street lighting, and danger might be perceived in hidden places, nooks and crannies, or in high buildings. However, these perceptions are frequently incorrect. Nevertheless, the presentation of various views of a project can be used to determine apparent levels of stress. These views can be presented in parallel with expert predictions of stress. Sound can be added to the images to simulate the loudness and character of a predicted noise. The REAL simulator at the U.K. Transport and Road Research Laboratory convincingly employs this technique.

Invasion of Privacy

The invasion of privacy by the placement of new structures that overlook houses, offices, and other buildings is a major problem in high-density areas. To simulate intrusion, the camera can be used to represent the view of an average person.

Access and Disruption

Changes in accessibility levels due to new projects can be measured by following typical routes and journeys that are popularly used in the environment of the project. Thus, factors within the project area could be identified that would facilitate or inhibit access to desired destinations: changes in access over time, during construction periods, and on a regular basis.

Identity, Scale, and Diversity

The relations between the character of the new project and the existing environment are common reasons for opposition to projects: whether it enhances, damages, or disrupts the local character of the area and whether it adds to or reduces the richness of the community's self-image. Simulated views of the project could be made of neighboring sites and common routes and could be compared with other parts of the community or with similar facilities elsewhere.

Aesthetics

The views from houses, apartments, and offices on residential streets, transit lines, and pedestrian networks can be produced to assess

1. The presence of aesthetically powerful elements, e.g., skylines, vegetation, water, historical areas, landmarks, and billboards; and
2. The quality of various views as to natural and urban composition; depth, mystery, and interest; view change and view blockage under different conditions.

Symbolism

Much of the environment is symbolic of the social group that has constructed it or owns it. Freeways may be interpreted as the invasion of an alien social group, public buildings may be viewed as an unnecessary expenditure of public funds, and certain styles of architecture may be seen as inappropriate to the community's self-image. Such interpretations of social impact often override purely environmental considerations. It will be important to have these fears articulated before construction. The explicit assessment of symbolism may thus become part of environmental assessment.

STRUCTURING PUBLIC RESPONSE

Some systematic ways are needed to obtain the public viewpoint without manipulation. Too many public hearings wander through details and allow only a few to speak. The presentation of proposals in a form that can be voted on and discussed, issue by issue, could help enormously. The Town Meeting Programme of the New York Regional Plan Association showed film sequences of environmental issues, and at certain points viewers were asked to vote among alternative policies. This program is the largest known example of public participation outside conventional political voting. Two million people were estimated to have viewed the films, and 50 000 responses were received on the first vote.

An early project carried out by the Berkeley Environmental Simulation Laboratory displayed to a citizen planning committee in Marin County, California, images of alternative land uses on open land that was under development pressure. Each committee member was provided with a voting dial and asked to vote on the alternatives presented. Votes were anonymous, but the totals were instantaneously shown on an electronic display system. Discussions ensued, preferred alternatives and combinations were simulated, and decisions were made.

TRUTH AND DECEPTION IN SIMULATION

One of the principal hazards of any communication medium is the ease with which the truth can be distorted. This situation is particularly easy to create when future environments are projected for which the facts are not available. We can test the level of realism when we simulate an existing environment, but projections of the future are more a matter of opinion. Most environmental proposals, as shown on plans and models, are devoid of familiar environmental features such as traffic congestion, landscape erosion, air pollution, poor maintenance, vandalism, billboards, street furniture, and signs, even though such may be the characteristics of the project area after a few years. It is not always the developers who want to maintain secrecy in the field of environmental planning. Planning agencies, highway departments, and other public bodies often do not wish to reveal their plans because they fear what some public groups might say or some developers might do. In the long run, regulations similar to truth in advertising legislation may have to be applied to the presentation of environmental projects.

Simulating the true consequences of a project should be the aim of a public environmental simulator. One way to accomplish such a difficult task is to make a distinction between the proposed environment that project planners have designed and the consequent environment that may result. Protagonists and antagonists of a project could be called on to articulate their predictions of the consequences to the environment, and simulations could then be made of both. Or an independent outside expert may be called on to make impartial predictions.

The simulation laboratory is committed to test different kinds and levels of simulation to see which are the most appropriate in different situations. Cost is the primary limitation on how much and how well plans and projects can be simulated. Once the initial investment has been made, the models will be the most costly item in the production process. One way to reduce model cost is to restrict the detail of those model aspects that are perceived in the real environment. Such perceptual models might, for instance, emphasize the aspects of projects visible to the general public, if that were the important issue. Models of this kind are likely to emphasize foreground detail around road channels (cars, street furniture, signs, front yards), details of building facades, and floor surfaces rather than rooftops or rear yards. A model we have built uses photo images of buildings and signs, special castings, and backdrops. Film and video montage can also reduce costs. If context models of an area are not available, then movies of project models can be set within movies of the real environment by fading or cutting from real context to model world as the camera enters the project area.

BERKELEY SIMULATOR AS A PROTOTYPE

The Berkeley simulator is being constructed as an ex-

periment. It may be used primarily as a laboratory instrument, but if it proves to be sufficiently real, economical, and relevant to public planning and design issues, it could become a prototype that would encourage the more general use of environmental simulators. Small environmental simulators are already in operation in places as far apart as the Bouw Centrum, the center for building and planning research in Holland; the Technion in Haifa; the University of Lund in Sweden; Oxford Polytechnic; and Perth, Australia.

In larger cities, a model of the city could be permanently placed under a simulator in an exhibition shed at some convenient location. The use of a simulator is seriously being discussed in the city of Jerusalem. All significant projects could legally be required to produce realistic models constructed according to guidelines and be set in the context model. The expense of these project models would probably be no more than is now being expended on project presentations, and the cost would be borne by the project developer.

All new projects would then be viewed from commonly used viewing points, and procedures could be developed for objectively assessing degrees of impact through visual image assessment. More significant projects might be displayed on public television—normal projects would simply be presented to planning commissions, citizen groups, and other bodies while the model is on public display. The bay simulation model in Sausalito, which is managed by the U.S. Corps of Engineers to calculate bay currents, silting, and water pollution, is regularly open to the public.

We are conducting a series of demonstration experiments to test which media are most appropriate to which planning situations and the levels of realism that each provides. Contemplated planning projects include the simulation of solar energy communities, high-rise control plans for the city of San Francisco, the simulation of fire breaks on the mountains behind Santa Barbara, and the intrusion of urban development along the 1920-km (1200-mile) coastline of California.

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