# CONCEPTS, APPROACHES, AND PROBLEMS OF APPLYING INTERACTIVE GRAPHICS IN COMMUNITY PARTICIPATION PROGRAMS FOR URBAN TRANSPORTATION PLANNING

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A framework for using interactive graphics to strengthen community participation in urban transportation planning is outlined. The relationship of interactive graphics to basic community participation objectives and techniques is assessed. A variety of interactive graphics needs and capabilities are reviewed, and 6 potential areas of application are described. The relevance of interactive graphics to planning and participation is examined. Illustrative, hypothetical interactive graphics applications for regional system and corridor-center planning projects from the Los Angeles area are used. A series of challenging implementation problems is given.

•TO GAIN a better understanding of how interactive computer graphics might apply within community participation programs, one should review the objectives and techniques of community participation. It is no coincidence that at least 1 broad approach to community participation emphasizes the need for stronger interaction between transportation planning professionals, such as highway location teams, and the communities through which proposed transportation facilities will pass. This interactive need of 2 groups that often misunderstand and misrepresent each other is quite similar to the interactive need of computer users, especially nontechnical users, and the data and modeling systems that are computer processed. Interactive graphics already has addressed this need, but stronger interaction also is needed here partly to reduce misunderstandings and misrepresentations and to achieve additional objectives. These include reduction in computer processing turn-around time. Real-time person-computer communication also can facilitate better comprehension of graphic-displayed information.

Among 3 sets of objectives for community interaction programs (1, 9) that establish the responsibility of the transportation agency, increase the effectiveness of the transportation facility location team, and generate alternative courses of action that are responsive to the values of the affected community, 4 objectives fall in the last category. The achievement of these could be facilitated by use of interactive graphics as a supporting tool. They consequently serve as objectives for interactive graphic applications in community participation programs. They include

1. Concept forming, which means generating new ideas about relationships between communities and major transportation facilities, particularly for potential impact problems;
2. Problem detecting and anticipating, which means identifying all important existing and potential impact problems for both users and nonusers;
3. Solution finding, which means enlarging the set of alternatives, both transportation and nontransportation, under consideration; and
4. Value exploring, which means attempting to determine the relative importance of impact conflicts and trade-offs, for different interest groups within a community.

Interactive graphics techniques may be used in association with and support of a

Table 1. Importance of interactive graphics to community interaction techniques.

| Community Interaction Technique | Potential Application of Interactive Graphics |
|---|---|
| Field work method | Probably minor |
| Holding and attending meetings | Could be useful |
| Operating a field office | Could be useful |
| Using advisory committees | Significant |
| Mediation | Could be useful |
| Analyzing past and current community plans | Significant |
| Reviewing local election issues | Probably minor |
| Mapping sociopolitical and environmental data | Significant |
| Illustrating final form of an alternative in everyday language | Significant |
| Hiring an advocate for the community | Probably minor |
| Carrying out a demonstration project | Probably minor |
| Employing community residents on project | Could be useful |
| Role playing | Could be useful |
| Sensitivity training and laboratory method | Significant |
| Charette | Significant |

Table 2. Classification of interactive graphics needs and potentials.

| | Range of Output Formats | | Potential Application | |
|---|---|---|---|---|
| Output Category | System Level | Corridor-Center Level | Major | Minor |
| Maps[a] | Zones<br>Networks<br>Grid coordinates<br>Facility symbols | Blocks<br>Routes<br>Grid coordinates<br>Facility symbols | Design and analysis of alternatives | Comparison of alternatives (significant differences) |
| Graphic aids | Bar charts<br>Pie charts<br>Line graphs<br>Frequency distributions<br>Tabular displays<br>Scatter diagrams<br>Perspective drawings<br>3-dimensional surfaces | Bar charts<br>Pie charts<br>Line graphs<br>Frequency distributions<br>Tabular displays<br>Scatter diagrams<br>Perspective drawings<br>3-dimensional surfaces | Comparison of alternatives (detailed and summary) | Redesign or modification of alternatives |

[a]Static or dynamic.

wide range of different community participation or interaction techniques. Generally, their potential value will correspond to the degree to which community (and decision-maker) participants are directly involved in the work of the transportation planner-engineer, particularly work with data, impact analysis, and computerized forecasting models. If a basic interactive need is to give the citizen and decision-maker participants a better understanding of the differences and interrelationships among various trade-offs among alternative plans, then interactive graphics should be used to strengthen, extend, simplify, and generally increase interactive capabilities. In a sense, community participation can be strengthened both by more interaction with planner-engineers themselves and by more interaction with their data and modeling systems.

Table 1 gives a number of possible community participation techniques that have been implemented or proposed recently and a subjective assessment of how interactive graphics would apply (1, 9). This assessment reflects the amount of impact information likely to be processed as well as the importance of the analysis tools of the planner-engineer. Of course, the specific application of any of these participation techniques will involve many more details affecting the applicability of interactive graphics. Therefore, these generalized participation techniques are presented only as background on the types of community participation programs within which interactive graphics might be employed.

The need for improved communication devices in urban transportation planning is serious. It is probably most serious when plans are presented to citizen groups and political decision makers. Plan results, particularly the significant differences among alternative plans, must be clear, unambiguous, and understandable. Communication problems can become quite severe when the number of alternatives is large, a wide range of different impacts is to be considered, or considerable use must be made of the outputs of computerized simulation models.

Computer and interactive graphics can potentially solve these communication problems. This section will briefly review various computer graphic display techniques. Computer-based display devices fall into 2 broad categories, maps and graphic or visual aids. In mapping, there are regional-system levels and corridor-center levels of detailing, and these correspond generally to transportation planning and community participation. Table 2 gives a summary of these basic graphic or communicative needs. The data given in Table 2 also indicate that several basic types of maps can be involved.

The computer mapping technique of spatially distributed data is of general interest in urban transportation planning, because it is quicker and cheaper and produces more maps than traditional drafting techniques can. The flexibility and speed of this technique also can be of great value in community participation or interaction activities, especially when new questions are raised or a desire to examine additional, geographically oriented data arises. Coupled with the low turn-around time offered by computer mapping is an on-line capability of an interactive mapping analysis procedure to sequentially examine a number of different maps or to modify or supplementarily analyze the characteristics of some maps.

The participatory implications and potentials of these computer mapping display techniques are particularly related to the levels of planning at which they might apply. Community participation in urban transportation planning has been weak at the regional-system level, and the recent surge of interest and progress in strengthening community participation has been associated largely with the corridor level of planning and project implementation. At both levels, however, interactive mapping might serve to clarify for the participant the results of planner-engineer analyses. Particularly at the regional level, dynamic mapping of, say, changes in travel volumes or residential densities might be quite helpful. At the corridor level, reduction in geographic scale permits increased detail in interactive mapping to the individual block and street or route level. Interactive mapping potential for participation at this level is particularly high, especially if the participant is allowed to manipulate on line certain route and neighborhood characteristics to examine associated consequences.

A major use for interacting mapping tools is in the design and analysis of transportation alternatives (14). This again applies at both system and corridor or center levels of planning. The ability to quickly generate additional alternatives and quickly examine some of their direct and indirect impacts will be a key feature. Additional system alternatives could be generated, for example, by adding or deleting specific routes or by increasing the capacity or flow characteristics of other routes. At the corridor level, additional alternatives could be generated by modifying route alignments, relative mode capacities, associated land uses, and other characteristics. In both cases, the ability to immediately display the results of comparative analyses of impact is essential.

Another important potential use of interactive mapping of particular significance for community and decision-maker participation activities is the comparison of alternative plans through a mapping of differences only. This could involve identifying only those subareas, point locations, or network links where 1 alternative displays an impact or distribution significantly different from another alternative. Displaying only these differences could allow the participant to quickly focus on the significant trade-offs among alternatives. Several alternatives could be analyzed in sequence and perhaps several different kinds of impacts could be displayed on a single map. This technique could offer a way of simplifying and reducing the quantity of data.

A second general category of graphics needs involves the various nonmap visual aids and display devices that might be devised (Table 2). Such devices could probably be used equally well at either system or corridor-center levels of planning and community participation. Their primary purpose is to simplify and clarify the relationships among different impacts or data items as well as among different alternative plans.

As a general rule, particularly for community and decision-maker participants, graphic aids of this type appear to be especially useful in comparing alternative plans. Devices such as the goal-achievement profile (10) allow a summarized comparison of relative impacts among different alternatives. Achieving this kind of simplicity, of course, sacrifices considerable detail and specific impact information from which the relative scores were derived. Interactive techniques could be used to determine the relative changes in impact that would be necessary to achieve, for example, a different ranking of goal-achievement scores. Such devices also could be used selectively to examine only the major or most significant differences among alternative plans. To some extent, such devices also might apply on an interactive basis in the redesign or modification of alternatives. Here an analysis result or impact might be modified interactively, and the associated plan changes necessary to achieve that impact could be derived. In this kind of redesign, both map and other graphic aids might be used simultaneously on an iterative basis.

## INTERACTIVE GRAPHIC POTENTIALS

Using 1 or more of the community participation techniques and graphic display techniques previously mentioned, one can identify a fairly wide range of instances in which interactive graphics might improve the community and decision-maker participation process in plan making. In fact, many of these areas of potential application correspond to features of the transportation planning process that are generally in need of improvement at the technical-professional level and in terms of community inputs. Each of 6 potential application areas to be discussed, therefore, is relevant for both improving community participation and strengthening the overall planning process. The distinction between system and corridor-center levels of planning continues to be an important way to classify planning-participation improvement needs. The most pressing needs appear to lie at the corridor-center level.

The same general scenario for using interactive graphics in support of community participation programs might apply for each application, but, because of the many ways in which participation techniques evolve in an actual case study, many additional details of the scenario would remain to be delineated. A carefully designed user environment for interactive graphics and other participation activities would be needed. Within this specially equipped room or area, a wide variety of wall-mounted charts, maps, tables, and graphs depicting major problems and the characteristics and differences of alternative solutions might be displayed. A remote computer terminal could be located here to facilitate not only interactive graphic applications but also the full range of conventional computer modeling applications and reports. Staff and community participants in the planning process could be encouraged to make full use of all materials in the room. Demonstrations and orientation sessions for computer applications, including interactive graphics, might be held. Appropriate technical assistance and backup particularly for interactive graphics applications could be provided.

Of the 6 applications to be described the first 3 emphasize interactive mapping and the second 3 emphasize other graphical aids.

### Incremental Development of Alternatives

To improve the performance or impact characteristics of a base case, one should interactively adjust certain features of an alternative. After examining the results of these incremental changes, one might test further changes. In addition to displaying in map form each alternative transportation system or corridor configuration for interactive modification, accompanying analyses of performance and impact outputs would be conducted by the computer and printed out on the display device to guide the next iteration. Changes in route alignment, capacity, number of entry points, frequency of service, and similar characteristics might be examined. The results of each test would be saved for later comparison. The UTRANS methodology, developed at the University of Washington (11, 12, 15), can be applied at a corridor level.

## Pure Development of Alternatives

One of the most attractive features of the interactive graphics is its ability to flexibly, incrementally, and almost immediately revise alternative plans to achieve different kinds of performance or impact improvements. A separate application might be the initial development of the base case. This development of a single alternative could serve as a useful learning experience. It might then proceed to various forms of incremental improvement and analysis interactively, but perhaps on a different set of terms (such as teamwork rather than individual effort). For example, the first phase of the UTRANS program involves the development of the initial base system through a consideration of design and capacity limitations. This application area might be organized around a mapping of demand and environmental constraints, perhaps by using overlays, so that alternate facility and route locations and sizes can be designed interactively by the user.

## Map Comparison of Alternatives

In addition to numerical analysis of the differences among alternative plans, one may also find it useful to examine the spatial distribution of such differences. If emphasis is given only to those differences that exceed some minimum level of significance (such as 20 percent variation), interactive mapping could be used to display only those differences for any pair of alternatives. Examples could include differences in accessibility provided, relative network loading, and residential displacements. Again, in this and other potential applications, relevance to community participation lies in strengthening communication and comprehension. In all instances, the technical aspects of user interaction, for both inputs to be made and outputs to be comprehended, must achieve greater clarity and simplicity for community and decision-maker participants than for the staff and professional participants.

## Graphical Comparison of Alternatives

Devices such as goal-achievement profiles, bar charts, pie charts, frequency distributions, and similar graphical devices might be used to indicate the differences among alternative plans (10). Emphasis would be placed on evaluation of alternatives rather than on their further refinement. Comparison tables or charts might be used to compare regional and community level impacts and possibly to calculate summary scores or cost-effectiveness ratios (16). A selective display of only the most significant differences among alternatives might be emphasized. Interactive and participative aspects could be strengthened by permitting a wide range of impacts and community versus regional differences to be quickly and efficiently displayed or recombined in sequence or both. Intermediate calling of maps for further examination also might be desirable.

## Classification of Regional and Community Goals

Classification of regional and community goals might take the form of comparative assessment of the impacts projected for different plans at regional and community levels. Although emphasis might be given to various graphical summary devices, supplementary use of computer-generated maps might also be made. The thrust would be toward a rethinking of transportation and transportation-related goals and objectives in light of the additional insights provided by specific impact forecasts, especially at the localized level. Experience has shown that the weights assigned to goals in abstract situations are likely to differ significantly from the weights assigned in actual conflict situations, which are frequently encountered at the transportation corridor planning level. The speed and flexibility of interactive graphics might be useful here to assist in such goal-weighting exercises as the Delphi technique (17).

### Sensitivity Analysis of Plan Evaluations

When the evaluation of alternative system or corridor plans is well advanced, a need may arise to acknowledge the uncertainty associated with many elements of the evaluation. Three kinds of uncertainty that exist are forecasted impacts, forecasted costs, and goal weights. An interactive sensitivity analysis technique could be applied to explore these uncertainties and to test a wide variety of user-selected changes in impact forecasts, goal weights, and cost forecasts. The purpose would be to test the degree of confidence that might be attached to the preferred alternative and to identify those conditions under which other alternatives might be preferred. Such a technique has been partially developed but has not yet been linked to computerized visual display devices where either graphical or map outputs might be used (19).

## RELEVANCE TO PLANNING AND PARTICIPATION

Among the many different issues and needs in urban transportation planning, at least 5 can be identified that have important implications for community and decision-maker participation. These 5 issues appear to be important at both regional and local levels, particularly at the local, corridor-center level of planning. Current trends in community participation seem to be emphasizing these more localized regimes for expanded community-planner interaction. Because each of these issues essentially involves an increase in the complexity, level of detail, and thoroughness of both planning and planning-related participation processes, there appears to be strong relevance for the application of an analytic tool that will streamline and intensify the process of information exchange. Interactive computer graphics appears to have this potential.

In addition to these substantive issues, however, a larger, overriding issue involves the stronger integration of community participation techniques in the ongoing urban transportation planning process. Before an interactive graphic component within community participation programs can be valuable, there must be a sustained commitment to the community participation process itself. All too often, particularly at the system planning level, community participation is sporadic, formalized, and relatively ineffectual. At least 3 steps of the planning process—goal identification, alternative development, and alternative evaluation—appear to need strengthened participation not only on a continuing system planning basis but also in terms of corridor-by-corridor and center-by-center planning. Until the system and locally oriented levels of participation are adequately strengthened, considering a role for interactive graphics will be largely academic.

Significant, participation-related transportation planning issues include

1. Number of alternatives, including incremental variations, that are considered;
2. Extent to which various staging options for implementing (and possibly mixing) alternatives are considered;
3. Range of localized impacts, both direct and indirect, that are considered;
4. Extent to which trade-offs within and between regional and localized goals are analyzed; and
5. Extent to which coordination with localized plans (especially nontransportation plans) is pursued.

Expanded community and decision-maker participation can help deal with each of these issues. They apply at both system and corridor-center levels of planning.

To help illustrate how such issues become embodied in specific plans and planning controversies, a series of examples from the Los Angeles region will be described briefly. Three examples involve system-level planning, and 3 involve corridor-center-level planning. In each case, significant opportunities appear to exist for strengthening community participation. In some examples, extensive revisions to propose plans have been made as a result of citizen reactions. However, these are not examples of the use of interactive graphics in strengthening community participation activities. Several of the transit-related examples, because of the expanded levels of community participation that are called for, will offer significant potentials in the next few years.

## System-Level Examples

### Rapid Transit Plan

Between August 1, 1973, and May 1, 1974, a consultant team undertook phase 3 of a major rapid transit planning effort for the Southern California Rapid Transit District (SCRTD) (18). This phase dealt with the refinement of a rapid transit plan reported in July 1973 and involved the most sustained level of community input of any of the 3 phases. During August, September, and October 1973, presentations were made at 18 formal community meetings in addition to other working sessions, presentations, and meetings that were held at each of the 78 municipalities in the district. County, state, and federal officials also were met with. The primary thrust of this participation effort was aimed at response and reaction to an already prepared plan. Many questions and suggestions regarding route, network, and station configurations were raised.

More than 900 specific responses from citizens and public officials were cataloged. They fell into 5 categories: stations, alignments, hardware, and technology; service and safety; funding, financial, and costs and benefits; environment; and political and public participation. A significant number of responses suggested additional and relocated rapid transit lines and stations. More than 100 responses asked how individual communities can be more strongly involved in plan refinement. The diversity of these responses and the clear indication of the need to define and analyze additional alternatives suggest that a major contribution might have been made by interactive graphics procedures, particularly to efficiently test proposed system modifications for performance and environmental impacts. The large number of suggested refinements was further evaluated eventually by the consultant team along 4 dimensions: capital costs and engineering issues, system usage potential, physical impact, and social impacts and planning policies. A substantial use of judgment appears to have been made in these assessments, and a considerable opportunity for more direct, immediate community participation in these plan refinement activities appears evident.

### Policy Analysis of Guideway Transit Systems

The SCRTD transit plan emphasizes a single, high-capacity, conventional rail technology alternative. The Southern California Association of Governments (SCAG) has inaugurated further studies of a wider range of technology options (3). These include bus rapid transit, small-group rapid transit, and personal rapid transit. Significantly different hypothetical guideway networks were layed out for initial sketch planning by case study sector. Widely varying travel performance and environmental impact characteristics were indicated preliminarily. Major emphasis was given to the need to consider both evolutionary and geographic staging options for the various technologies and their components. Any continuing refinement of these guideway transit options also should include opportunities for significant community and decision-maker input. Because, as an extension of work on the SCRTD rapid transit plan, careful evaluation of many kinds of service and impact trade-offs will continue to be necessary, a potential for using interactive graphics to define and evaluate a fairly wide range of alternatives appears to be good.

### Regional Aviation System Plan

During June 1973, a specially appointed citizen hearing board completed a 1-year comprehensive review of a Southern California regional aviation systems study previously conducted for SCAG (4). A series of 10 public hearings at various locations throughout the region were held by this citizen board. The board itself held 14 working sessions to evaluate testimony as well as to consider further details and information compiled in several different impact areas. Again this form of community participation represents essentially a reaction to, rather than an ongoing involvement in, the preparation of a system-level transportation plan. Several serious deficiencies in the initial plan, from the local community's point of view, were advanced. The citizen board consequently presented to SCAG its own recommendations regarding the regional airport system.

The citizen board determined that several aspects of the initial plan (airspace conflicts, noise levels, and air quality) were insufficiently handled. Concern for these indirect effects as well as reduced projections of air travel demand led to suggested reductions in the size and number of airports listed in the initial plan. Because of the complexity of various demand and impact characteristics and criteria applied to 17 existing and proposed regional airport sites, efficient, easily understood analysis tools and communication devices were needed during community participation. This also was an opportunity for effective employment of interactive graphics. For example, such techniques could have been used to explore the implications of various site-related criteria for noise levels (including examination of noise contours), air pollutant emissions, and land use types and densities in the vicinity of airports as well as the implications of different ground access connections, runway and terminal capacities, and overall airspace capacities.

## Corridor-Center-Level Examples

### Wilshire Corridor

First priority staging in the rapid transit planning activities of SCRTD has been given to the 16-mile (26-km) Wilshire corridor, which extends west from the Los Angeles central business district (CBD). Several major activity centers lie along this corridor, together with some of the higher residential and employment densities in the region. Recent local-level controversy regarding the proposed mass rapid transit, conventional-rail, subway line within the corridor suggests that considerable further analysis and planning of multimodal transportation options within the corridor will be necessary (7). A full examination of other transit options, including low-capital-intensive measures, bus rapid transit, personal rapid transit, vehicular control measures, and improved conventional bus service, appears appropriate for levels of travel service and impacts on adjacent land uses. If major corridor-level transportation studies are forthcoming for the Wilshire corridor, significant opportunities appear to exist for using interactive graphics to sharpen and strengthen the number and diversity of multimodal transportation options in association with their land use relationships in the corridor. Resolution of transportation issues in this corridor is likely to influence strongly the direction of rapid transit in other portions of the region.

### Los Angeles Central Business District People-Mover Network

Detailed planning for a 1.7-mile (2.7-km) automated people-mover distributor, integrated within the downtown Bunker Hill urban renewal project that links two 4,000-space parking garages, also has been accompanied by preliminary planning for a larger transit distributor network serving the entire downtown area (8). As many as 10 different peripheral parking facilities could be linked by up to 19 miles (31 km) of elevated people-mover guideways. Community involvement in this preliminary planning has not been significant to date, but it is probable that any more detailed work on a CBD distributor transit system will require extensive input from downtown business people and landowners and downtown commuters and shoppers who would provide the bulk of system patronage. Inputs also should be sought from peripheral residents, who would also be significantly affected. Interactive graphics could again provide a potential for more carefully examining 2 broad kinds of trade-offs: local (aesthetics, integration with downtown buildings, station locations, coordination with other modes, street traffic congestion, air quality levels, noise, and station sizing) and those dealing with linkages to other parts of the region (coordination with rapid transit systems, coordination with freeway access points, peripheral parking facilities location, and relation to direction of approach to the CBD). A wide range of locational and technological alternatives already appear worthy of consideration, and community response to such alternatives is an important feature of their evaluation.

## Norwalk-El Segundo Freeway Corridor

The Interstate 105 (Century Freeway) corridor straddles a 17-mile (27-km), 10-lane, east-west freeway connecting Los Angeles International Airport with 9 communities and 4 north-south freeways to the east. One of 12 alternative route alignments was adopted in November 1965 and July 1968. In 1969 and 1970, a series of public hearings were held regarding detailed design of the adopted route alignment within the traversed communities. Two cities, Downey and Hawthorne, opposed the final route location from the beginning, and they offer an example of the difficulties in achieving consensus on both alignment and design. An interdisciplinary consultant team conducted detailed design studies for the freeway. They considered such indirect impacts and opportunities as economic and fiscal structure, housing displacement and replacement, community facilities, local circulation, neighborhood environmental values, and joint use development (5).

Community participation in the design of the freeway ranged widely, varying from official refusal to accept the route itself to extensive community communication and involvement programs, and many formal and informal contacts in the Watts-Willowbrook area. For those communities where some degree of participation was achieved, it was found useful to distinguish 5 different categories of community interest groups. These categories show the orientation that application of interactive graphics might have taken. In general, the detailed level of analysis and the range of social, economic, and environmental impacts considered suggest that communication of the differences among alternative freeway designs could have been facilitated by interactive graphic means. The 5 different interest groups together with the kinds of impacts that were analyzed are as follows:

1. Owners and occupants of property displaced by freeway (impact on property values, extent of displacement, and types of families and businesses displaced);
2. Owners and occupants of properties left adjacent to freeway (impact of noise, air, and dust pollution; impact on property values; changes in neighborhood boundary; and barrier effects);
3. Neighborhood or area adjacent to freeway (barrier effects on access to schools and other community facilities, changes in local vehicular and pedestrian circulation patterns, and development of freeway-related land uses);
4. School districts (impact of noise, air, and dust pollution; change in school attendance boundaries and pupil loads; and reduction of tax revenue); and
5. City and county, including special districts and special interest groups (changes in economic tax base, local traffic reorientation and freeway access, and pressure for accelerated land use change.)

## IMPLEMENTATION PROBLEMS

While the potential of interactive graphics to sharpen the participatory process in urban transportation planning appears strong, there have been few, if any, real accomplishments to date. Problems of implementation appear to be major, but these are concerned less with the technology of interactive graphics and more with the nature of the planning process itself. The most serious implementation problems relate to these broader planning process questions. Several problems relating to the technical aspects of computerized modeling and interactive graphics, though significant for any potential user, are particularly demanding for the nontechnical user associated with community and decision-maker participation. In some instances, the problems of implementation of interactive graphics in community participation appear formidable but not insurmountable.

1. Community participation process itself must be strong.
2. Interactive graphics must be built into the existing planning and participation process.
3. Interactive graphics must be "sold" to public agency staffs.
4. The suspicions of community residents and political decision makers concerning computerized analysis procedures need to be overcome.
5. Careful attention must be given to the data absorption capacity and attention span of participants.
6. Results must be understandable to nontechnical participants.
7. Maximum advantage must be taken of the limited time available to participants.
8. Related computerized forecasting procedures must be sensitive to a wide range of policies.
9. Quicker, less costly demand simulation models need to be developed.
10. Regional and local planning agencies cannot be expected to bear the software development costs associated with interactive graphics applications.

The community participation process itself must be strong. Interactive graphics can be viewed only as a supplementary tool for strengthening the broader process of interaction of community groups, decision makers, and the planner-engineer. Because community participation at the system planning level has characteristically been weak, the most promising area for using interactive graphics appears to be in those corridor planning activities built around well-organized, sustained, community participation efforts.

Interactive graphics must be built into the existing planning-participation process. Technical specialists in interactive graphics must work closely with planning agency staff members and other potential users and must fit interactive graphics to ongoing community participation activities rather than the reverse. For interactive graphics to gain real acceptance and use, a practical, incremental, small-start approach is probably necessary.

Interactive graphics must be "sold" to public agency staffs. For ongoing applications within overall community participation programs, public agency planner-engineers must provide leadership and guidance. Their own interest in these techniques and their capabilities for applying them themselves must be high. If their commitment to computerized analyses and plan evaluations is low, their interest in this form of interactive graphics will also be low.

The suspicions of community residents and political decision makers about computerized analysis procedures need to be overcome. The frequent confusion and fear associated with computer modeling in general will most likely carry over into interactive graphics procedures. The confidence of nontechnical participants in the reliability, usefulness, and workability of person-machine interaction must be firmly established. This means confidence in the use of computers in the first place. The key role of the participant's own judgment in the process must be clearly shown.

Careful attention must be given to the data absorption capacity and attention span of participants. This is an important problem area in interactive graphics when a trade-off has to be made between simplicity of operation and flexibility to perform many kinds of analysis (6). For the nontechnical person to participate, even more simplicity, including straightforward and step-by-step capabilities, is required. If the nontechnical participant is overwhelmed by maps, charts, data, and procedures, he or she will quickly lose interest.

Results must be understandable to nontechnical participants. As a general rule, maps must not be overly complex and detailed, charts and tables must not have too many different dimensions, and data and impact displays must be explicit enough to illustrate effectively the basic trade-offs. A major purpose of interactive graphics in community participation is to make the results of analysis more immediately informative and useful.

Maximum advantages must be taken of the limited time availability of participants. Effective use must be made of the short turn-around time advantages of interactive graphics. In addition, however, advance technical preparations must be carried out smoothly, so that, during actual interactive operations, the process moves quickly and smoothly for all participants. Transition from interactive graphics activities to other dimensions of the community participation program also must be smooth.

Related computerized forecasting procedures must be sensitive to a wide range of policy issues. Although they are not directly a part of interactive graphics capabilities, the supporting analysis and forecasting models that must be used to project the impacts of various alternatives must be improved. These modeling needs are now receiving considerable attention in the transportation planning community (2). Their link-up with more sensitive interactive graphics analysis procedures is significant. In general, a series of forecasting models is likely to be necessary to permit effective trade-off analyses among conflicting issues and goals.

Quicker, less costly demand simulation models are needed. For interactive graphic systems that are supported by travel demand forecasting models (particularly trip distribution, modal split, and traffic assignment models), past experience has shown that a large computer core is required. Combined with the computer storage requirements of interactive graphics systems, the processing time and cost characteristics associated with interactive graphics applications using such models can be excessive. This indicates need for more "sketch planning" models in travel demand forecasting (2).

Regional and local planning agencies cannot be expected to bear the software development costs associated with interactive graphics applications. Because the use of interactive graphics in community participation activities and in transportation planning is still in its early stages, and because, at the local level, applications are likely to be unique and nonrepetitive, the relatively high case-specific development costs of interactive graphic systems will be prohibitive at the local level (6). There appears to be considerable merit in the concept of developing a series of modular interactive packages that can be used by the transportation planning community as a whole (13). U.S. Department of Transportation sponsorship of interactive graphics demonstration projects, perhaps for transit planning applications at the corridor level, appears to be appropriate.

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