Intermodal Surface Transportation Efficiency Act and Interactive Transportation Planning and Decision Support: A New Conceptual Model

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The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) changes the conceptual model for transportation planning and decision making by redefining the set of central problems and acceptable solutions that transportation planners must address and by giving the reshaped planning process a system of information feedback loops. This new conceptual model is called Interactive Transportation Planning and Decision Support (ITPDS). It is characteristically flattened, cross-functional, data-rich, messy, and customer oriented. The implementation of ITPDS would be significantly enhanced by placing stakeholders in a collaborative meeting environment supported by an interactive and accessible geographic information system relationally linked with a variety of data bases, models, and multimedia representations. Although a computer-based ITPDS system is not now in use, it is thoroughly feasible. Such a system would support ISTEA's new data and analysis requirements and improve organizational cooperation and productivity through data sharing, visualization, and consensus building. A computer-based ITPDS would also provide a tool that could graphically link long-range plans with transportation improvement programs.

Thirty years ago, in a seminal essay entitled *The Structure of Scientific Revolutions,* Thomas Kuhn described the history of science as a series of paradigm changes (*1*). According to Kuhn, a paradigm is the universal, generally accepted set of central problems and solutions used by a community of practitioners to define what they do. Redefinition of a paradigm occurs after a period of what Kuhn called "abnormal science," during which time practitioners become increasingly uncomfortable about the lack of fit between their expectations (which are generated by the normal model) and their observations (which result from practice and experiment). The crisis builds until a new paradigm emerges, reestablishing fit not so much by negating the previous set of problems and solutions as by incorporating them into a more comprehensive model that deals better with current interests and reflects better current observations of the environment.

Such a change is occurring right now in transportation planning, and a number of important features of this emergent model are reflected in provisions of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and its implementing rules, particularly 23 CFR 450 Subparts A–C concerning statewide and metropolitan planning. Over the course of the last 2 years it has become clear to many across the country that ISTEA really does establish a redefinition of the central problems for transportation professionals by placing new emphasis on connectivity, choice, air quality, and cost efficiency. ISTEA also confirms a new set of acceptable solutions for the set of transportation problems by giving priority, for example, to system management over construction of new capacity and by shifting attention to manipulating travel demand rather than increasing travel supply. To implement these changes in focus, the language of both the act and its implementing regulations aims at promoting changes in the planning and programming process, changes that will, it is assumed, produce a more integrated and fiscally efficient transportation system.

There is much in this post-ISTEA planning process that will look very familiar to planners; however, planners should not be fooled by familiarity. They need to pay attention to the effects of the new mandates on the traditional model. Thus, for example, it is important to consider the implications of moving planning elements and activities to different areas of the process, of creating new planning and system performance linkages, and of infusing new information and analysis requirements into the planning process. It is also important to think about the implications of requiring more public participation and of vigorously shuffling the roles and responsibilities of traditional players—metropolitan planning organizations (MPOs), state departments of transportation (DOTs), and transit agencies—while adding new ones—for example, air pollution control boards and private freight shippers. The result of the changes, we argue, is a new conceptual model for what transportation planning is and how it happens.

Although the outlines of this new model are not as explicit in the regulation as many would like them to be, a careful reading of the planning rule and its preamble discussion reveal five major themes, from which we have constructed the principal features of the model that we call Interactive Transportation Planning and Decision Support (ITPDS). Briefly, after ISTEA the planning process will be flatter, cross-functional, data-rich, messy, and more customer oriented. As we hope to make clear in this paper, ITPDS represents a practical vision of how the new planning requirements can be made to work in the real world. For the purposes of this paper, we focus on metropolitan-level planning; however, the principles of ITPDS can be applied as well to both statewide and corridor-level plans.

We also suggest that, although not absolutely necessary, ITPDS virtually begs for implementation in a collaborative, computer-supported environment. Shiffer (*2*), for example, describes a prototype of such an environment for urban design that combines a simple geographic information system (GIS) with multimedia representations. An environment designed to support development of an MPO's long-range plan and transportation improvement pro-

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gram (TIP) would require considerable resources, including a collection of both spatial and nonspatial information and an assemblage of technical tools, particularly in view of the 15 planning elements listed in 450.316 and the air emissions analysis needed for compliance with the Clean Air Act Amendments of 1990. The vision, however, of stakeholders sitting together in a meeting room interacting collectively with a GIS that is relationally linked to a variety of robust data bases, what-if models, and multimedia representations creates the exciting possibility of transforming the transportation decision-making activity through data sharing, visualization, cooperative planning and design, and consensus building.

The technology is certainly within our grasp. And our experience during TRB panels and National Transit Institute curriculum development committees, in which we have participated in fairly simple collaborative word processing in a physical meeting room, as well as descriptions of computer-supported meeting environments such as those at Xerox's Palo Alto Research Center Colab (*3*) or the University of Arizona's College of Business and Public Administration (*4*), suggest the capability of the computer to enhance the kind of collaborative decision-making process now mandated by ISTEA.

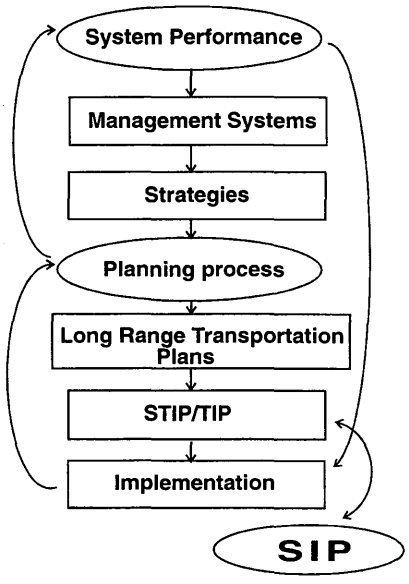

FIGURE 1 Pre-ISTEA project planning model.

BACKGROUND

As many have pointed out, ISTEA redefines familiar transportation concepts and requirements such as the comprehensive, continuing, and cooperative process, the federal-aid highway classification system, TIPs, public participation, and transportation system management. It also abandons others, for example, separate areawide highway location studies and transit project alternatives analysis as well as the distinction between federal-aid primary and secondary highways. ISTEA also establishes some new requirements such as congestion management systems, conformity, state long-range transportation plans, the national highway system, and 15 metropolitan and 23 statewide planning factors for consideration. It even changes the name of one of the U.S. Department of Transportation's (U.S. DOT's) modal administrations from the Urban Mass Transportation Administration (UMTA) to FTA. ISTEA is not, however, just a tinkering with names and definitions. Taken as a whole this legislation and its implementing rules embody a fundamental conceptual shift regarding the nature of the transportation problem and thus the kinds of solution that are acceptable and the manner in which the planning and programming of these solutions should occur.

In research presented at the 1977 Annual Meeting of TRB Manheim described the emergence of a model for urban transportation planning that had been institutionalized through a series of planning guidelines from FHWA and UMTA in the mid-1970s (*5*, p.324–353) (Figure 1). Programming, he argued, had replaced long-range planning as the primary concern of transportation planners. He defined programming as the mid- to short-range project selection process whose goal is development of a realistic list of resource-constrained construction activities. And, indeed, programming—which involves project proposal, analysis and evaluation of design alternatives, selection, preliminary engineering, and construction—has been the central occupation of transportation planners for more or less the last 25 years. Moreover, few would dispute that the normal solutions implemented during this period have been building, expanding, or otherwise improving highways to increase roadway capacity for cars and trucks, the dominant form of transportation in the United States. Meanwhile, transit's primary problem has been viewed, with few exceptions, as providing mobility for the transportation disadvantaged (that is, the poor, the old, and the carless) and maintaining traditional fixed-route systems to carry those on work trips into the old urban core (*6*). Pedestrian and bicycle movements have generally been considered neither a transportation problem nor a transportation solution; rather, they have been almost universally relegated to the domains of recreation and urban design.

In a sense, however, even as Manheim described his programmatic model, he set the stage for the swing back toward planning that is reflected in ISTEA. As Manheim warned almost a quarter century ago, programming is not planning. The regulations, he wrote, did "not [make] clear to what extent the TIP must be consistent with the Long Range Plan. . . . Nothing . . . in the new FHWA-UMTA regulations requires consideration of a range of alternatives, identification of social, economic, and environmental effects, or timely public involvement, in developing the TIP and its annual element or the TSME [transportation systems management element]." Moreover, since only major transit projects using federal funds had to undergo alternatives analysis, Manheim suspected that, over time, programming would produce "assemblages of projects proposed by lower-level jurisdictions . . . transit agencies and state highway agencies" unrelated to larger goals (*5*, p.344–346).

When in the early 1980s Meyer and Miller described the decision-making process commonly used for programming transportation projects, they too noted the abandonment of normative social goals and the dominance of individual or regional political goals as motivators for what got built (*7*, p.77–92). We have found this observation well supported by our own conversations with various federal staff, transportation planners, and transit managers. According to the general wisdom, until ISTEA state DOTs made most of the important decisions about highways, whereas transit operators selected at least three-quarters of the transit projects in the United States. Rarely was there much coordination across modes. Generally the process would begin when a DOT or operator sought funding in Washington, D.C. If the response was positive a highway location study or a transit alternatives analysis was performed along with a draft environmental impact statement (EIS); if all went

well the desired final version of the project was selected, funded, engineered, and built, all following guidelines from one of the modal administration's grants management staff. Congressional earmarking could speed the process along; citizen participation or legal action under the National Environmental Policy Act (NEPA) could slow or stop it. The legal requirement that the project be included on a metropolitan TIP was hardly noticed. Since TIPs were easily amended and not financially constrained, they functioned more like wish lists than serious capital programs (*8*). Throughout the process the essential relation was that between the grant recipient, who both planned and executed the project, and the federal government (U.S. DOT or Congress), which controlled the funding.

The programmatic model got things done and yielded many projects that were beneficial to local regions, including the extraordinary Interstate highway system. It is fair to say, however, that the programming model tended to be quite conservative, giving highest priority to proven solutions such as highways and fixed-route transit even as awareness of the economic costs and other negative impacts of these solutions grew. Suffice it to say, the failure of the programmatic model to respond to a changing social and political environment became increasingly evident to a range of observers, particularly as various transportation-related concerns emerged as matters of significant public debate. Among these concerns were the continued failure of most metropolitan regions to meet Clean Air Act goals for ozone and carbon monoxide along with an accumulation of research showing vehicles to be a major cause of the problem (*9*); increasingly congested roads despite road building (*10*); the growth of the NIMBY (not in my backyard) syndrome, which made it difficult to site both large- and small-scale transportation projects (*11,12,* p.171–256); the realization that transit had generally failed to follow the move of population and activity to Edge City (*13,14*); the development of an argument that the lack of infrastructure investment had contributed to America's loss of competitiveness in a global marketplace (*15*); and the decline in real dollars of spending on transportation (*16,17*). The passage of ISTEA should be viewed as an effort to fit a new set of solutions to this new set of transportation problems.

To some extent ISTEA accomplishes this by returning to the broad planning concerns of the 1960s and 1970s. Certainly the intent of this act goes well beyond the relatively narrow programmatic problems of increasing system capacity or improving mobility for disadvantaged groups. The transportation problem now explicitly includes energy efficiency, air pollution, economic development, and global competitiveness as well as connectivity and choice (*18*).

ISTEA, however, also reflects much that is new since the 1960s. Indeed, one can argue, for example, that underlying a large part of ISTEA's approach to transportation problem solving are the principles of quality management, as set forth by Demming, Juran, Crosby, and others. These principles have brought a major paradigm change to business management and are threatening to do the same to public administration. For example, this way of thinking reverses the traditional process of " produce it, price it, promote it." Instead, customers' needs, desires, and expectations are elicited first and are then used to shape the design of products and services that meet customer criteria. Such products promote themselves. Second, when a service or product regularly deviates from some level of acceptable customer-defined quality, attention is given to the process of production rather than to worker performance; indeed, workers, those who use and understand the system, are viewed as the source of the solution rather than the source of the problem and are asked to help fix the process.

ISTEA begins with the premise that the transportation product is not performing acceptably—too little connectivity, too much congestion, too much air pollution. Then, to a large extent, ISTEA seeks process solutions and draws on the expertise of system users to help find them. For example, the concept of flexible funding, the delegation of power over real money to MPOs, fiscal constraints on TIPs, and conformity can all be viewed as process changes. In addition, to continue the analogy with the quality management model, under ISTEA, customers—both internal customers (that is, the workers or public employees) and external customers (that is, the system users, whether they are freight shippers or commuters)—are asked to help shape both the public involvement process and, through this process, transportation products that meet their needs and expectations.

These are just some of the ways ISTEA expands and redefines the business of transportation planning and programming. But process change alone does not completely explain the new model. The glue that ties the whole thing together, integrating the technical and planning activities, is information. The 15 factors for metropolitan planning and the 23 factors for statewide planning represent data that must be collected, analyzed, and fed into process and products. The monitoring and management systems are actually information systems related to asset management and system performance. They function as both inputs and outputs of the overall planning and programming process. Moreover, this information must be shared among all of the cooperating partners, including the public, in the reengineered transportation system.

FEATURES OF ITPDS

The key to understanding the ITPDS model is to see it as a cooperative and inclusive planning process combined with linked planning products [the long-range plans, major investment studies, the state transportation improvement program (STIP) and TIP, not to mention the state implementation plan (SIP)] and embedded in an information system (Figure 2). The outlines of this model are visible throughout both the new planning regulation and its preamble discussion. For example, the framers distinctly tie together process, products, and information in their clarification of how the management systems relate to planning.

> The planning process provides a mechanism for linking the existing human, natural and built environment with future development patterns. . . . While the most recognized products of the process are the transportation plan and TIP . . . the continuing generation and analysis of information [for the management systems] through the planning process is also a vital product. The planning process as envisioned in ISTEA is a dynamic activity which effectively integrates current operational and preservation considerations with longer term mobility, environmental and development concerns. (*19*, p.58041)

Another example is found in the discussion of programming: "Programming is no longer just assembling a list of projects that may be able to proceed; it is now a process for comprehensively managing project advancement in relation to other transportation and transportation related activities that impact transportation system performance" (*19*, p.58048).

In other words the new conceptual model begins with the linear clarity of programming's traditional problem-seeking/problem-solving process and then enhances it by creating information loops that link system performance back to goals and strategies, tying to-

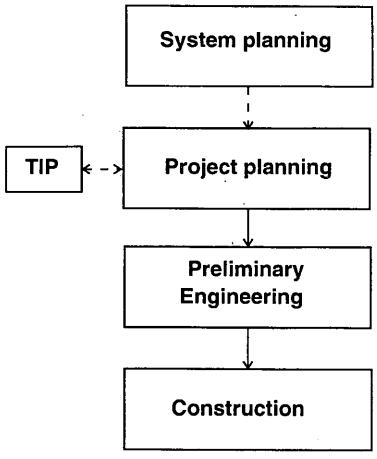

FIGURE 2 Simplified version of post-ISTEA project planning model.

gether not only the various modes of transportation but also the process and its typical outputs—plans, programs, and management systems—at different scales and on different levels. Compared with what has gone before, ITPDS is decidedly flattened, cross-functional, data-rich, messy, and customer oriented. Application of the model provides a tool for addressing the legislative mandate to create a more inclusive, better coordinated, more responsible process that will produce a more efficient, better coordinated, more responsible transportation system.

Flattened

A major aspect of the new model is the flattening of power relationships among major players. Although 450.312(c) gives MPOs the lead in coordinating the various planning and programming activities, 450.312(a) explicitly states that the MPO, the state, and public transit agencies will "cooperatively determine their mutual responsibilities" with regard to who performs major investment studies and how the transportation plan, the TIP, and the work plan are developed. Thus, other than placing the MPO at the center of what can be viewed as a kind of project team, the regulation remains open with regard to who should do what. A similar disbursal of responsibility occurs with regard to the development of the management systems. Although generally states are given the lead here, 450.320 flattens a strictly top-down approach by mandating cooperation:

> As required by the provisions of the management system regulations 23 CFR part 500, within all metropolitan planning areas, the congestion management, public transportation, and intermodal management systems, to the extent appropriate, shall be part of the metropolitan transportation planning process.

Indeed, in responding to an objection about the vagueness of role definition in the notice of proposed rule-making (NPRM), the federal policy staff refused to set firm criteria, explaining that planning responsibilities must be shared, that cooperation means "working together," and that the sorting of roles and duties "should be driven by local decisions regarding best mechanisms for achieving coordination" (*19,* p.58052).

In addition, it is important to note that the cooperative approach, when it is applied to planning major transportation investments, tends to flatten even the relationship between the implementing agency and the federal funding agency. According to 450.318(b),

> when any of the implementing agencies or the MPO wishes to initiate a major investment study, a meeting will be convened to determine the extent of the analyses and agency roles in a cooperative process which involves the MPO, the State department of transportation, public transit operators, environmental resource and permit agencies, local officials, the FHWA and the FTA, and where appropriate community development agencies, major governmental housing bodies, and such other related agencies as may be impacted by the proposed scope of analysis.

The rhetoric of the regulatory language suggests an equality among participants that supports the regulation's explicit assignment of responsibility to the group as a whole for the decision regarding what agency will perform the corridor/subarea study and which major alternatives should be evaluated. Since the study must be multimodal, even as it fulfills a number of formerly modal-specific requirements, such as FTA's alternatives analysis under Section 3 of the Federal Transit Act, and since it may not be performed by the agency that will ultimately implement the outcome, there is a significant weakening of the relationship that often predetermined the modal outcome of previous major investment studies. What this means is that FHWA and FTA have, albeit tentatively, relinquished some control over the federal purse strings in recognition, as the proposed rule-making states, of "the increased responsibility of States and local decision makers in evaluating alternative investments and their financial responsibility for the Federal resources provided" (*20,* p.12069). Or, in other words, ISTEA has continued a general flattening of the relationship between the federal and local levels.

Certainly there is a good possibility that the new model will fail if the stronger players are allowed to overwhelm the weaker ones. There is also the possibility that the adoption of the flattened project team approach, well known in the private sector, will actually increase rather than decrease accountability for all players since there is no longer a fixed set of organizational rules behind which players can hide (*21,* p.166). Nevertheless, although there may not be specific rules and definitions for how the flattened process will work, the federal policy makers assert that they will be watching to ensure that no agency dominates unreasonably: "Evaluation of the level of cooperation will be a major factor in FHWA/FTA's planning finding made in conjunction with STIP approval and certification of the planning process in TMAs" (*20,* p.58045).

Cross-Functional

The cross-functional feature of the model is related to flattened, but it refers primarily to the composition of the planning team. In a sense it is the model's equivalent to intermodal. Very simply, it means that the new process must bring together a working group having a range of perspectives and interests. Planning teams will no longer be limited to those with a single perspective but must also include "other providers of transportation, e.g., sponsors of regional airports, maritime port operators, rail freight operators, etc." [450.312(a)], as well as planners, operators, permitters, environmental resource staff, federal highway and transit administration staff, local officials, housing experts, private providers, and interested citizens. Even the planning products will be more cross-

functional. For example, the corridor/subarea study for major investments serves a varied set of legislative goals—alternatives analysis, input to the environmental statement, financial analysis—even as it considers a "range of alternative modes and technologies (including intelligent vehicle and highway systems), general alignment, number of lanes, the degree of demand management, and operating characteristics" [450.318(b)].

Data-Rich

Transportation planning has always been based on the technical analysis of data. Under ISTEA this basis is substantially broadened and deepened. Section 450.316(a) requires "explicit consideration" of 15 elements, which are to be "analyzed as appropriate, and reflected in the planning process products." Some of these elements are relatively new to transportation planners, for example,

> the likely effect of transportation policy decisions on land use and development and the consistency of transportation plans and programs with the provisions of all applicable short- and long-term land use and development plans (the analysis should include projections of . . . economic, demographic, environmental protection, growth management, and land use activities . . . and projections of potential transportation demands based on the interrelated level of activity in these areas) [450.316(a)(4)]; the effects of all transportation projects [as determined through an analysis of] the effectiveness, cost effectiveness, and financing of alternative investments in meeting transportation demand and supporting the overall efficiency and effectiveness of transportation system performance and related impacts on community/central city goals regarding social and economic development, housing, and employment [450.316(a)(6)]; [and] an analysis of goods and services movement problem areas, as determined in cooperation with appropriate private sector involvement . . . addressing interconnected transportation access and service needs of intermodal facilities). [450.316(a)(7)]

In addition, to meet the mandate, plans shall "consider" (a word that implies collect and analyze data) energy use; roadway connections; abandoned rights-of-way; life-cycle costs for bridges, tunnels, and transit operations; and transportation-related air emissions. This general list of planning elements is further elaborated in the discussion of the transportation plan at 450.322, which adds requirements for information on congestion management strategies from ride-sharing to pedestrian facilities and pricing; bicycle facilities; rehabilitation and maintenance of the existing system; multimodal corridors; the extent to which the metropolitan plan meets national and state goals for housing, economic development, and environmental protection; financial capacity; and public participation. In a comparison of ISTEA and the previous metropolitan planning provisions prepared by FTA planning staff, this list represents a sizeable increase in requirements for data and analysis; previous rules had simply required consideration of "appropriate" information without specifying areas (*22*).

Finally, just to enforce the mandate, the discussion at 450.322 states that the plan must be more than a mere list of policy statements and that it must be updated every 3 to 5 years "to confirm its validity and its consistency with current and forecasted transportation and land use conditions and trends." The plan must be a strategic plan including "both long-range and short-range strategies/actions that lead to the development of an integrated . . . intermodal system" and shall "include design concept and scope descriptions . . . in sufficient detail . . . to permit conformity determinations." Thus, it is clear that to carry out the new mandate a great deal of current data as well as valid analytical tools will need to be made available to the planning team in forms that allow comprehensive and concrete integration and cross-analysis of information. Or, in other words, transportation planning needs a more data-rich environment.

Messy

Balancing the collection, evaluation, and integration of information is the feature that we call "messy." It is a recognition that the new planning process is never quite finished because it is dynamic, nonlinear, evolving, iterative, flexible to the point of being slightly chaotic, complex, ad hoc, open to all, and generally hard to grasp. In the preamble discussion for the proposed rule-making, the new planning model was called a "systemic process," with the "plan . . . [being] dynamic, subject to more frequent revision and intended to serve as a 'current' framework for transportation decision-making. . . . It [is] . . . contemporaneous, comprehensive, and strategically driven." Indeed, planners have always known that planning is continuous; now the regulation institutionalizes this truth by finding that a partial plan not only is acceptable but also is expected as the natural outcome of the working document [(450.322(b)(8)]. Messiness is an almost inescapable feature of a more inclusive and cooperative process in which various planning activities need to be carried out simultaneously, allowing for a dynamic flow of information that differs according to local situations. A simple example of such messiness can be seen in the discussion of how NEPA requirements should be folded into the corridor/subarea studies. These studies will provide documentation for the EIS, but they cannot be the EIS since they are actually alternatives analyses that may result in substantial modification of the original investment concept [see 450.318(f)].

Customer Oriented

Finally, customer oriented in the ITPDS model means not only that customers' expectations and demands shape the transportation system but also that customers are involved in the planning process. The development of the transportation plan, according to 450.322(b), begins with identification of the "projected transportation demand of persons and goods in the metropolitan planning area." Planners may not find this mandate particularly noteworthy until they consider that the definition of "demand" comes not simply from the outputs of various technical projections and models but also from the involvement of the customers themselves, and that these customers are being asked to become involved early in "an interactive and integrated public sector decision-making process designed to respond to [their] needs" (*23*).

Actually the public participation section of the final rule represents one of the more substantial rewritings of the proposed rule. The NPRM pointed in the direction of enhanced public involvement but left the nature of the new public participation mandate rather open. The final rule adds significant detail. Section 450.316(b) explicitly encourages participation by a wide range of customers, including private providers, freight shippers, ride-sharing agencies, and public officials, as well as those "traditionally under-served by the transportation system, including but not limited to low-income and minority households." According to the rule, the effort should be to create a "proactive public involvement process that provides complete information, timely public notice, full public access to key decisions, and supports early and continuing involvement of the

public in developing plans and TIPs" [450.316(b)(1)]. The preamble discussion makes clear that certification of both statewide and metropolitan planning processes will include an assurance that performance criteria for public involvement are met (*19,* p.58055).

COMPUTER-SUPPORTED ITPDS

A number of practical problems are likely to arise during the attempt to plan and make decisions within the kind of flattened, cross-functional, data-rich, messy, and customer-oriented process that we have described. Not the least of these is the need to provide information on a great diversity of topics for a group with widely varying levels and areas of expertise. We suggest that use of computer-supported planning techniques rooted in a GIS could help to overcome a good portion of this problem while actually improving the quality of the group product.

A GIS displays information in spatially defined thematic layers that can be assembled one on top of another to produce useful composites, which can then be manipulated and analyzed. For example, wetlands, steep slopes, and public parklands in a community can be digitally mapped in different layers; these could be overlaid on other layers showing roadways, fixed-rail commuter and freight services, bus routes, paratransit service areas, bike lanes, sidewalks, and commercial land uses. The composite might then be used to envision potential environmental issues arising from construction of intermodal linkages, or it might be used to illustrate where new intermodal connections would address multiple objectives.

A GIS can also be linked with nonspatial data bases, models, and multimedia representations through relational and object-oriented structures, thereby significantly enlarging the scope of the information system available for query and analysis. Visual representations of specific physical factors attached to locations on the GIS and viewed as either slides or videos would allow stakeholders to visit a site without leaving the room. This could be particularly useful when the focus is regional transportation planning. At any rate, a good review of what is currently available in the way of multimedia is provided by Kindleberger (*24*), whereas Schiffer (*2*) and Shiffer and Wiggins (*25*) have discussed generally the usefulness of visualization as a way to translate quantitative information into qualitative understanding for planning with nontechnicians. Langendorf (*26*) has experimented with a GIS-supported *charrette* model (*27*) to redesign parts of Dade County, Fl., after Hurricane Andrew, and Hartgen et al. (*28*), for example, have described use of a GIS in conjunction with simple models for long-range regional transportation planning in North Carolina. These all suggest to us that the linkage of multimedia with the GIS can create a planning tool that is both powerful and legible. There are still a number of issues that need to be resolved for handling transportation networks in an all-purpose GIS, but these are being worked on. For example, Transcad by Caliper Corporation is a transportation-focused GIS that allows users to ask questions of the spatial data and display layers, and the development of linkages between TRANPLAN and ARC/INFO is currently under way.

Although many current GISs are designed to be run only by highly proficient technical staff and are not designed to be used in group environments, ITPDS in a collaborative planning setting needs an information system that is broadly accessible to a wide variety of users through well-designed graphic interfaces. Ideally, it should be a potent decision support system having quite robust interactive capacities, permitting users to query the data base in various ways as well as do what-if analyses. For ITPDS the computer support system would also need to contain impact, trend, and financial models; some of these models are reasonably good right now, whereas others require serious work. The addition of hypermedia capacity to the GIS would allow users to display the impacts of various decisions both textually and graphically. Finally, an on-the-fly annotation system would allow local stakeholders to actively participate in the creation over time of a truly comprehensive regional information system.

One need not, however, wait for such an ideal system to be developed. As Shiffer and Langendorf have demonstrated, GIS-based applications for supporting group planning and site design efforts in collaborative and *charrette*-like situations are beginning to occur now. Although currently available information systems may be imperfect and incomplete, their use could still provide significant aid to stakeholders who are attempting to carry out ISTEA mandates in a flattened, cross-functional, data-rich, messy, and customer-oriented environment. To understand something of how this computer-supported ITPDS model would function, one needs to imagine a group of stakeholders and cross-agency staff sitting together in a room viewing the same computer-generated images on a wall-sized screen. A staff technician operates the hardware, keying in commands and making annotations in response to comments and questions from the group. Assuming that all participants have some basic understanding of how the system works as well its informational capacities, any individual can call for display of the maps, overlays, information, model results, and visualizations that are in the GIS-based decision support system. Thus, all members of the collaborative planning group have access to the full range of information and analysis in formats that allow them to integrate concerns in multiple ways and to visualize the results of suggestions.

We think that this tool would significantly enhance both the functioning of the new conceptual model for transportation planning and the quality of the plans and programs that are its products. Few will argue the computer's ability to store, manipulate, analyze, and display large quantities of information. According to Peters (*21,* p.108) equal access to information is essential for the success of flattened work processes in which everyone is responsible and accountable. Access to information is also an explicit criterion for the new public involvement process under 450.316. The ability of this system to display and manipulate information in graphic, tabular, and textual modes can facilitate communication among people across functions and areas of expertise. The system's capacity to zoom in and zoom out, displaying information at different scales, as well as its capacity to accept comments or annotations would help to organize the messy complexity of the new model. It would also help to maintain focus and thus the productivity of a collaborative group. Finally we suggest that this system would enable clearer linkages between planning and programming. For example, if TIP projects were placed in the GIS and overlaid on the long-range plan, decision makers and stakeholders could see immediately both program balance and intermodal connections that might otherwise be missed. And in the end this is the purpose of both ISTEA and ITPDS—facilitating better linkage between planning and programming by developing a process firmly based on a comprehensive understanding of the needs of all the users of the total transportation system.

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Publication of this paper sponsored by Committee on Passenger Travel Demand Forecasting.