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Authors

Kanafani, Adib
Manheim, Marvin L.
Khattak, Asad
et al.

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CALIFORNIA PATH PROGRAM
INSTITUTE OF TRANSPORTATION STUDIES
UNIVERSITY OF CALIFORNIA, BERKELEY

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Adib Kanafani
Marvin L. Manheim
Asad Khattak
Nicholas J. Vlahos

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The Transportation Center
Northwestern University

PATH Program
Institute for Transportation Studies
University of California

Adib Kanafani
Director, Institute of Transportation Studies
University of California at Berkeley
109 McLaughlin Hall, Berkeley, California 94720
(510) 642-3585, FAX (510) 642-1246

Marvin L. Manheim
William A. Patterson Distinguished Professor of Transportation
Northwestern University
2001 Sheridan Road, Evanston, Illinois 60208
(708) 491-8676, FAX (708) 467-1777

Asad Khattak
Assistant Research Engineer, Institute of Transportation Studies
University of California at Berkeley
108 Naval Architecture Building, Berkeley, California 94720
(510) 642-9208, FAX (510) 643-5456

Nicholas J. Vlahos
Assistant Professor - Research, The Transportation Center
Northwestern University
1936 Sheridan Road, Evanston, Illinois 60208
(708) 491-5015, FAX (708) 491-3090

Abstract

In this research we propose a framework for a transportation planning methodology that recognizes the key role that teamwork plays in the decision-making process. We recognize that the transportation planning process has evolved for many reasons, and develop a cohesive framework for providing intelligent decision support to teams deliberating planning problems. The design methodology considers both user and functional issues in building a matrix of building block functions (BBFs) to support a particular planning process. We illustrate the design methodology by using as an example a recent planning problem from California.

Introduction

Urban Transportation Planning is facing challenges and opportunities in the rapid developments of intelligent transportation systems. The challenges to planning arise from the increased range and added complexity of the choices available to transportation planners. Two examples of these choices are real time information and increasing levels of automation. In a similar manner, the opportunities for transportation planning are evolving rapidly. These opportunities are emerging because of the availability of information, communications, and computation technology. These elements that add intelligence to the transportation system can be engaged to add intelligence to the planning process itself

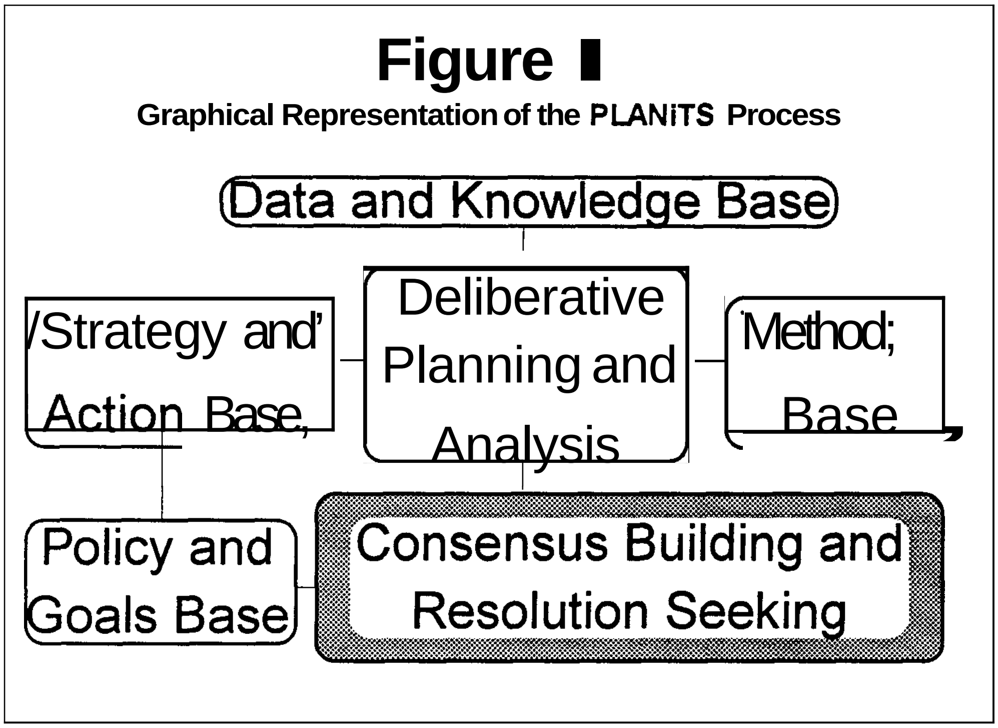
The planning process has evolved over time to deal with **a** number of key issues, such as congestion, pollution control, safety, and accessibility to specific subsets of the population. Clearly the set of issues will continue to mature as we enter the next century. The implementation of IVHS technologies, many of which have system-wide implications, will require a change in the institutional arrangements that are currently at work in transportation planning. Recent legislative initiatives, such as ISTEA, the California Congestion Management Program, and the Americans with Disabilities Act have also posed a challenge to transportation planning as it requires specific processes and imposes certain mandates. Political issues become more complicated, as organizations bring the judicial system into the process. Finally, the interaction of dynamic transportation systems creates new challenges for the mathematical analyses used in transportation planning.

Teamwork and group interaction are emerging as critical issues in a number of disciplines (Manheim 1992). Personal and small-group computing have become an important part of many problem solving processes, but few in transportation planning seem to be addressing these issues. An example is the set of software technologies known as ***groupware.***

A group-based methodology is required to address real-life complex interactions within and between organizations in the transportation planning process. Researchers at the University of California have developed a framework for integrating planning and analysis in a computer supported environment that facilitates group problem solving, including deliberation and consensus seeking. The planning process has been proposed to be integrated into a computer system called ***PLANiTS.*** (Kanafani, et. al., 1993)

A key architectural component of PLANiTS is the realization that the transportation planning process requires a set of parallel computer processes to support the deliberation and consensus seeking activities that usually occur in planning. **A** computer-based decision support system is proposed to support a deliberative process in which alternative strategies are analyzed and evaluated and decision makers are assisted in reaching resolution concerning plans and the programming of projects. This component will be designed using insights gained from developing decision support applications in other transportation and related problems such as production planning, vehicle dispatching, marketing of transportation services, and revenue management (Vlahos 1991; Manheim 1993; Xie 1992; Crotty 1993).

A number of different approaches to computer supported decision making and deliberation support systems have been explored, and the exploration process will continue as new techniques and products emerge. We believe that these techniques have the potential of enhancing the process of deliberation and consensus building that is necessary to arrive at programming decisions. Specifications for a system suitable for transportation planning have been defined, as have the determinants of a prototype for inclusion in early versions of PLANiTS. Figure 1 is a graphical representation of the proposed PLANiTS process. (Kanafani, et. al., 1993)



Research Background

A Revised Perspective on the Transportation Planning Process

Planning is not always the result of a rational determination of needs. The planning process is not neatly defined. The logical progression of steps and of causal relationships often gives way to the competition for scarce resources, or to the pursuit of opportunities. Planning is often mandated by a political process that is driven by different concerns that are presumably higher than those of the system being planned. It is sometime driven by funding opportunities, as is not uncommon in urban transportation where Federal and State programs mandate and fund planning. Because few large projects are undertaken without such funds, the funding mechanism largely determines the realm within which local and regional decisions regarding transportation improvements are made. Opportunities for transportation improvements also arise in new land development programs, or in the rehabilitation of older developments. Mandates, such as those relating to services for disabled people and congestion management, also require planning activities in transportation. Stake holders in the political process, either special interest groups or individual politicians, play a very important role in shaping the perception of needs thereby focusing attention on, and gaining support for, particular transportation improvements.

In a recent review of the current urban transportation planning process in California (Kanafani, et. al. **1993)** researchers conducted interviews with a selection of county, city, regional, and state transportation planners, and with developers of new technologies. The purpose was to determine how planning is currently taking place, and to assess attitudes and knowledge about new technologies and the issues that arise in their implementation.

The major findings from the study can be summarized as follows:

- Recent legislation has played an important role in shaping the current planning process.
- Many planners are concerned that there are no effective incentives or sanctions around the legislation.
- Passage of ISTEA increased the funding and role of regional transportation planning agencies.
- State and local agencies are responding to the changes by creating new processes that emphasize coordination for prioritizing and programming transportation projects throughout the region.
- All urban counties in California now have some type of travel demand model of the UTPS type, such as EMME/2, MinUTP, or TRANPLAN.

- Analysis and transportation modeling, however, are not key concerns of most local planners; the use of models appears more as a procedural formality rather than an inherent part of a planning process.
- Because of limited funds, local planners must concern themselves primarily with obtaining funding for projects already judged to be needed.

Analysis plays an inadequate role in planning and decision making. In order for analysis to play a more meaningful role in this process it would be necessary to expand its scope beyond the demand analysis focus that characterizes most UTPS modeling.

The integration of the modeling elements into the actual deliberation and decision making process is another pre-requisite for ensuring that analysis does support planning. This integration requires that the deliberation process encompass elements of modeling such as the goals of the participants, modeling assumptions, prediction scenarios, and the objectives of optimization models.

The introduction of IVHS technologies is not seen as simply an incremental expansion of the set of options available to transportation planners. There is uncertainty, doubt, and sometime outright misgiving regarding new technology. Therefore, it is imperative that a planning methodology be developed that would permit a thorough analysis of IVHS elements within the overall context of exploring the broader set of transportation solutions. What is more important, it would seem desirable that a mechanism be found to integrate the knowledge accumulation about IVHS technologies into the planning process. The current lack of knowledge and the absence of experience are potential causes for the general apprehension about IVHS technologies that is to be found among local transportation planners.

The multiplicity and complexity of rules and requirements mandated on to the planning process by the myriad of laws and regulations have tended to bureaucratize the planning process, often at the expense of adequate attention to the real issues and tradeoffs that face planners. The use of computer based decision support systems might help disentangle the convoluted procedures and assist planners in focusing on the important issues.

Introducing Team Support Systems Into Transportation Organizations

How can a transportation planning organization use information technology to solve problems caused by its constituents, benefactors, and adversaries? Clearly the transportation planning process for a significant metropolitan area will rely on the interaction of more than one organization. These organizations must work together in a coherent network if their region is to obtain the appropriate resources needed to achieve their desired goals. Competition for the resources needed by the public sector organization is influenced by a variety of forces. Cities and regions face major competition because of the impacts of competition on the firms located in the area or which the city or region wishes to attract to that area (Manheim, Elam, Keen, 1989). Therefore, to support the planning process for these organizations, one must first understand the overall structures of the transportation planning alliance as a whole.

For very large planning situations that arise in major cities today, we assert that it is not a stretch of thought to consider the alliance as a single organization, each section with its own goals, objectives, measurement criteria, and reward structure. Therefore, we should be able to look at research on organization structure of large companies to develop an understanding of how the alliance might function.

Several researchers have observed that the organization structure that is emerging in some leading companies is different from any of these traditional organization forms. Hedlund has called these organizational forms hetarchical organizations (Hedlund and Rolander 1990).

Drawing on the observations of both sets of researchers, and our own interviews and observations, Manheim extends and modifies the arguments of these researchers to characterize the hetarchical organization (Manheim 1992). In the context of the public sector transportation planning organization, the key elements of the hetarchical organization are:

- Many centers of competence, each with a different specialization and role in the overall process
- **A** combination of formal hierarchical structure, for formal responsibility, and an informal power structure, in which multivalent power relationships are the bases of power
- ***An*** environment in which firm culture is very important in establishing reference frames for negotiating agreements (Ohmae 1989)
- Important power centers are located outside the firm boundaries, in strategic partners of various types (customers, suppliers, distributors, etc.) (e.g., Johnston and Lawrence 1988)

In this type of organization, the critical assets are the personal networks of relationships, the processes by which incremental changes are made, and the information technology channels and systems that disperse the right information to the true, informal, decision-making teams.

Increasingly, teams are observed in the private sector cutting across the boundaries of the organization (Johnston and Lawrence 1988). Often, teams will involve members from other organization that are strategic partners: partners in a joint venture, in an R&D activity, or suppliers of critical components or important distribution partners. This observation is highly interesting given the multiple organization structure of the problem we are considering, even though the domain is the public sector.

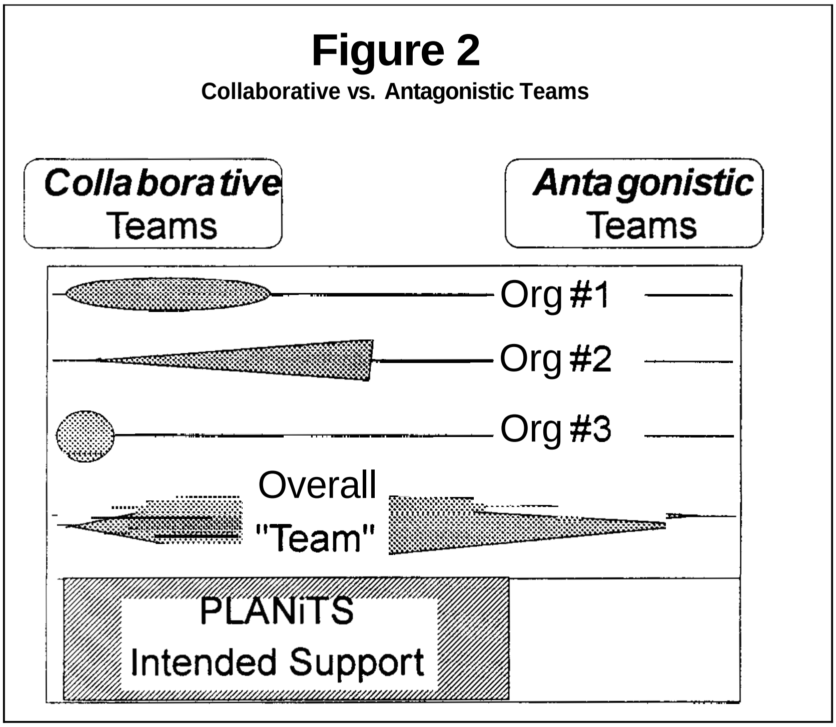
The working arrangements for teams and their members raise complex issues (Mills 1991; Galegher et al 1990; Gabarro 1990; Hackman 1990; Larson and LaFasto 19891. Regardless, teams are being used very frequently, and are major elements of an organization's strategy to deal with the critical strategic issues identified previously.

One key issue is that not all parties in the transportation planning process will necessarily be working in a friendly manner to achieve a similar set of goals. The ideal situation is for all teams and their members to be ***collaborative.*** Unfortunately, situations will arise where teams and their members are in fact ***antagonistic.***

Figure 2 describes this situation as a spectrum. In the figure, three smaller teams from different organizations are involved in the planning process. Each team has its own internal situation, and can be represented somewhere on the spectrum between collaboration and antagonism.

The overall team working on the problem, however, will likely have a more complicated set of interactions. While a detailed analysis of these interactions is beyond the scope of the research, we assert that the overall "alliance" working on the transportation planning problem is likely to have more diversity between collaboration and antagonism.

It is important for team support methodology to address antagonism as an issue, but at some point excessive antagonism will cause the "alliance" to fail no matter how much team support is present. This is represented by the shaded box -- PLANiTS should focus on the collaborative process while understanding and having a limited set of tools to address antagonistic team members or organizations.



Synthesis: A Team Support System for Transportation Planning

Given the assertion that teams are a key component of the transportation planning process, how does one develop a working environment to support decisions made by these teams? Manheim uses the term Task/Team Support System (Manheim 1992) to describe a class of decision support systems geared towards helping a team solve a particular task. A Task/Team Support System provides full information system support, for individual and collaborative work, for the members of a team that shares a specific task or function, whether the individuals are working at the same or different places, and at the same or different times.

We believe that incorporating elements of this class of decision support system will be of assistance to the transportation planning community. How to implement a team support system, however, is unclear. In the following section, we will attempt to develop a framework for a prototypical team support system for transportation planning.

A Conceptual Framework for Team Support in Transportation Planning

Today's challenges and opportunities suggest a planning process that can take advantage of the information that will become available as emerging transportation technologies are developed. Unfortunately, this statement is true only if the information gathering needed for an advance transportation planning methodology is embedded in the emerging technologies. **As** high quality information becomes available, the planning methodology should have at its disposal the analytical power and the support tools needed to use this information intelligently

The basic principle of the proposed planning framework is the intelligent use of knowledge to support deliberation and decision making. To make this principle operational, we introduce two important features of the planning framework. The first is to recognize that transportation planning is a deliberative, dialectical process that seeks agreement on programming decisions. The second is to recognize the necessity to supplement models with expertise and with a knowledge base that becomes richer as experience with new technology is gained. The methodology proposed to implement these principles are computer based and uses an interactive on-line environment to facilitate deliberation and to integrate it with analysis.

Transportation Planning as Deliberation

Transportation planning is primarily a deliberative process of negotiation and consensus building that is supported, rather than driven, by analyses and projections. The contemporary context of transportation planning is one where there is a diverse group of actors and stake holders who are driven by different motives and are advocating conflicting objectives; who have different value systems with which they measure their expectations from the transportation system and with which they judge its impacts; and who are all vying for a common, usually limited, resource pool. It is a context of dialectical tension between opposing forces. Recent legislation has made it mandatory that planning be multifaceted, multi-modal, and multi-agency. The broadening of the scope of transportation planning, and the decentralization of transportation planning powers have brought many actors into the planning and decision making processes, and has made consensus seeking a central feature of these processes.

To deal with this aspect of planning we place at the heart of the methodology a computer based team support system. Planners work with the system to facilitate deliberation, to synthesize positions, and to seek consensus. This consensus seeking is not limited to the final stages of the process when people come to agree on what to program for implementation, but is dispersed throughout the process. Planners need to consider goals, criteria, constraints, models, and predictions before they can accept the results of analysis and come to a consensus on programming. Of course, the methodology cannot guarantee that consensus will be achieved, but it facilitates the process of seeking that consensus. Using its rich knowledge base and powerful analytic tools this computer based intelligent facilitator seeks to discover win-win propositions, to clarify trade-offs in meaningful, and when possible, quantitative terms, and to support trade-off analysis whenever optimal solutions are not possible.

Computer-Supported Deliberation and Analysis

The proposed methodology integrates analysis and decision-making in an interactive environment. This requires a substantial computer aided decision support system. The computer system includes two main elements. One of the elements is the knowledge and methods base. It includes the data base and database management system, the knowledge base and the collections of methods, and models and tools that perform analysis. Another element is an inference system that assists the user in selecting the level of analysis needed to supplement knowledge from the knowledge base. The other element is a computer based deliberation support system. This is a system that facilitates the sharing of information, ideas, and views as part of the deliberation that takes place in planning and decision making.

The computer support of the process permits the search through rich data and knowledge bases, and allows the users to explore alternatives from an array of technologies and other interventions that are found in what is called the Action Base. The system can be operated in a group environment where users from different organizations work together to explore alternatives and seek consensus on planning decisions. The system provides quick response analysis and interpretation. It can also be operated separately by individual users either privately, or as part of shared, networked computer environment.

It should be noted that the methodology does not assume a level of computer competence for all team members. While computer **support** is a cornerstone of the methodology, there will often be key team members (such as senior officials of organizations) that either do not have computer training or do not have enough available time to become familiar with a detailed computer-based support system. The methodology does assume, however, that at least one member of every team using PLANiTS has sufficient computer skills to manage the interaction that the team members have with PLANiTS.

***Executing Group Tasks Using Team Support* Systems**

Team support systems allow organizations to evolve and interact in ways which parallel the styles of their employees. Team support appears to be a critical component of the public sector transportation planning process, since much of the process involves communication and negotiation between officials of government, development, and community organizations.

Team support systems are sets of tools for supporting teamwork activities among members of groups. These tools have a number of functionalities depending on their specific focus. We describe these functionalities as "Building Block Functions" or "BBFs" for short. Most problems can be modeled by mixing and matching the appropriate blocks to generate the required style of work.

At this point, we will use the phrases ***team support system*** and ***decision support system*** in a way that is not quite interchangeable. Team support systems are a superset of decision support systems; some decision support is for the individual. BBFs are team-oriented, but many of them can be used by an individual for personal organization of information used.

The decision support research community often describes the functionality of team support system tools by the type of work done by each tool. Using this classification scheme, there are six key categories of team support BBFs:

- Communication Tools
- Collaborative Work Tools
- Group Decision Support Tools
- Group Coordination Tools
- Workflow Management Tools
- Information Sharing Tools

Our design methodology, however, considers an alternative approach to classify BBFs. We consider the type of support in the decision-making process that each BBF provides. This gives us following classification:

- Presentation or Synthesis Tools
- Analysis Tools
- Judgment Development Tools

Table 1 contains a cross-reference matrix of potential Building Block Functions classified by both schemes.

A key design point is that the team members that use PLANiTS will often want to conduct individual analysis of issues using PLANiTS in a stand-alone style. This point is emphasized by allowing each individual to have his/her own set of PLANiTS problems and data. Teamwork is enabled by allowing users to selectively share information from their own PLANiTS models into a "team model" of the problem being solved.

In Figure 3, each individual has his own set of PLANiTS information indicated by the smaller circles. Each user has his own presentation, analysis, and judgment tools; many but not all would be standard PLANiTS functions. Each user also has a personal representation of the problem and of the potential solutions being considered.

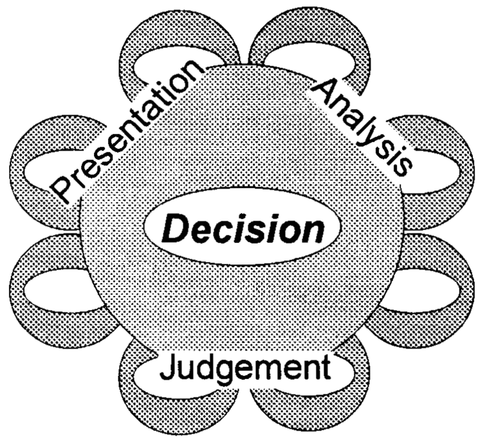
When all the individuals meet as a team, however, the team considers a superset of problems, solutions, and tools. This superset is indicated by the larger circle in Figure 3. The superset includes all information that individual team members decide to share with the team. Individuals, however, may keep information to themselves. This decision is represented by the portion of each circle outside the boundaries of the team circle.

Table 1: Building Block Functions Cross Referenced Support Provided vs. Group Interaction

support / Interaction	Presentation	Analysis	Judgement
Group Decision support		Brainstorming Commenting "Delphi" Techniques	Voting Scoring Ranking
Collaborative Work	Group Dictionary Group Memory	Issue Analyzing Group Discussions	
Workflow Management		Categorization Searching Rule-Based Routing Deadline Setting and Enforcement Mathematical Tools	Categorization Deadline Setting and Enforcement
Information Sharing	Personal Information Management Graphical Representations Hypertext Linking Management Reports	Surveys Form Design	Rule Development
Communication	Sound/Video Access Screen Sharing Electronic Mail Bulletin Boards and Conferences	Access Control Electronic Mail Bulletin Boards and Conferences	Anonymity Real-Time Conferencing Electronic Mail Bulletin Boards and Conferences
Group Coordination	Synchronous and Asynchronous Work Executing Multiple Group Tasks Group Scheduling	Synchronous and Asynchronous Work	Synchronous and Asynchronous Work

Figure 3

The Team Model in PLANiTS



Large Circle: "Team of Teams"
Smaller Circles: Each organization's team

One of the goals of PLANiTS' team support is not to substitute for face-to-face meetings, but to provide new alternatives when face-to-face meetings are not possible. Because people work at different places or have different schedules, meetings are not always possible. Team support technologies provide the necessary tools to make it possible for people to communicate with each other when meetings are not possible. Another goal of PLANiTS is to support face-to-face meetings through a combination of analysis and judgment tools.

Some individual organizations may resist adopting the type of team support systems being developed for PLANiTS. Resistance might come from:

- Lack of information about team support - what it will do, what it costs, what are the benefits
- Lack of resources to implement teams support properly - managers, computers, application developers

- Fear of the effect of team support on the individual job - lack of a team culture, fear of too much change

A proper conceptual design of how team support systems will help potential users as well as appropriate technical supports are important success factors.

A Design Methodology for Team Support Using Building Block Functions

Our prototypical design methodology involves technical issues but also social and organizational issues. Team support system technologies are emerging, and a design methodology must emphasize flexibility and the ability to learn from intermediate results. In this section, we will formalize the necessary steps in the process of team support design and implementation and explain their use in the overall PLANiTS system.

In addition to the discussion below, one must be remember that in many cases adopting this methodology will be a significant investment in a computing environment. If faced with such a situation, one should also consult the general literature on software engineering for a discussion of understanding cost/benefit tradeoffs in software development.

Factors for Adopting Team Support Systems

The first step is to make sure that the PLANiTS team support system is really needed to address the issues faced. There are a number of features that, when found, suggest that team support is appropriate.

These features are generally oriented toward communication. There might be strong needs for effective and efficient communications between planners to stay informed about decision processes taking place in different parts (organizationally or geographically) of the system.

Another feature is when there is a need for deliberation and dialog. In some organizations, employees are encouraged to coordinate with and learn from each other. Such organizations believe that the base of success is having all employees working toward common goals. Another set of features occurs when planners cannot exploit opportunities because of a lack of information about new technologies.

The final part of this process is to understand the needs of the organization for team support. From the diagnosis of the issues and problems faced by the organization, it can be determine what types of team support, if any, should be considered. The matrix in Table 1 should be used as an aid to develop an appropriate first set of support needs.

User Assessment

The ideal situation is that everybody in the transportation process belong to one or more teams. Not all users, however, will be doing similar tasks and expecting similar assistance from a team support system.

Consider as an example three major professional groups: managers, analysts, and support staff. Clearly people in these groups will have different tasks and therefore different requirements of a team support system. Managers will generally emphasize group decision support, analysts will want the system to interact with existing methodologies such as models, databases, spreadsheets, etc. Analysts will generally want to use team support to collaborate with colleagues. Support staff will generally have needs around workflow and document management.

Therefore, it is important to understand the mix of people using the proposed team support system as a prerequisite to develop the system's fbnctional requirements. Equally important to job descriptions is the amount of experience with computers and other information technology that team members have. Mismatches of complexity with staff experience can lead to frustration, additional costs, and eventually disregard for the team support system.

Functional Assessment

Once the key staff members that will use a PLANiTS team support system are identified, it will be necessary to understand the functions that each set of staff members needs. It is therefore necessary to work with a representative of each set of staff members in developing a functional assessment. The assessment should try to understand the:

- Ultimate goals of the team and the organization
- Major processes of each team member and how these processes interact within the organization
- Tasks that each user must achieve in order for the system to succeed.
- Potential problems and issues that the team members must face in daily work
- Bottlenecks that occur in the organization - where work is delayed for technical, resource, or political reasons
- Standards for ideal operations within the organization
- Support needs such as training of each type of team member

Notice that the fbnctional assessment process builds an ad hoc team of developers and users. Therefore, the ability to use the PLANiTS team support ideas in the fbnctional assessment will have the benefit of gaining acceptance for the idea within the organization. This concept forms a keystone of our research plan.

The functional assessment should refine Table 1 to develop a revised set of building block functions needed to develop the team support system.

System Selection / Design Criteria Development

Once the set of BBFs has been generated, attention must turn to the actual development and customization of the team support environment. We will not discuss methodologies for actual software development at this time.

The issue, instead, is practicality. When development is to begin, there will be a set of commercial groupware products available in the marketplace. The practical issue is to understand which products are appropriate from a functional standpoint. Potential software packages should be classified according to the matrix of Table 1 in the same manner as we have classified the theoretical building block functions. This process will show which BBFs will be able to be prototyped rapidly using existing software packages, and which BBFs must be either custom-developed or delayed.

This set must be pruned further considering other constraints. **As** an example, some computer operating systems are a barrier, as very little in the way of team support systems have been developed for those platforms. Other major barriers are the compatibility of products with each other as well as with existing software, the ability to tailor the product to specific needs, the user interface quality, cost, and customer support and training services.

If it is decided to start from scratch and develop a custom team support system application, traditional software engineering methodologies will be used to guide the process. These methodologies, however, should be adapted to take into account the unique problems inherent in designing a system for multiple users.

User Training

It is important to properly train users on the PLANiTS team support system. This includes education about the following issues:

- Who will be using the system (e.g. planners, citizens' groups, politicians)
- Why the system is in place (e.g. decision support for advanced planning problems)
- What types of work the system can support (e.g. deliberation, project programming)
- How specific components of the system work (e.g. building block functions)

The education has to then be augmented by traditional training on the use of software systems, with particular emphasis on the role of the team within the system.

Usage Elicitation

The team support system is useless if key people do not use it. If there are some people in the planning environment who do not want to use the system, they may be convinced by stressing the need for a cooperative culture, the fact that all intended groups of users are expected to cooperate, and the penalties from a lack of resolution on issues such as resource allocation.

Problem Diagnosis and User Feedback

Throughout the implementation process, it will be important to anticipate problems and elicit continuous comments from users. These problems will be analyzed and, if appropriate, changes made to the PLANiTS team support system.

An Example: Team Support Building Blocks for HOV Lane Analysis

The joint research effort between the University of California and Northwestern University is to use the above design methodology to develop a team support environment for the PLANiTS system. The research effort is still in progress.

At this juncture, there is a lack of concrete examples which have used the approach outlined in this paper. The main reason is that few software methodologies in the transportation planning area exist to emulate the processes described above. Current research work is developing a prototype system to test on several transportation planning examples. We expect to be able to discuss these results late in 1994.

In the meantime, this section describes a simple example of how a planning methodology such as PLANiTS that emphasizes teamwork might be used in a transportation planning process. We have made many simplifications to the problem to emphasize the design methodology.

Problem Definition

The example that we will use is whether a "High Occupancy Vehicle (HOV) Lane" should be built on Interstate 80 in California between the Bay and Carniquez Bridges. In reality, decisions have already been made in this example; our use of this example is purely to provide a situation where a system such as PLANiTS should eventually be able to provide team support to the decision-making process.

Several alternatives are given to the implementation of HOV lanes. They include increased transit service, increased tolls at both bridges, enhancement of existing alternate routes, and implementing one of several advanced traveler information systems. The decision makers are concerned with many issues around this decision, including delay, safety, air quality, and promoting transit usage in the region.

Teams Involved in the Planning Process

This problem is an excellent example of the different levels of teams that come together to work on a complicated transportation planning decision. At first glance, there are at least four different types of teams that influence the decision process:

- State and regional planners analyzing the traffic impacts of alternative decisions
- Congestion Management Agencies for Alameda and Contra Costa Counties

- Elected officials and support staff for the cities on the path of the proposed improvement (Richmond, Albany, Berkeley, Emeryville)
- Three citizens' groups, each with its own special interest (promoting transit usage, preserving the wetlands near San Francisco Bay, maintaining air quality)

Within each type of team, there are many smaller teams that work on parts of the problem. These teams pool their information to influence the decision-making process.

The Role of Deliberation

The key role that deliberation plays in this planning process is clear. Not only is the final decision subject to deliberation, but almost every step in the process for preparing for the final deliberation is in itself subject to even more deliberation. Some examples include:

- What are the objectives that the team should use to decide on a solution?
- What assumptions should be made about the current transportation system (e.g. volumes, capacities, delays)?
- What methodologies are appropriate to use in studying this problem?
- What is the timetable for reaching a decision?
- What are the political implications of the planning process?
- Which, if any, special interest group's point of view will be seriously considered?

Each point above as well as many others are subject to debate by various teams involved in the planning process. Current transportation planning methodologies do not adequately reflect the importance of this deliberation in the final set of decisions.

Using Building Block Functions to Support Teamwork

After studying the problem, the rationale for supporting teamwork, and the role of various types of team members in the decision-making process, we develop an initial set of building block functions of the PLANiTS system that would provide immediate assistance to the teams. Table **2** discusses the rationale for 12 candidate building block functions. Each building block function provides specific benefits to the problem-solving process. Some BBFs are likely to be more effective if other BBFs are in fact implemented. **An** example is that voting and ranking will be less effective if anonymity is not available.

Table 2: Building Block Functions for the HOV Lane Example

Building Block Function	Purpose
Anonymity	Bring out differing points of view, reduce dominant forces in meeting dynamics
Brainstorming	Provide ability to develop a large set of alternatives to a problem that might improve upon traditional selections
Categorization	Group similar alternatives for easier analysis and judgement
Conferences - Real-Time	Provide an environment where more than one person can participate simultaneously in a meeting situation
Conferences - Dispersed	Provide an environment where the work can be done without having to gather all the participants for face-to-face meetings
Deadline Management	Force decisions to be made, discourage participants from backtracking and reviewing issues where decisions were made
Electronic Mail	Provide a mechanism for private conversations between team members
Graphical Representation	Make it easier to study complex numerical information
Group Dictionary	Elicit discussion about terminology or assumptions where there is disagreement among team members
Mathematical Tools	Needed for technical analysis as part of the transportation planning methodology
Ranking	Used to prune sets of alternatives to more managable numbers for further analysis and judgement
Voting	Needed in order to achieve decisions throughout the process

Summary

In this research we propose a framework for a transportation planning methodology that responds to the challenges and opportunities posed by advances in new technologies. Specifically, we propose a methodology that exploits emerging information technologies to develop decision support for the many teams that are found to work on transportation planning problems. The concept of a "Building Block Function" (BBF) is introduced as the functional form of the decision support that PLANiTS should provide.

An example was used to illustrate the effects that teams have in the transportation planning process. The current efforts representing the second phase of this research are focused on further development of a preliminary version of PLANiTS and associated elements.

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