TRANSPORTATION SYSTEM MANAGEMENT (TSM) GAME/SIMULATION

by
Aaron Adiv, Richard D. Duke, Jac L.A. Geurts, and Steven E. Underwood
Urban Planning Program
College of Architecture & Urban Planning
The University of Michigan
Ann Arbor, Michigan 48109
U.S.A.

PROBLEM STATEMENT

Transportation System Management was established in September 1975, by the U.S. Department of Transportation. During the past six years, TSM has become commonplace for transportation technicians. In contrast, policy makers in both the private and public sectors seem to lack knowledge about TSM and its advantages. In the seven years of TSM history it became apparent that the existance of an enterpreneur on the local level is the key for successful implementation of TSM strategies. (The strategies themselves are well established by now). Thus, it is essential that the community be well informed about TSM in order for certain community members to assume this entrepreneural role, or at least to support it.

The District of Columbia Department of Transportation (DOT) has a policy of promoting citizen involvement in the development and selection of transportation strategies for neighborhood traffic problems. Effective citizen involvement requires educating the participants about pertinent transportation considerations. Some of these considerations are technical in nature. The DOT needs an instructional device that will convey the necessary information to citizens while promoting productive participation in the planning process.

The intrusion of traffic from surrounding areas into residential neighborhoods has become a major problem, and it is the Department's responsibility to protect local streets and neighborhoods from traffic which belongs on the arterial system. Specific transportation problems related to the heavy traffic on local streets includes noise, speed, accidents, volume and vibration. In addition, excessive traffic can affect both the appearance and desirability of a neighborhood, thus having the potential to reduce the incentive for residents to maintain their property. This may also lead to a reduction in neighborhood identity and stability.

The Neighborhood Traffic Management (NTM) process of the Washington D.C., DOT addresses the problems of traffic intrusion. This approach attempts to increase the quality of life in a neighborhood while maintaining mobility and access for resident and non-resident traffic. In this process the following objectives are stressed: promoting the use of alternatives to single occupant vehicle travel, such as high-occupancy-vehicle travel; reducing speed and other traffic problems; encouraging neighborhood revitalization and stability; maintaining reasonable access for goods and service vehicles; maintaining reasonable access for local travel; diverting traffic to METRO, and keeping traffic on designated arterials.

NTM relies heavily on Transportation Systems Management (TSM) strategies to achieve these objectives. TSM embodies low-capital, non-facility oriented strategies focusing on the movement of people and goods rather than vehicles. These strategies are in contrast to traditional long-range, capital intensive strategies. TSM operates both on the demand and supply sides of the transportation system in order to improve effectiveness and productivity of the existing invested resources.

TSM/GAME/SIMULATION by Adiv/Duke/Geurts/Underwood

The DOT wants to involve the community in the development and selection of TSM solutions to neighborhood traffic problems. In order to make a meaningful contribution to the NTM process, community participants need instruction on the nature of neighborhood traffic problems, and the impacts of alternative solutions. The presentations of this information has been limited to a combination of familiar methods including lectures, discussions, written materials, and audio-visual aids. Although these methods are usually adequate for conveying sophisticated information, they are less effective in public meetings where antagonisms over issues can be easily provoked and frequently lead to an impasse in the planning process.

In addition, traditional methods of presentation can also inhibit the participation of community representatives. A technical lecture on TSM strategies may drive a wedge of "expertise" between the DOT representative and the general public, actually reducing participation in the NTM process. Moreover, technical discussion on TSM strategies are usually perceived as boring as well as alienating to the non-professional.

In contrast, game/simulations have proven to be particularly useful in enhancing communication in sessions involving planning professionals and citizens. The TSM game will not require high levels of experience or background to play, and the general public can play together with experts without suffering too great a disadvantage. The TSM game will invite proponents and opponents in the NTM process to sharpen their perception of problems. Game/simulations make participants open to objective learning of complex phenomena and experiencing other perspectives on the issues. Furthermore, the participant's learning is enhanced through the gestalt nature of the information being conveyed in the game. The participant actually experiences a simulation of the transportation problems represented by the game without the risks associated with reality. Finally, the game can serve as an icebreaker at the beginning of meetings regarding the NTM issues.

Thus, gaming/simulation offers many benefits over other planning methods; it bridges the knowledge gap between citizens and public officials, it sharpens perceptions in the planning process, it creates a dynamic process where players can see the results of their actions and attempt to correct them, it can model complex social situations that might otherwise defy modeling, it creates an insulated world where players can participate without risk, thus, more creative solutions to problems can be achieved.

LITERATURE REVIEW

A transportation component generally appears in all games dealing with the urban environment: for example, METRO-APEX (Duke, 1970), and SNUS - Simulated Nutrition System (Duke, 1977). However, there are only a few games designed to deal exclusively with transportation issues. One of the most recent examples is the CONRAIL Railorad Deregulation Game (Duke, 1979).

Owing to lack of previous research combining transportation issues with Gaming/Simulation methodology, the review here will be divided into two sections: The first one will explore TSM, and the second will review Gaming/Simulation Methodology. Please note that the Gaming/Simulation methodology discussed here differs from the mathematical simulation modeling employed by programs such as UTPS (U.S. FHWA and UMTA), or manual estimations of changes in mode choice due to TSM (U.S. FEA,1977).The Gaming/Simulation methodology discussed here serves basically as a means of communication. As a result, it emphasizes the process of the game more than the actual numerical results which it produces. In contrast, the UTPS simulation is a predictive model which puts major emphasis on accurate prediction of transportation outputs. The TSM Game/Simulation, which is currently being constructed, is in no way a duplication of existing simulations in the UTPS package.

TSM/GAME/SIMULATION by Adiv/Duke/Geurts/Underwood

Transportation System Management (TSM)

In September 1975 the Federal Highway Administration (FHWA) and the Urban Mass Transit Administration (UMTA) jointly issued regulations requiring each metropolitan area to develop a Transportation System Management (TSM) plan as part of its short term transportation improvement program (U.S. DOT, 1975). The issue of the regulations provided an official seal of approval for a planning concept which was emerging during the 1970's. The concept embodies low-capital, non-facility oriented strategies focusing on the movement of people and goods rather than vehicles, and manifests itself as the antithesis to the long range capital oriented strategies which have dominated the transportation field since world war II. TSM strategies operate both on the demand and supply sides of the transportation system in order to improve effectiveness and productivity of the existing invested resources in the transportation system. Perhaps the best definition of TSM can be found in the federal regulations:

> "Automobile, public transportation, taxies, pedestrian, and bicycles should be considered as elements of a single Urban Transportation System. The objective of Urban Transportation System Management is to coordinate these individual elements through operating, regulatory and service policies so as to achieve maximum efficiency and productivity for the system as a whole." (U.S. DOT, 1975)

TSM as a planning concept, rather than just another mandated set of federal regulations, grew as an inevitable response to decreasing financial resources, escalating costs of construction for both highway and mass-transit facilities, disenchantment of citizens with the negative effects of the highway system, changing life styles reflected in the environmental and the conservation movement, and finally the energy crisis. One of the best reviews of TSM as a concept can be found in Orski (1979) and in Orski (1980). A reflection of the confusion among transportation planners between the TSM concept and the TSM regulations can be found in Jones, Jr. (1980) and Shunk (1980). They both describe the phenomenon wherein transportation planners assemble bits and pieces from capital intensive transportation projects for reporting purposes alone in order to respond properly to the mandated regulations. The lack of financial rewards to communities which pursue TSM actions; the lack of TSM designated federal grants; the inherent philosophy of TSM which is biased toward low capital solutions with low visibility; all these tend to reduce TSM to an annual reporting ritual.

The mandatory administration of TSM by Metropolitan Planning Organizations (MPO's), which are relatively weak political organizations reemphasizes the reporting ritual as a substitute to a true commitment to the planning concept embodied in TSM. The existence of TSM as a planning concept prior to its official designation in the regulations can be found in earlier works (Pratt and Associates, 1973) which examined low cost, urban transportation alternatives, and by Kirby, et. al. (1974) which examined para-transit options.

This reporting ritual is perhaps the best indication of the fact that TSM is no longer a foreign concept to transportation technicians. This is, as Orski (1980) indicates, quite an achievement for a concept which has been established only 4-5 years ago. The diffusion of the TSM concept was not accidental. In order to promote and explain TSM, the Transportation Research Board (TRB) under the joint sponsorship of UMTA and FHWA organized special workshops on TSM in 1976 and in 1979. Both resulted in special State of the Art reports (TRB, 1977, and TRB 1980) containing proceedings of the workshops which included papers by experts in the field. While the 1976 conference, following the issue of the new regulations, concentrated on "how to do it," the purpose of the second conference, as defined by Meyer and Roak (1980) in their introduction to the TRB report was:

TSM/GAME/SIMULATION by Adiv/Duke/Geurts/Underwood

"To identify what has happened in TSM planning since 1976 and to develop recommendations that should lead to better assimilation of the TSM concept in both the Urban Transportation Planning process and the ongoing transportation programs of every urban community."

Substantial work has been done in the past five years exploring the possibilities and promises of TSM, evaluating various action strategies, and reiterating the history, rationale and planning concept embodied in TSM. For comprehensive reviews of TSM planning concept see Lockwood (1979), Gakenheimer and Meyer (1979), Keyani and Putman (1977), and Jones Jr., Garrison and May (1978). Various TSM strategies were studied and tested, by either using real life experiments or through simulated models. For a review of actual experimentation with TSM strategies such as the priority lane for high occupancy vehicles, ramp metering and counter flow, see Morin (1979), and for parking management, see Peat, Marwick, Mitchel and Company (1979).

A noted set of studies assessing the efficiency of TSM both as a strategy of transportation system improvement and a philosophy of planning administration was conducted by Jones Jr. and Assoc. at the University of California, Berkeley. The final report, Jones, Garrison, May et al. (1978), provides a policy oriented executive summary. The technical studies included among others, a simulated model of priority treatment of high occupancy vehicles on freeways (Kruger, May and Cooper, 1977), and on surface streets (Jovanis, May and Deikman, 1977), and a sketch planning model suited to constrained optimization and full cost accounting (Schonfeld, Garrison and Jones Jr., 1977). Further, a selected bibliography for TSM (Hickok and Cortllyon, 1978) was included.

The agenda and the recommendations of the recent TRB conference on TSM (TRB, 1980) provide the most updated guide for future directions and actions of TSM. The Agenda addressed three major topics: (1) Roles of organizations, public and private enterprises, and professional disciplines in TSM planning, programming and implementation; (2) Neglected high-achievement TSM actions; (3) An area-wide planning context for TSM.

The TSM Game/Simulation precisely addresses these agenda items. It is concerned with implementation of TSM, emphasizing the role of both the private and the public sectors. It intends to revitalize neglected options which have proven themselves in the past, rather than experiment with new ones. Finally, it intends to highlight conflicts facing TSM within neighborhood planning.

Gaming/Simulation

The literature of gaming/simulation is now extensive; recent reviews include: Coppard and Goodman (1977); Greenblat and Duke (1975); Shubik and Brewer (1972); Patterson (1971); Negleberg and Little (1970); Geurts, (1981). These documents focus on the theory of gaming/simulation; public policy uses of gaming/simulation; impact of the technique; and, finally, description of many examples of games used for public policy applications. The past work most cogent to the problem at hand views gaming/simulation as a hybrid form of communication especially suited to capture a complex dynamic system and to convey this model to decision makers to assist their understanding of the problem in the pre-decision phase. This concept is best illustrated in Duke (1974). There are many examples of the application of these concepts to real world problems, the most pertinent recent example being the Conrail Deregulation Game (Duke, 1979).

No matter how the concern may be expressed, there is mounting evidence that major institutions, public and private, are finding increasing difficulty in developing a comprehensive image to guide policy decisions and even more difficulty in transmitting these ideas to other members of the policy community.

Richard E. Meier forecast this development in the keynote address to the Tenth Annual Meeting of NASAGA (North American Simulation and Game Association) in Los Angeles, 1976. Addressing the question of future developments in gaming/simulation, he emphasized that accelerating change in the world would force major changes in institutional structure. Technological, economic and political change would bring functional and structural change, both through diversification as well as through abandonment of traditional activities. A simultaneous and parallel development would compound the problem in that the myriad changes would also signal an increasing tempo or rate of change bringing into sharp focus the need to plan ahead, to foresee the future. Meier believed that efforts by management to confront these conditions would inevitably lead them to gaming/simulation through default; there simply are very few other useful techniques available. Among the several possibilities, perhaps the disciplined use of gaming/simulation offers the most promise for achieving consensus and support on policy questions.

The characteristics of the Transportation Systems Management problem are several:

(1) complexity along the several dimensions of finance and economics, technology and science, bureaucracy and administration, social problems and political reality, and so forth;

(2) a future orientation which implies that precedent and the lessons of the past are of limited value, particularly in light of the energy crisis and of diminishing financial resources;

(3) the lack of a clear paradigm for action since no comprehensive satisfactory model exists in an operational mode;

(4) the need for a dynamic process for closure on TSM overview, an interactive process which deals with the widely varying perceptions of the many actors in the dialogue;

(5) the need to transmit the new perception of TSM throughout the community.

This problem has taken on new dimensions and it is gaining new urgency. Traditional techniques for transmitting a coherent overview of complex reality are weak, and have proven ineffective as a way to effectively transmit TSM. Because the primary actors in the affected institutions are oriented along differing perspectives by their previous training, and because they are motivated by differing perceptions of reward within the structure, it becomes important to evolve a technique which is interactive, dynamic and quick. Interactive, in that it brings the actors into a productive exchange of ideas; dynamic, in that it changes in response to the cumulative perceptions of the participants; and quick, in that major policy issues often come unexpectedly and with a ferocity that demands attention.

TSM/GAME/SIMULATION by Adiv/Duke/Geurts/Underwood

RESEARCH METHODOLOGY

"Gaming/Simulation" as defined here is both a learning and communications tool. Gaming has become widely accepted as a realistic and captivating "hold-harmless" technique for examining cause-effect relationships, for communicating ideas, and for getting key people involved in new and better ways of recognizing and solving problems. The approach has a standard methodology described in Duke, (1980 a). The game design will be undertaken in several phases, as follows:

Phase I- Investigation

This initial step entails the review of all pertient TSM literature and the preparation of a detailed problem statement for submission to and review by the client, i.e. the District of Columbia, D.O.T.

Phase II- Specifications and Criteria

The objective of this phase is to develop a "blueprint" for the gaming/simulation which is to be built. Working from established procedures, and using an extensive checklist of questions, a written statement is prepared, documented and reviewed. This statement states in detail the objectives of the Gaming/Simulation, the technical character of the product, and the expected results to be achieved with the product. This document serves to guide the evaluation done in Phase VII. Important specifications for the TSM - game are that the game will take three hours to operate through three cycles of play. The game can be played by 3 to 10 participants (most likely 6). The neighborhood of Capitol Hill in Washington D.C. has been selected for providing input to the design of the game. The street-map of this neighborhood is attached as figure 1.

Phase III - Description of the Model

This phase calls for developing a detailed schematic of the logical model to be presented in the game. To be sure that the Gaming/Simulation presents a valid paradigm, the model must be explicit and complete before the construction of the Gaming/Simulation begins. In reality this is not a single model, but a linked "model set" which takes into account: the actors, public and private, and their patterns of interests and decisions; the various transportation programs which compete for attention and funding; budgets, including both income and expense; transportation dynamics in serveral dimensions (income, housing, employment, travel characteristics, etc.); selected TSM strategies; demographics, and the data base which reveals this interplay. Phase III results in a written report with necessary schematics. For the schematic of this TSM - game, see figure 2.

Phase IV - Building the Gaming/Simulation

The model resulting from Phase III is now translated into a Gaming/Simulation product designed to the "Specifications" developed and approved in Phase II. This procedure of construction is well tested, and there are many examples that can be presented of final Gaming/Simulation products developed for significant clients (United Nations: FAO, UNESCO; Jet Propulsion Lab; U.S. Department of Energy; Chase Manhattan Bank; City Bank of New York, CONRAIL; U.S. Department of Health, Education & Welfare, State of Oklahoma, etc.).

Phase V - Testing and Evaluation

In this phase, the Gaming/Simulation is tested through the "Rule of 10" (a minimum of ten field trials, of which the last three must be fully acceptable). The cities of Ann Arbor, Lansing, and Detroit are considered for test runs. A technical evaluation of the product against the specifications developed in Phase II is completed. This technical evaluation is supplemented by actual field use for the client.

Phase VI - Dissemination and Local Use

In this phase of the project, the game is disseminated to the local neighborhood as a communications and teaching device, carrying the knowledge that has been gained to the various "actors" that are involved. At this point, according to experience, the project becomes self-supporting, with the nominal costs of reproducing, distributing and operating the game being defrayed by contributions from participants or sponsors. A manual of instructions is provided explaining player activity, operator requirements, and the overall context of gaming.

The model is constructed in such a way that it can be easily modified to deal with other situations using generally-available data. An inexpensive micro-processor (easy-to-use and widely available) is employed in a series of interactive cycles to process the participants' decisions and report on their consequences.

It is also expected that the game would be suitable as a teaching device in schools and universities.

Phase VII- Evaluation

In this final phase, the project undergoes final evaluation. The criteria for evaluation are the "Specifications" developed in Phase II.

SCHEMATIC STRUCTURE OF THE TSM-SIMULATION/GAME

Any game can be analyzed in terms of the twelve gaming elements: pulse, scenario, cycle sequence, steps of play, rules, roles, models, decision sequences and linkages, accounting system, indicators, symbology, and paraphernalia, Duke, (1980 a). During the construction process these elements are advanced one by one, as understanding about the game emerges. In a trial and error process they are woven together to form the basic fabric of the game. It is necessary to define each gaming element along two dimensions: (1) its substantive content, and (2) the game mechanisms that are thought to be appropriate for representing this content in the game. The description of each element that follows is preliminary, but it offers the flavor of the gameset that will emerge.

Pulse

A pulse is some event or problem introduced during the course of play to focus the participants' attention on a single aspect of the problem. Pulses will be introduced either by the participants' selection of random event cards, or through a programmed generation function facilitated by the microprocessor. The events that require a special focus include changes in traffic generators (e.g. - office, shopping, hospital, subway station, etc.), traffic problems (e.g. - travel time, lack of access, neighborhood disruption, congestion, lack of parking, pollution, noise, vibration, etc.), changes in through traffic, and input from pseudo roles (e.g. -police, fire chief, etc.). Each cycle begins with a new pulse of TSM - strategy.

TSM/GAME/SIMULATION by Adiv/Duke/Geurts/Underwood

Scenario

A scenario is simply a text outlining the plot of the game. It outlines starting conditions and describes conditions leading into play. The scenario is presented to each participant as an introduction to the game in the players' manual. The material that is presented in the scenario includes, first a description of the physical transportation system, in terms of the streets, sidewalks, parking facilities, bike trails, bridges, tunnels and traffic control devices. The description also sums up the recent history of traffic flows (of automobiles, bicycles, trucks and transit) and contrasts these flows with the existing capacities.

Second, the scenario lays out the problems that have been experienced with the transportation system. Attention is paid to lack of consistency with local land-use planning objectives, access to and from police services, comfort and convenience of travelers, complexity of demands on users and lack of access to: employment opportunities, schools, recreation, areas of natural beauty, community education and churches / religious facilities. The impact of the transportation problems on commercial and residential property values and sales, on the disruption of neighborhood cohesion and neighborhood stability and on the safety for pedestrians and travelers is shown too. Finally the scenario describes higher user costs and higher travel time, road maintenance problems, higher operating costs, congestion, loss of open space, parking costs, lack of on-street parking, lack of parking, aesthetical problems, air pollution, noise pollution, vibration, crime and problems relating to access to and egress from major roadways.

Third, the characteristics of the major roles, including a description of their values, goals, and travel behavior are included in the scenario. The roles mentioned are: mass transit users, bikers, pedestrians, auto users, non-travelers, residents, school children, house wives, employees, workers, local businessmen, through commuter, transportation planner and transportation engineer. Relevant values are convenience, clean air, time, aesthetics, safety, mobility, economy and equity. The goals incorporated into the role description in the scenario are, among others: increased residential property values, increased/decreased commercial activity, improved residential quality of life in terms of social life and social pattern modification, increases in safety, reduction of accidents, improved aesthetics, improved air quality, decreased noise pollution and decreased vibration. Other goals are: reduced road user costs (personal), reduced congestion, maintained emergency vehicle access, and maintained and improved access to shopping, residences, parks, recreational facilities, work, school, commercial facilities, and community facilities. Of every role the travel behavior is described in terms of speed, volume and trip purposes such as work, schools, recreation, hospital visits, social events etc.

Fourth, the scenario presents the characteristics of the TSM actions that can be taken to solve the traffic problems. Actions described are signal timing, crossing control, entry control, land usage control, curb control, speed control, parking control, pre-trip assistance and en-route assistance. Other actions mentioned are parking pricing, transit / paratransit pricing, operational improvements, mode transfer, management efficiency, transit, street /highway, paratransit operation and lane changes.

Fifth, experts positions on the transportation problems are explained in the scenario. Expert roles considered are policemen, engineers, planners and the department of transportation.

Cycle Sequence

The cycle sequence is a relatively simple, but very important, part of game design. The typical order of events includes the following elements:

TSM/GAME/SIMULATION by Adiv/Duke/Geurts/Underwood

Pre-game Operations
Introduction
Cycle sequence (run three cycles)
- initiation
- steps of play (policy and actions)
- mini critique
Post-play discussion and critique

The pre-game operations are those activities that must be conducted before the actual presentation of the game.

During the introduction to the game the participants are presented the scenario outlining the plot of the game. This is described in the players' manual. The operator should also discuss the following: (a) gaming-simulation as an instructional medium; (b) the purpose of the game; (c) the rules of the game in outline form, and (d) the roles represented by players in the room.

Following the initiation of the game the participants will follow specified <u>steps of play</u>. These delineate the explicit progression of activity in the game. In this game the participants will have five steps of play to guide their activites:

Phase I 1. Players select TSM strategies from among preprepared options.
Phase II 2. Players (as commuters) make decisions about mode and route choice (origin and destination are exogeneous). Computer produces the resulting traffic volumes and speeds, which are then indicated on the game board.
Phase III 3. Players select local roles.
4. Players make local trips and record problems and happenings.
5. Players receive and inspect traffic and socio economic impact data that are relevant to each role (computer output).

For steps 2-4 the simulated time horizon is one hour during peak. For steps 1 & 5 the simulated time horizon is one year.

During the mini critique of the cycle, all play stops and an intellectual discussion ensues, under the direction of the game operator. The discussion addresses two questions: (1) What are the results of the cycle just completed? (2) How does this experience relate to the real world problem? This will be the participants' opportunity to evaluate the alternative TSM strategies.

Following the final cycle the participants engage in a <u>post-play discussion and critique</u> in which they systematically examine the model presented by the game from the perspectives of the various roles. This gives every player a chance to see what happened from the viewpoint of the other role players. Following this critique, the players and the operator should focus on the reality which has been represented by the game rather than on the game itself.

<u>Rules</u>

A few simple rules are employed; most will be self-evident to the players. The participants are to:

1. Obey the traffic laws that govern their travel behavior, (e.g. one-way streets, no parking, etc.).

2. Account for travel costs, travel time and other travel experiences on appropriate form.
3. Minimize travel time and travel costs, when making mode and route choices as commuters.

These are made clear to the players at the outset, and any changes during play should be posted in a conspicuous way.

Roles

There are two primary role categories represented in this game: local roles and those of commuters who travel through the neighborhood. Assuming that local traffic in the neighborhood is quantitatively neglectable compared to the through traffic, the game ignores the impact of local travel on the overall traffic volume in the neighborhood. It is concentrated on the burden that through traffic imposes on the local people in terms of their travel, and the socio-economic and environmental problems that they experience.

The local roles include both businesspeople / administrators of enterprises (e.g. hospital) and neighborhood residents. The local businesspeople /administrators are motivated by an increase in sales and services provided by their enterprises. Usually this requires an easy access to the enterprises, large volumes of incoming traffic, and ample parking. The businesspeople will favor measures that increase traffic in the vicinity of their businesses and oppose transportation strategies that reduce it.

The neighborhood residents are represented by a number of diverse individuals with a variety of values and goals. These roles include: heads of households, housewives, children, senior citizens, etc. They have a variety of incomes, and levels of wealth, ages, occupations, etc., but they will share a number of values and goals concerning traffic in their neighborhood. The values that are shared include: convenience, clean air, time, aesthetics, safety, mobility, economy and equity. The goals shared by both businesspeople and residents are the same as those incorporated into the role descriptions in the scenario (see page 8).

The neighborhood residents want to decrease the amount of through traffic in their neighborhood. They will generally support strategies that will achieve their objectives, reduce the volume of through traffic, and maintain accessibility. The residents will oppose strategies that will lead to increases in the speed and volume of traffic in their neighborhood, reduce accessibility, or work against their objectives.

The specific local roles described in terms of scenario, travel habits and goals are:

1) The owner of a small business who lives in neighborhood and travels each morning to his local place of business. This person evaluates the performance of his business as a function of traffic in its vicinity.
2) A head of household / home owner who travels from his neighborhood's home to a workplace outside it. He evaluates living conditions and especially the impact of through traffic on the value of his property.
3) A housewife with children who brings children to day-care centers and schools from her home. As such she cares mostly about safety, playing facilities and shopping.
4) A senior citizen who travels by walking to local newspaper stand and socio-recreational facilities. He cares about safety, property value, library, senior citizens center and quality of public parks.
5) The director of the hospital moves ambulances through the neighborhood. He evaluates parking facilities, expansion possibilities, and accessability.

6) The home delivery pizza-shop owner moves a delivery van through neighborhood ond evaluates ease of delivery, land value etc.
7) A teenoger who delivers newspopers on his bike ond cares far sofety, recreation, sociol composition (other friends).

The commuter who travels through the neighborhood is motivated to find the shortest poth (time and distance) to his destination. His destinotion is usuolly work. The commuting population is olso quite diverse. He will generolly support strategies that decreose the length of his trip, decrease the time for a trip, decrease his gas consumption, reduce the weor and teor of his car, ond increase the quolity of the drive ta his destination. He will oppose meosures that work ogainst these objectives.

The transportation plonner believes that the D.O.T. con solve the traffic prablems in their neighborhood. He believes in free choice for the residents, but he concedes thot it does not alwoys work well in practice. He tries to oppeal to reason ond to avoid conflict, and as a result he seems to agree with everyone. His physical plons represent his concept of o bolonced system. While most plonning is incremental he follows a highly rotional model of chonge. His greatest limitotion is thot he has to deol with the city as it is.

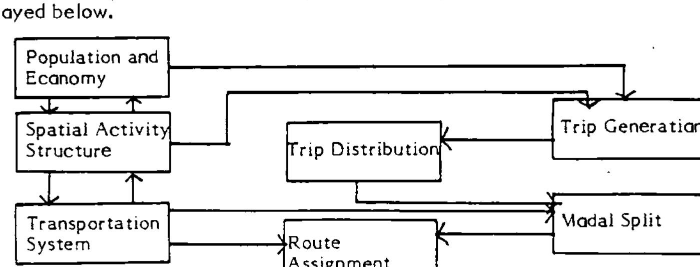
The other "expert" thot hos influence in determining the use of TSM is the transpartation engineer. The engineer believes that although the automabile is the most desirable form of tranportation, it does have its limitations; especially in cities where heavy traffic is a problem. These limitations are due primarily to external diseconomics, (e.g., noise, reduced safety, vibration, congestion, pollution, etc.). To overcome these limitations he desires new constructions: new bus lanes, HOV lanes, traffic signals, etc. He uses "objective" analysis based anly on measurable costs and benefits to justify his positian.

The roles of the transportation planner and engineer are optional and only gamed when the number of participants are between 8 and 10. When there are less than 8 participants the operator will simulate the presence of these roles by taking a more octive role in the discussion.

Models

A model is a representation of reality, showing major elements ond their relationships. These are statements of theory; they indicate definitions, assumptions, and prapositions from available general theories that seem germane. In the game they are used to keep track of logical processes in the accounting system.

The simulation of peak-hour travel behavior requires the application of simple land use and travel demand models that can adjust in response to changes in troffic generators and TSM strategies. The model sequence in a typical transportation analysis process is displayed below.



TSM/GAME/SIMULATION by Adiv/Duke/Geurts/Underwood

A simplified version of this sequence is required to simulate changes in traffic flow in response to the implementation of alternative TSM strategies.

Decisions; Sequences and Linkages

The matrix in figure 3 describes the sequence of decisions and linkages between the players' actions. These represent the typical sequence of decisions that the player can make during a normal cycle of play. Across the top of the matrix are the gamed roles; down the left side are the steps of play.

Accounting System

The accounting system is a set of fixed procedures incorporated directly into the game to deal consistently with player decisions. The transportation demand models will direct much of the accounting in this game. Again, these include simple modal split, and route assignment models. Trip generation and distribution are exogenous in this game. The inputs to the accounting system will include the transportation network and impedances, current traffic volumes, transportation productions and attractions, entities, players travel decisions, TSM strategies and related events. The output of the accounting system will include direct and indirect, private and social costs of this transportation system. Most computations will be accomplished through the microprocessor.

The input from the commuter role into the accounting system assumes given origins and given destinations. For every O - D pair (O=origin, D=destination) the number of trips will be given. The game assumes nine different O-D pairs.

The computer produces 36 commuter option cards (COC) that offer a choice of mode and route. The COCs for a certain O-D pair are the same. A COC would look like this:

COMMUTER OPTION CARD for trip from O_1 to D_2

Mode: / Route:	TRANSIT		CAR	
	Bus	Metro	Single Car	HOV
Non-Through Traffic	1	3		-
Through Traffic Residential	X	X	5	8
Through Traffic Non-Residential	2	X	6	9

Option: pick one of nine options

Every cell contains two pieces of information: estimated travel time and estimated costs.

The cards are distributed in such a way that each commuter receives as many diverse trips as possible. Each player will be asked to evaluate six COC cards. The operator will receive 36 decision cards, being 4 cards for every O-D pair. So, for every O-D pair the total number of trips (input) and the distribution over options 1 to 9 (from players) will be known. The computer-program transforms this into data on volume and speed per street.

For the commuters this is a quick (10 minutes) introduction into the determinants of commuter behavior. A COC-card will sometimes show a number of equal combinations of travel time and / or costs for different choices. These choices will have different impacts on the neighborhood. The players will find out about those impacts later, when they play the local roles.

The most used routes through the neighborhood that commuters will use to get from a certain origin to a certain destination are shown on the COC.

Indicators

Indicators are those aspects of the accounting system that the operator chooses to emphasize for the participants. The indicators describe the games progress. Travel characteristics are emphasized by indicators such as speed, volume, noise, pollution, safety, vibration, comfort and convenience, vehicle mix, and direct /indirect travel costs.

Symbology

Symbology is the physical representation of the indicators. They are visual aids symbolizing the gamed phenomenon. The physical transportation network is represented by a physical map of the neighborhood on the gameboard. It shows the existing road network as well as the land-uses. Characteristics of each road link are described on the map, (i.e., one-way streets, parking, speed limits, etc.). The physical system is also be represented in the microcomputer. The microcomputer has the capacity to adjust the travel characteristics of each link in response to changes in demand and TSM strategies. This information can then be placed manually on the gameboard next to the appropriate links.

The TSM strategies are physically represented on overlays that fit the gameboard. Each strategy has its own symbology and represents a set of rules that will govern travel behavior.

Small playing pieces that represent alternative modes of transportation (automobile, bus, truck, bicycle, walking, etc.) symbolize travelers. These pieces will be moved along the transportation network according to the rules.

A series of event cards corresponding to various levels of traffic congestion dictate the responses of the travelers to the different levels of congestion. Other event cards describe major events that influence traffic on the system.

Street-Event Cards differ for residential and non-residential streets and for different levels of congestion. On some of the links a traveler passes, an event card has to be taken from a stack. The card indicates through a photo or a graph, some of the traffic problems that the traveler encounters, and / or tells the traveler the costs of overcomming them.

The Travel Card is a record of the local trip that every player has to keep in terms of: streets / links passed, time per sheet, costs per sheet, extra time / costs through events, a short note on other happenings.

The Commuter Option Card (COC) presents to the commuter a simple matrix that shows combinations of choices for travel mode and travel route. There are different COCs for every trip from the built-in commuter-origins to the built-in commuter destinations. The card not only shows the options available, but also describes the estimated travel time and costs related to every option. On that basis the commuter has to select one of the options.

SUMMARY

Gaming/Simulation has proven to be an effective technique for enhancing communication among citizens and professionals. It is particularly useful in capturing complex phenonmena associated with a large number of variables. The Gaming/Simulation technique transforms the participant from a passive listener to an active player. For these atributes the gaming methodology was selected as a means to diffuse information about the opportunities associated with TSM.

Simulation per-se is not new to the transportation planner. Network simulations have been used in the tranportation field for several decades. However, in the past simulation was restricted to predictive modelling. In contrast, the TSM Game/Simulation utilizes the methodology for improving communication among professionals and citizens. Participants in the game "discover" TSM through game playing. By playing their role or switching to "act and behave like opponents" they are able to understand better other persons' points of view.

BIBLIOGRAPHY

Adiv, A. (1981), "The Structure of Work Trip Based on Analysis of Trip Diaries in the San Francisco Bay Area," Transport Studies Unit, Oxford University, International Conference on Travel Demand Analysis: Activity-based and Other New Approaches, St. Catherine's College, Oxford, 9-11 July, 1981.

Adiv, A. (1982), "The Commuter's Versus the Analyst's Perception of Automobile Travel Cost," Paper prepared for the 61st Annual Meeting of the Transportation Research Board, April 1982.

Coppard, L.C., and F.L. Goodman (1977), Urban Gaming/Simulation '77, School of Education, University of Michigan.

Duke, R.D. (1970), "METRO-APEX: A Training Exercise in Air Quality Mangement Employing Computerized Simulations in the Context of Urban Regions," Washington, D.C., U.S. Department of Health, Education and Welfare.

Duke, R.D. (1974), Gaming: The Future's Language, Sage Publications, N.Y., 1974.

Duke, R.D. (1977), "National Nutrition Planning in Developing Countries Via Gaming-Simulation," Health Education Monographs Supplement, Vol. 5, 1977, pp. 53-57.

Duke, R.D. (1979), "Railroad Deregulation - A Game/Simulation," Washington D.C., Consolidated Rail Corporation.

Duke, R.D. (1980) "A Paradigm for Game Design", Simulation and Games, Vol. II, no. 3, September 1980, pp. 364-377, (a).

Duke, R.D. (1980), "Format for the Game - Logic or Intuition?", Simulation and Games, Vol. II, no. 1, March 1980, pp. 27-34, (b).

Geurts, J.L.A.,(1981), Model en Spel, De Bijdrage Van Simulatie aan de Planning Van Lange Termijn Sociale Processen., (in Dutch: Model and Game, the Contribution of Simulation to Long Term Social Planning), Dissertation, University of Nijmegen, Nijmegen, 1981.

Greenblat, C.S., and R.D. Duke, ed. (1975), Gaming-Simulation: Rationale, Design and Applications, Sage Publications, N.Y. 1975.

Hickok, B., and Carelyon, C. (1978) Transportation System Management: A Selected Bibliography for Transportation Planners and Engineers, Institute of Transportation Studies, University of California, Berkeley, March 1978.

Jones, Jr., D.W., (1980), Transportation System Management in 1970, State of the Art and Future Directions, "Institutional Dimension of Transportation System Management: A Bottom-Up Approach", Transportation Research Board, Special Report 190, 1980.

Jones, Jr., D.W., Garrison, W.L., May, A.D. et. al. (1978), Transportation System Management: Promise, Performance, and Prognosis, Institute of Transportation Studies, University of California, Berkeley, December 1978.

Jovanis, P.P., May, A.D., and Deikman, A. (1977), "Further Analysis of Selected Impacts of Traffic Management Strategies on Surface Streets," Institute of Transportation Studies, University of California at Berkeley, October 1977

Keyani, B.I., and Putman, E.S. (1977), Transportation System Management: State of the Art, prepared for UMTA by Interplan Corporation, Santa Barbara, California.

Kirby, R.F. et. al. (1973), Para Transit: Neglected Options for Urban Mobility, The Urban Institute, Washington, D.C.

Kruger, A.J., May, A.D., and Cooper, R. (1977), "Further Analysis of Selected Impacts of Traffic Management Strategies on Freeways," Institute of Transportation Studies, University of California, Berkeley, October 1977.

Lockwood, S.C. (1979), "TSM Planning - An Emerging Process," in Gray, G. E., and Hoel, L.A., Public Transportation, Prentice-Hall, pp. 345-381.

Meyers, M.D., and Roark, J.J., "Introduction, Conference Summary and Findings," Transportation System Management, State of the Art and Future Directions, Transportation Research Board, Special Report 190, 1980, pp. 1-8.

Morin, D.D. (1979), "Improved Utilization of Existing Facilities" in Gray, G.E., and Hoel, L.A., Public Transportation, Prentice Hall 1979, pp. 638-661.

Orski, C.K. (1979) "Transportation Planning As If People Mattered," Practicing Planner, Vol. 9, No. 1, March 1979, pp. 22-25.

Orski, C.K. (1980), "Transportation System Management: Obervations and Comments on Future Directions," Transportation System Management in 1980, State of the Art and Future Directions, Transportation Research Board, Special Report 190, 1980, pp. 10-11.

Peat, Marwick, Mitchel, and Company (1979), Study of Parking Management Tactics, prepared for FHWA, December 1979.

Pratt, R.H. Associates, Inc. (1973) Low Cost Urban Transportation Alternative: A Study of Ways to Increase the Effectiveness of Existing Transportation Facilities, prepared for U.S. DOT, Office of Transportation Systems.

Schonfeld, P.M., Garrison, W.L., and Jones, Jr., D.W. (1977), "A Macroscopic Approach to Transportation Policy Analysis," Institute of Transportation Studies, University of California, Berkeley, December 1977.

Shubik, M., and G.D. Brewer (1972), "Models, Simulations and Games - A Survey." Report prepared for Rand's Advanced Research Projects Agency, May 1972.

Shubik, M., and G.D. Brewer (1972), "Review of Selected Books and Articles on Gaming and Simulation." Report for Rand's Advanced Research Projects Agency, June 1972.

Shubik, M. and G.D. Brewer (1972), "The Literature of Gaming, Simulation, and Model Building: Index and Critical Abstracts." Report prepared for Rand's Advanced Research Project Agency, June 1972.

Shunk, G.A. (1980), "TSM: Alternative Institutional Roles, "Transportation System Management in the 1980, State of the Art and Future Directions, Transportation Research Board, Special Report 190, 1980, pp. 22-24.

Transportation Research Board (1977), Transportation System Management, Special Report 172.

Transportation Research Board (1980), Transportation System Management, State of the Art and Future Directions, Special Report 190.

U.S. Department of Transportation (1975), "Transportation Improvement Program," Federal Register, Vol. 40 No. 181, September 1975.

U.S. FEA (1977)) "Guidelines for Travel Demand Analysis of Program Measure to Promote Caprools, Vanpools and Public Transportation."

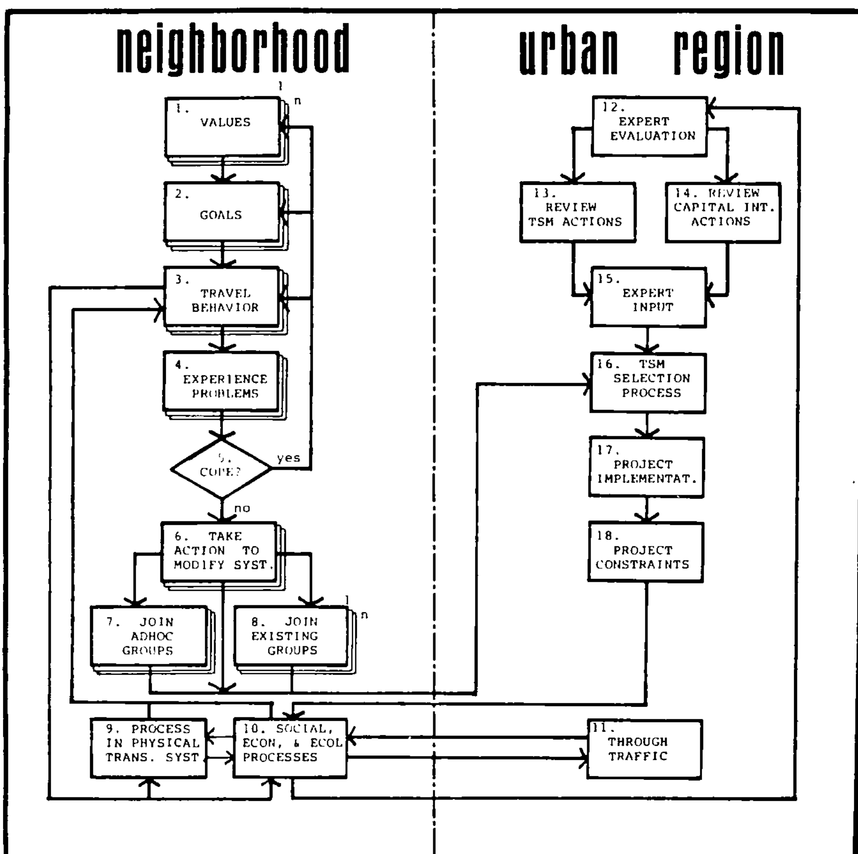
U.S. FHWA and UMTA, "UTSP - Urban Transportation Systems Planning, Computer Package".

NOTE:

Dr. Jac L.A. Geurts is a visiting scholar from the University of Nijmegen, The Netherlands. His contribution is supported by a NATO Science Fellowship administered through the Dutch Organization for Pure Research (ZWO) and by a Fulbright Fellowship.

FIGURE 1

PROBLEM SCHEMATIC AND COMPONENT SELECTION



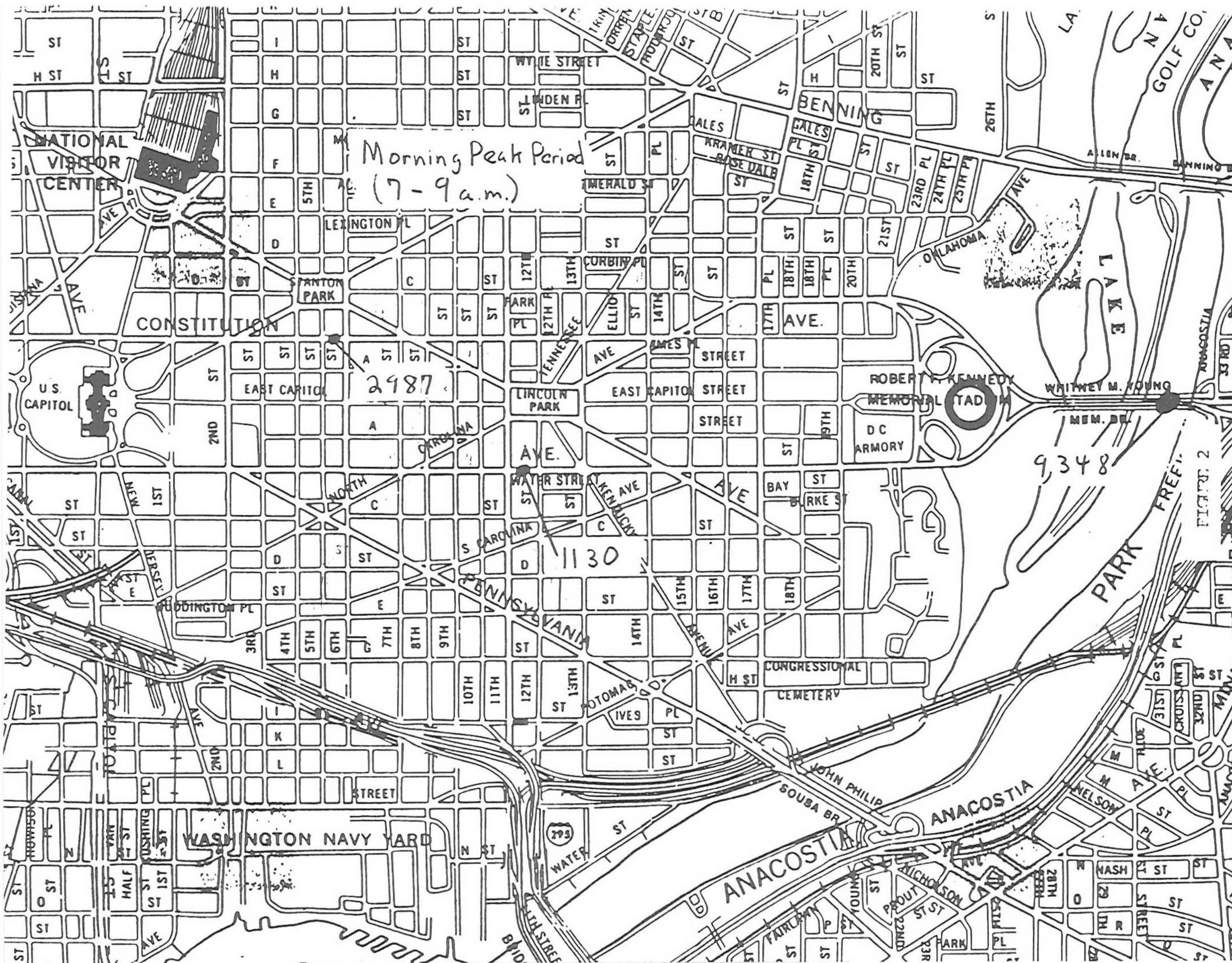

Morning Peak Period
(7 - 9 a.m.)
2987
1130
9,348
NATIONAL VISITOR CENTER
U.S. CAPITOL
CONSTITUTION
EAST CAPITOL STREET
STANTON PARK
LINCOLN PARK
LEXINGTON PL
ROBERT F. KENNEDY MEMORIAL STADIUM
D C ARMORY
WHITNEY M. YOUNG MEM. BR.
BENNING
OKLAHOMA AVE
LAKE
CONGRESSIONAL CEMETERY
JOHN PHILIP SOUSA BR.
ANACOSTIA
ANACOSTIA PARK FREEWAY
WASHINGTON NAVY YARD
PENNSYLVANIA AVE
S. CAROLINA
NORTH CAROLINA
TENNESSEE AVE
KENTUCKY AVE
POTOMAC
WATER STREET
NICHOLSON
NASH ST
NELSON PL

FIGURE 2

ROLES / STEPS OF PLAY	COMMUTER	LOCAL ROLES	OPERATOR
Phase I			
1. Evaluate TSM action		discuss and evaluate	lead discussion
PHASE II			
2. Commuters make trip decisions	receive 6 commuter option cards, make 6 decisions on travel mode and travel route		hand out cards to commuters
PHASE III			
3. Select local role*		select and read role-description card	collect COCs. enter commuter's decisions in computer, show computed results on board
4. Make local trip and record problems/events		travel from a given origin to a given destination, draw event cards, record selected route, travel time, costs and events on travel card	guide through travel procedure, hand out travel cards, prepare output for step 5
5. Receive traffic and socio-economic data from operator and inspect data		receive role-specific output, read role specific output and compare with data on travel card	hand out role specific output to local roles; prepare computer for next cycle

*All participants will perform two roles: One commuter role in Phase II, one role in Phase III. The first cycle will start with Phase III. Phase II will be preprepared.

FIGURE 3