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Proceedings of a Workshop on Interactive Graphics for Transportation Planners

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PROCEEDINGS OF A WORKSHOP ON INTERACTIVE GRAPHICS FOR TRANSPORTATION PLANNERS

by
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INTRODUCTION AND OBJECTIVES

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The workshop attracted transportation planners from transit and regional planning agencies, consulting firms, and local governments. It explored the use of interactive graphics coupled with multi-modal transportation planning.

Several key aspects of the use of interactive graphics were explored in panel discussions and demonstration workshop sessions. These aspects included the evolution of interactive graphics technology, the structured application of this technology in implementation, the operational environment, impacts on planning agencies and future applications of this technology.

The demonstration of applications was made possible by use of Metro's EMME/2 system. Metro is the Metropolitan Planning Organization (MPO) for the Portland area. Metro is the first planning jurisdiction in the United States to use EMME/2, so Metro's experience with the implementation of the system is particularly valuable. After acquiring the Urban Transportation Planning System (UTPS) in 1977, Metro began to look for new technology to better serve their regional transportation planning needs. In 1983, Metro acquired the EMME/2 system. Metro personnel who have used the system on a day-to-day basis have valuable insight into the functional aspects of this new technology.

One important point was that this workshop is not designed to draw comparisons with the UTPS system, or to act as marketing for the EMME/2 system.

The advent of this new technology also provides a challenge to educators to train entry-level people in the use and application of this new technology. To this end, Portland State University is in a unique situation, having access to Metro and a working, practical application of interactive graphics.

THE EVOLUTION OF INTERACTIVE GRAPHICS SYSTEMS

Jerry Schneider, University of Washington
Michael Florian, University of Montreal
Eugene Canty, ETC Associates
Edwin DeLong, Urban Mass Transportation Administration

1. Review of Graphics Systems, Jerry Schneider

    Graphics have always been an integral part of transportation planning and design. Traditionally, graphic output has included desire line maps, travel pattern maps, and various volume and capacity applications. This was generally done by hand from tabular computer output. Since computer graphics began to be developed for transportation planning applications in 1972, there has been no coherent effort developed to implement this technology. In fact, this workshop is only the third such conference in the last

14 years to deal with applications of interactive graphics technology.

Computer graphics technology in transportation planning generally falls into two categories, computer-aided design, (where the results from a simulation model are put into graphic form); and mapping applications, (where no simulation model is involved). The following is a brief overview of some of the important computer-aided design systems that have been developed:

INTRANS-BROWSE was a system designed by Yehuda Gur of the University of Illionis, Chicago Circle. Its primary outputs were maps of UTPS output. The transportation planning community never really accepted this system, although it was used by the Chicago Area Transportation Study (CATS) and Tri-State Transportation in the New York area.

LOCATOR is a computer package which was developed in 1972 as a routine to assist in the location facilities. Its graphic output included histograms, shortest path trees and tables of performance measures. It included two search algorithms to and the formulation of alternative location patterns.

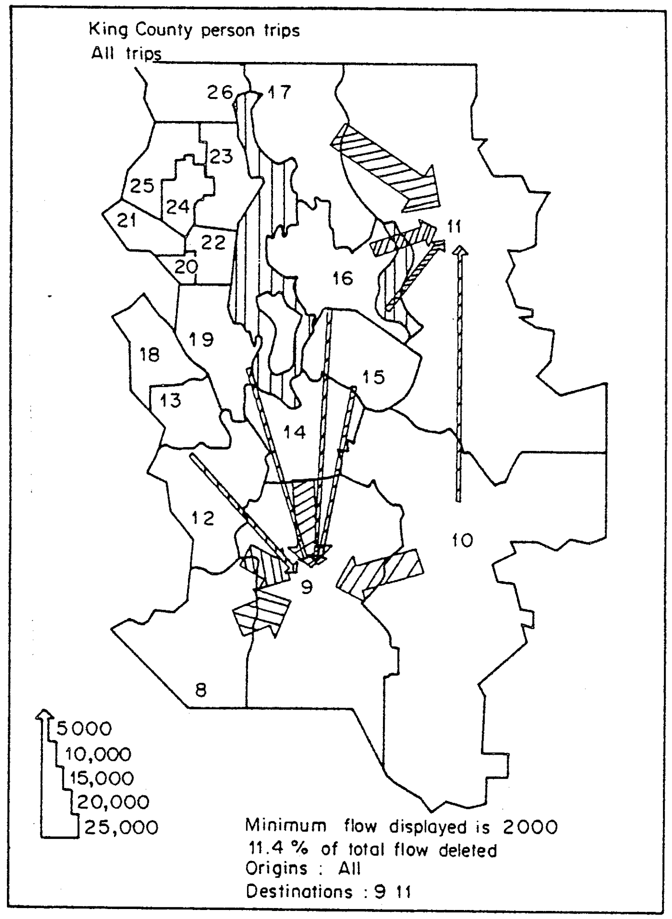
IGTDS, the Interactive Transportation Design System, was designed by Matt Rapp a doctoral student at the

University of Washington, and was the first system integrated with a simulation model. This system produced many graphic displays to aid the evaluation of many alternative transit designs with regard to how well the system might perform, and how service and accessibility was distributed spatially. The system produced both maps and tabular displays. Some displays were similar to those in the LOCATOR package. The system also contained a routine to detect errors in input data. It could handle only the many origins to one destination problems.

TNOP, the Transit Network Optimization Program was also developed by Matt Rapp. The system was designed to deal only with a transit system. This system was applicable to a many-to-many origin/destination problem. This system was applied by the General Motors Transportation Systems Center in Bellevue, Washington (near Seattle). Unique features of the graphic output of this system include a facility for showing transit vehicle locations at specific observation times and isochrone diagrams of transit travel times.

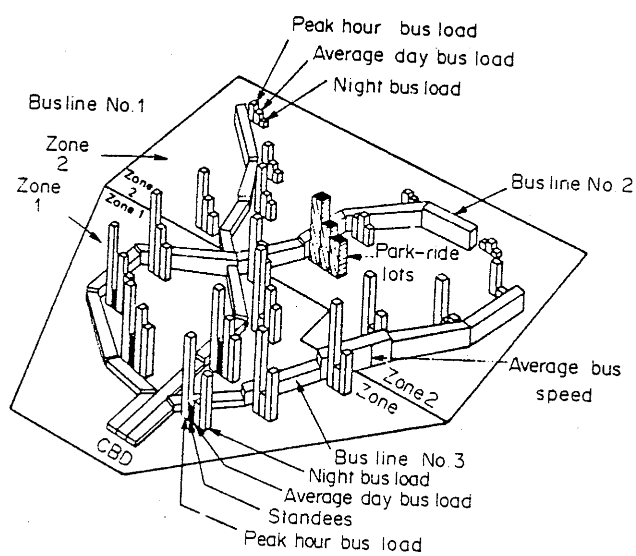
FREGRAF was developed at the University of Washington to evaluate alternative ramp control strategies for large scale simulations of the flows on freeway segments. Both input and output data can be evaluated

FIGURE 1



Many-to-two FLOWMAP display.

FIGURE 2



Three-dimensional displays of origin/destination data.

in graphic form allowing for good contact between the analyst and the data base. The time dimension can be incorporated to evaluate various impacts over time. This system was used to evaluate the impacts of alternative ramp control strategies over a 13-mile stretch of freeway in Berkeley, California.

NETGRAF was also developed at the University of Washington for use with a large scale simulation program called NETSIM. NETGRAF's major application is for evaluating alternative traffic control strategies. It is capable of producing a wide variety of graphics and maps for NETSIM output. Various mapping programs applicable to transportation planning were also discussed. A review of some of these systems follows:

FLOGRAF is a system that can be used to show the dynamics of commuter traffic through time. Graphic output includes traffic densities on each link in the network, histograms and colored network maps. All of these functions can be performed interactively.

FLOWMAP, was designed at the University of Washington. This program can be used to map origin/destination data in a variety of ways. This program also allows the user to modify maps interactively and can deal with any type of flow data and evaluate migration patterns organized in an origin/destination format.

VECTOR ACCUMULATION PROGRAM, is a mapping program developed at the Metropolitan Council of the Twin Cities in Minnesota. Overall traffic patterns and transit trip patterns can be mapped with this system.

CENVUE, is a system that can portray transit data in three dimensions. This system has been used in several Master's thesis projects at the University of Washington.

Development of interactive graphics systems is continuing at a number of institutions. This research is exploring new applications of this technology to areas such as land use management, interactive graphic dispatching of dial-a-ride vehicles, aviation simulations, and visual scene simulations. The continuing development of these systems will require well trained individuals to customize available software and a greater awareness and acceptance by transportation professionals of the great potential (as yet unrealized) for this new technological capability. A more detailed review of applications of computer graphics to transportation planning and design problems can be found in Computers, Environment and Urban Systems, Vol. 9, No. 1, 1984.

2. <u>The Role of the Government and General Motors in Technological Development</u>, Eugene Canty, ETC Associates

Government activity in the development of transportation planning technology began roughly 17 years ago. This first involved the hiring of a team of consultants by HUD to evaluate methods of improvement for urban mass transit systems. This work included a critique of state of the art planning software systems by General Motors researchers. The task of technology evaluation moved to UMTA after its creation in 1969. In 1972, consultants were again hired to critique UMTA and the state of the art in planning hardware and software systems. The main thrust of UMTA's research and emphasis was on new systems and vehicles rather than planning and analysis methods. UMTA has not done a great deal until recently on research into the field of interactive graphics but intensively supported UTPS program development. The role of UTPS and interactive graphics are perceived differently and they perform different functions and can be used in a complementary fashion.

The first development of transportation planning software came as a result of the Interstate Highway Program. These systems had characteristically large data bases geared to large public works projects, and were tailored to a civil engineering perspective. A small number of alternatives were looked at in great detail. The use of multi-objective criteria in transportation planning is a relatively recent phenomenon. Given the nature of large public works projects, and the lack of a large number of objective criteria to be evaluated, analysis procedures did not need to be as comprehensive as they might be in future applications.

Interactive graphics evolved as an alternative to the large-scale, batch oriented environment of early planning hardware/software combinations and to the need and desire to explore a wider range of design alternatives in a more timely manner. This has been a slow change over time, but the need for this new technology is becoming apparent, and many new approaches are being tested.

General Motors began research into new techniques including graphics in the late 1960's. The UTPS process, from the GM researchers' point of view was obsolescent. It was not appropriate to improve UTPS; new techniques and algorithms needed to be developed. Specific attempts to improve algorithms included the integration of specialized fields into the process. These areas included quantitative economics for demand estimation and modal choice; and political, social and behavioral aspects of system evaluation.

Urban transportation-related interactive graphics research at GM in the early 70's was an outgrowth of graphics work already underway for automobiles. Display terminals used light pens and were hard-wired to large IBM mainframe computers with advanced operating system software. Graphics included basic networks and polygonal structures. Emphasis was placed on the integration of geographical zonal structures with traffic and transit networks.

In the late 70's much GM research was done using the Prime series mini-computer with PRIMOS operating system. Hardware and software could be made more easily adaptable to various organizations than was the case with the large mainframe applications. This system had large data storage capabilities, a very fast CPU, and was applicable to complex analyses. Contemporary with this technology was the advent of the Tektronix 4010 series terminal which utilized storage tube technology and produced high quality graphic output for a modest cost. This type of terminal could be connected over telephone lines to a mainframe or minicomputer, thus allowing much easier access to a greater variety of users.

This transferability theme was a recurring one for GM in its research. GM acquired the IGTDS package and recoded it for use on IBM operation systems. Careful documentation made the system more usable for those without prior computer experience. A copy of this recoded system was made available to UMTA who did a design application in conjunction with Seattle area public agencies. The results showed a significant productivity influence with planning professionals. This increase was measured at 700 percent.

GM also acquired the NOPTS program package under license from Dr. Matt Rapp. It was extensively rewritten and recoded into the TNOP package which along with IGTDS was marketed to a number of public agencies and universities by GM and since 1981 by ETC Associates.

Future directions for research appear to be the continuance of transferability of software systems for a variety of operating environments, the integration of planning and operations, and the integration of zonal structures with implicit socio-economic data and political boundaries into the software systems.

Beginning in the late 1970's and continuing to this date, General Motors has also been active in the development and application of transportation planning software and interactive computer graphics to its industrial and commercial activities. One example of this is the use of computer graphics and special algorithms as an aid in location planning and analysis of automobile dealerships in most medium and large urban areas. Current work at GM extends both to large-area computer networks and to stand-alone computer graphic work stations incorporating supermicro computers.

3. <u>The Academic Perspective on the Development of Interactive Graphics</u>, Michael Florian, University of Montreal

The Transportation Research Center at the University of Montreal has been very active in the development of interactive graphics systems in transportation planning, in particular the development of the EMME/2 system. The important developments that led to the eventual creation of EMME/2 will be discussed in the following paragraphs.

In 1972, the Ford Motor Co. supplied a grant for transportation modeling research. A great deal of theoretical work was done, looking at the way one represents traffic and transit, and simulations involving flows and modes in a mathematical way. This theoretical research led to a better understanding of the underlying mathematical processes in transportation modeling.

In 1976, work began on a multi-modal integrated model. Also in 1976, a pilot implementation project of this multi-modal system was done to test its practicality. This system was known as EMME (a bilingual acronym for Multimodal Equilibrium). In 1979, the system was tested in Winnipeg. Results were very encouraging as far as the applicability of this system to an actual planning situation.

As head of the Transportation Research Center, Michael Florian traveled to Lausanne, Switzerland in 1976 to visit the Institute for Techniques in Transportation. There he met with Matt Rapp, creator of TNOP. The ease of use in interactive graphics was very appealing. This initial contact with interactive graphic technology motivated the development of a new, interactive graphic version of the EMME system, which later would be known as EMME/2.

The use of interactive graphics involves a different view of transportation planning than is traditionally held. The four stage model in popular acceptance represents a straight jacket approach to planning with the same process being used to evaluate a large number of diverse situations. The development of the mathematical models used in EMME, and the interative aspect of graphics is seen as a way of introducing flexibility into the planning process. Important attributes of interactive technology include interactive access to the data base, to analytical tools and to analyzing results.

The team involved in the development of EMME/2 at the University of Montreal was a small, inclusive group. Heinz Speiss, who did part of his Ph.D. dissertation at the University of Montreal on the design of EMME/2, made a major contribution to the work of this team. It should be noted that Heinz Speiss also contributed to the programming of TNOP before coming to Canada.

One important caution to the use of interactive graphics is that impressive graphic and interactive capabilities could be compromised by poor underlying models. In the case of EMME/2, no compromise was made, with the underlying mathematical models being very much able to stand on their own without the flashy graphics.

4. The Role of UMTA in the Evolution of Interative Graphics, Edwin DeLong, UMTA.

Interactive graphics have had a hit-or-miss pattern of development. High costs led to the necessity of large organizations undertaking research. Federal funding has been instrumental to the development of this technology. In the last two or three years, federal funding has been drastically cut. The installation of EMME/2 at Metro was partially funded by a Section 8 grant, which UMTA hopes to continue.

UMTA's involvement with interactive graphics began in 1976 when the rights to TNOPS were acquired. UMTA renamed the system ITAM. This was a very expensive system, and it was difficult for many agencies to justify the expense. UMTA gave a series of seminars to promote the use of the system. Even in a time-sharing environment, this system proved too costly to gain widespread acceptance.

In 1978, UMTA made UTPS available with IGTDS and TNOPS as options, all compatible with an IBM operating environment. After this point, UTPS has not been developed further, with the main thrust of UMTA's research being in the field of microcomputers. Areas being investigated most heavily for the application of micros are transportation systems management and operations analysis. Future areas of research will include conversion packages to give PC display screens high level graphics capability, and thus making interactive graphic technology more readily available to a larger number of jurisdictions at a reduced cost.

THE EVOLVING POLITICAL CONTEXT OF URBAN TRANSPORTATION PLANNING,

Rick Gustafson, Executive Director, Metro

There is a perceived gap between state-of-the-art technology and the implementation of that technology into the political process. This is a gap that needs to be closed. As a general rule of thumb it has been said that the political process is about ten years behind the technology, but that gap is closing with the advent of user friendly advanced computer technology.

There is a need in planning in general, and transportation planning particular, to be flexible, to be able to change and not to implement rigid unbending plans to be followed at all costs. Planners often have to learn to be more flexible. Although this is not easy, it is required if a planner is to be successful. There is a problem in pursuing one train of thought or underlying philosophy in planning, and this can be seen through our experience with the freeway revolt in the late 60's and the periodic shifts in planning philosophy from neighborhood preservation to freeway removal.

There is a big difference between planners and politicians. The politician is an individual charged with reflecting public opinion, whose chief goal is to remain in office, avoid controversy and maintain control over those things that might generate controversy. Politicians are also responsible to provide the assumptions that technicians and planners use to provide information and to develop plans. These assumptions can change dramatically. If planners raise themselves above the political process, they lose the ability to discuss important issues and probably won't last long in the profession. This is a dangerous mistake to make.

In Portland, there have been cycles of controversy, which influence how and when things get done. One such period was in the mid-1970's when the I-205 freeway was being built. Multnomah County had a terrible time deciding on the configuration of the freeway even though the land had already been purchased. Also, the demise of the Mount Hood freeway occurred during this time, and highway and transit interests fought bitterly over the disposition of the surplus funds. One very subtle but extremely important accommodation made during this time occurred when the Chairman of the Oregon Transportation Commission, the President of the Tri-Met Board, and Portland's Mayor Neil

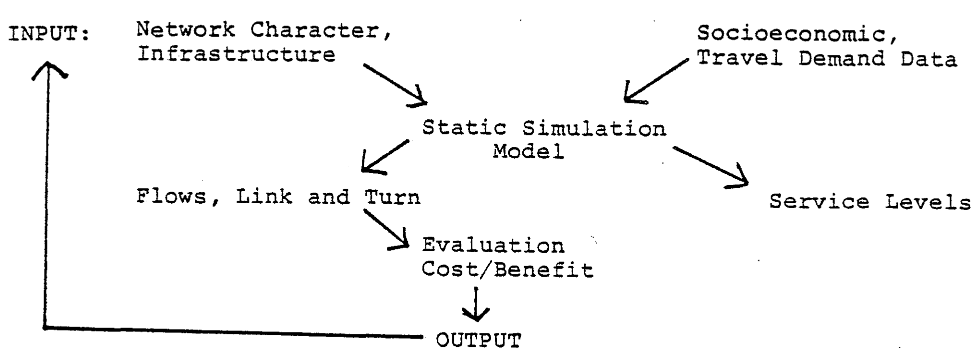
Goldschmidt met to try and put a stop to this competition and war of numbers. With each jurisdiction producing its own set of numbers, traffic counts, ridership information and so forth, the planning process was confusing and local governments had a difficult time understanding what was going on and why nothing was being accomplished. The result of this meeting was that regional transportation planning was to be consolidated into one jurisdiction, CRAG (Columbia Region Association of Governments, the predecessor to Metro). This critical decision resulted in a pooling of resources that essentially made it possible to develop the transportation planning system at Metro to its current level. In the late 1970's, the glue that held this consensus together, Neil Goldschmidt, left for Washington. The people of Portland elected a mayor who was in total opposition to the process, a governor was elected who didn't know anything about it, and a President was elected who wanted to destroy it. Through all this, the system persists, and is still functioning well in what has been an almost diametrically opposed political environment, because it works and because it uses its power effectively.

The Executive Director of Metro really must play two roles. As an elected official, responsibility is to constituents in the region because Metro is a regional government. Also involved is the role as the head of the Council of Governments. As Metro's political leader, the executive must exert political leadership on behalf of the region's interests, and as director of the COG, the responsibility is to build consensus so all of the other governmental bodies can make decisions for themselves. These two roles are often difficult to reconcile. As a COG, Metro has been very successful. Metro provides the table for other jurisdictions to sit down and build a consensus, and Metro has been very helpful in providing high quality information for these decisions and helping to forge consensus.

DESCRIPTION OF THE EMME/2 SYSTEM,

Michael Florian, University of Montreal

This presentation is a combination of three programs which detail what EMME/2 can do, examples of plots and graphic output and a simulated interactive session. The transportation planning process implicit in the use of the EMME/2 system is as follows:



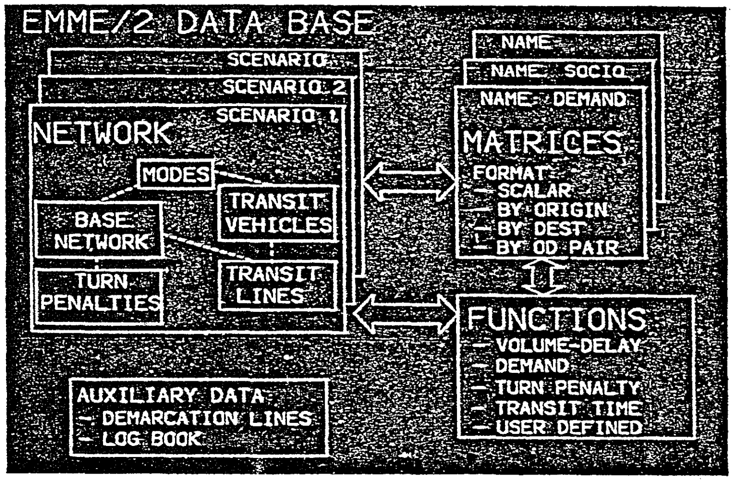
Input Data for EMME/2 includes several types of information. Network infrastructure is necessary, which includes all movement by car, by transit or walking. Origin/destination data is also necessary, as is output from travel demand models. EMME/2 has a variety of conventions to handle the coding and integration of this information into the data base.

Simulation models in EMME/2 include such facilities as equilibrium assignment, shortest path, with a bi-modal assignment in the development stages. The results of these simulation models take the form of traffic and transit volumes, mode split, transfer volumes and a variety of other manipulations.

Algorithms in EMME/2 include an equilibrium assignment algorithm for road traffic which incorporates turn penalties at intersections with fixed or variable demand. The transit assignment algorithm is multi-path and can be used for transit modes and auxilliary transit modes. This algorithm is built on behavioral analysis and integrated pedestrian movement. An equilibrium assignment is also provided for a multi-modal assignment. The modes which may be used in the assignments include auto, transit and auxiliary transit.

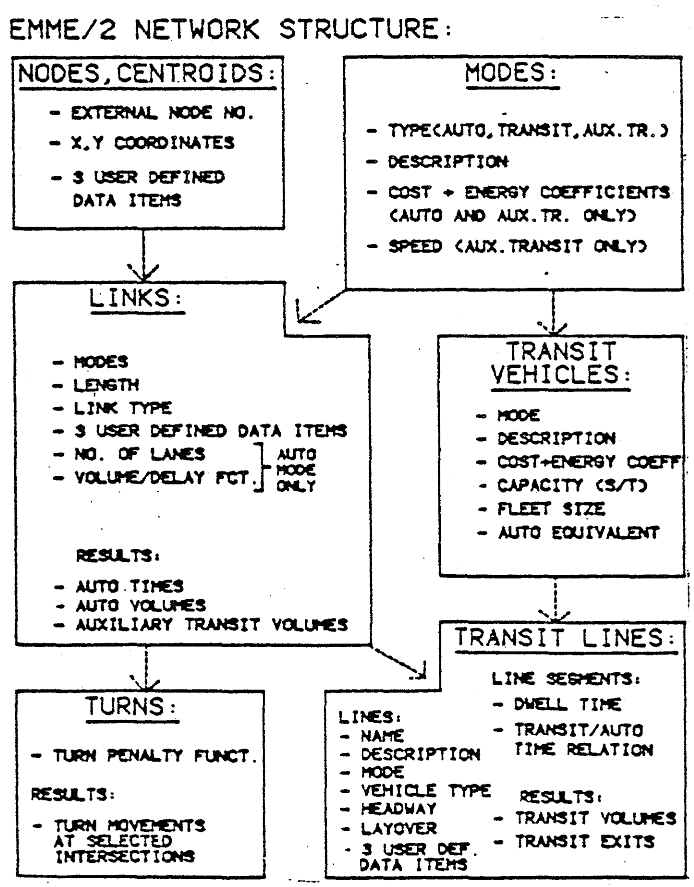
There are many advantages to the use of interactive graphics over traditional planning packages. These include: the ability to look at data once it is stored; the graphic representation of data for error checks; more time

FIGURE 3



EMME/2 DATA BASE

FIGURE 4



EMME/2 NETWORK STRUCTURE

Source: EMME/2 - User Oriented Materials and Documentation.

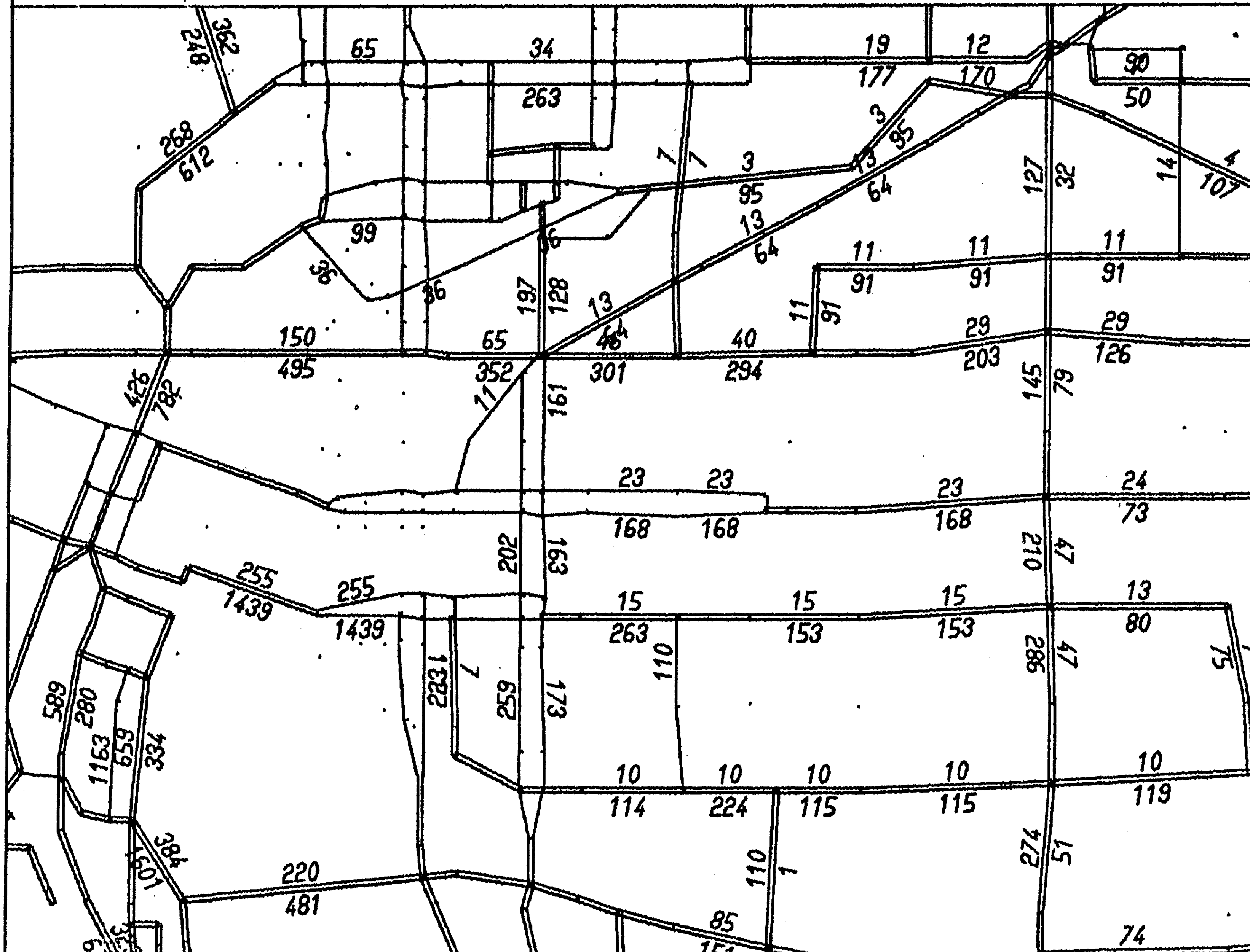
available to plan; results can be graphically communicated; and, the assistance of a computer programmer is not needed to operate the system in a normal planning environment.

From the aspect of computer design, EMME/2 has many attributes. These include an efficient data base design, the ability to see network and matrix data, transportability, a modular design, uniform program personality and an efficient man/machine interface. Data can be checked at entry for errors. From the standpoint of the user, EMME/2 was designed for ease of operation and incorporates the following design characteristics: a consistent form of notation in the menu-driven programs, selective data access, interactive calculators, and interactive graphics worksheets.

The EMME/2 data base consists of four major elements: network data, matrices, functions, and auxiliary data. Network data includes the base street and highway network and transit lines and vehicular characteristics. The matrices can be scaler, origin/destination, or origin/destination pair. Functions in EMME/2, which are treated as data include volume delay, demand, turn penalty, transit time functions and any functions the user wishes to define. Auxiliary data can consist of demarcation lines for geographical characteristics and a user log book. All of these elements combined constitute a scenario, although a scenario need not contain all of the elements. Each scenario could describe a different design alternative, and different scenarios can be compared. Network data can be selectively accessed in the form of partial networks of nodes and subnetworks of links. Matrix data that can be selectively accessed includes origin/destination submatrices and a constraint matrix.

Plots display the data base graphically. The example plots given were from a Tektronix 4114, a high resolution monochromatic graphics terminal. Many characteristic plots were shown. The windowing feature allows the user to either look at the network as a whole, define a window using croshairs or x,y coordinates or to center a window of a given diameter on a specific node. In addition, the window has a zoom feature that allows the user to expand or contract the field of view, or to walk the window across the network. EMME/2 displays nodes with or without numbers and the user can specify the height of node boxes and numbers. A variety of characteristics can be plotted by EMME/2 on the auto network These include, among others, detailed drawings of turning movements at intersections, displays of traffic volume on links and at nodes, and shortest path trees on the base network defined by time or distance. Transit network plots include transit volumes at nodes and on links, transfer boardings and alightings at nodes, in addition to all of the network plotting capabilities that do not display assignment results. Functions and matrix data can be

TRANSIT VOLUMES



emme/2

LINK TYPES:
11 TO 18
21 TO 28

TRANSIT LINES:
ALL LINES

THRESHOLD:
LOWER: .0001
UPPER: 100000

WINDOW:
LL: 26/30.51
UR:29.67/33.27

EMME/2 PROJECT: EASTSIDE 1983 CALIBRATION
SCENARIO 8301: 83 PM ODSRVY Assignment

DATE: 85 03 20
MODULE: 6.22
USER:1473/ dw

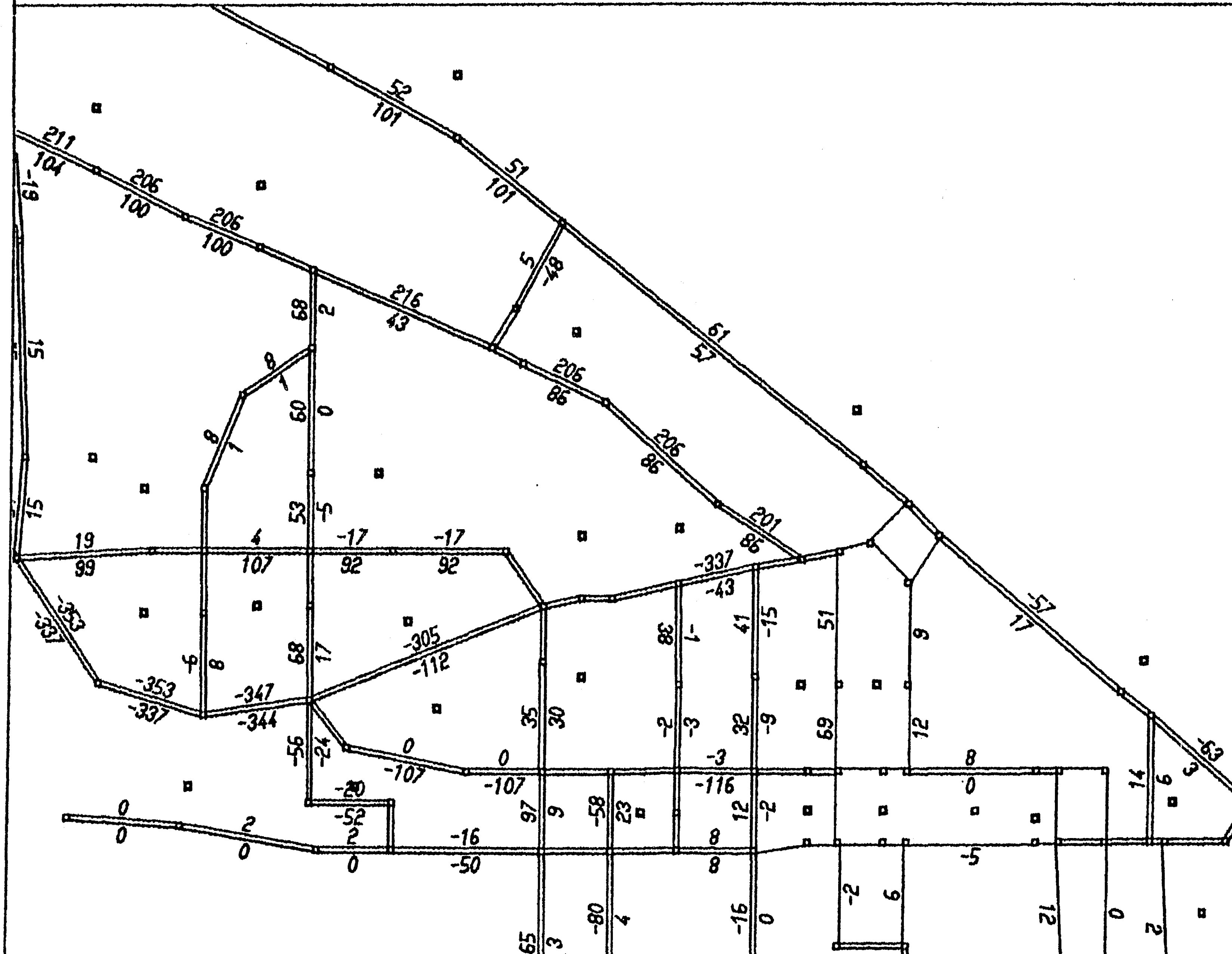
TOTAL VOLUMES ON AUTO NETWORK

DIFFERENCE SCENARIO 4444 - SCENARIO 1111

emme/2

LINK TYPES:
21 TO 28

THRESHOLD:
LOWER: -10000



WINDOW:
LL:24.37/33.82
UR:25.99/34.24

EMME/2 PROJECT: NORTHWEST TSM TRAFFIC STUDY
SCENARIO 4444: St Helens Rd one lane each direction (Copy of 8888)
SCENARIO 1111: Steel Bridge link removed

DATE: 84 88 14
MODULE: 6.13
USER: 1479/ fdn

displayed graphically also, with functions as line graphs and matrix data as histograms or paired bar charts displayed on the network. All of the information contained in the plots can be read as tabular data also, with transit line summaries and itineraries being one example.

When used interactively, EMME/2 modifies the data base to reflect changes. For example, if a certain link were removed, EMME/2 would remove it from the node and link files, and the assignment would be redone to reflect the change. The specific calculators that reflect interactive changes include for matrix data, zone numbers and zone groups and for network data, link data, i node, j node and all node data calculators.

IMPLEMENTATION ISSUES

Keith Lawton, Metro

The integration of new technology into transportation planning in an agency requires many adjustments and consideration of many issues. Metro acquired EMME/2 in 1983 and began its use while the UTPS system was fully implemented.

Selection

There are a number of important characteristics that should be taken into account in the selection of a transportation planning package. These include the comprehensiveness of the package, relative expense, ease of use, and the prospective computer environment (whether it is used on a mainframe or a dedicated mini or microcomputer). The system must be a proven system, one which has undergone sufficient testing to assure consistent output and accuracy. Also, the availability and quality of graphic output and the sophistication of data manipulation and model structure are important factors.

More specific choice criteria pertain to functional aspects of the system. Ease of use usually involves a menu-driven system with graphic input and display capabilities. Multi-modal analytical potential is especially important for an MPO, which must consider many different modal alternatives. The framework for triptable preparation is also important and has direct bearing on the ease of matrix manipulations. The new system should also have consistency with the existing modeling environment in the agency. A structural similarity to the existing modeling system can reduce expense and problems in initial implementation. In terms of system performance, it is important to have good network assignment capability. For highway networks, this would include a capacity restraint/equilibrium capability, and for transit, a stochastic or multi-path assignment.

Implications

Graphical output has many implications for the planning agency. Analysts can be more productive, as more scenarios can be compared in a shorter period of time. In general, analyses can be more complete. However, this all requires a very good assignment procedure with a large number of analysis zones and a good algorithm; graphical output is to some extent wasted if the assignment still requires manual "smoothing".

There are several other implications with an easy-to-use graphically based system. One is that it is also easy to make big mistakes quickly. There is a temptation to use less qualified staff with the system. Users still need a good understanding of the zone structure, underlying modeling assumptions, calibration and limitations of the system. This type of system allows a shift in the skills needed in the planning office. Planners can spend less time being "computer jocks" and more time being transportation planners. Consequently, programming, particularly job control language skills, will be needed less. The availability of such a system does not lessen the need for good transportation planning skills. It will, however, improve the productivity and quality of work from experienced and trained transportation planners and engineers.

Implementation Experience

As mentioned earlier, Metro began implementation of the EMME/2 system in 1983 in conjunction with the continuing use of the UTPS package. Two overriding considerations were used in formulating the strategy for the implementation of EMME/2. These were that the work flow would not be interrupted, that the simultaneous use of EMME/2 and UTPS on different projects would be necessary. Because UTPS is weak in assignment results, this function should be moved first. The implementation was planned in two stages:

<u>Stage 1</u>

Trip table preparation and matrix manipulation would be left on UTPS.

Network preparation, assignment and analysis of results would be switched to EMME/2.

<u>Stage 2</u>

Migrate full model to EMME/2 and Pixel, including:

- triptable preparation
- matrix squeeze/expand operation

Carry out complete re-calibration

- This opportunity is being used to change the basic zone systems which affect model application.

Specific tasks included in the first stages of implementation included the transfer of the existing UTPS network base from UROAD to EMME/2 through downloading. Triptables were also downloaded. Next, transit networks were built and updates and modifications to the networks were made. Metro's experience is that it is possible to fine tune a network more easily on EMME/2 than on UTPS. A number of new scenarios were created and assignments were done. In the assignment procedure, one hour per iteration is required, due to computer limitations and the fact that we are using a zone and 8000 link system. Most often assignments are done overnight (10 to 12 iterations).

In the second stage of implementation, matrix manipulations created the most difficulty in transfer and re-integration into the EMME/2 system. The notation and approach to triptable preparation in EMME/2 is different from that of UTPS. This phase of implementation might be much easier if there has been no previous experience with the Umatrix conventions on UTPS. Discussions with the staff of the greater Vancouver Regional District in British Columbia confirm this. In matrix manipulations, Metro is finding that the new system configuration is relatively slow and cumbersome and requires a great deal of space to execute. We are planning to write our own procedures in programming language "C" in the Unix environment (outside of the EMME/2 package). In order to alleviate the problem of EMME/2 having no simultaneous matrix squeeze/expand function as in the Usqueeze function of UTPS, Metro has written procedures in "C" which are used in the Unix environment and batched-in to EMME/2. Another problem being faced by Metro is that the constraint of one user per data base leads to the creation of multiple data bases to run parallel tasks, leading to an increase in time and space requirements.

The Metro configuration of EMME/2 contains a Pixel mini-computer. This system configuration brings several benefits and several practical constraints. The EMME/2 system itself is unlimited in the number of zones and links that can be coded, but the Pixel imposes practical limits. Currently, Metro is using 400 zones, 2500 nodes and 8000 links. Typically, 5 or 6 users are logged on to the system simultaneously, and two EMME/2 data bases can be used at once. Heavy demands are created when network updates, an assignment, and matrix calculations occur simultaneously. This leads to a slow down of the system and much slower response in terms of graphic output. As is typically the case, the ease of use of the system has led to an increased number of users and a much greater demand on the system. It should be noted that Metro does not use the Pixel solely for EMME/2, it is used by the agency for a variety of tasks. Advantages of the Pixel include its very fast CPU and access to a plentiful array of software. It is, however, rather slow in its tape and floppy disk back up and I-O processor.

The Pixel has proven to be an extremely cost-effective system, with an initial purchase price between $25-35,000. The combination of the EMME/2 software package and the Pixel has resulted in halving Metro's computer costs when compared with previous use of the UTPS system. It is estimated that the implementation of the EMME/2 system at Metro has more than doubled planner productivity, with a much greater quality of output.

THE QUICK RESPONSE SYSTEM

Gary Spanovich, Transportation Consultant

The Federal Highway Administration's Quick Response System software package was utilized in several transportation planning applications. Through these applications, some general conclusions can be drawn as to the system's strengths and weaknesses and the role it can best play in the planning process. The system has been used with other software systems, so that each system can do that part of the planning process that it does best. An evaluation of the QRS and other microcomputer packages were discussed. Although QRS is not a graphics package it is an option to EMME/2 for some users.

The three test cases cited where QRS was used for all or part of the analysis include:

1. The transportation implications of alternative comprehensive plans for the city of Las Cruces, New Mexico.

2. Transportation Planning implications of a 200 acre and a 400 acre comprehensive plan change from residential to high tech industrial zoning for Clackamas County, Oregon.

3. A transportation analysis of alternative land use development scenarios for the Portland International Airport.

Through this experience, QRS can be evaluated through a variety of applications.

The QRS software system simulates the following:

1. Trip Generation: Based on land use forecasts, the number of future trips are produced by geographic area (travel zone).

2. Trip Distribution: Three trip purposes, home to work, home to other, non-home based trips, triptables are calculated for all inter and intra travel zone person trip movements.

3. Mode Split: Transit and highway trips are identified using a modal split model which converts person trip tables to vehicle trips and person transit trips.

4. Traffic Assignment: Vehicle trips are assigned to the highway network.

The QRS system operates on an Apple II or IBM PC microcomputer under the USCD-p-System Version IV. Two disk drives and 64k of RAM are required.

The QRS system's greatest strength appears to be in the trip generation and trip distribution phase. Given land use data, triptables can be generated in a day or two. In the trip distribution phase, the inputs of productions and attractions are used to create a travel time matrix with three outputs, zone to zone trips, trip length and trip end summaries. The mode choice model is rudimentary, using gravity model outputs. The assignment phase is a many-to-one assignment which identifies O/D pairs. It is also relatively cumbersome, and contains no volume/capacity analysis function.

The QRS system appears to be at best when used in conjunction with other software packages. In this way, the relative strengths of the different packages can be utilized. In this type of analytical framework, QRS is generally used for trip generation and distribution. Overall, QRS appears most useful when used in small urban areas as a sketch planning tool.

To supplement the QRS system, other off-the-shelf software packages can be used for mode split and assignment. IRAP, Interactive Routing Assignment Program and CAPCALC, Capacity Calculations are distributed by Roger Creighton and Associates. IRAP utilizes travel impedances and triptable inputs to perform an all or nothing assignment. IRAP output consists of intersection traffic volumes by approach and movement. These become inputs to CAPCALC which calculates a volume/capacity ration and a Level of Service. Whereas these software packages work very well together, when used alone they can be quite limited.

A current application of a combination of software packages is being done as part of a traffic study for an Environmental Impact Statement for Clackamas County, Oregon. This methodology utilizes QRS and the County's IBM PC for trip generation and triptables, EMME/2 for the traffic assignment and CAPCALC to analyze intersection capacity.

By combining readily available software packages, the transportation planner can create a system that is superior to each of its individual parts. It is important to be on the lookout for new packages that can enhance current ones and to be aware of the best applications for each individual package.

THE APPLICATION OF THE EMME/2 SYSTEM IN PORTLAND, METRO CASE STUDY

Andy Cotugno, Transportation Director, Metro.

Two major topics are addressed. First, how the transportation modeling process is structured at Metro for analyses of the Portland metropolitan region and second, some case study examples.

Since computer modeling first began at Metro in 1976, the process has been gradually refined over time. The first plans developed using computer modeling were quite sketchy compared to what is possible today. As analysis became more detailed, more and more travel analysis zones were added to the system. This increase in zones, while necessary for a good level of detail, was quite expensive. Given capacity constraints of the system, and the increasing cost of the larger zone networks, the zonal system has been broken down into three networks. Each zonal configuration is used to window and highlight a certain area. In the Portland area, the zone systems include the westside, eastside and central area, and the bi-state network incorporating Clark County.

The zones are quite fine around the area of interest, while other areas are represented by a more coarse system.

Trip Generation is done for all 1400 zones. Trip distribution is done at the sub-network level and assignments are also done for each of the four sub-networks. Of the four networks, the bi-state is the only one still using UTPS exclusively. The other networks are on EMME/2. The central area was not created as a separate network, but obtained by factoring the eastside network. Again, the size of the individual sub-networks is a function of node and link limitations on the system. Sub-networks reflect implementation of a window of detail and a generalized connecting region.

In addition to transportation planning for the region, another Metro function is the formulation of population and employment forecasts. These forecasts form the base for all transportation modeling. The forecasts are adopted by the Metro Council with little public discussion, but based on considerable input from local planners. Triptables in current use are mostly calibrated from 1980 population and employment data. The 1983 mode split is still being calibrated. Calibration has been assisted by a 1977 in-home survey by Metro of O/D data where all pertinent information was obtained. A new survey is being planned for this Spring. Also, a 1983 on-board O/D survey conducted by Tri-Met the regional transit agency, is being used to calibrate the mode split model. Having the population and travel forecasting functions in the same agency is an advantage of the MPO for regional transportation planning.

The combination of UTPS triptables and EMME/2 networks have been used in a number of applications. These include Banfield Freeway Ramp closures, downtown, central area and Northwest area street closures and the Steel Bridge closure. These applications are all connected with the upgrading of the Banfield Freeway and the construction of the new Banfield Light Rail line. Year 2000 studies include McLoughlin Boulevard options, Johnson Creek Boulevard options, the Gladstone Parking Plan and options for 257th Avenue. Another application of EMME/2 was the analysis of Tri-Met's 1983 O/D survey. An encouraging result of these studies is that in the case of the Banfield ramp closures, actual on the ground traffic counts are very close to those predicted by EMME/2.

The subnetwork zonal aggregations are working well, and are currently being used in a variety of analyses. The networks are constantly being updated and revised. In the future, greater capacity might allow for even larger and more detailed subnetworks.

THE FUTURE OF INTERACTIVE GRAPHICS

Andrew Davis, Tektronix.

It is difficult to predict the state of the art of interactive graphics in five years. This stems partly from the swift integration of interactive graphics into computer-aided design which has already occurred. The next five years will invariably see a decrease in cost of interactive graphic systems, a more widespread use of such systems, higher quality systems and greater compatability between systems.

Graphics is a key interface between the user and the computer. In the past, color was often considered unnecessary. Nowadays, the capability to utilize the human visual system leads to much higher performance and greater ease of use and understanding. Today's high performance systems utilize up to 256 colors, and in some systems, the user can adjust the colors to fit their own needs. High resolution is also important. In today's graphics, good resolution is about 100 pixels per square inch. In five years, resolution will be higher and have less distortion. Flat panel displays use less power, are lightweight and not as bulky as traditional display terminals. Because the panel is flat, distortion induced from a curved tube surface will be eliminated. These displays may be as large as a desk top for critical work.

Three-dimensional applications will also be important in the future, and are changing the way we think about three dimensional modeling. Eventually, physical modeling might be eliminated altogether. Three-dimensional depth algorithms are currently being improved to add more realism to the display. Currently, a three-dimensional display takes two to three hours to produce. In five years, these displays could take as little as five minutes. Another key trend for the future in graphics is that of standardization. This would open up greater communication and exchange possibilities as well as giving the user access to a greater range of data. This trend could lead to the creation of common data bases, which could greatly reduce the cost of data base maintenance for each group of users. Another trend for the future is the increasing quality of hardcopy output. These improvements will be necessary to match the subtle color variations possible with more sophisticated color graphics. The current problem of raster stair-stepping will be eliminated in the more advanced future systems.

The programmable work station will greatly increase user productivity. Major trends in these work stations include greater use of graphics, and the standardization of interfaces. Whereas menu-driven programs are easy to use, they are often rigid and tightly structured. Future menu-driven software will have to be more flexible to add a dimension of user creativity. Also in the work station of the future will be a greater use of icons, compact visual representations similar to what is used with the Apple MacIntosh and other PC's. Also, the display screen will be able to be broken up into windows, so the user can deal with several graphics applications at one time. Interactive graphics editors will also be incorporated, and should make graphic editing as easy as using a pen and pad. All of these improvements are designed to enhance productivity and especially creativity. These future developments will also reflect a trend toward standardization across functions and a greatly reduced learning time.

Future products might also integrate artificial intelligence, where computers actually use logic and reasoning to solve problems, and where computers will be able to write programs. Research is being done in this area by interviewing many experts in various disciplines to document the logic used in their thought processes for integration into a computer decision-making routine.

In summary, the most important future trends in interactive graphics and to a large extent the entire computer industry, is that of the standardization of user interfaces into common data bases, the growth of artificial intelligence and natural languages, and increasing quality of products at a generally decreasing price which will result in a greater dispersal of computer technology.

THE IMPACT OF INTERACTIVE GRAPHICS ON PLANNING AND PLANNING ORGANIZATIONS

Andy Cotugno, Metro
Ken Dueker, Portland State University
Sy Adler, Portland State University

The Impact of EMME/2 at Metro, Andy Cotugno

Two types of impacts will be discussed. The first is the impact that modeling has on the planning organization, i.e., in-house modeling as opposed to contracting out. The second set of impacts are the specific impacts that EMME/2 has had in the Metro organization. These will be viewed from the perspective of the MPO, drawing on the author's experience with in-house modeling at Metro and with contracted modeling as in Columbus, Ohio.

A first major decision to be made if you choose to do in-house modeling, is that you must attain some expertise in that field. Qualified staff are crucial to any modeling effort. Metro currently has five full-time staff working in transportation modeling. Good staff people are expensive, but their expertise is indispensable.

One impact of EMME/2 at Metro is the increased dispersion of information. Travel forecasts are coming into broader use, and with this comes the need for increased public and technical scrutiny of these forecasts. The validity of the information is that it must be believable. The use of interactive graphics helps in this validity issue. The model displays not only output and results, but the internal workings of the model. This could be termed "glass-box" modeling as opposed to the old concept of the "black-box". Interactive graphics tools are much more productive than those of the traditional batch environment. There is at this point a trade-off between in-house modeling done on a microcomputer and contracted modeling done on a mainframe. The micros are slower than the mainframes, and often large jobs, such as matrix calculations and assignments must take place overnight.

Interactive graphics also help change the type of planning work being done. Long range planning is more productive, and hence more time can be alotted to important short-term plans. For example, short range planning will be done to a greater extent than the past in transit planning, with some actual service planning to be done for Tri-Met's Transit Development Plan. Construction impacts have been analyzed for the Oregon Department of Transportation (ODOT). Traffic management as well as planning can be done with the new system at Metro. Other short-range projects facilitated by the use of EMME/2 are analysis of neighborhood traffic issues, traffic analyses for direct input into environmental impact statements, and for miscellaneous short-term highway projects.

Since the implementation of the EMME/2 system, staff workload has increased. This is in part due to the simultaneous integration of EMME/2 into the modeling department and trying to meet current project deadlines. Staff people have also been busy training outside agency users on the use of EMME/2. To a large extent, future productivity will be affected by the level of proficiency of the off-site user, and the corresponding staff time requirements to facilitate this off site use.

It is apparent that since Metro acquired EMME/2 and an increase in modeling capability, that the demand for Metro's transportation planning services has increased. More questions can be answered in a more complete way.

Nature and Implications of Impacts, Ken Dueker

From the discussion so far, certain key points can be made as to the impact of interactive graphics on transportation planning organizations. Of the impacts to be discussed, system productivity is the key issue, along with the increase in demand for service that this increase in productivity brings.

From the discussion by Keith Lawton, several important impacts of interactive graphics can be identified:

1) A decrease in computer costs;

2) Savings in staff time;

3) A change in the mix of staff, less computer expertise and more analytical capability;

4) More jobs with which to amortize the cost of the system;

5) An overall increase in the quality of analysis.

One issue that arises from this discussion is that of the control of information. Whereas there are certain advantages to different agencies working off of the same data base, it might be risky to allow other jurisdictions access to information. This could lead to the development of competing scenarios, each with its own agenda, and each drawn from the common data base. Agency control over this information may come undone. With UTPS, the agency controlled both the process and the output. With EMME/2 some of this control is relinquished, with the agency now controlling the framework of analysis.

Two models of technological change and its effect on organizations can be used to illustrate what is going on at Metro and what other agencies might wish to consider in adopting new technology. In the first model, the adoption of new technology changes the organization. The organization experiences change as a result of the adoption of new technology. In the second model, the organization is changing, and looks for new technology to help accommodate the change. Aspects of both models can be applied to the situation at Metro. First, Metro began to look for a way to upgrade its transportation modeling system to meet regional needs. After the adoption of EMME/2, many changes have occurred as a result of the new technology that might not have been anticipated at the outset.

The widespread adoption of interactive graphics technology will be a slow process, hindered by budgetary and political constraints. However, the key issue is not really cost, but of the quality of analyses and value of time. Because of the flexible, more responsive nature of interactive graphics and the quality of output possible, adoption of this technology will occur, although slowly.

With this new technology comes a challenge to educators. This challenge is to train entry-level personnel in the use of these types of systems. This is a difficult situation. Because of the shrinking size of Universities' budgets, technological improvements are difficult to access. From PSU's standpoint, the technology may be more accessible than at other institutions, given the proximity of Metro. PSU has already placed interns at Metro and Tri-Met to use the EMME/2 system. It is possible that PSU might be able to tap in to the EMME/2 system much like the ODOT and Tri-Met have done. In the University setting, it is also possible to explore the interrelatedness of similar systems. One such system currently being used at PSU is the Criterion Inc. Landtrak geographical information software package, where the vendor has entered into an agreement with the University for use of the system for educational applications.

Aspects of Organizational Change, Sy Adler

The integration of systems such as EMME/2 into the planning process transmits the power of information up to higher officials and down and out to the public. This new technology is an embodiment of traditional planning functions. The strong user orientation of the system allows officials and agencies to organize themselves and to do their own interpretation of the data.

The nature of information in planning is becoming increasingly politicized. Although EMME/2 is very quick and has attractive graphics, it is still very much like UTPS in its dependence upon population and employment forecasts. Forecasts can be quite controversial, with the resulting data often politicized. Through questioning of the final outputs of forecasts, basic modeling assumptions can also be called into question.

Another aspect of this improvement in technology is that more people are attracted to the process. Due to the ease of operation of this new technology, the analytical capability once held by one large organization can be dispersed to smaller agencies and individuals. It is quite possible that in the future, the transportation planning agency will consist of a small core of sophisticated computer models, where all actual analysis and planning activities are dispersed to other agencies.

GENERAL DISCUSSION

Local agencies do rely heavily on Metro's forecasts. Metro has a regional analysis staff, and at present there are not too many localized studies. EMME/2 represents a change for better information and will not reduce the need for regional analysis. With EMME/2 local jurisdictions have better analytical power.

The credibility of data is an important issue. In previous use of EMME/2 in Stockholm and Montreal, many different types of analysis were done, ranging from finely detailed transit planning to regional transportation analysis. Use of the system depends on the level of detail desired. In these analyses, though, 30-40 percent of the data had some distortion. In the United States, credibility of data is especially important. There is fierce competition between cities for access to quality information and this is part of the politization of the process.

Experience in Seattle and elsewhere has shown that with increasing dispersal of quality of information comes an increase in the potential for stalemate. Metro can be seen as an arena for compromise in this process, and the avoidance of stalemate conditions will be related to the amount of redistribution of analytical power that occurs.

It is easy to take a technological improvement out of context. It is quite possible that the political process as a whole will not be affected by the adoption of new technology. Technology is not responsible for stalemates, people are.

UMTA EVALUATION PROJECT

Edwin DeLong, UMTA

UMTA is in the process of putting together a series of reports that explain the features of various computer modeling packages in transportation planning. Users are being contacted for insight into the performance of specific systems. UMTA is also acquiring some inexpensive packages for their own use and testing. Because the present administration is promoting private sector interest, most of the evaluations will be in the form of contacting private users and agencies for their evaluations. In this evaluation, UMTA is trying not to pin good or bad labels on the systems, but to explain system capabilities. The project is targeted for completion in December, 1984.

Several systems are being evaluated. Those of special interest include: PRC Voorhees, COMSIS MLTP, GKS Tran-Plan, EMME/2, T Model, ASSIGN by CH/2M Hill, and IRAP by Roger Creighton.