Development of Interactive Visualization Tool for Effective Presentation of Traffic Impacts to Nonexperts

PANOS PREVEDOUROS, DAVE BRAUER, AND RANDOLPH J. SYKES

The effective presentation of traffic impacts to a broad range of public and private constituencies is an essential part of the approval process for proposed improvements to transportation infrastructure. The increased sophistication of audiences and demand for greater participation by the public in decision-making processes makes effective public education an essential component of transportation planning efforts. A tool was developed for the interactive visualization of traffic impacts (IVTI) that offers clear, comprehensive, and effective views of proposed transportation enhancements. IVTI is essentially a tool for visualizing and organizing the output of traffic engineering models. Its main advantages compared with those of existing traffic simulation and animation programs are that IVTI does not require any training for users to understand the displayed results; roadway layouts and vehicles are photorealistic instead of simplified geometric representations; and adjacent land uses are in full display, which permits a more direct assessment of the consequences of the proposed traffic plans. The traffic model currently employed by IVTI is TRANSYT-7F. The IVTI system has two primary components: a development system and a delivery system. The development system generates a template of the presentation into which the audio, video, and image assets are captured in digital form and integrated into the general presentation framework. The TRANSYT-7F analysis results are imported into IVTI and converted into data structures (e.g., roadways and vehicles), resulting in a photorealistic visualization of the underlying model. The delivery system, a scaled-down, portable version of IVTI equipped with video projection capabilities, enables interactive presentations of the visualizations of the subject transportation improvement to an audience.

This paper presents the development of an original computer-driven tool focused on the interactive presentation of traffic impacts. The development of the tool arose from the need for effective presentations to decision makers and to the general public so that planned transportation improvements can achieve a level of support (both in citizen sentiment and in funding allocations) leading to successful implementation. The goal of the project was to develop a turnkey hardware and software system enabling the Hawaii Department of Transportation (HDOT) to visualize the results of planned traffic improvements using multimedia imagery and visualization techniques.

The resulting tool is called IVTI, acronym for interactive visualization of traffic impacts. IVTI visualizations and presentations are developed for a Macintosh. IVTI is driven by the results of TRANSYT-7F (T7F), which is a widely used traffic simulation program. The ultimate vision for IVTI is to be able to present results from a variety of engineering and planning computer applications. T7F runs on a personal computer (PC) host, and output reports are transferred to the IVTI system in file format.

IVTI combines T7F outputs with corresponding visual and audio information to create technically effective and aesthetically appealing presentations. IVTI is capable of providing multimedia visualizations from both the "bird's eye" view (i.e., 1 mi = 1 screen) and "over intersection" view (i.e., 100 ft = 1 screen) of the section of roadway under analysis. Traffic on the roadway is represented either as simulated traffic (individual cars) or as symbolic flows (color-coded arrows), depending on user preference and the volume of traffic being modeled. At a minimum, visualized data include the information contained in the summary reports output by the traffic model. The user can call up detailed numeric reports of traffic flow at each intersection as well as explanatory media such as audio, video, graphics, and text. Furthermore, the presenter can use IVTI interactively to answer questions from the audience.

The need for effective presentations (primarily to nonexperts of the fields of traffic and transportation engineering or planning) was the driving force behind the development of IVTI. This need is discussed in the next section, followed by a detailed presentation of IVTI in another section. The fourth Section presents T7F, the underlying traffic simulation program, as well as a case study done for IVTI. Finally the fifth section summarizes the presentation, appraises the achievements so far, and discusses planned and potential future enhancements.

NEED FOR EFFECTIVE PRESENTATIONS

General

In his book Guerilla Marketing, Jay Conrad Levinson states that "every type of entrepreneurial enterprise requires marketing. There are no exceptions. It's not possible to succeed without marketing." Few engineers and transportation planners consider themselves to be entrepreneurs, let alone marketing professionals. In fact, few planners in government think in private-sector terms, such as competition, results orientation, and customer-driven objectives. In the era of re-inventing government, however, well-focused marketing of public works projects can mean the difference between public acceptance or lack of funding.

The result of one's failure to market proposals for public works projects convincingly has been an increase both in the number of projects that remain unfunded as well as in the success of special interest organizations at being able to stop projects from proceeding as planned. In not promoting the benefits of and in communi-

---

P. Prevedouros, Department of Civil Engineering, University of Hawaii at Manoa, 2540 Dole Street, Suite 383, Honolulu, Hawaii 96822. D. Bauer, Pacific International Center for High Technology Research, 2800 Woodlawn Drive, Suite 180, Honolulu, Hawaii 96822. R. J. Sykes, Statewide Transportation Planning Office, Department of Transportation, State of Hawaii, 600 Kapiolani Boulevard, Suite 306, Honolulu, Hawaii 96813.

cating inadequately the risks associated with many projects, government agencies have not provided requisite infrastructure to ensure that problems such as congestion are well managed for the common good.

The effective presentation of traffic impacts to a broad range of public and private constituencies has become an increasingly essential part of the approval process for proposed improvements to transportation infrastructure. Examples abound of transportation projects that have not materialized because of lack of public support. The failure of the Honolulu rapid transit system is the most recent of a long line of transportation improvements in Hawaii that have failed despite the compelling need for congestion relief. Each of these initiatives, had they proceeded as planned, would have provided a substantial long-term benefit in the form of added transportation capacity.

What caused these initiatives to fail was, in large part, the lack of good marketing. Government did not provide the public with a clear picture of the benefits of and alternatives to these projects in a way that made it clear that the associated costs were both justified and reasonable. The case can be made that lack of an effective presentation of the impacts of planned infrastructure improvements and related alternatives analyses was responsible in great measure for the demise of these and other projects in Honolulu and elsewhere. Although the means of disseminating information to broad cross sections of the public have grown tremendously during the past 20 years, government entities have been slow to adopt new techniques for delivering ideas about public works improvements and even slower to recognize the increased sophistication of the public with respect to its understanding of issues.

With the advent of the Intermodal Surface Transportation Efficiency Act of 1991, state and metropolitan planning organizations are now mandated to provide opportunities for public involvement in all phases of transportation planning. In the eyes of many planners, this requirement underscores the need for better tools to educate the public about transportation and public works issues. As the public increases its participation in analyzing transportation deficiencies, its knowledge base will increase exponentially, as will its ability to understand a range of solutions and considerations much broader than what otherwise may have been envisioned. It will be increasingly difficult to sell engineering-defined solutions to traffic problems without effective marketing.

Presentations to Decision Makers

Elected and appointed officials make funding decisions about complex public transportation projects on the basis of their individual understanding of the project as well as on a range of political and other considerations. From a transportation planner's perspective, it is essential that these decision makers have the benefit of the essential engineering analyses underlying a project. Often, the planner's access to the decision maker is limited, and opportunities to explain the intricacies of alternatives may be lacking. Transportation engineers, by their training and professional standards, traditionally respond to public works needs with analyses that result in "correct" solutions. Such linear problem solving often does not lend itself to the dynamic world in which politicians operate. Frequently there is a communications gap that can result in unrealistic expectations on the part of the public and inadequate resources to carry out the project as the engineers have envisioned.

Transportation planners must market their ideas to decision makers every bit as effectively as they do to the public. Given the constraints that have been identified, it is clear that a presentation tool is necessary to ensure that the essential information about a project is communicated as effectively and efficiently as possible. Ideally, such a tool should have the ability to

- Define the scope of the project,
- Delineate the alternatives that have been considered,
- Provide all relevant information concerning risks,
- Establish costs and contingency factors, and
- Give a clear picture of the improvements resulting from the project.

In addition, the tool should be able to mitigate the effects of any public-speaking deficiencies that an individual planner may have.

IVTI Concept

IVTI has been developed as a tool for delivering a clear, comprehensive, and effective view of proposed transportation enhancements. The system has been structured to provide a flexible, low-cost marketing platform that meets the needs of government planners to answer questions about transportation initiatives by both decision makers and the public. It meets this need in two ways:

- IVTI helps deliver the before-and-after visual impact of planned improvements to an audience on the basis of computer-supported analyses of alternatives, costs, and benefits.
- IVTI can be used either as an interactive component of a live presentation or in a stand-alone, kiosk-type delivery mode so that the public can interact with the system directly.

As opposed to other forms of audiovisual presentation assistance, IVTI's flexibility allows the presenter to tailor the information to the needs of each audience. Individuals witnessing the presentation see real-life roadways and simulations on the basis of analyses done by computer-based models. The aerial and driver-level views that IVTI provides make it possible for persons in the audience to understand otherwise complex mathematical outputs quickly and to weigh the pros and cons of various alternatives on the basis of these visualizations. Questions from the audience may be answered by reference to any of the menu-driven screens containing underlying data about the proposed transportation improvement.

IVTI SYSTEM

System Overview

Significant benefits could be realized if multimedia visualization capabilities were developed for the data contained in a T7F final report (*1*). T7F operates strictly in batch mode so truly interactive modeling and simulation of a traffic network, with a multimedia front end for visualization, would not be possible using this package. However, a DOT traffic engineer or planner could use T7F to develop several different options for a given traffic network, saving each report as a separate ASCII text file. A multimedia visualization of the traffic network for each option examined could be developed using IVTI. The T7F report files would be used as input for setting up the parameters of the multimedia visualization. Each

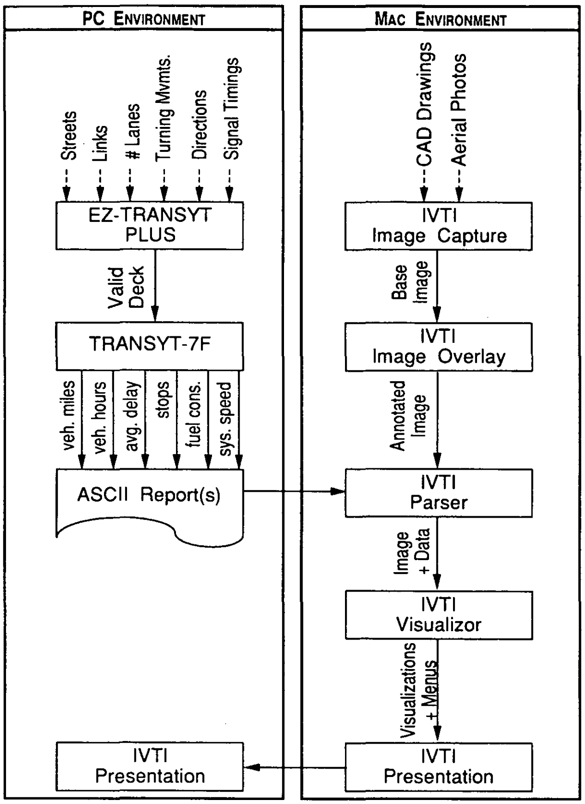


FIGURE 1 IVTI system overview.

option for the traffic network could be "visualized" and then organized as a single presentation showing the before, during, and after effects for a proposed roadway improvement. The overview of this system is shown in Figure 1.

Suppose, for example, that a traffic engineer was developing new signal plans for the recently widened portions of a highway. The first step would be to collect all data necessary for running T7F. The next step is the input of data for use by T7F. This can be done by using either the T7F input module or one of several available user-friendly data manager and preprocessing software; EZ-TRANSYT has been used in the IVTI applications so far (*2*). The traffic engineer would use T7F to output the report files for the existing conditions and for the planned improvements, including the best settings for traffic signals.

Simultaneous with these analyses, a multimedia visualization of the highway would be developed using IVTI. A graphical, overhead view of the highway would be produced using either digitized aerial photographs or computer-assisted drawings. The highway traffic network would be overlaid on the aerial view using tools provided within IVTI to identify objects modeled within T7F, such as intersections, linkages, and turning movements.

Once the multimedia visualization was complete, the report files from T7F would be imported into IVTI. The user would use an option within IVTI to set up a master menu for the visualization, identifying each report file and annotating it with some explanatory text (e.g., Hwy_1: Existing traffic conditions on the recently widened highway, Hwy_2: Traffic signals optimized for morning rush hour).

The multimedia visualization could be used to present the various options for traffic signal timings on the highway. The IVTI user would select an option from the main menu and would be treated to a bird's eye view of the highway. The traffic flow would appear as individual cars moving down the highway or as color-coded symbolic "flows" with numbers, starts, stops, and turns consistent with the T7F report. The user could zoom in on particular intersections for a closer view or request actual numbers/graphs on traffic flow instead of animated graphics.

Top-Level Design

The top-level design of the IVTI system is presented in Figures 2 and 3. Figure 2 shows the flow of data into and out of IVTI from external systems. Ideally, the presentation script and storyboard would be developed by a "production manager" (public affairs officer, etc.) and provided in hard-copy form to guide the logic of the presentation. Video, music, audio, photos, photo logs, and computer graphics (hereafter referred to as assets) would be collected and cataloged in their native form by a "production specialist." The production specialist or a computer specialist would then use the IVTI development system to convert these assets into the proper digital form for use by the computer. A traffic engineer would be responsible for performing the necessary T7F analysis and providing the output files to the computer specialist for conversion into IVTI. The logic of the presentation would then be developed by the computer specialist using the script and storyboard as a guide. The assets would then be integrated into a single, executable, digital IVTI presentation file, which could be run on either the development system or the smaller, portable presentation system.

Figure 3 depicts the top-level block diagram of the IVTI development system. In general, an IVTI presentation is generated by first creating an outline followed by the production of a template. The audio, video, and image assets for the presentation are then captured in digital form and integrated into the general presentation framework. The T7F analysis results are imported into IVTI and converted into data structures. Aerial images are manipulated to link parts of the image to the data structures (e.g., roadways and vehicles). The visualizations are then merged into the overall presentation.

A brief narrative of each of the major system functions identified in Figure 3 follows. All operations are activated via on-screen menus.

1. *Outline IVTI presentation:* In the presentation mode, the user activates the outline option and selects the major headings to be used, identifying the screens and layouts to be used within each major heading. Once the outline is completed, a template of the presentation is generated. This template is an executable version of the final presentation with placeholder material instead of actual assets. Saved templates may also be selected directly, without the creation of an outline file, for immediate use in creating a presentation.

2. *Capture digital audio:* In the presentation mode, the user activates the assets option and selects the audio icon. An audio capture tool is launched that allows the user to digitize voice or music in the appropriate format and save the result in a file. The file is saved in the audio assets list.

3. *Capture digital video:* In the presentation mode, the user activates the assets option and selects the video icon. A video capture tool is launched that allows the user to digitize video and sound in the appropriate format (Apple Quicktime) and save the result in a file. The file is saved in the video assets list.

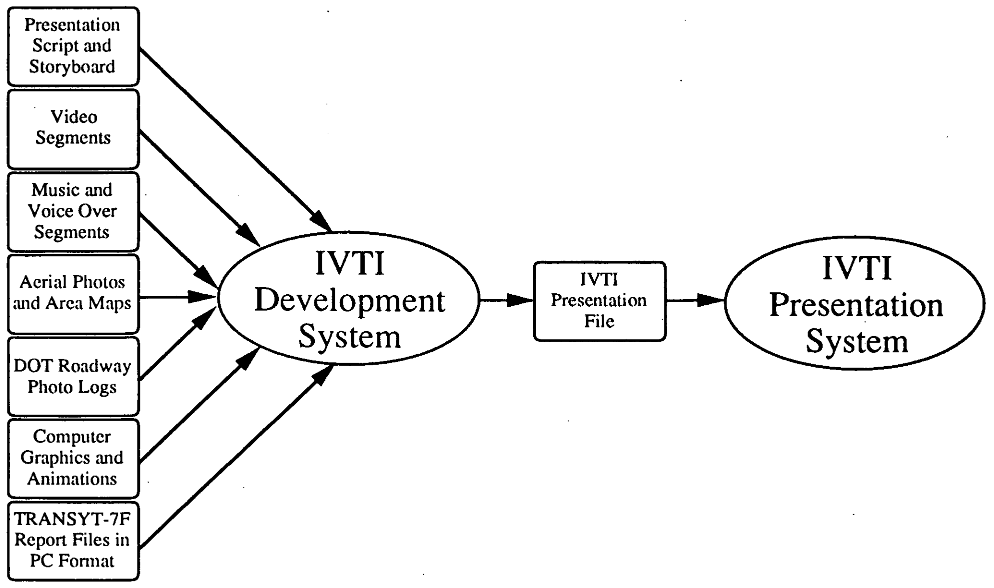


FIGURE 2 External inputs and outputs.

4. *Capture scanned images:* In the presentation mode, the user activates the Assets option and selects the image icon. An image capture tool is launched that allows the user to digitize flat art or photos in the appropriate format and save the result in a file. The file is saved in the image assets list.

5. *Convert image formats:* In some cases, images and computer graphics already may be provided in digital form. It may be necessary to convert these images into the proper format. The user activates the assets option and selects the image icon. A tool is launched that determines the original file format and converts it to the appropriate format for use in IVTI. The same capabilities are provided for audio and text.

6. *Construct general IVTI presentation:* The process for constructing the IVTI presentation proceeds after a template has been generated or selected (Process 1) and the appropriate assets have been collected (Processes 2 through 5). The user activates the template option and then steps through the presentation using the rewind, back step, play, step, and stop buttons in the control menu and replaces filler material in the template with proper selections from the assets lists.

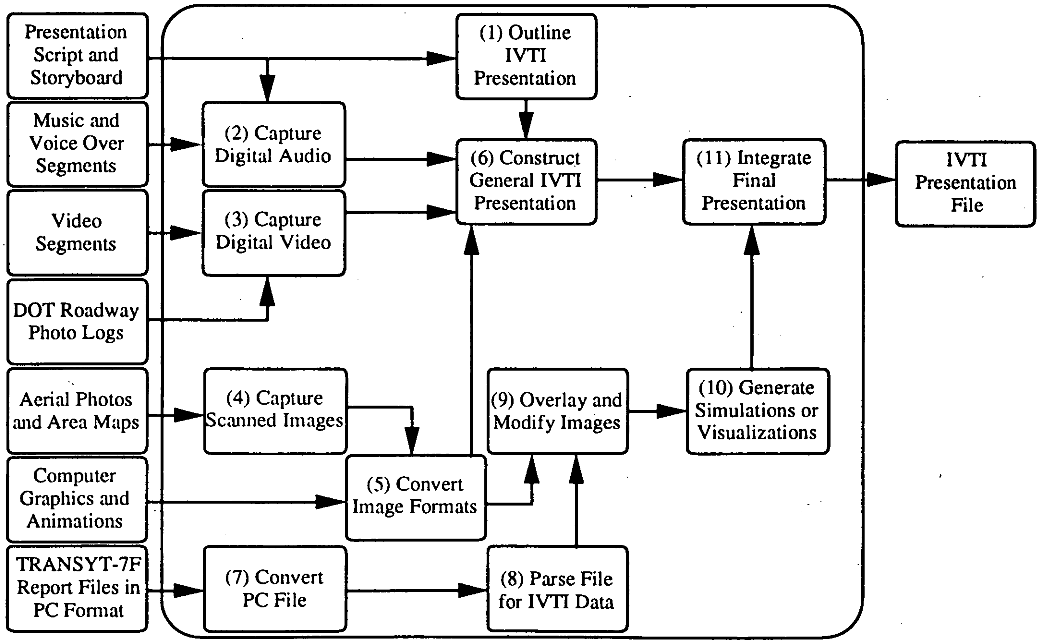


FIGURE 3 IVTI development block diagram.

7. *Convert PC file:* In visualization mode, the report file generated by T7F is converted into Macintosh format using Apple file exchange conversion tools.

8. *Parse file for IVTI data:* In visualization mode, the user activates the data file option and then selects the parse option. The user identifies the file to be parsed and provides a name. The IVTI system automatically generates a T7F data file for use in the visualization.

9. *Overlay and modify images:* In visualization mode, the user activates the Overlays option. To create an overlay, a view and an associated data file must first be selected. Menu commands and graphical tools are invoked to select vehicle samples for use in the visualization. Other menu selections are used to overlay vehicle paths and turning movements on the image. The overlay is then named and saved for use in the generation process.

10. *Generate visualizations:* The T7F data file and its associated view and overlay files are used to generate automatically a separate visualization file that shows a complete cycle of traffic movement for the given visualization.

11. *Integrate final presentation:* The general presentation (with assets incorporated in Process 6) is linked with the visualization files developed in Process 10. The user employs menu selections to create a stand-alone presentation file and directory for playback on the IVTI delivery system.

System Hardware

The block diagram of the IVTI development system is indicated in Figure 4. The principal component is a NuBus-based Macintosh computer (such as a IIci) with 8 MB of main memory and 200 MB hard disk drive. Incorporated within the Macintosh IIci machine is a card for audio and video capture (*3,4*). Two monitors are provided to facilitate development. A flatbed or slide scanner is used to capture graphics. External video devices (camera or videocassette

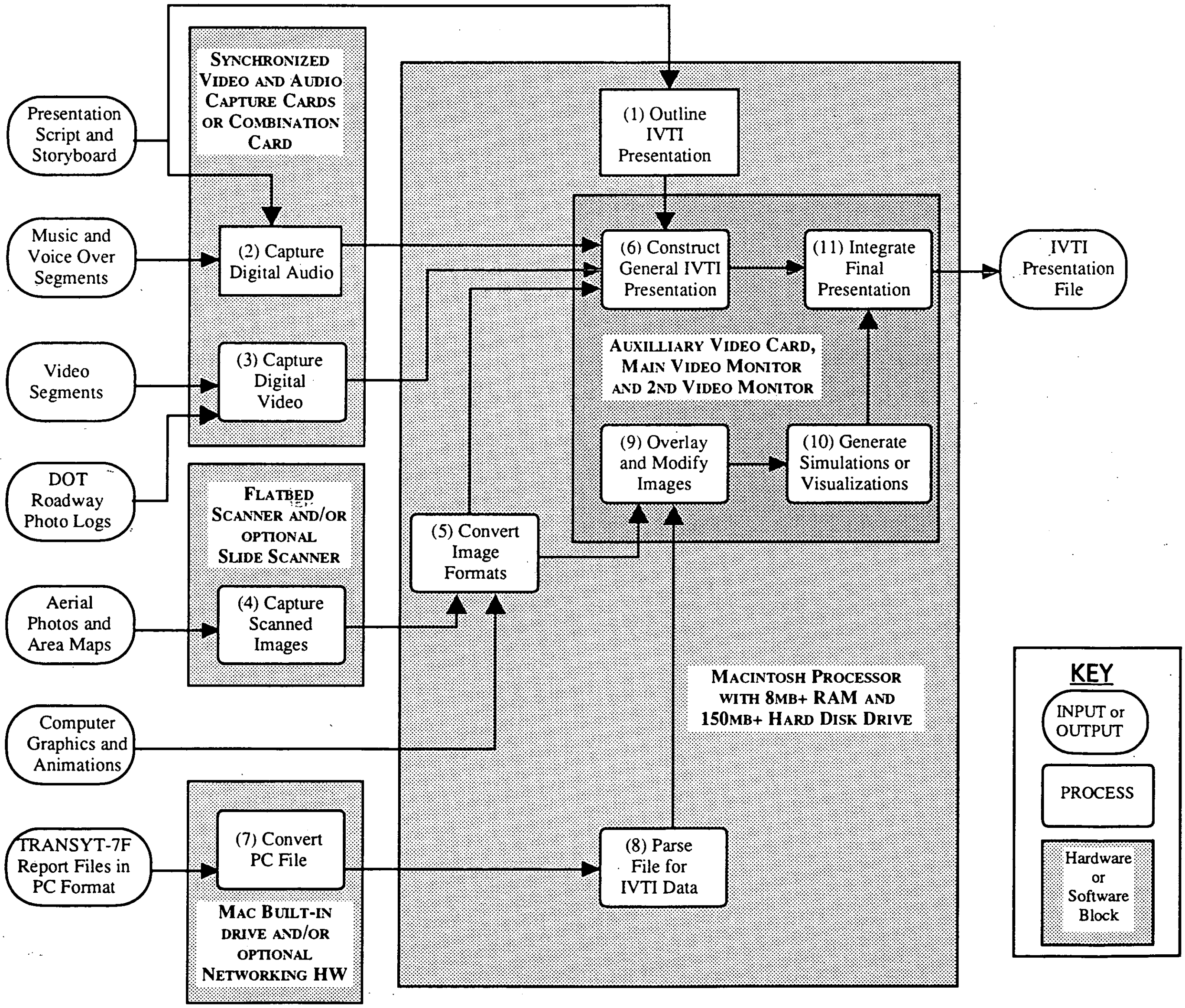


FIGURE 4 IVTI hardware block diagram.

recorder) can be attached to the audio and video capture card for input of video assets. Networking hardware is included to allow the IVTI development system to access local area networks for files.

The hardware for the IVTI delivery system is a Macintosh IIci identically equipped with the same audio and video playback card as those of the development system. Portable Macintosh notebook computers were considered, but they currently do not support the audio quality desired. The system includes a card to provide quality stereo audio output and to drive the external projection device. Amplified stereo speakers and a liquid crystal display (LCD) panel (for overhead projector) are provided to facilitate presentation to large audiences.

System Software

IVTI custom software for the development system assumes that information to be incorporated in an IVTI presentation already has been converted into the appropriate digital format using commercial off-the-shelf software. The functions implemented by the IVTI custom software for the development system are shown in Figure 5. The IVTI main program has two modes of operation. In the presentation mode, an IVTI presentation is developed. An outline of the presentation is created, from which a presentation template is generated. Asset files in the appropriate digital format are then integrated into the template. Asset files may include graphics, audio, and video, as well as simulations or visualizations output from the simulation mode.

From the IVTI main program, the IVTI simulation mode is accessed to create simulations or visualizations from T7F data files and associated aerial photos or maps. A simulation is created for intersections or aerial views where movements of individual vehicles are desirable. A visualization is created where individual vehicle movements are inappropriate—for example, if the area of coverage is so large that individual cars cannot be seen, or if the number of vehicles to be simulated is too large for processor capacity. Visual-

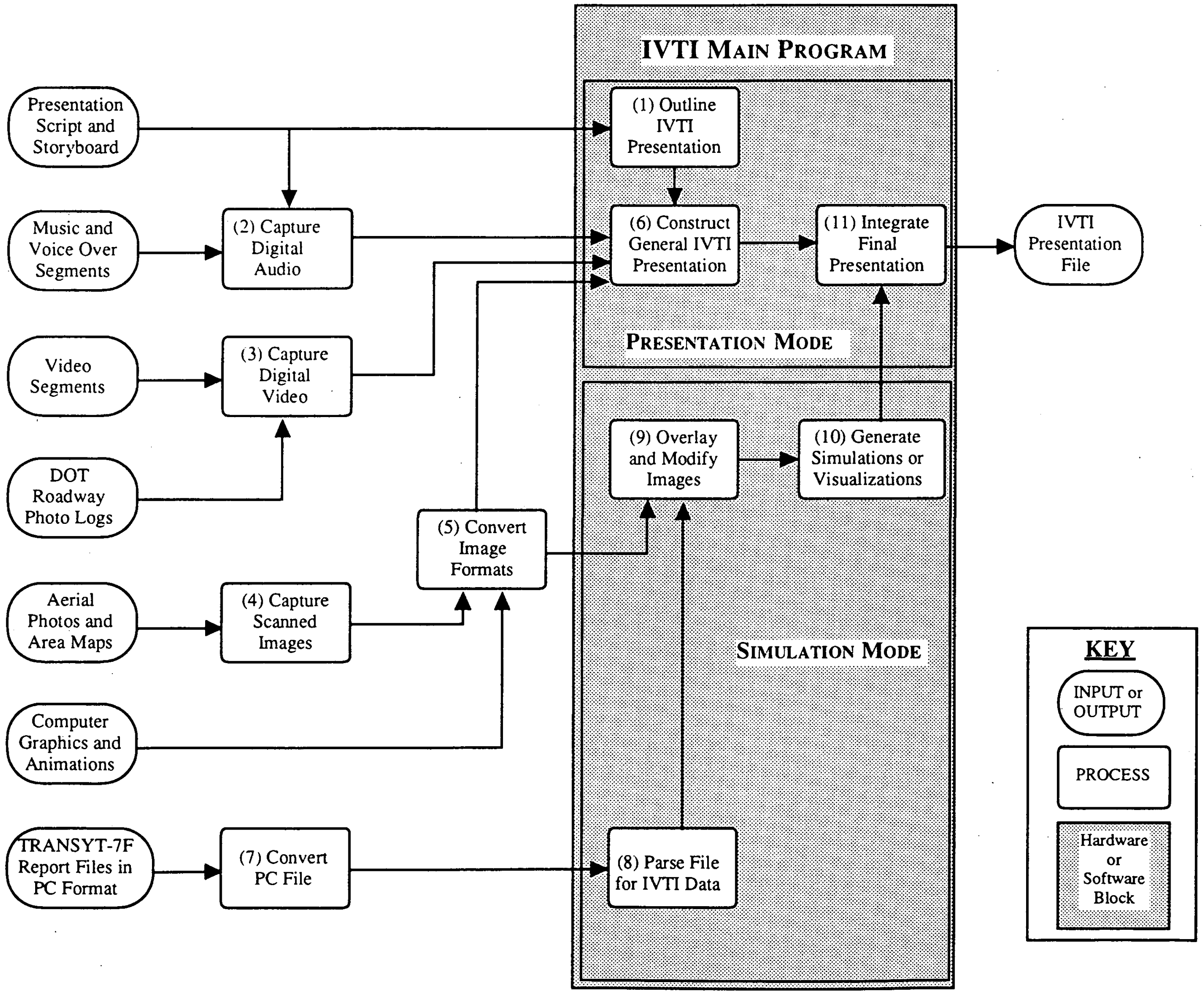


FIGURE 5 Custom software block diagram.

izations then use color-coded graphics to convey traffic flows. The executable MacroMind projector (*5–7*) IVTI presentation file output by the IVTI development system represents the custom software component of the delivery system.

TRAFFIC ANALYSIS WITH TRANSYT-7F

TRANSYT-7F Background

TRANSYT is the acronym for Traffic Network Study Tool. The original version of TRANSYT was developed by Dennis Robertson at England's Transport Road Research Laboratories in 1967. T7F is a macroscopic simulation tool; thus, it processes platoons of vehicles instead of individual vehicles. The analyst can control the size of the simulation steps, which essentially controls the size of the platoons.

Signalized intersections are controlled by either mechanical pretimed or electronic controllers. The latter collect input on vehicular demand from detectors embedded in the pavement or from cameras (i.e., image processing results in real-time counts of approaching vehicles) and set the duration of green accordingly, so that demand is satisfied in a timely and efficient way. Regardless of the technology used, signals operate under a phasing scheme specified by traffic engineers. The phasing is the exact sequence in which the various vehicular and pedestrian movements receive the right of way. The duration of a complete sequence of signal indications is defined as the cycle length. Under a pretimed mode of operation, both phase durations and cycle length are fixed. Traffic-actuated local controllers have the ability to extend or reduce the durations of green (within prespecified limits that ensure safe pedestrian processing, if applicable); therefore, both phase and cycle lengths vary.

It is noteworthy that there is no procedure available that would enable traffic engineers (and local electronic signal controllers) to select the best phasing scheme for each signalized intersection. Thus, a side utility of T7F becomes apparent: assessment of traffic processing under various signal phasing options and choice of phasing scheme best suited to a particular intersection.

There are two main types of estimations with T7F: simulation and optimization. In simulations, T7F estimates measures of effectiveness (MOEs) on the basis of the exact inputs without any alterations. The MOEs from a simulation reflect existing conditions and serve as a base case for comparisons. In optimizations, T7F maintains the exact vehicular traffic data and consults the minimum phase requirements (as set by the modeler on the basis of pedestrian crossing requirements or other constraints); it selects the cycle length (from a prespecified range) that results in the best performance index (PI); and, then, it optimizes phase durations and progression offsets so that negative MOEs such as delays and stops are minimized.

Optimization is achieved through the minimization of an objective function that is called the PI. Because the PI is the sum of "negative" factors (that is, long delays and large number of stops denote poor signal operations), the objective is to minimize it.

T7F input requirements include network geometry, volumes, saturation flows, average speeds, signal phasings, minimum intervals, cycle lengths, and factors describing local driving behavior. The output includes a number of MOEs such as delays, average speeds, queue lengths, and fuel consumption per intersection, specified route, and the entire network. Time-space, progression, and flow profile diagrams are provided on request.

Use of T7F in IVTI: Case Study of Dillingham Boulevard

The first application of IVTI focused on short-term alternatives for alleviation of congestion for the morning commute from west Honolulu to the central business district (CBD). The analysis focused on Dillingham Boulevard, a five-lane arterial that roughly connects the airport area with the CBD. Dillingham Boulevard was selected because it is a key arterial into the CBD for commuters on the H-1 freeway. Given its relatively light traffic in the reverse-commute direction, it is a logical candidate for contra-flow. For the case study, two alternatives were explored: contra-flow and the addition of a high-occupancy-vehicle (HOV) lane, both CBD bound.

The temporary subtraction of a lane from the reverse-commute direction and its addition to the peak direction of traffic is accomplished with closely spaced traffic cones that are set and removed manually by a crew on a light-duty truck. The use of this process (called "coning") is applied along several miles of arterial streets in Honolulu during regular week days. Coning is managed by the Department of Transportation Services of the City and County of Honolulu.

The arterial analysis of Dillingham Boulevard using T7F included ten signalized intersections, all of which are equipped with demand-responsive, electronic signalization systems, the controller of which receives demand input from loop detectors imbedded in the pavement. A number of estimations were run, the results of which are summarized in Table 1.

Platoon progression diagrams generated by T7F indicated a misallocation of resources at the present time. The CBD-bound direction of Dillingham Boulevard is heavily loaded (resulting in a very dark density plot), whereas the reverse-commute direction is clearly underutilized (very light density plot). In contrast, a much more even density was displayed after a lane was taken from the reverse-commute direction and given to the downtown-bound traffic on Dillingham Boulevard.

The results for three highly congested intersections were further verified by using the HCM/CINEMA software (*8*) and by taking advantage of its built-in NETSIM subroutine for microscopic simulation of flow at a single intersection. (NETSIM, from network simulation, is another FHWA/U.S. Department of Transportation-approved traffic simulation software package. It is based on microscopic simulation; thus, individual vehicle trajectories can be tracked and animated on the screen. This improves the analyst's ability to detect weak elements in the intersection's operation.) The results were clearly in favor of the contra-flow lane addition.

A possible threat to the success of the coning for the provision of a contra-flow lane may arise because of the high frequency of buses (and bus stops) along Dillingham Boulevard. Stopping buses generally do not pose a problem because in both directions there is a second lane on which vehicles could divert and avoid stopping behind the buses. However, after coning, only one lane will be available for the reverse-commute direction on Dillingham Boulevard. Thus, buses stopped to process passengers may block the single lane while the signal is green, and oversaturation may occur. This effect was initially assessed with T7F by assuming a lower saturation flow rate ($s = 1,500$ vehicles per hour of green per lane) for the single through lane. The results indicated a small increase in average delay but no oversaturation. This potential operational problem was also analyzed with NETSIM by estimating that buses stop every 3 min (20 buses per hour), which is close to the average morning headway between buses. The results show that bus blockage does not pose a

TABLE 1 Summary of Traffic Analysis Output

Part 1: Entire Network (Dillingham Boulevard and intersecting streets)

		EXISTING CONDITIONS	OPTIMAL CONTRA-FLOW	FORCED CL CONTRA-FLOW	OPTIMAL w. HOV LANE
	Cycle Length (CL) in seconds	110	80	110	110
	MEASURES OF EFFECTIVENESS				
1	Number of Congested Street Segments (1)	**6**	**6**	**7**	**4**
2	Average Delay in Seconds per Vehicle	**27.2**	**30.5**	**36.6**	**28.1 (31.0)**
3	Average speed in mph	**10.3**	**9.5**	**8.4**	**9.9**
4	Fuel Consumption in gln/hr; all traffic	**431**	**445**	**480**	**439 (484)**

Part 2: Main Arterial Street (Dillingham Boulevard only)

		EXISTING CONDITIONS	OPTIMAL CONTRA-FLOW	FORCED CL CONTRA-FLOW	OPTIMAL w. HOV LANE
	Cycle Length (CL) in seconds	110	80	110	110
	MEASURES OF EFFECTIVENESS				
1	Number of Congested Street Segments (1)	**3**	**2**	**5**	**1**
2	Average Delay in Seconds per Vehicle	**9.3**	**7.1**	**9.9**	**8.7 (11.1)**
3	Average speed in mph	**19.9**	**21.7**	**19.5**	**20.4**
4	Fuel Consumption in gln/hr	**218**	**204**	**212**	**224 (286)**
5	Max. Theoretical Throughput	**1515 (1947)**	**2104 (2614)**	**2411 (2782)**	**2411 (2504)**

Note (1): Lanes approaching but not exceeding 100% capacity utilization.

threat to the operations after coning (i.e., delays increase but no oversaturation occurs).

The second part of the analysis involved the assessment of the potential success of an HOV lane. The HOV lane specification prohibits all left-turning movements along Dillingham Boulevard while the HOV operation is in effect (i.e., 5:30 to 8:30 a.m.). The following two key assumptions were made before modeling Dillingham Boulevard with an HOV lane:

1. One of every three vehicles is eligible to use and will use the HOV lane.
2. The maximum possible banned left-turn vehicles will modify their routes closely around Dillingham Boulevard.

The first assumption simplifies the modeling effort because the through traffic to downtown is evenly spread across the three available lanes; thus, an explicit modeling of the HOV lane is not necessary. This assumption was made because of the limited resources available for this part of the analysis. It is, therefore, assumed that the average occupancy of downtown-bound traffic is 1.33 persons per vehicle, which is reasonable by Honolulu standards. The second assumption is conservative because it forces all left-turning traffic to find a legal way around the prohibition of left turns in the immediate vicinity of Dillingham Boulevard.

Table 1 summarizes the MOEs. For the HOV lane option, a second set of estimates is given in parentheses. These estimates reflect the added travel time of the approximately 1,000 left-turning vehicles, which should perform a set of three right turns around a block to reach the street segment they would have by turning left from Dillingham Boulevard. The HOV lane option is compared with the following:

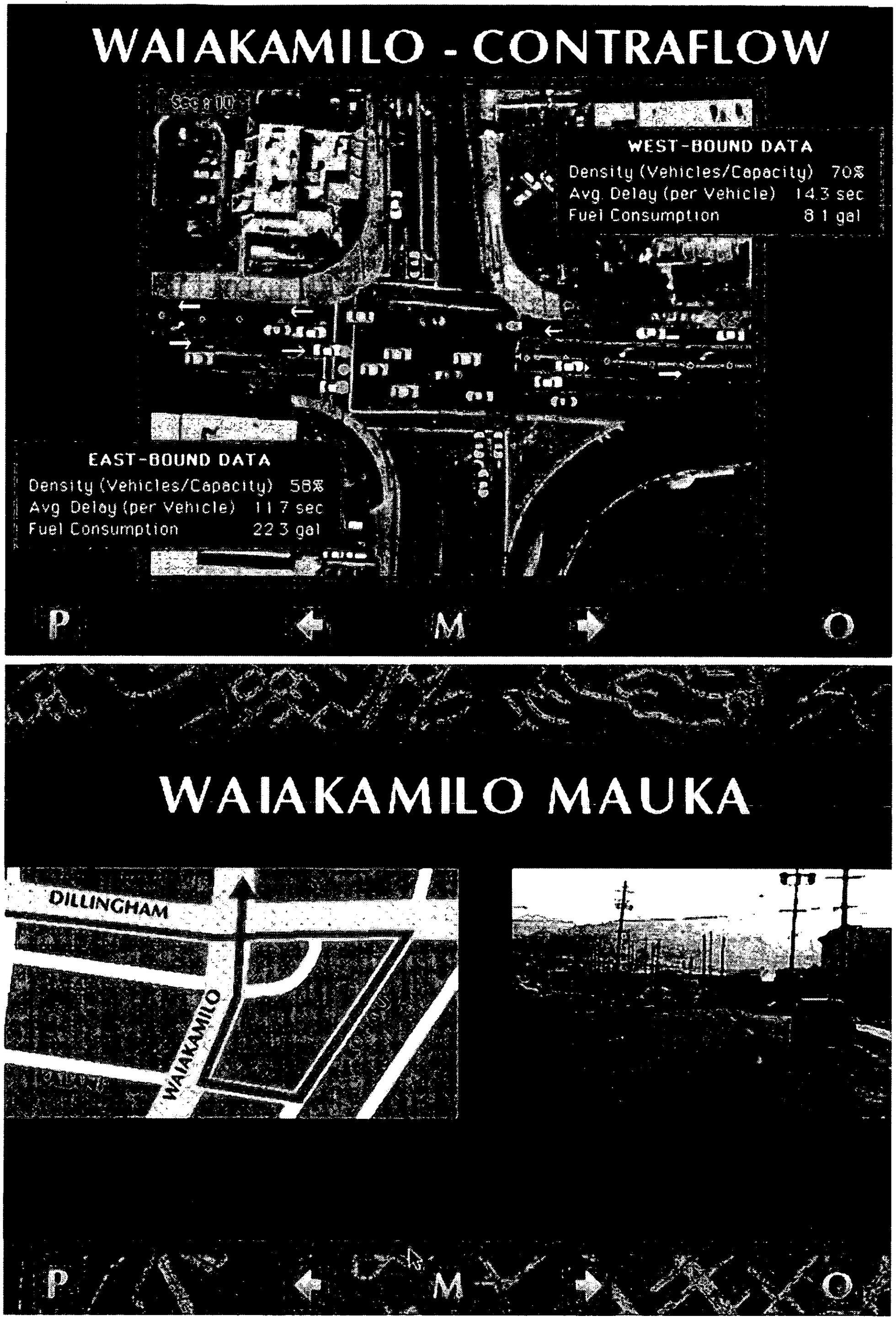
- Existing conditions,
- Contra-flow with optimal signal timings, and
- Contra-flow with forced signal timings to maintain the existing cycle length.

The maximum theoretical throughput (maximum number of vehicles that can be processed in 1 hr) for the downtown-bound traffic will be much better for all options considered as compared to the existing situation: The facility will be able to serve more than 2,000 vehicles per hour along the peak direction as opposed to about 1,500 at present. At best, the HOV-lane option will provide as much throughput as the contra-flow option. The optimal contra-flow option (Column 2) is a better option, particularly when the critical statistics of congestion (delay) and fuel consumption are considered. However, the appeal of an HOV lane and its potential to reduce single-occupant vehicles should not be underestimated. Thus, a combination of HOV and contra-flow was suggested for fine-tuned analysis because it is an effective and comprehensive option.

Samples of the presentation of this case study with IVTI are shown in Figure 6. The print quality does not do enough justice to the IVTI quality of presentation since IVTI has been designed with exclusive focus on presentation on monitors or projection screens.

SUMMARY

The IVTI system has introduced a new form of model visualization into traffic project presentations. The photo-realistic simulations created by IVTI from T7F output reports enhance understanding of the impacts by showing traffic flow in a real-world context. Demonstrations of the two IVTI presentations completed thus far



WEST-BOUND DATA
Density (Vehicles/Capacity) 70%
Avg. Delay (per Vehicle) 14.3 sec
Fuel Consumption 8.1 gal

EAST-BOUND DATA
Density (Vehicles/Capacity) 58%
Avg Delay (per Vehicle) 11.7 sec
Fuel Consumption 22.3 gal

FIGURE 6 Sample output from IVTI.

have yielded favorable feedback. Overall, IVTI has achieved its goal for the effective organization, visualization, and interactive presentation of traffic impacts that are derived from widely accepted traffic and planning analysis computer software. This approach to presenting public works projects will enhance understanding of the goals, benefits, and costs. With a clearer understanding of a proposed project by the general public and by governmental officials, fewer delays in the approval and funding process should result.

IVTI complements other automated design facilities and, from a marketing perspective, will allow HDOT to manage its customers' expectations about the project and throughout all phases of the construction process. HDOT intends to utilize IVTI in its present form to assist in presentations about forthcoming highway projects.

Although this paper has focused on IVTI's utilization of T7F and its ability to present analyses and plans for signalized street networks, future development efforts are expected to include freeway and parking analyses as well as linkages with both harbor and airport projects. The latter are mandated by the Intermodal Surface Transportation Efficiency Act, which focuses on the connections among all modes of transportation, and the distribution of flows of people and goods among them. In addition, several encouraging inquiries from consultants, state DOTs, and municipal governments have boosted the efforts of the developers of IVTI (the Pacific International Center for High Technology Research) to offer it for the PC environment. Future endeavors include input module additions and modifications to enable IVTI to utilize output files from TRAF-NETSIM, other traffic software, as well as trip distribution and assignment output from planning and GIS-T software applications.

The estimated cost of IVTI development has totalled about $250,000. The cost per presentation is expected to vary because a single presentation might consist of any number of graphs, charts, artist renderings, text, animation, aerial photographs, computer graphics, audio voice-overs, and soundtracks. Computer hardware for a kiosk operation would cost about $2,000, not including design of the kiosk itself. System support staff includes individuals with transportation planning and modeling expertise, an Apple Macintosh computer analyst, and persons familiar with the dissemination of the public information.

ACKNOWLEDGMENT

This paper was based on research supported by the Hawaii Department of Transportation and the Hawaii Department of Business, Economic Development and Tourism. The support of the sponsors is gratefully acknowledged.

REFERENCES

1. *TRANSYT-7F User's Manual,* Version 6.4, Transportation Research Center, University of Florida; FHWA, U.S. Department of Transportation, 1991.
2. *EZ-TRANSYT PLUS User Guide,* Version 6.0. Transtek Software, Falls Church, Va., 1989.
3. *Supercard User Manual,* Version 1.5. Silicon Beach Software, San Diego, Calif., 1989.
4. *Supercard Language Guide,* Version 1.5, Silicon Beach Software, San Diego, Calif., 1989.
5. *MacroMind Director Studio Manual,* Version 3.0. MacroMind Inc., San Francisco, Calif., 1991.
6. *MacroMind Director Interactivity Manual,* Version 3.0., MacroMind Inc., San Francisco, Calif., 1991.
7. *ADOBE Photoshop User Guide,* Version 2.0., Adobe Systems Inc., Mountain View, Calif., 1991.
8. *HCM/CINEMA User Guide,* Version 2.0., KLD Associates, Inc. and Polytechnic University, Brooklyn, New York, 1990.

Publication of this paper sponsored by Committee on Citizen Participation in Transportation.