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16. Abstract

The use of 3D modeling in simulation has become the standard for both the military and private sector. Compared to physical models, 3D models are more affordable, more flexible, and can incorporate complex operations. Unlike a physical model, a dynamic virtual model can react to environmental variables or user input. Additionally, virtual models can be run in the context of other dynamic behaviors such as working traffic lights, functioning train crossing gates, moving vehicles, and air quality analysis.

A simulation allows you to interact with the space and explore areas that you want to see more closely. And if you want to see more detail in something that hasn't been modeled, it takes less than half an hour to go back to the model, make changes, and bring it back into the simulation.

Traffic simulation models such as VISSIM, WATSIM, and PARAMICS are on the forefront of integrating 3D visualization packages into their systems. The easy to use multimedia user interface and fast interactive response provide a powerful tool for urban traffic and environmental planners. At this time this technology is still cutting edge and an evaluation of current use and innovations is paramount to wider transportation industry acceptance.

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AN EVALUATION OF 3-D TRAFFIC SIMULATION MODELING CAPABILITIES

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Research Report SWUTC/07/167621-1

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ABSTRACT

The use of 3D modeling in simulation has become the standard for both the military and private sector. Compared to physical models, 3D models are more affordable, more flexible, and can incorporate complex operations. Unlike a physical model, a dynamic virtual model can react to environmental variables or user input. Additionally, virtual models can be run in the context of other dynamic behaviors such as working traffic lights, functioning train crossing gates, moving vehicles, and air quality analysis.

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EXECUTIVE SUMMARY

The use of 3D modeling in simulation has become the standard for both the military and private sector. Compared to physical models, 3D models are more affordable, more flexible, and can incorporate complex operations. Unlike a physical model, a dynamic virtual model can react to environmental variables or user input. Basic military uses of dynamic modeling include rotating turrets, elevating gun barrels, and moving tank treads, all of which can be based on preprogrammed data, real-time user input, or artificial intelligence (AI). Additionally, virtual models can be run in the context of other dynamic behaviors such as working traffic lights, functioning train crossing gates, moving vehicles, and air quality analysis.

Real time traffic simulation modeling provides a visual, interactive model that you can easily manipulate. It is a valuable tool for the design review process, when users want to be able to visualize a project quickly and flexibly. Urban areas can be modeled as the need arises; buildings can be added and taken away. GIS data can be incorporated into the simulation, along with photos and CAD data. A simulation allows you to interact with the space and explore areas that you want to see more closely. And if you want to see more detail in something that hasn't been modeled, it takes less than half an hour to go back to the model, make changes, and bring it back into the simulation.

Traditionally, visualization has been used to convey the final design to decision makers, stakeholders, and the public. Today, some transportation agencies are finding new ways to integrate visualization into the project development process. The current state of visualization within the transportation community is one of eagerness to use the technology, but minimal organization for its implementation. Transportation agencies throughout the United States are looking for guidelines and best practices for its use.

Traffic simulation models such as VISSIM, AIMSUN, and PARAMICS are on the forefront of integrating 3D visualization packages into their systems. The easy to use multimedia user interface and fast interactive response provide a powerful tool for urban traffic and environmental planners. At this time this technology is still cutting edge and an evaluation of current use and innovations is paramount to wider transportation industry acceptance.

Proposed Research

This research will provide a comprehensive list of all traffic simulation models that currently have incorporated or are in the process of incorporating a 3D interface. The models will be evaluated based on functionality, industry applications and current use.

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INTRODUCTION

Background of Traffic Simulation

Just as general modeling and simulation found in other disciplines and engineering branches, transportation modeling and simulation is the mathematical abstraction of part of real world transportation systems and moving the mathematical model through time in a virtual environment. Many dimensions categorize transportation modeling and simulation, among which the level of modeling detail is widely known. Three levels of detail are available, i.e. macroscopic, mesoscopic, and microscopic, each of which progressively provides more modeling details. Currently under exploration is a fourth level of detail called nanoscopic transportation which, if implemented, could provide the finest modeling detail to transportation system operations.

Representing one extreme of the spectrum, macroscopic simulation models roadway traffic as one-dimensional compressible fluid where disturbances in traffic flow propagate like waves. The fundamental law of macroscopic simulation states that, on a segment of the roadway, traffic flows in equals to traffic flows out plus any storage. Macroscopic simulation can achieve very large scale modeling with relatively low resolution. Examples of macroscopic simulators are KWaves, NETCELL, and KRONOS. Mesoscopic simulation is a trade-off between scale and resolution. A typical modeling technique adopted by mesoscopic simulation is Cellular Automata (CA) where time-space domain is partitioned into cells. Vehicles are modeled as particles which hop from one cell to another governed by some predetermined constraints. An example mesoscopic simulator is TRANSIMS. At the other end of the spectrum is microscopic simulation which provides high modeling resolution and also represents the state-of-the-art. Microscopic simulation models driver-vehicle units as particles, but the behavior of these particles is personalized by car-following, lane-changing, and gap-acceptance models. Examples of microscopic simulators are CORSIM, VISSIM, Paramics, AIMSUN, and HUTSIM.

Microscopic traffic simulation models (also known as car-following or time-continuous) typically represent each vehicle as an entity and use random numbers to predict various factors such as desired speed, red/yellow traffic light signals, and gap acceptance (acceptable time interval between oncoming vehicles to enable an “opposing” vehicle to cross the roadway). Simulation models are used to estimate travel times once traffic flow volumes have been predicted by other means. Sometimes, simulation models are used to fill the data gaps where no data is available.

Time-continuous models or car-following models have in common that they are defined by ordinary differential equations describing the complete dynamics of the vehicles' positions x_α and velocities v_α. It is assumed that the input stimuli of the drivers are restricted to the own velocity v_α, the net distance (bumper-to-bumper distance) $s_\alpha := x_{\alpha-1} - x_\alpha - l_{\alpha-1}$ to the leading vehicle $\alpha - 1$ ($l_{\alpha-1}$ denotes the vehicle length), and the velocity $v_{\alpha-1}$ of the leading vehicle. The equation of motion of each vehicle is characterized by an acceleration function that depends on those input stimuli:

$$\ddot{x}_\alpha(t) = \dot{v}_\alpha(t) = F(v_\alpha(t), s_\alpha(t), v_{\alpha-1}(t))$$

In general, the driving behavior of a single driver-vehicle unit α might not merely depend on the immediate leader α − 1 but on the n_a vehicles in front. The equation of motion in this more generalized form reads:

$$\dot{v}_\alpha(t) = f(x_\alpha(t), v_\alpha(t), x_{\alpha-1}(t), v_{\alpha-1}(t), \ldots, x_{\alpha-n_a}(t), v_{\alpha-n_a}(t))$$

Microscopic models typically simulate traffic systems on a vehicle-by-vehicle basis by updating position, speed, acceleration, lane position, and other state variables on time steps, such as on a seconds basis, as the vehicles interact with traffic signals, signs, other vehicles, and roadway geometrics. Some simulations allow use of even smaller time steps for more accurate behavioral analysis and/or use an event-driven structure for more computational efficiency. Microscopic simulations generally also include detailed modeling of traffic signal operations. Accurate modeling of traffic signals will be a requirement for derivation of surrogate safety measures. However, all microscopic traffic simulation models were designed assuming that drivers behave in a "safe" manner, but according to their particular driver behavior characteristics (i.e., aggressiveness for gap acceptance and lane changing). This is true in the real world also, but because of misjudgment and mistakes, crashes do occur. Any derivation of surrogate measures must account for this basic fact that simulations do not (currently) include crash occurrence (FHWA, 2006).

Transportation professionals use traffic analysis tools to find the best transportation solutions for their regions. However, as transportation solutions become more sophisticated and complex, so do traffic analysis tools. As a result, many public agencies are facing new and difficult issues regarding traffic analysis and simulation tools for transportation decision making. Some of these common issues include: how to choose an appropriate tool, how to manage and review a complex traffic simulation study, and how to model intelligent transportation system (ITS) and advanced traffic management and control strategies. Rather than each public agency addressing these challenges separately, agencies can tackle them in a collective and comprehensive manner through the PFS process (FHWA, 2006).

Traffic microsimulation analysis tools can help evaluate these complex solutions by modeling real-world transportation networks on a system wide scale that is difficult with more traditional methods. Dramatic improvements in computer processing speeds and capabilities in the past decade have enabled traffic microsimulation software to model increasingly complex and larger scale transportation systems. As a result, microsimulation is quickly becoming popular among traffic analysts and is playing an important role in transportation investment decisions (Vassili Alexiadis, James Colyar, and John Halkias, 2007).

Microsimulation provides the ultimate in detailed analysis. There are many questions which are simply not able to be answered by conventional analysis. Deterministic analyses like the HCM and the different roundabout models can evaluate individual intersections. Only a microsimulation analysis can take into account the true impact that the individual intersections, weaving areas, control devices, and transportation modes have on each other.

Microsimulations are forced to work within the constraints of the physical world. Even though a roundabout or loop ramp has two lanes when a heavy truck is on it there is very little room for any other vehicles. The impacts of the roadway geometries and the physical size of the vehicles have tremendous impacts that are not taken into account with macroscopic or deterministic analysis.

Just a few of the many questions that can be answered with a microsimulation analysis:

- Public Relations - the 3D visualizations are terrific public relations tools
- Travel Demand Analysis – macroscopic models can gain a lot from the microscopic models
- Operational Analysis – there is no more detailed analysis than a microsimulation

Literature Review

By harnessing the power of computational techniques initially developed on academic supercomputers, urban planners, and engineers are creating vivid animations of urban life to solve problems ranging from urban sprawl to traffic jams to site selection.

<u>State-of-the-Art</u>

Current literature describes many case studies of 3D traffic simulation usage in transportation planning activities and its added benefit to these projects. Transportation design visualization has evolved from artistic renditions of proposed changes and photos to immersive 3D animations and simulations representative of a proposed transportation improvement. Simulated representation may be appropriate in some instances during the planning phase, but visualization during the planning process may be much more useful and appropriate. Planning documents are often spreadsheets that are difficult to read, populated with acronyms and abbreviations that must be deciphered or plans that are filled with dense narrative describing a process, procedure, policy or proposal.

The visual simulations that are used during project design are often not appropriate for use during the transportation-planning phase. The projects have only been identified based on a project need or objective. It is too soon in the process, and therefore the project alignment, context, scope and other details have not yet been defined. It would be premature and misleading to the public and other partners to imply through simulation that these decisions have been made. The public may balk at further involvement with the planning and project development if the project appears to have a completed design.

Planning documents traditionally contain a very limited amount of visualization. Simply adding photos, images, flow charts, diagrams or maps to illustrate, transportation planning may be more clearly conveyed. 3D traffic simulations are generally scenario based and when incorporated with a microscopic simulation model allow users to have the visual impact when testing design alternatives by providing a clearer understanding of the consequences of these alternatives.

The current state of visualization within the transportation community is one of eagerness to use the technology, but minimal organization for its implementation. Transportation agencies throughout the United States are looking for guidelines and best practices for its use.
A majority of the current use of visualization occurs at the grass-roots level within transportation agencies. Most of this use is driven either by a specific project or by a project manager.
The result is that most transportation agencies are reactive to visualization versus being proactive in its development. People with minimal to no experience with visualization are determining its use or nonuse for their project(s). Because the use of this technology is being driven by people with a lack of experience, clear standards or guidelines need to be developed or adhered to by transportation agencies. Because there are no accepted guidelines, research and development for visual tools is limited to job-related experience and trial and error. Despite the lack of focus and direction, the use of visual tools by transportation agencies is increasing. This increase is primarily the result of outside forces, such as the need for project acceptance from the public for controversial design issues. Almost every large-scale project today uses some form of visualization capability. Visualization is becoming "expected," especially for high-profile projects requiring extensive public involvement (Hixon, 2006).

Examples of 3D Traffic Simulation Use

The traffic analysis and simulation sector has been moving more and more towards improved visualization capacities, consultants say that the ability to demonstrate project impacts is ever more important, with programs like S-Paramics, PTV's VISSIM and Aimsun from Spain.

As part of the literature review of this study, examples of 3D traffic simulation use was compiled. Some of those examples include:

Shanghai Harbour (China)

China has been building huge new harbour facilities in recent years to cope with its astonishing growth in industrial output and exports. The largest of all these new facilities will be the deepwater port serving Shanghai and the east coast which, with Shanghai port itself, will comprise the largest capacity in the world. Consultant Wu & Song Associates experts in traffic simulation modeling were brought in as part of the design team for the project. The designers wanted to optimize the road layout and operation and to do this needed to understand the impact of various operating patterns for control signals and lights. There was particular concern about the kind of delays that could be caused to flows in the traffic at the ten entry gates as vehicles pulled over and diverted to one side for inspections. The kind of measures that could be used for mitigation needed to be understood as well. Another consideration was how these factors might change with the rising levels of traffic in the first few years of the port operation. Wu & Song Consultants considered a different simulation model before deciding that Aimsun was better suited for modeling container operations. Aimsun used a mixture of vehicle demands including container trucks and private vehicles like cars and minivans. According to Dr. Jia Hao Wu who runs the consultancy the 3D display capacity of the model proved very useful for public consultation and discussions and to explain many of the concepts for operation (Software for Road Infrastructure, Oct., 2006).

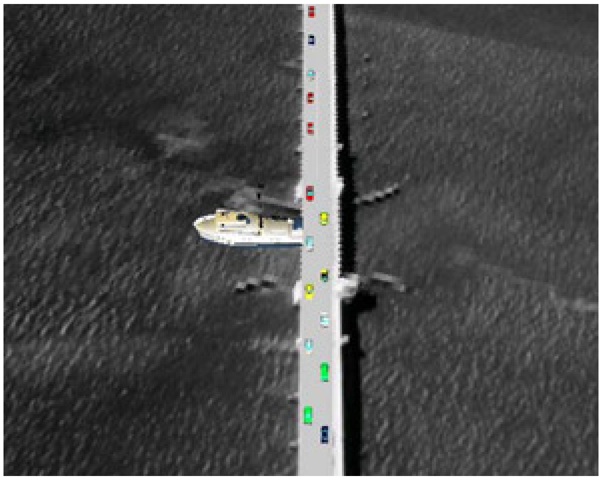
UK's M42 Motorway (England)

In the UK highway construction is particularly difficult because of the dense population and eminent domain is a fiercely contested issue especially in urban areas where the difficulties of fitting in extra capacity are enormous, alternative means of addressing the issue of capacity demand are being investigated and demonstrated. In this project an extended version of the S-Paramics microsimulation software from Sias was developed for "live" feedback to help build the new Active Truck Management System for the UK's M42 motorway. This project used the 3D real world simulations to interact with various stakeholders when making visual display representations of strategies. Project leaders the visualizations were a key factor in getting stakeholder "buy-in" to the plans when they could see how strategies would work (Software for Road Infrastructure, Oct., 2006).

Sanibel Causeway Improvements Study (USA)

PBS&J was selected by Lee County to conduct a project development and environment (PD&E) study for improvements to the Sanibel Causeway and three causeway bridges located in Lee County, Florida. The analyses considered the removal of the entire causeway, as well as rehabilitation and replacement alternatives for the three bridges.

Figure 1. The VISSIM Traffic Model Used To Simulate Traffic Operations for a Fixed Bridge Alternative



Source: www.pbsj.com accessed January, 2007.

Traffic was evaluated and simulated for three alternatives: a 26-foot drawbridge with one lane onto and two lanes exiting the island; a 50-foot mid-level drawbridge with one lane onto and two lanes exiting the island; and a 70-foot fixed-span bridge with only one lane exiting the island.

Each bascule bridge alternative considered the need for an additional lane on the Sanibel Causeway for traffic exiting the island.

VISSIM traffic simulation models were developed for each of the alternatives based on existing PM peak-hour traffic conditions. The alternatives were compared based on measures of effectiveness (MOEs), for example, travel time, driver delay, levels of service (LOS), queue lengths, and average vehicle speed. The videos clearly showed significant differences in traffic congestion between the alternatives. Video clips of the VISSIM 3D traffic simulations were created for each alternative and were shown to the public at community meetings and a public hearing.

Figure 2. VISSIM Used To Simulate Toll Plaza and Bascule Bridge Operations

Source: www.pbsj.com accessed January 2007.

These traffic evaluations revealed that a fixed-span bridge, with one lane exiting the island, would provide the best capacity off the island, yielding a free-flow situation. The fixed-bridge alternative also offered uninterrupted flow for shipping traffic, providing improved safety conditions in a channel known for strong currents (www.pbsj.com accessed January, 2007).

Research Objective

The objective of this research will be to provide a comprehensive list of all traffic simulation models that currently have incorporated or are in the process of incorporating a 3D interface. The models will be evaluated based on functionality, industry applications and current use.

The main outputs of this project will be an enhanced set of traffic simulation models with 3D visualization capable tools for helping traffic engineers solve traffic management problems.

NEEDS OF VISUALIZATION IN TRAFFIC SIMULATION

The need for visualization within the transportation community can be traced back to two factors: (1) improvement to the design process and (2) public and stakeholder involvement. Both of these issues have driven the advancement and use of the technology needed to create immersive 3D worlds to explore the options offered by traffic simulation.

What is Simulation?

In general simulation is defined as dynamic representation of some part of the real world achieved by building a computer model and moving it through time (Drew, 1968). A successful traffic simulation model is an abstraction of a real system that retains the system's essential aspects. The model can be used either to enhance the understanding of how the system works or to investigate the potential effects of proposed modifications to the system (Papacostas and Prevedouros, 1993).

What Is Visualization in Traffic Simulation?

Visualization is a simulated representation of proposed transportation improvements and their associated impacts on the surroundings in a manner sufficient to convey to the layperson the full extent of the improvement (Hixon, 2006).

There are a number of analytical simulation tools used for testing roadway designs. The tools can be used to test capacity for a system, intersection and signal timing performance, or general traffic flow performance evaluation for a road network. Some of the more common tools are: HCS, CORSIM, Synchro, SimTraffic, Transyt 7F and VISSIM. These tools are more commonly used for urban and high traffic road systems.

Simulations typically involve building a schematic representation of the roadway network. Many of the tools can use a computer aided drafting (CAD) representation of the road design as a background for tracing the network. These typically import some 2D format such as a drawing exchange file (DXF) format, which can be exported directly from Microstation. Some of these tools, most notably VISSIM, can import and use as a background a 3D model including texture maps. If a road model in Microstation were requested as the base for this type of simulation model, a typical pipeline for conversion of a Microstation model would be to export as virtual reality markup language (VRML) (Taylor and McDaniel, 2007).

Tremendous advancements in simulation technology have brought about new capabilities in modeling transportation systems. Current simulation technologies are able to model individual vehicles and pedestrians in a large area. However, their data is generally available as large tables that must be analyzed statistically, and it is difficult to interpret the impacts of these phenomena upon the rest of the transportation system. A parallel advance in visualization systems, capable of operating on ubiquitous personal computers, makes possible the rendering of the transportation system in 3-D, virtual reality. By utilizing this technology, researchers, analysts, and planners can view the transportation system through virtual traffic cameras, traffic-monitoring helicopters, or first-person from an individual driver or pedestrian viewpoint. Thus, impacts of traffic changes could be visually demonstrated. Other potential applications include simulation and visualization of work zones on freeways, the addition of a rail system in the median of a freeway, and the status of the network due to some natural disasters like hurricanes and floods.

This high fidelity 3-D visualization of traffic flow immerses the users through virtual, real-world viewpoints (i.e., traffic camera, helicopter, driver, pedestrian) and allows them to view the study area through various perspectives in a very rich virtual environment that contains high-fidelity terrain and structures representative of the real world.

City planners, traffic engineers, and other decision makers can apply this technology to various problems or purposes, such as the following:

- congestion/choke points
- the effectiveness of new technologies and highway improvements such as high speed rail and other ITS deployments
- the effects of construction phasing and lane closures (allowing for 'what if' analysis for a variety of traffic conditions)
- the development of commercial or residential sites (e.g., value of visualization) (FDOT, 2006).

According to Edward Lieberman, President of KLD Associates, after the simulation has been run interpretation of the simulation results is most critical. 3D animation displays of the traffic environment (if available) are a most powerful tool for analyzing simulation results. A careful review of this animation can be crucial to the analyst in identifying:

- Cause and effect relationships. Specifically to origins of congested conditions in the form of growing queues can be observed and related to the factors that caused it.

- Anomalous results (e.g., the creation and growth of queues when conditions are believed to be under saturated) can be examined and traced to valid, incongested behavior; to errant input specifications; or to model deficiencies (Lieberman and Rathi, 2006).

DESIGN OF THE STUDY

The methods used to gather pertinent information relevant to 3D visualization in traffic simulation include reviewing the current literature in many forms. This research will employ the internet, transportation journals, newspapers, traffic simulation brochures and user manuals as well as other forms of published literature. The World Wide Web was used to access historical articles, periodicals, and other research databases relating to traffic simulation. Telephone and email will be used to contact various traffic simulation software vendors to request additional information and references to other locations where information might be obtained.

Once the review of the current literature is complete and background information is compiled from this a list of all traffic simulation models with 3D visualization capability will be noted. A previous study done by the author (Boxill, 2001) will also be used as a reference for all traffic simulation models.

Initial Screening

After the comprehensive list of all traffic simulation models has been compiled an initial screening will take place to pare down the list to traffic simulation models with 3D visualization capability. Then it briefly describes main characteristics of each simulation model followed by a summary of the models selected as a result of the initial screening.

Evaluation

All traffic simulation models with 3D visualization capabilities will be evaluated based on general features, innovations, calibration and validation, and known limitations.

Accompanying DVD

An accompanying DVD is included with this report to supplement the information provided for the selected models. Actual screenshots, brochures, quick facts, and program demos are included.

CURRENT TRAFFIC SIMULATION MODELS WITH 3D CAPABILITY

The integration of traffic simulation models with the 3-D visualization tools has been successfully accomplished. The output files from the traffic simulation are converted to an XML file and fed into a 3-D visualization engine as an input. With this technology the user has the ability to attach to or detach from a vehicle and fly around the database, zoom in and zoom out, freeze the simulation, and resume. Researchers, analysts, and planners can view the transportation system through virtual traffic cameras, traffic-monitoring helicopters, or first person, from an individual driver or pedestrian viewpoint, and look at the congestion points (FDOT, 2007).

After the initial screening of the comprehensive list of traffic simulation models five models were selected for further evaluation.

Selected Models

Microscopic traffic simulation models that have presently incorporated a 3D viewer and are included in this report are:

Table 1. Selected Models and Developers

Model	Developer
S-Paramics	**Sias**
Paramics	**Quadstone**
Vissim	**PTV**
Aimsun NG	**TSS**
DynaSim II	**Dynalogic**
Cube Dynasim	**Citilabs**

**Selected Model Descriptions and Features*

S-Paramics – *Sias Limited*

Paramics Microsimulation is the software sales, support and training division of SIAS Limited. It has developed S-Paramics, a software system for road traffic flow analysis at any scale. S-Paramics was created by SIAS in the early 1990s, and is now widely used in the UK and throughout the world.

S-Paramics simulates the individual components of traffic flow and congestion over very wide areas, bringing a high level of integrity to traffic management and road network design. Unlike other systems, it does not rely on other software for routing information, and can therefore properly model the causes and effects of wide area congestion experienced in the real world. It is fully functional within an ITS and UTC context, and links directly to adaptive control systems for high fidelity real-time simulation.

Figure 3. Examples of 3D Traffic Simulation Animations in S-Paramics [1]

Source: www.sias.com/sias/s-paramics accessed February, 2007

S-Paramics simulation models include a physical description of the road network, and all additional features which affect traffic flow such as bus operations and traffic signal settings. The variable behavioral characteristics of modeled drivers and vehicles within S-Paramics generate an accurate representation of the complex and variable circumstances that lead to congestion in all types of road network (Sias Limited, 2007).

Some of the unique features of S-Paramics include:

- S-Paramics is unique in providing dynamic assignment over road networks of unlimited size. No other traffic flow modeling system offers the same level of functionality and features.

- S-Paramics enables non experts such as stakeholders and the public to interactively test "What If" scenarios and immediately see the results in terms of real time traffic flows and congestion.

- Wide use throughout the world, S-Paramics microsimulation brings new standards of integrity and veracity to traffic flow modeling.

- Easy to use ...
  S-Paramics was originally introduced to enable SIAS's transportation engineers to become more effective by reducing the time it takes to build traffic models, and boosting their confidence in the output. The data requirement is similar to that of other modeling systems, but takes advantage of other data sources, such as digitized road layouts and aerial photographs. S-Paramics helps modelers build better models by identifying potential problems which might otherwise remain hidden.

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* All model descriptions and features come directly from literature provided by the respective model developers.

- Validation…..
  Thousands of S-Paramics models have now been validated by SIAS's clients, covering every conceivable network type and situation. S-Paramics models represent networks as diverse as Plymouth, Katowice, Amsterdam, Antwerp, and the London M25 orbital route, and the software is being deployed by consultancies, local authorities and central government agencies throughout the world.

- Huge application ...
  S-Paramics is being applied to trunk, urban, suburban, inter-urban and rural scenarios for a very wide range of situations. It can model signalized intersections, bus priority, LRT corridors, emissions control, roadway weaving, ramp metering, toll plaza design, UTC, ITS, wide area traffic management, road works design, car parks, multi level inter-changes, deviations from design standards, pedestrians and cyclists, traffic survey site layouts, local traffic impact, strategic traffic impact, wide area development assessment, unusual/non-standard layouts and complex junctions, incidents, the effect of accidents, mode interchanges, slow moving traffic, ferry crossings, single-carriageway overtaking ... in fact we are unaware of any road traffic scenario that S-Paramics cannot model with great accuracy. This is of vital importance to both traffic modelers and those involved in public consultation, and committee presentations.

These features are for S-Paramics release 2005.1. In December release 2006.1 will be available.

S-Paramics Summary of Functionality *(Sias Limited, 2007)*

Applications
S-Paramics can be applied to large complex congested urban networks as well as simple isolated intersections and .large rural and inter-urban networks.

Types of Networks Modeled

Intersections
Road networks that can be modeled include intersections (signalized or unsignalized), grade separated intersections, vehicle actuated signal plans, and pedestrian interaction.

Road Network: Links
- Lane restrictions by vehicle type or size.
- Lane change at any point.
- Overtaking on two way road, up to three abreast.
- Definable link categories.
- Local link modifications.

Road Network: Vehicles
- User configurable vehicle classes (no limit).

- Variable driver behavioral characteristics.
- Multi-section vehicles shapes.
- Optional external control of vehicle release.

Road Network: Public Transportation
- Scheduled public transportation services.
- Multiple occupancy bus stops.
- Bus stopping and passenger loading model.
- Automated bus route generation.
- Optional external control of timetable.

Road Network: Time
- Variable operation by time of day, eg. bus lanes, restrictions, signal timings, demand profiles
- Incidents - lane blockage or vehicle slowing defined to occur at random or pre-defined times.

Road Network: Visualisation
- 3D visualization with use of CAD models, e.g. 3D cityscapes
- Pollution modeling + 3D view of hotspots
- Interactive flying mode.
- Automatic screen grabs for movie making.
- Easy application of textures.
- 3D shapes and skies library.

Assignment
- All or Nothing assignment.
- Dynamic assignment: feedback option.
- Stochastic assignment: perturbation option.
- Vehicle type specific cost parameters.
- Link specific cost parameters.
- Macro and micro level routing facilitated by waypoints.
- Optional fixed path routing for small area analysis.

ITS
- ATM controlled motorway signs, for speed and lane restrictions and hard shoulder running.
- Route Guidance, for VMS route information and car park redirection.
- Programmable driver response profiles.
- Links to MOVA, SCOOT and SCATS.
- ITS controller visualization enables gantries to be modeled as 3d objects, and visual messages displayed.

Reporting: Data Analysis Tool

- Reports differences between models.
- Aggregates and analyses multiple runs.
- Compares performance of base and design models.
- Compares model output and survey data.
- Reports on link and turn counts, journey times, queue lengths, events, vehicle emissions, speed, delays etc.
- Select link analysis.
- Signal saturation.
- Cordon generation.

Reporting: Economic Performance

- Economic assessment of road schemes.
- Reports BCR and NPV.
- Adheres to TEN guidelines (www.sias.com, accessed February 2007).

For more information on S-Paramics contact:

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http://www.sias.com

Paramics – Quadstone *(www.Paramics-online.com)*

Quadstone Paramics is the only truly independent vendor of microsimulation software - as they develop market and sell our own software and are able to offer a high quality, uniquely independent and unbiased service. Quadstone Paramics is a suite of microscopic traffic simulation tools being used in over 40 countries world-wide with excess of 1000 customers including commercial consultants, cutting edge transportation researchers and state-funded Government agencies providing a powerful, integrated platform for modeling a complete range of real world traffic and transportation problems.

Paramics modules work together to improve usability, integration, and productivity allowing users, and their clients, to get added value from the modeling process. Paramics is fully scaleable and designed to handle scenarios as wide-ranging as a single intersection, through to a congested freeway or the modeling of an entire city's traffic system.

Paramics has been deployed successfully in hundreds of networks worldwide and has been particularly useful in modeling large-scale networks in California, New York City and Sydney amongst others. Additionally, Paramics has been utilized on numerous ITS projects in Europe and Australia.

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[*] All model descriptions and features come directly from literature provided by the respective model developers.

The Paramics Software Suite

The Paramics components that make up the software suite of tools include:

- **Modeler** - Modeler provides the three fundamental operations of model build, traffic simulation (with 3-D visualization) and statistical output accessible through a powerful and intuitive graphical user interface. Every aspect of the transportation network can be investigated in Modeler including:

  + Mixed urban and freeway networks
  + Right-hand and left-hand drive capabilities
  + Advanced signal control
  + Roundabouts
  + Public transportation
  + Car Parking
  + Incidents
  + Truck-lanes, high occupancy

  By modeling individual vehicles Modeler provides the transportation professional with insight into and better understanding of many hundreds of network issues, resulting in a more efficient and effective approach to projects.

  The high quality visualization of the vehicles in the network makes modeler the perfect tool for presenting project results to non-technical audiences.

- **Processor** - Processor is a batch simulation productivity tool used for easy sensitivity and option testing. Processor can be used to automate simulation and analysis processes, reducing user down time, and speeding up the model development lifecycle. Processor utilizes the core Paramics simulation and works in harmony with Analyser to make the generation of complex model statistics an effortless task.

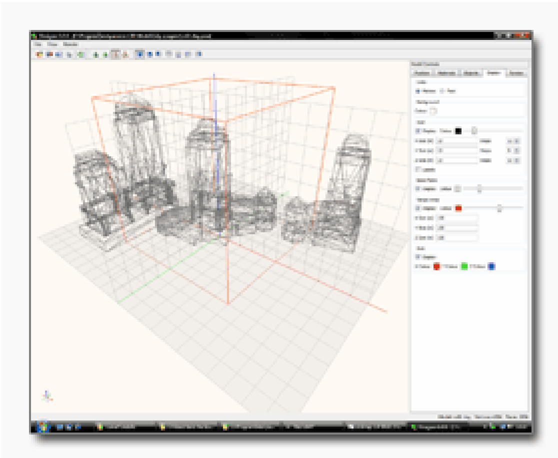
- **Paramics Analyser -** Analyser is the powerful post-data-analysis tool used for custom analysis and reporting of model statistics. Analyser can be used to interrogate a single set of data or it can be used to compare multiple datasets from multiple sources e.g. base layout, alternatives, and observed field data helping to speed up the model calibration and validation process. Analyser provides statistics suitable for every user's needs including user definable HCM style Level of Service and MOEs. Analyser provides a set of automation tools such as report templates and project workspaces to help users manage their data and minimize the time required to obtain project-critical statistics.

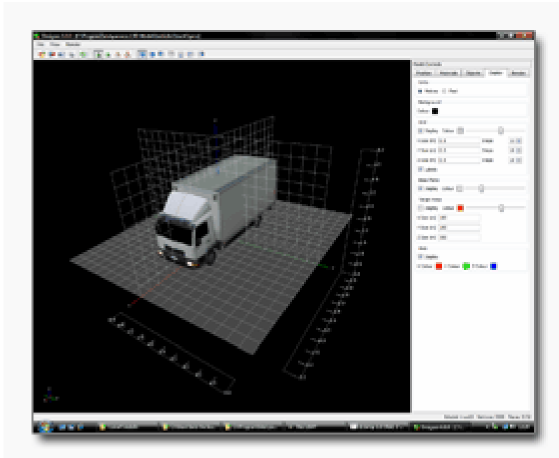
- **Paramics Monitor** - Monitor is a pollution evaluation framework module that integrates directly with the core Paramics simulation. Monitor can be used to collect pollution data at the most detailed per-vehicle level.

Paramics Designer - Designer is a 3D model building and editing tool provided for use with Paramics Modeler. It can be used to prepare complex and life-like 3D models to aid the visualization of any traffic model for presentation and public exhibit.

Designer is free to any licensed user of the Paramics applications and is provided with over 800 ready-to-use, life-like 3D models.

Figure 4. Screenshots of Paramics Designer





Source: www.paramics-online.com accessed January 2007

Application Areas

Paramics can be applied to any aspect of a modern transportation network with equal ease and clarity. Some of the most common application areas include:

- Priority intersections, signalized intersections and roundabouts
- Urban cities, corridor studies and congested freeways
- Public transport and light rail
- Actuated signal control
- Special user groups e.g. HOV, emergency vehicles, transit priority
- ITS elements e.g. ramp metering, VMS, route control, lane usage, freeway speed control
- Work zones, event management and pollution modeling
- Public presentation

Presentation

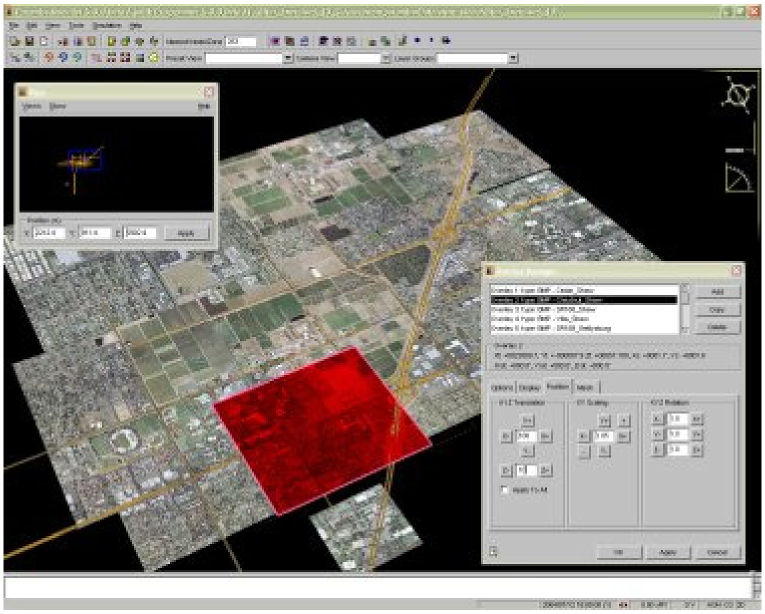
Paramics provides a range of visualization and presentation tools to suit different user needs during the whole lifespan of any model. A range of display tools designed for engineers are provided. These graphics tools help with network building, understanding driver behavior, calibration and validation, and real-time statistics feedback.

In addition, Paramics provides cutting-edge 3D visualization of the virtual world. 3D network geometry, life-like vehicle shapes and 3D models, weather effects, terrain mapping, real-time video capture, and video editing/storyboarding are just a few of the advanced features provided for visualization and presentation purposes.

Figure 5. Example of Paramics 3D Traffic Simulation

Source: www.paramics-online.com accessed January, 2007

Figure 6. Screenshot of Paramics Modeler



Source: www.paramics-online.com accessed January 2007.

For further information and licensing options go to the company website and fill in the contact information form.

VISSIM – PTV America (www.ptvamerica.com)

VISSIM is part of a suite of traffic software offered by PTV America. It is a microscopic, behavior-based multi-purpose traffic simulation program. The other program in the suite is VISUM which is used to build conventional four step models for regional and statewide planning while also serving as a powerful analysis and data management tool for traffic engineers and transportation planners. One of its purported strengths of VISUM is that it offers detailed public transportation service planning, with a data model for routes and schedules that goes beyond traditional demand models.

VISSIM is a microscopic, time step and behavior based simulation model developed to analyze the full range of functionally classified roadways (including rail road crossing and toll plaza) and transit operations. It is capable of modeling traffic with various traffic control measures in a 3D environment. VISSIM assists in comparing different alternates in designing roundabout, at-grade intersections, and high-type traffic interchanges.

VISSIM can model integrated roadway networks found in a typical corridor as well as various modes consisting of general-purpose traffic, buses, HOV, HOT, light rail, heavy rail, trucks, pedestrians, and bicyclists. The following components and strategies can also be modeled in

VISSIM:

- Variable Message Signs (VMS),
- ramp metering, incident diversion,
- transit signal priority,
- lane control signals,
- dynamic lane control signs, etc (www.ptvamerica.com, 2007).

Typical use cases for VISSIM have included a comparison of intersections with regard to design alternatives (unsignalized and signal-controlled; grade separated interchanges), an analysis of bus and LRT preferential treatments, capacity analysis and testing of transit priority schemes, analysis of traffic management systems such as alternative route control, traffic flow control, toll roads, section control systems, access control and special lanes, feasibility analysis of large networks (e.g., roadways) with alternative route choice using dynamic assignment, wide range of highly specialized traffic engineering tasks, such as capacity analysis simulation of traffic-calmed areas including all relevant road users of railroad block section operation and of toll plaza or border control facilities, simulation and visualization of passenger flows at a multi-modal transit center, an a 3D model of an underground train station with different levels linked by escalators and stairs.

Major features of VISSIM

Easy Network Editing

- Convenient and intuitive network editor with a customizable user interface and a flexible network topology
- Creating and editing traffic networks based on background images (e.g. city maps, aerial photography, CAD drawings in different digital formats)
- Highly exact positioning of numerous network elements (e.g. detector positions, location of signal heads, speed decisions, priority rules) and stochastic elements (e.g. desired speed distribution, acceleration and car-following behavior)
- Possibility of importing VISSIM networks which have been exported from VISUM (together with travel demand matrices and route information). By pre-defining standard intersections in VISUM ("junction editor) it is possible to quickly create larger traffic networks for microscopic simulations
- Import of network topology and fixed time signal control from signal control design tools like CROSSIG and P2

Easy Set Up Of Large Networks By Additional Import Of Partial Networks

- Efficiency is improved with the help of the "read additionally"-function: With VISSIM it is possible that several users can access and edit data on one large project at the same time.
- What is more, sub-area networks can be aggregated to one large network.
- Assembling network components: The user can create a library of sub-area networks or access pre-defined standard junctions.

Sophisticated Vehicle Behavior Modeling

- Driver models and network topology is suited for left-hand driving as well as right-hand-driving
- Scientifically sound car-following models for urban and motorway/freeway traffic respectively with time steps as low as 1/10 second.
- Adjustable lane-changing behavior models provide the user with realistic modeling of various merging situations (e.g. motorway junctions, merge-in-turn, zip-merge)
- Modeling merging areas including details like co-operative lane change
- Expandable collection of different vehicle types as well as user-defined changes of driving behavior (defensive/aggressive driver), even within the same stretch of road.
- Modeling parallel vehicle flows (e.g. cars and motorbikes/cycles) driving in the same lane as well as overtaking inside wide lanes.
- Selecting between different types of traffic demand modeling: either static routing based on turning movement data/intersection counts or free route choice using dynamic assignment based on alternative routes.
- Transparent dynamic assignment module offering a variety of parameters using trip purpose related and time-dependent origin-destination matrices. True multi-class networks, i.e. route choice can be determined for each vehicle type, thus allowing pedestrian precincts, bus lanes, HOV lanes, driving restrictions for trucks etc. to be modeled.

Urban and Regional Traffic Control

- Priority rules for a wide range of applications such as non-signalized intersections, conflicting movements at signals or keep-clear-areas
- Highly-detailed modeling of intersections of any kind of geometry
- Built-in fixed time signal control
- Built-in ring/barrier actuated control (NEMA/Type 170)
- Any other type of vehicle-actuated signal controller can be coded with VAP, the C-like traffic control language.
- Interfaces between other vehicle-actuated signal control methods such as Econolite ASC/3, VS-PLUS, and Siemens NextPhase
- Open C-interface for signal control manufacturers and developers of control programs.
- Interfaces to adaptive signal controllers SCATS, SCOOT and SPOT/Utopia.
- Application of VAP to model Intelligent Transport Systems (ITS) and regional control operations such as dynamic speed control or alternative route guidance systems.
- Numerous functionalities for testing vehicle-actuated control operations via manual detector activation and reproducibility using macros.

Numerous Analysis Options

- VISSIM provides a wide range of customizable evaluations such as number of vehicles, average speed, travel time, delay time and length of traffic tailbacks. A collection of the most important parameters can be generated automatically (intersection/node evaluation).

- Highly aggregated output data such as number of vehicles and delays within the entire network.
- Additional macroscopic link evaluation showing vehicle speeds, density or emissions (only with optional emissions module)
- Determining signal control parameters like min/max and average green time per signal group/phase, waiting time after detector calls and display of dynamic signal time tables and user-defined parameters.
- It is possible to export simulation results to VISUM for detailed graphical display (e.g. flow bundles, node flows).

A Variety of Animation Capabilities

Different animation capabilities support in particular a non-technical audience by offering clear and descriptive presentations.

- Visualizing vehicle movements within the network in 2D and 3D.
- Large vehicle library with various 3D models.
- Displaying the vehicle movements from the driver's seat in 3D mode.
- Realistic 3D display by importing 3D objects in 3DS format and modeling simple static 3D objects using the optional module V3DM.
- Editing and storing keyframes as a storybook to be used for the creation of AVI films in VISSIM. Additionally, keyframes can be used as pre-defined views that can be quickly accessed during the simulation/animation
- Free VISSIM-Viewer for display of short simulations or animations of network files.

Efficient Model Architecture Based On Application Interfaces

- VISSIM networks can be exported from the macroscopic planning tool VISUM. Therefore, it is possible to quickly and efficiently edit large networks in VISUM. The data is then exported to VISSIM for simulation. The user has access to all VISUM functionalities such as assignment procedures or matrix estimation methods (TflowFuzzy).
- Improved route search and faster model parameterization with the help of extra functionalities based on VISUM's dynamic assignment.
- It is possible to export simulation results to VISUM for a detailed graphical display (e.g. flow bundles, node flows).
- Interface to frequently used databases like Microsoft Access.

VISSIM offers a wide variety of urban and highway applications, integrating public and private transportation. Even complex traffic conditions are visualized in an unprecedented level of detail providing realistic traffic models.

This software combines traffic engineering expertise with 3D animations, guarantying a convincing presentation for both technical experts and decision makers, in particular when important decisions on costly projects have to be taken. VISSIM convincingly shows how effective a projected measure might be regardless of whether a new road is going to be constructed or a new tram line is being planned. VISSIM is used in more than 70 countries worldwide (www.ptvamerica.com, 2007). For a free demo contact:

WASHINGTON
19505 Vashon Hwy SW, Suite A
Vashon, WA 98070-1850
(206) 463-3768 | tel
(206) 463-5055 | fax

AIMSUN NG – Transport Simulation Systems (TSS) (www.aimsun.com)

AIMSUN NG developed in Barcelona, Spain is a fully integrated suite of traffic and transportation analysis software that includes:

AIMSUN Modeler

Imports digital maps for model building, translates other network models into AIMSUN models, and has powerful and flexible editing capabilities, unlimited Undo and Redo, Copy and Paste, high quality printing, thematic drawing etc. One feature of the Modeler is data fusion which means that it has incorporated data translators that can provide functions such as import Saturn Networks, import/export EMME/2 Networks, import CUBE Networks (using the GIS interface), CAD Support: DWG and DWF, GIS Interface, Shape files (GIS de facto standard), Creates Network geometry automatically when the additional necessary information is available (i.e. number of lanes per section, flow directions, turnings at intersections…), preserves historical & Real time Detector Data, and iImport control plans (TRANSYT, Synchro, VS-Plus, Utopia and SCATS).

AIMSUN Simulator

AIMSUN is a microscopic traffic simulator that can deal with different traffic networks: urban networks, freeways, highways, ring roads, arterial and any combination thereof. It has been designed and implemented as a tool for traffic analysis to help traffic engineers in the design and assessment of traffic systems. It has proven to be very useful for testing new traffic control systems and management policies, either based on traditional technologies or as implementation of Intelligent Transport Systems.

AIMSUN can simulate adaptive traffic control systems such as SCATS, VS-PLUS and C-Regular; vehicle actuated, control systems that give priority to public transport, Advanced Traffic Management Systems (using VMS, traffic calming strategies, ramp metering policies, etc), Vehicle Guidance Systems, Public Transport Vehicle Scheduling and Control Systems or applications aimed at estimating the environmental impact of pollutant emissions, and energy consumption.

Simulation Approach

AIMSUN follows a microscopic simulation approach. This means that the behavior of each vehicle in the network is continuously modeled throughout the simulation time period while it travels through the traffic network, according to several vehicle behavior models (e.g., car following, lane changing).

The system provides highly detailed modeling of the traffic network, it distinguishes between different types of vehicles and drivers, it enables a wide range of network geometries to be dealt with, and it can also model incidents, conflicting maneuvers, etc. Traffic equipment present in a real traffic network is also modeled in AIMSUN: traffic lights, traffic detectors, Variable Message Signs, ramp metering devices, etc.

One of the main new developments at the core of the simulator is the ability to use simulation step lengths as low as 0.1 seconds. It allows improvements such as the incorporation of variability in drivers' reaction times. The richness of other parameters available for characterizing the different types of objects and traffic conditions means that the only limitation to the precision of the model is the quantity and accuracy of the data collected.

Other features of AIMSUN simulator include traffic management strategies such as:

- Rerouting (By origin, by destination, by vehicle type)
- Speed modification (by vehicle type)
- Lane closure (by vehicle type)
- Incident creation
- Control plan modification

Simulator features also included traffic control, dynamic traffic assignment, public transit, and simulation speed.

AIMSUN Planner

AIMSUN Planner is a Demand Analysis Component that has two main objectives:

- To support all the operations necessary for the calculations with the Origin to Destination matrices as required by the analysis of the demand in transport planning
- To provide a computational platform for the manipulation of the Origin to Destination matrices to generate the inputs to the microscopic simulation.

To achieve these objectives it contains the functions to:

- Edit O/D matrices
- Manipulate O/D matrices: join, split, balance
- Matrix balancing based on a Furness model
- Matrix adjustment based on link flow counts based on a Bi-level Gradient Heuristic

- Automatic Generation of Local Traversal OD matrices for sub-networks
- Detailed analysis of the results of transport planning operations
- Traversal Matrices

Interactive generation of a traversal matrix (cordoning) is easy. The user selects with the mouse the sub-network of interest, and then selects the global O/D matrix whose traversal has to be estimated. The Traversal Calculation will automatically complete the task.

Planner Approach

This component consists of an ad hoc version of a Static User Equilibrium model, the corresponding Frank-Wolfe algorithm for transport planning analysis, and all the associated visualization functions.

The static user equilibrium traffic assignment is based, as is usual in these types of models, on Wardrop's principle.

For licensing and other product information contact:

USA
PBS&J
1735 48th St.
Marion Iowa 52302
Telephone 319.377.4668
Fax 319.377.4669
www.pbsj.com
E-mail: psinha@pbsj.com

Dynasim II – Dynalogic (www.dynalogic.fr/uk)

Developed by Dynalogic in 1994, the dynamic simulation software Dynasim II is used by many community and engineering and design departments throughout the world Upgraded in January 2007; Dynalogic now distributes Dynasim II as a new generation multimodal dynamic simulator.

Dynasim II enables users to simulate and visualize displacements by restoring the various behaviors of the users (light vehicles, heavy trucks, drunk, rail, bicycle, and pedestrians). The user, guided by the intuitive graphic interface of Dynasim II, easily models any type of installation, from most elementary to most complex one. The Dynasim II's animator gives users a tool to present their projects in 2D or 3D, to the decision makers and the public.

With Dynasim II, each project is an association of scenarios of networks, flow, signals and public transport. This management enables to preserve the history of the project by making it evolve/move by simple combination of geometries, traffics, signals programming and public transit for example:

Network scenarios
A network defines a whole of copies containing the geometries of installations published using a support cartographic in the format image or vectorial.

Flow scenarios
The assumptions of traffic are defined, for each category of vehicles, using matrices origins/destinations sampled over the simulated period.

Signal scenarios
The module of signals programming integrates logics DIASER (France) and NEMA (the United States). It proposes the graphic edition of the operations of micro-regulation.

PT scenarios
The lines of collective transport are skeletal according to their routes, the type of material and their frequencies (fixed, dispersed, schedules).

Simulation scenarios
A scenario of simulation is the association of a scenario of network and flow. It can then be supplemented of a scenario of signals and/or PT.

Dynasim II Features

An Unlimited Range Of Vehicle Models
Dynasim II has an important library of vehicles. The user can add new mobiles by defining their physical capacities kinematics, their characteristics and their charts 2D/3D. The library of vehicles is completely new, integral more realistic automobiles: transparent panes, animation of the wheels and taking into account of the positions of the axles in the calculation of the trajectories.

Skeletal Behaviors of Control
To restore the behaviors of the users as well as possible, the user is able to parameterize various types of control by using the module of edition of the behaviors.

Continuous Lane Changing
Lange changing is continuous and can be done on several multifiles objects. The duration and the distance necessary to the lane changing is completely skeletal by class of vehicle.

Behaviors
The vehicle handling during the changes of file is henceforth skeletal according to the speed of the user and the vehicles surrounding it. The user can give an account of different type of control.

Pursuit Law
Two pursuit laws were implemented in Dynasim II, the user who can create and publish his own laws.

Paths
For each couple origin/destination, the objects traversed in simulation can be posted making it possible to appreciate the validity of the routes or to locate, in the zone of edition, the errors not making it possible the vehicles to reach their destination

Animation
Rendering of simulations was also re-examined, as well for visualization 2D of displacements, as for the representation in 3D of operation of simulated installation.

2D Animation
Dynasim II proposes a new bookshop of vehicles of high definition. The underpath object makes it possible to easily simulate bridges and tunnels.

3D Animation
The 3D rendering engine has been improved, integrating instances of objects and the alpha layer of textures for returned transparence. Dynasim II calculates a level of detail and eliminates the objects except fields and distances, allowing the management of large scenes 3D (on scale of an agglomeration).

For licensing information go to the Dynasim II website at www.dynalogic.fr.

Cube Dynasim (www.citilabs.com)

Cube Dynasim is an extremely powerful software system allowing planners and engineers to very quickly simulate, visualize, and evaluate the effects of proposed changes to the geometry or operating characteristics of the transportation network and impacts of changing land-use and travel demand. Cube Dynasim captures all the intricacies of traffic behavior and is able to perform detailed operational analysis of complex traffic flows while realistically emulating the flows of automobiles, trucks, buses, rail, bicycles, and pedestrians.

Cube Dynasim enables the user to easily and accurately simulate nearly any transportation system regardless of geometric configuration, vehicle types, or driver behavior in a user friendly graphical environment. Cube Dynasim captures all the intricacies of traffic behavior and is able to perform detailed operational analysis of complex traffic flows while realistically emulating the flows of automobiles, trucks, buses, rail, bicycles and pedestrians. Cube Dynasim has been successfully used around the world to simulate urban roadway networks such as:

- Roundabouts
- On-street parking maneuvers
- Multimodal transit centers
- Bus malls
- Parking Lots
- Transit priority and preemption
- Bike lanes

- Pedestrian priority areas
- Expressway facilities
- Complex expressway interchanges and weaving areas
- High occupancy vehicle lanes
- Toll plazas and facilities
- Construction areas and lane closures
- Ramp metering on expressways
- Railroad priority and preemption
- Taxi stands
- Grade separated intersections
- Complex and closely-spaced intersections
- Uncontrolled intersections
- Large-regional networks
- Two-way-left-turn-lanes
- ITS technologies
- Special event traffic
- U-turns
- Evacuation plans
- Truck terminals
- Advanced signal systems and technologies

Below are some examples of the Cube Dynasim 3D interface in screenshots.

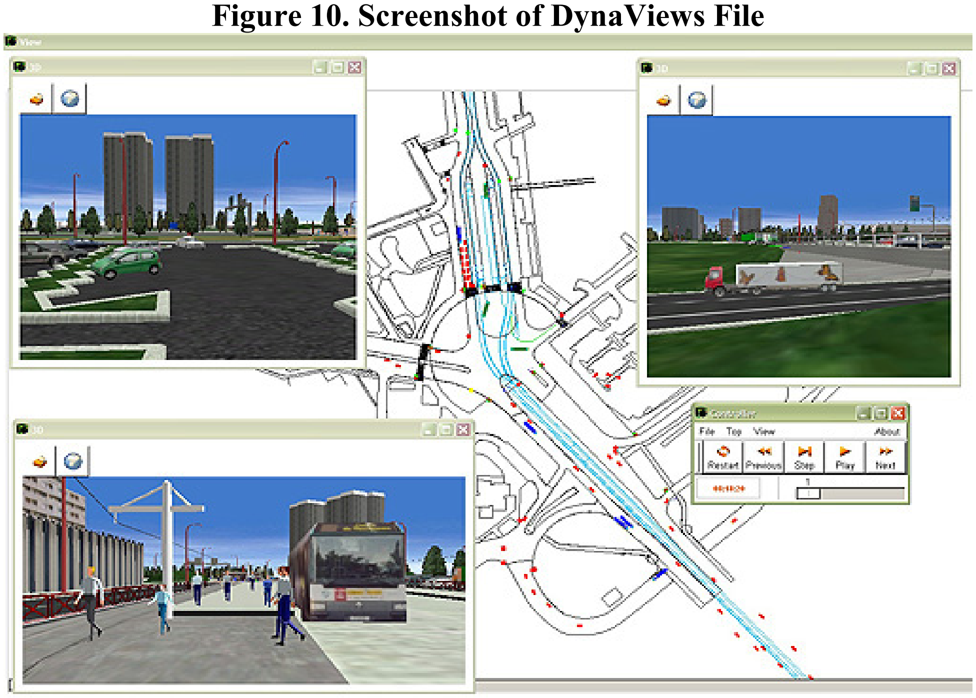
Figures 7-9. Cube Dynasim Screenshots of 3D Modeling

Source: www.citilabs.com accessed February, 2007

The stunning 2D and 3D animation produced by Cube Dynasim provide the analyst and decision makers with a clear understanding of the consequences of alternatives.

After a simulation project is complete or throughout the review process, Cube Dynasim allows users to export and compile the animations and results into a single executable file. This DynaViews file may be freely distributed and shared with clients, decision makers, or the public. Download a demonstration DynaViews file. With DynaViews, the animations are 'live' and may be viewed at any speed. The user is free to maneuver about the 3D space. There is no need to compile the animations or create movie files. Images from DynaViews may be captured and used in reports and presentations such as the one below.

Figure 10. Screenshot of DynaViews File



Source: www.citilabs.com accessed February, 2007

The 3D animations may be visualized on the background maps or the user may supply their own 3D landscapes. Dynasim uses landscapes in 3DS format, a standard format similar to DXF or SHP and written by any 3D creation program. Users can easily create their own 3D landscape using their background maps as a basis in whatever program they prefer.

With DynaViews, a virtual visit of the site is provided and is the perfect solution for public presentations. Kiosks can be set up at project open houses and the public can be allowed to run and view the simulation. The animations in DynaViews offer all the same features as Cube Dynasim and the users are free to maneuver about and zoom-in on what is most critical for them.

Three licensing options are available for Cube Dynasim. To obtain a quote for the purchase of a product or receive more information or a printed brochure, or for any other matter, contact:

Citilabs, Inc.
312 Clay Street, Suite 180
Oakland, California 94607, USA
World Wide Web
www.citilabs.com

Summary of Selected Models

AIMSUN is a full-featured simulation model with the ability to obtain detailed state variable information on each vehicle on time scales with better than second-by-second accuracy. AIMSUN has a set of APIs and has been interfaced to external codes in the past, such as EMME/2 and SCATS. AIMSUN's car-following logic has been shown to be realistic in tests during the SMARTEST study (Algers, et al., 1997). A significant advantage of AIMSUN is that the gap-acceptance behavior of drivers is modified based on their delay time. Most other models do not represent such phenomena. AIMSUN also has a model for vehicle-actuated NEMA controllers and allows for a look-ahead distance restriction at junctions. Most of the necessary elements are modeled in AIMSUN to support the collection of surrogate measures at a reasonable level of fidelity.

VISSIM appears to be a full-featured microscopic simulation model with the ability to obtain detailed state variable information on each vehicle on time scales with better than second-by-second accuracy. VISSIM has been interfaced to other external codes before, including hardware signal controllers, thus the developers have experience in development collaboration. The priority rules feature of VISSIM appears to allow complex modeling of junction behavior, including friendly merging (situations where following vehicles will slow for merging vehicles to create a gap), as it occurs in the real world. It is not apparent that other simulation models are able to represent such behavior (AIMSUN supports such an effect at freeway ramp junctions). Another advantage of VISSIM is the representation of on-street parking behavior and double parking. VISSIM has NEMA controller models available (i.e., using the VAP macro language), and adaptive algorithms and real controllers can be integrated and evaluated rather easily with the real-time interface. There are complexity issues involved with setting up the multitude of priority rules at each junction, although, again, this flexibility allows for very detailed modeling of location- and vehicle-specific interactions. However these affect the usability of the software more so than the ability to obtain surrogate measures. VISSIM appears to support most of the modeling features required for obtaining surrogate measures at a reasonable level of fidelity.

Paramics is another full-featured microscopic simulation model with the ability to obtain detailed state variable information on each vehicle on time scales with better than second-by-second accuracy. Paramics has been interfaced to other codes before, and the API continues to be refined and extended by researchers around the world, including "extensibility" of the input processor(s) and output processor(s). A significant disadvantage of the Paramics model is the use and reliance on origin-destination matrices to derive traffic volumes. Paramics appears to support most of the modeling features required for obtaining surrogate measures at a reasonable level of fidelity, although some modeling elements are described only at a functional level.

Dynasim provides four key benefits, (1) Dynasim is completely integrated within the Cube system. This provides seamless data transfer from GIS and other databases, other traffic analysis software, as well as the other cube libraries. (2) Dynasim is a scenario-based simulation. Dynasim offers a completely different user experience than any other simulation providing a way to build, manage, and run an unlimited number of simulation alternatives. Instead of managing directories of redundant simulations, the entire simulation project is built and managed within a single file. A scenario-based simulation system saves users huge amounts of time, effort, and money. (3) With any microsimulation the numeric results are paramount. But because of the randomness in human behavior, any microsimulation model must be run several times for any particular scenario. Dynasim is unique in that whether the simulation has to be run five, ten, or one-hundred times, the amount of work for the user is the same. Tell Dynasim how many runs to perform and it does the runs, compiles the results, and generates summary statistics. (4) One of terrific byproduct of microscopic simulation is the animations that provide the analyst and decision makers with a clear understanding of the consequences of alternatives. What makes Dynasim unique is that Cube Dynasim allows users to export and compile animations and results into a single executable file. This DynaViews file may be freely distributed and shared with clients, decision makers, or the public.

S-Paramics is a comprehensive traffic flow modeling software for the analysis and design of urban and highway networks on five continents. S-Paramics offers wide area vehicle routing with dynamic feedback for accurate traffic flow modeling within a context of active ITS and UTC. Uniquely S-Paramics offers wide area modeling of bus and tram or light rail operations running to scheduled timetables in congested networks with realistic bus-stop queuing and loading vehicle following, gap acceptance and overtaking behavior. This system models traffic flow at any scale. Unlike the other systems, it does not rely on other software for routing information, and can therefore properly model the causes and effects of wide area congestion experienced in the real world. Sias the makers of S-Paramics offers on-going training and support to its users from on-line help to general advice.

Citilab developers offer one of the leading transportation planning software's with **Cube Dynasim.** With Cube Dynasim users have constant tracking of every vehicle in the network. The user can determine what measures should be collected and at what level to aggregate the results for their particular study. The output measures are automatically collected, compiled, analyzed, and statistics about each scenario are calculated. Data viewers have been built into the software interface for instant feedback to the user. Cube Dynasim performs a microscopic, stochastic, event based simulation. The simulation produces vehicle movements on the network according to realistic driver behavior based on statistical observations. The fluctuations experienced day to day are reflected run to run. It is necessary with any stochastic microsimulation to perform multiple runs and statistical analyses of the results.

The ability to simulate multiple runs of a scenario is inherent to Cube Dynasim and all results are compiled and necessary statistics are calculated automatically saving the user time in compiling and analyzing results. Statistics can be calculated anywhere in the system by placing data collection points in the strategic areas of the simulation. Graphics are provided showing Vehicle Flows, Travel Times, Queues, Speeds, Delays, etc. All statistics may be stratified by time of day and location. These charts may be saved for incorporation into study reports. (www.citilabs.com accessed March, 2007). For licensees with a software maintenance contract Citilabs provides free support via telephone, fax, mail, or e-mail. Citilabs also offers preconfigured catalogs, applications, and scripts that can be downloaded such as an application to automatically calibrate friction factors given an observed trip length and a utility program emme2pt.exe to convert transit line data from emme2 format to Voyager PT format.

STUDY FINDINGS AND CONCLUSIONS

Because of the extent of hardware and software applications currently available, it would be extremely difficult to determine which product(s) should be used for best practices or for cost–benefit analyses. However, developing sound standards and guidelines for the use of these products is attainable. The most effective way for visual tools to be implemented and standardized is to institute them as a logical extension of the planning and design process. Three-dimensional traffic simulation tools are already in place; however, transportation agencies have been reluctant to use them because of the expense of training and additional staff hours required for 3-D production.

To meet the increasing demand for visualization, further research is needed to provide transportation agencies with the guidelines, best practices, and cost–benefit analyses for the use of visualization. The goal would be to have transportation agencies formally recognize visualization as a core service within the project development process.

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