S-PARAMICS - Software

S-PARAMICS, produced by Scottish firm SIAS (http://www.sias.co.uk) is one of the most modern software packages for dynamic micro simulations of traffic phenomena. The ability to simulate traffic components and the resulting congestion, managing the results of these calculations in real time representations, both bi-dimensional and tri-dimensional is the result of more than a decade of integrated work between software developers and transport engineers.

(Analysis of a staggered intersection at Segrate). Starting from a description of the road network, it becomes possible to implement an extraordinarily detailed model with all typologies of intersections (roundabouts, crossroads, feeder roads), descriptions of public transport services, drivers behavioural characteristics and all vehicle characteristics (acceleration, deceleration, geometric dimensions…). (Ancona – 3D representation of a new roundabout)

Clearly, this will result in the construction of a highly sophisticated model capable of taking all the variables that determine the phenomena of congestion at every road network level into account.

S-PARAMICS is the only software that can enable the construction of dynamic allocation models on networks of practically any dimension. No competing product offers a similar level of functionality or such a large number of distinctive features. S-PARAMICS allows even non expert users to verify scenarios of the “what would happen if” kind, analysing results in real time, in terms of traffic flows, queue formation and congestion generation. S-PARAMICS is the most used dynamic micro-simulation software in the United Kingdom and reaches extremely high qualitative standards.

The data necessary for developing traffic models with S-PARAMICS software does not differ qualitively nor quantitatively from the data normally requested by other micro-simulation software (calculations, queuing analysis, road geometry…) while at the same time guaranteeing much more reliable results. Guaranteeing the proper scientific approach and the operation of the product derives from the many cases studied by the SIAS head office in recent years, starting from the analysis of individual intersections up to urban scale models to test the most varied themes connected to road and transport planning, such as:

- Analysis and synchronization of traffic light intersections;
- Verification of roundabout geometry;
- Verification of the introduction of reserved lanes
- Phenomena of “shuttle effect” on highways
- Dimensioning of ramps and access points in traffic and resulting queues;
- Regulatory processes of lay by areas and urban traffic as well as the introduction of traffic moderation elements;
- Processes relating to road maintenance;
- User response to the introduction of motorway sign message panels;
- Management of lay by areas

Furthermore, with S-PARAMICS, it is also possible to evaluate ‘non traditional’ themes, such as:

- Effects induced by traffic accidents
- Effects induced by the presence of cyclists and pedestrians
- Management of emergency services
- The presence of slow vehicles in rural areas
- Traffic phenomena cause by public demonstrations
- Emission control

(Milano Brera Garibaldi, Traffic model and Emmission analysis)

Of course, in addition to graphical representations S-PARAMICS allows the obtaining of both statistical and numerical reports of the “total area” up to the level of “single vehicles for each moment of movement”, thereby providing extremely efficient instruments for the validation and calibration of the implemented traffic model, essential for ensuring correct responses in simulation phases. Very successful software in the United Kingdom and distributed exclusively in Italy by Systematica.

THE PRINCIPLES OF MICRO SIMULATION IN S-PARAMICS

The rapid growth of information technology in recent years has made it possible to develop programs able to consider numerous variables simultaneously. In the field of transport planning this development has led to the implementation of software capable of taking into account the variables that act on a system of mobility to a level of detail never thought possible. High performance processors at low costs allow the development of micro-simulation traffic models practically without limits of scale, ranging from individual intersections to national road networks.

The S-PARAMICS program, invented and developed by SIAS ltd, is a traffic model with two elements to be considered in synthesis. On one side, the transport offer (the road network and the means of collective transport) and on the other, the mobility demand (the quantity of trips that need to make use of the transport offer in a defined period).

This software is characterised by a highly sophisticated model of car following and lane changing with functions ranging from choosing the optimal routes to take, to a ‘learning’ dynamic, to the possibility of integrating with intelligent transport systems, as well as the ability to directly interface instruments for automatic traffic adjustment, such as management systems for coordinating traffic lights SNTP. It gives the user the possibility of introducing public transport systems and evaluating their influence on other traffic components whether in movement or stationary not to mention the simulation of traffic lights which favour public transport forms.
VEHICLE AND DRIVER CHARACTERISTICS

With S-Paramics, the movement of every vehicle is governed by three distinct and integrated models, the ‘vehicle following’ model, the ‘gap acceptance’ model and the ‘lane changing’ model. Vehicle dynamics is a relatively simple element. In synthesis, it is a combination of the vehicle characteristics (kinematic, dynamic and geometric) and the characteristics of the user. These models are applied simultaneously at the level of individual vehicles. During the simulation, the behaviour of each vehicle is instantaneously evaluated and a complex set of variables is considered which determines its behaviour: what’s the top speed that a vehicle can reach on its current curve (determined by the characteristics of the curve, the physical characteristics of the vehicle and the behavioural characteristics of the driver)? What is the position and the speed of the previous vehicle? What is the position and speed of all vehicles present at the intersection and who has the right of way? Do they need to stop or turn at the intersection? Do they need to obey traffic lights? Is there a sufficient interval (gap) for the car to stop in terms of time and distance within the traffic flow or does the vehicle in question have to change lane? Does the vehicle have to speed up to change lanes? Are there public transport vehicles that have to stop? Can this car overtake the slower cars in front? Are there administrative limits that have to be obeyed?

As in reality, the vehicles characteristics are not uniform, nor is the behaviour of the users. S-PARAMICS allows you to define the parameters that determine the simulation process.

Regarding vehicles, there are three types of determinant characteristics:

- Physical, such as the geometric characteristics of the vehicle and any trailer, the weight of the various elements, the number and location of axles;
- Dynamics, that control acceleration and deceleration, with particular attention to the characteristics that govern the behaviour of heavy vehicles along a gradient;
- General, the characteristics that define the basis of the vehicles, such as the type of engine (crucial for the analysis of pollutants emitted), how defined routes are completed (such as with buses, where route choice option is off) and the purpose of the journey.

As far as the users are concerned, we can define their behaviour expressed as aggression and awareness (of the network). During the simulation process, the factors determine the ‘gap acceptance’ parameter of the driver, the way that the driver reacts to the other vehicles in the network and how they perceive the characteristics of the network itself in terms of lane changing and overtaking.

These elements, associated with the parameters of vehicle perturbation and familiarity, allow for the characterization of the process of assignment.

THE CHARACTERISTICS OF CURVES AND KNOTS

A network of S-PARAMICS can be synthetically reduced to a set of knots connected by curves representing the road system. The curves can be classified in typological categories, with numerous characteristics being associated with each category, geometric, physical and modelling which determine its use during the simulation process.
In relation to the geometrical and physical characteristics for each category, you can assign the width, number of lanes, maximum travel speed and slope. It’s also possible to associate modelling parameters, such as functions of cost, tolls, characteristics of use (like defining curves as major or minor, or whether they belong to principal of secondary roads) location characteristics (urban or suburban), usage limitations on the part of certain vehicle categories (by type, height, weight, type…), possibility of overtaking, visibility at intersections.

A knot can be a point where even a single road characteristic changes: altimetric profile, the size, the speed limit, number of lanes or the presence of reserved lanes. A knot can represent the intersection of two or more roads with the resulting description of the setting of priorities at that very knot. The geometry of the knot is a determining element to evaluate the speed that you can exit the curve and enter the next one. At intersection knots between streets, different typologies can be associated; right of way, roundabouts, traffic lights.

THE ASSIGNMENT PROCESS

In S-PARAMICS every time a vehicle enters a curve, it evaluates the choice of the path that minimizes the generalized cost. The route choice is made during the simulation process based on specifically calculated tables, usually at the beginning of the allocation process with information regarding forecasted journey times for all possible routes from the curve to the final destination.

Clearly, these tables take proper account of the possible limits to the use of certain parts of network (bus lanes, for example) In addition; we define two separate tables of possible routes for users defined as Familiar and Unfamiliar. The users with a heightened awareness of the network (Familiar) consider all valid routes including the alternatives that would entail use of the secondary parts of the network. Users with a lower awareness (Unfamiliar) consider only principal routes as valid.

A determining element which renders S-PARAMICS an extremely effective instrument is the ability to set the calculation of route tables not as rigid, but as a dynamic element (feedback). This allows for the cost of the journey (and therefore the route taken) are continuatively recalculated in the course of the simulation taking into account the phenomena of congestion at the knots and curves, consequently modifying the possible choices of the users.

RESULT ANALYSIS

At the end of the assignment process S-PARAMICS evaluates the results through a large number of synthetic reports. You can analyze aggregate network data, such as average speed of distance covered in any minute of the simulation, the number of vehicles on the network in every minute of the simulation, the average cumulative time spent by all vehicles inside the network... Defining routes of particular interest for the simulation, you can analyze more specific data, such as the minimum, maximum and average journey times and average the number of vehicles taking a particular route, the types of vehicles etc.

Naturally, you can perform analysis on single curves, for the whole simulated period or defined sub periods; for every manoeuvre in the network and, in synthesis, for every curve, the model supplies data relative to the total num-
ber of vehicles passed. It also shows the cumulative time spent, the length of the curve, average speed and number of vehicles present throughout.

At a more detailed level, you can get data relative to zone of origin, zone of destination, typology of vehicle, distance travelled, arrival times the time spent and the use of fuel and the driving speed, instant by instant.

Another interesting element is the queuing times; the graphic representation of the latest version allows you to highlight the minimum, average and maximum number of vehicles queuing, very effective, both for individual curves, and for user defined routes.

EMISSION ANALYSIS

The terms pollutant and polluting are often used improperly; technically, vehicles emit harmful substances which have the potential to compromise air quality if they exceed certain concentrations.

S-PARAMICS can generate realistic emission data with according to several parameters, such as the type of engine (cubic cylinders) power types (gasoline or diesel), acceleration, deceleration, speed, distance....

For each simulation, the software examines a sophisticated database produced by TRL (Transport Research Laboratory) containing the information needed to evaluate vehicle emissions and analyze them according to their characteristics. The reference database used in S-PARAMICS contains information about the following harmful substances:

- Carbon Monoxide CO
- Carbon dioxide CO2
- Volatile parts of gasoline (Hydrocarbons VOC POH)
- Oxides of Nitrogen (NOx)
- Particulates (PM10)

All the substances are qualifies in terms of milligrams per second with the exception of particulates, expressed in terms of micrograms per second. The database also evaluates fuel consumption in millilitres per second. The TRL database allows the assessment of particulates in relation to diesel engines, the main source of this substance. S-PARAMICS allows you to associate the simulated vehicles of no less than eight types of engines (less than 1400 cc, catalytic and non catalytic, between 1400 cc and 2000 cc not catalytic, catalytic and diesel, 2,000 cc not catalytic makers, diesel and catalytic).

Since S-PARAMICS works at microscopic scale, it is able to assess the emissions caused by stopping a vehicle due to the presence of pedestrians or speed bumps and comparing it with the emissions of a normal drive at low speed. This element is crucial for the definition of strategies of “traffic calming” in the urban environment.

HARDWARE REQUIREMENTS

For best functioning S-PARAMICS software requires the normal hardware found in personal computers. Systematica and SIAS will be happy to advise users in the buying or updating of hardware peripheries to install the software. What follows are the suggested computer characteristics for normal functioning.
No particular processor is needed. Any Intel processor is acceptable.

SIAS recommends a minimum PIII at 400Mhz. A faster processor will allow faster simulations. S-PARAMICS can also manage parallel processors.

The memory required depends on the dimensions of the simulated model. A minimum of 128Mb RAM is recommended. Most of the Systematica PCs which run S-PARAMICS have 256/512 Mb of RAM.

S-PARAMICS needs 50 Mb for installation and an analogue quota for Exceed software in order to function.

A screen resolution of 1280 x 1024 and 16 bit colour are necessary. The graphics card is key for efficient model simulation. The card must be 100% compatible with the standard 3D open GL with at least 32 Mb of memory. Systematica computers have an ATI Radeon 7500 card with 64Mb of RAM and NVDIA GEFORCE MX 420 with 64 Mb of RAM.

S-PARAMICS has been tested on Windows 95/98, Windows 2000, Windows NT, Windows XP and Windows 7 32/64 bit.

S-PARAMICS uses a protection key for license control. Currently, all keys come with USB support.

S-PARAMICS for Windows needs the software Hummingbird Exceed X Window Server with the 3D extension.

The software has been developed in English. For proper operation on a PC with “Italian” settings it is necessary to introduce the system variable “LANG” and assign the value “C” (Settings – Control Panel – System – Environment Variables – System Variables).

All owners of an S-PARAMICS licence are required to take a training course before they can take advantage of support services and maintenance. Systematica
is the only company in Italy authorized to conduct such training courses, which may take place either at our offices or at the offices of the customer.

Each corporate client must identify at least one member of staff to follow a training course for software “base”. This condition must be fulfilled in order to gain access to support services and maintenance. There are several options regarding the training courses, which are detailed below:

**BASE COURSE**

A three day course for a maximum of four. If the course takes place at the client offices, a transfer fee will be applicable.

**The course consists of:**

**Day one:** Presentation of the software, its functions and characteristics. Basic functions of encoding network (curves, knots, intersections and yield junctions with traffic lights and roundabouts).

**Day two:** management of vehicle types, from flow profiles to the definition of simulation periods, encoding of complex network details, such as staggered intersections, roundabouts of abnormal sizes and dimensions, ramps and lanes for fast entry / exit.

**Day three:** Processes for assignment, managing the digital output and statistics, practical examples, management of support service and maintenance via the web.

The Systematica tutors will show practical examples to illustrate some features, such as the use of raster basis, the functions of vehicle tracing, simulation of accidents and other features of the software.

**IN COMPANY BASE COURSE AND WORKSHOP**

Five day ‘in company’ course at the client’s headquarters for a maximum of four participants in addition to the reimbursement of travelling expenses.

**ADVANCED COURSE**

Two day course designed to allow users who have already completed a basic course to learn some advanced methods of using S-PARAMICS, among which: Traffic lights with vehicle sensors, optimisation of traffic lights, network estimation processes, report generation and practical solutions to various problems. The advanced course will take place at the offices of Systematica or at the offices of the client, in addition to reimbursement of travel expenses.