TRAFFIC FLOW MODELS

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Introduction

Describe how vehicles travel over roads, at which speeds, what the distance is between them, how long they take to travel over a certain road section, etc. Combining the models with other information supports estimations about current and future traffic states. This allows answering questions about the presence and duration of congestion, travel times and travel time delays, emissions and safety assessment. In turn, the information can be used in a variety of applications including transportation planning and traffic control.

The history of traffic flow modelling starts in the 1930s. Bruce D. Greenshields presented his findings about the relationship between vehicle speed and the distance between vehicles at the Annual Meeting of the Highway Research Board (United States). Even though he had some predecessors doing similar research, Greenshields is often considered the founder of Traffic Flow Theory. The 1940s were a relatively quiet time for traffic flow theory, but from the mid 1950s many new models were introduced. Most of these new models include dynamics of traffic flow, i.e. they describe how traffic flows change over time, due to for examples changes in inflow of vehicles or traffic lights changing colour. Different types of models were developed and applied for road design. However, research in this area mostly stalled again in the 1980s. Faster and easier to use computers brought a new era of traffic flow research from the mid-1990s, resulting in most of the models that are still applied today. Many of today's applications require efficient numerical methods for fast and accurate predictions. Applications include transportation planning, road design, safety assessment, nvironmental assessment, traffic management, evacuation planning and route advice.

Traffic flow models have been developed and used since the beginning of the twentieth century. Traffic flow models are part of a long history of mathematical modelling of physical and other systems. Scientists and engineers use mathematical models as simplified representations of real-world systems. They are applied to explain and predict weather or chemical reactions, behaviour of materials or humans, fluid or traffic flow, etc. In this section we present a short overview of the traffic flow modelling efforts up to date. Since the introduction of the first traffic flow model in the 1930s the number of models has increased. We only focus on the ones that are still most relevant in practical and scientific applications, but we can still identify about 50 different models, many of which have been developed over the last two decades. To gain some basic insight into traffic flow modelling and the principle variables involved, we shortly discuss the main concepts of agent based and continuum traffic flow modelling. They are discussed in much more detail in the following chapters. Furthermore, we introduce other classifications of models and make a link between traffic flow models and models of other complex systems.

Traffic Flow Models.

1. Agent-Based Models and Their Variables.
2. Continuum Models and Edie's Definitions.
3. Classifications of Models.
4. Traffic Flow, Fluid Flow and Other Complex Systems

Levels of traffic modelling

.Increasingly as traffic modelling software evolves, restricting these developments to the traditional concepts and definitions of traffic modelling levels becomes problematic.

Five levels of modelling that can be used to describe the various applications of models

1. **Strategic models – EMME (Sydney Travel Model STM).**

   Strategic models Strategic models cover large areas generally with limited detail. They use complex algorithms and mathematical formulae to determine delay and travel time (these models have traditionally been deterministic but on-going research in this area includes stochastic applications). Strategic models are generally multi-model models that examine broad transport demands.

2. **Highway assignment models – EMME, TransCAD, Dynameq, VISUM, Aimsun, CUBE, OmniTRANS.**

   Highway assignment models Due to the strong links between highway assignment models and strategic models it is recommended that the zoning system used in highway assignment modelling is consistent with (or has a direct equivalence to) the strategic modelling. Highway assignment models require two key inputs:

- **Network** The model network incorporates physical characteristics of the road network such as number of lanes, link length and road hierarchy.
- **Demand** – demand for Highway Assignment Models can come from two sources:
  - **Strategic models** – where output trip tables from strategic models are used as input to highway assignment models.
  - **Traffic generation/distribution models** – where trip tables are developed from first principles using traffic generation and trip distribution models
  - **Microsimulation models** – Paramics, VISSIM, Aimsun, Commuter (strictly speaking some of these software now employ nanoscopic agent-based simulation).

Macroanalytical (Strategic highway assignment) These models are similar to those used in strategic modelling, however they only examine vehicle flows. The models generally include more detail than a strategic model and should include some level of intersection delay (most commonly intersection approach delay applied to links). These models are generally based on a traffic equilibrium assignment. Typically in NSW these models are in EMME or TransCAD

Mesoscopic simulation (Meso highway assignment) These models cover large areas and include intersection details to more accurately reflect intersection delay. At present they are not used extensively in NSW. Mesoscopic models can use an equilibrium assignment but may also include the ability to dynamically model route choice. Examples of mesoscopic modelling packages include Dynameq, VISUM, Aimsun, CUBE Avenue and OmniTRANS. Macroanalytical highway assignment models combine the network and demand using volume delay functions (or speed flow curves).

3. Corridor models – LinSig, Transyt, SCATES.

Multi-intersection models Multi-Intersection models are typically used for the analysis and optimisation of a corridor or small network. Corridor models can either be analytically or simulation based. Corridor models will provide optimised signal timings under infrastructure and demand scenarios, however some of these modelling software require the user to define an appropriate phase sequence. LinSig is RMS' preferred multiintersection model however other examples include TRANSYT and SCATES. VISUM, VISSIM, OmniTRANS and Aimsun are also capable of providing optimised signal timings either directly or through interfaces with LinSig and TRANSYT. Due to the nature of the models, traffic surveys must be undertaken at all intersections to be modelled. Other critical data collection includes signal operation, queue observation and saturation flow measurement (or estimation). Future traffic flows can be estimated using highway assignment models or by applying growth factors as appropriate, although highway assignment models should only be used to estimate traffic growth as they are generally too coarse to adequately produce detailed turn movements.

4. Single Intersection models – SIDRA.

Single intersection models are used at isolated intersections or where the effects of coordination are not required to be modelled explicitly. Single intersection models will provide optimised signal timings under infrastructure and demand scenarios, however the user must generally define an appropriate phase sequence (note that a number of single intersection software packages allow for phase optimisation but these are not generally used in NSW). SIDRA is the most commonly used single intersection modelling software in NSW and can automatically remove phases from the phase plan if a more effective intersection operation results. Undertaking option assessment in a single intersection environment can have significant time and cost saving advantages. However, if the intersection influences (or is influenced by) another intersection or downstream queuing then corridor or microsimulation modelling of a preferred option should be undertaken to ensure network effects are adequately considered. Single intersection modelling requires traffic surveys of the intersection to be modelled including traffic flows, signal operation and queuing. Future traffic flows can be estimated using highway assignment models or by applying growth factors as appropriate.

Appropriate use of modelling Before deciding on the appropriate level of modelling, the first decision to be made is whether modelling is necessary. Transport modelling can be expensive and there may be better value for money achieved by means other than modelling. Several key questions require consideration in determining if modelling is necessary. These questions include:

- What is the project objective?
- Why is the analysis required?
- What are the characteristics of the project being analyzed?
- What questions should the analysis answer?
- What are the road network features and traffic characteristics?
- Are traffic problems identified?
- What are the scenarios to be studied/tested?
- What are the design years?
- Who are the recipients of the result /who will approve the model?
- What is the extent of the model required?
- What data and information are required for the model and are these data available, affordable and practical?
- What modelling outputs are required?
- What is the peak period (or representative time period that covers project criteria) to be modelled?
- What are the potential benefits/uses of the model beyond the project?
- What previous relevant experience modelling work has been undertaken in the vicinity and is it appropriate to re-use it?

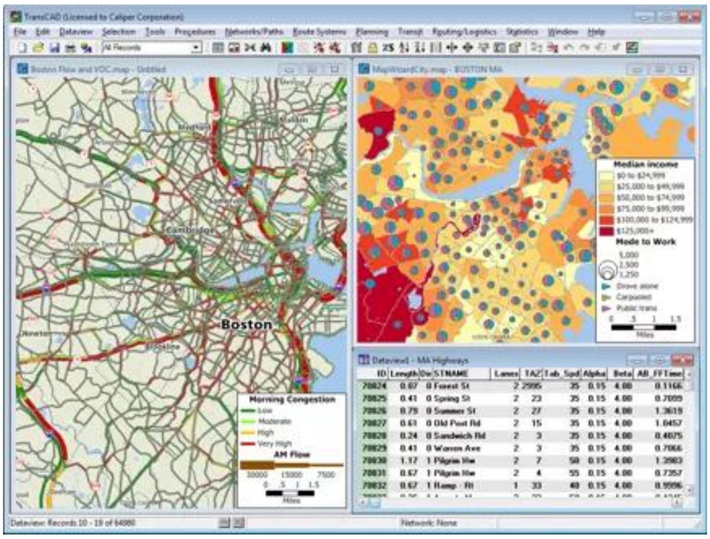
- What are the risks and implications of likely errors in the modelling results? Preliminary analysis using first principles, simple analytical methods or site visit may be sufficient to answer the above questions. If preliminary analysis is deemed not to be sufficient then modelling may be required. Once it is determined that modelling is required, the next step is to determine the most appropriate level of modelling. The use of the appropriate level of modelling is critical in determining the success of a modelling project. The use of inappropriate software can lead to poor project outcomes as well as significant cost and delays. When assessing the level of modelling to be used consideration must be given to:

- Traffic.
- On-road public transport.
- Pedestrians.
- Cyclists.
- Road network features.
- Traffic control systems.
- ITS applications.
- Environment

1. TransCAD,

TransCAD is software for transportation planning. In addition to the standard point, line, area, and image layers in a GIS map, TransCAD supports route system layers and has tools for creating, manipulating and displaying routes. TransCAD uses a network data structure to support routing and network optimization models. TransCAD includes trip generation, distribution, mode choice, and traffic assignment models that support transportation planning and travel demand forecasting. TransCAD has a set of dynamic segmentation and linear referencing tools for managing highway, rail, pipeline, and other networks.

Product history



TransCAD was first released as a MS-DOS-based transportation GIS package in 1985. TransCAD 3.0, the first Microsoft Windows version, was released on May 28, 1996. TransCAD 4.8 was replaced by TransCAD 5.0 on January 2, 2008, and later TransCAD 6.0 and TransCAD 7.0. The most current version is TransCAD 8.0.

Web-based version

TransCAD for the Web is a web-based version of TransCAD that uses application source code that can be edited using Javascript, HTML, and ASP.NET. Application templates (Mapplications) are used to create a web application or service. The default templates include Ajax applications and mashups that use Google Maps via the Google Map API. TransCAD for the Web was the first web-based GIS for Transportation (GIS-T), and remains the only transportation GIS with web development capabilities.

TransCAD is the first and only Geographic Information System (GIS) designed specifically for use by transportation professionals to store, display, manage, and analyze transportation data. TransCAD combines GIS and transportation modeling capabilities in a single integrated platform, providing capabilities that are unmatched by any other package. TransCAD can be used for all modes of transportation, at any scale or level of detail. TransCAD provides:

- A powerful GIS engine with special extensions for transportation
- Mapping, visualization, and analysis tools designed for transportation applications
- Application modules for routing, travel demand forecasting, public transit, logistics, site location, and territory management

TransCAD has applications for all types of transportation data and for all modes of transportation, and is ideal for building transportation information and decision support systems. TransCAD runs on readily-available hardware under Microsoft Windows and embraces virtually all desktop computing standards. This has two important benefits:

- You can acquire and install TransCAD at a much lower cost than any other integrated GIS and transportation modeling solution
- You don't have to build custom applications or complicated data interchange modules to perform transportation analysis with GIS data

A Powerful GIS for Transportation

TransCAD is a state-of-the-art GIS that you can use to create and customize maps, build and maintain geographic data sets, and perform many different types of spatial analysis. TransCAD includes sophisticated GIS features such as polygon overlay, buffering, and geocoding, and has an open system architecture that supports data sharing on local- and wide-area networks.

TransCAD is the only software package that fully integrates GIS with demand modeling and logistics functionality. This makes it possible for models to be much more accurate and efficient. For example, network distances and travel times are based on the actual shape of the road network and a correct representation of highway interchanges. Also, with networks, you can specify complex road attributes such as truck exclusions, delays at intersections, one-way streets, and construction zones. Further, data preparation is greatly facilitated and the database and visualization capabilities catch errors before they cause problems.

In TransCAD, different modeling equations can easily be derived and applied for different geographic subareas. Similarly, TransCAD brings new and much-needed capabilities for measuring geographic accessibility. The GIS approach also provides a graphical solution that is easily understood. Users can convey highly technical information to the non-practitioner in a very straightforward and understandable manner.

TransCAD extends the traditional GIS data model to include transportation data objects such as transportation networks, matrices, routes systems, and linear-referenced data. These extensions make TransCAD the best data management and analysis tool for working with transportation data. You can use the GIS functions to prepare, visualize, analyze, and present your work, and use the application modules to solve routing, logistics, and other transportation problems with greater ease and efficiency than with any other product. Networks and matrices can be of virtually unlimited size.

- **Networks:**

Transportation networks are specialized data structures that govern flow over a network. Networks are stored in a highly-efficient way, enabling TransCAD to solve routing problems very quickly. Networks can include detailed characteristics such as:

a. Turn delays or restrictions
b. Overpasses, underpasses, and one-way links
c. Intersection and junction attributes
d. Intermodal or interline terminals, transfer points, and delay functions
e. Zonal centroid connectors
f. Link classifications and performance functions
g. Transit access, egress, and walk transfer links

Matrices:

Matrices hold data such as distance, travel times, and origin-destination flows that are essential for many transportation applications. TransCAD provides functions for creating and manipulating matrices, and tools for spatial analysis and advanced visualization of matrix data. This combination lets you see and understand transportation flows and network characteristics in new and different ways.

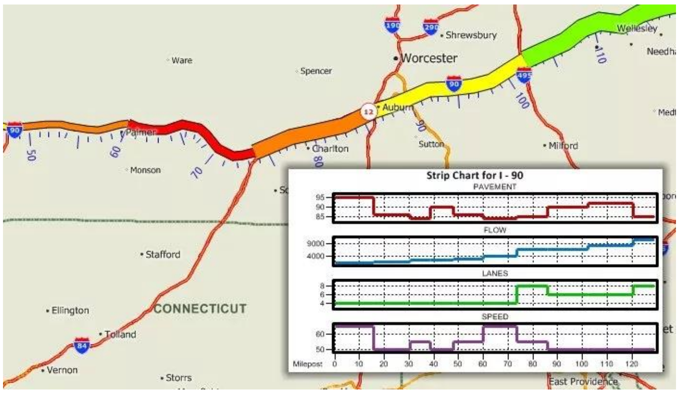
	1	2	3	4	5	6	7	8	9	10	11
1	30159	15207	0	37	1	2	205	110	3	734	41
2	9062	74491	82	333	19	72	924	1928	127	370	898
3	1	2	12855	4	1	1	1	13	2	7	15
4	16	97	1	104882	4025	5184	154	7380	447	245	1402
5	2	7	0	3782	5022	409	486	500	12	12	164
6	1	8	1	9225	946	3203	5	1827	370	158	211
7	586	924	304	300	53	62	40559	2123	98	147	204
8	318	949	39	12774	1607	795	1620	506427	22094	5854	37881
9	9	28	7	533	25	105	196	36884	25153	281	2562
10	4	6	4	364	11	6	3	4841	197	38138	20240
11	150	217	17	2741	150	26	234	26865	632	8607	199281
12	217	206	77	2119	200	383	566	38474	2749	12532	49447
13	42	123	7	919	15	122	115	1416	64	329	1038
14	58	175	103	672	21	152	47	1036	68	322	797
15	46	79	0	188	8	24	112	861	40	41	466
16	22	85	0	283	3	6	166	306	141	12	235
17	24	72	0	69	7	5	47	143	24	33	132
18	5	13	1	5	1	1	4	21	4	8	10
19	921	1606	0	236	4	1	85	214	31	12	112
20	199	376	3	95	17	4	185	2573	16	52	929
21	81	110	0	51	1	1	30	322	4	40	507

Routes & Route Systems:

Routes indicate paths taken by trucks, rail, cars, buses, or individuals traveling from place to place. TransCAD includes tools to create, display, edit, and manipulate routes, and unique display technology for mapping routes in a clear and compelling fashion. You can organize a set of related routes into a single route system layer, and include route attributes, stop locations, and vehicle schedules.

Linear Referencing:

TransCAD allows you to identify the location of transportation features as a distance from a fixed point along a route. TransCAD can display and analyze these data sets without conversion and includes dynamic segmentation functions to merge and analyze multiple linear-referenced data sets. This makes TransCAD a natural choice for:



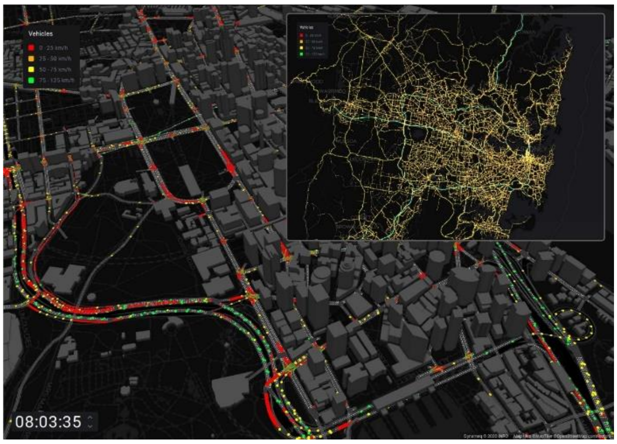
a. Facility infrastructure and operations data
b. Accident locations
c. Pavement or rail condition ratings
d. Traffic flows and transit ridership data
e. Facility alignments
f. Capital project data

2. Dynameq

, Vehicle-based Traffic Simulation and DTA

Dynameq is a vehicle-based traffic simulation and dynamic traffic assignment (DTA) that combines mesoscopic and microscopic properties to create traffic simulation fit for planning your city. Dynameq provides scalability from a single congested corridor to an entire city, all without losing detail. Vehicle trajectories over the entire network provide the transparency needed to understand exactly what is happening in the network, wherever and whenever it matters.

3D, 360° Simulation Playback



Seeing is believing. Immersive, interactive simulation playback brings stunning clarity to traffic simulations, from individual vehicles to bottlenecks to route diversion on parallel corridors. Illuminate vehicle route choice in a few clicks and understand how traffic patterns change across the city. Storyboard and share animations with production-quality video recording.

One Model, Many Applications

Detail at Scale. One platform for consistent city-wide traffic planning, from site impact and signal operations to off-corridor diversion and large-scale impacts.

Dynameq simulates individual vehicles with car-following, lane changing and gap acceptance behavior to produce realistic traffic models.

Signal operations

Transit signal priority

Roundabouts

Ramp metering

Interchange configuration

Active traffic management

TA model convergence for efficient base year calibration and forecasting on highly congested scenarios.

Tolling

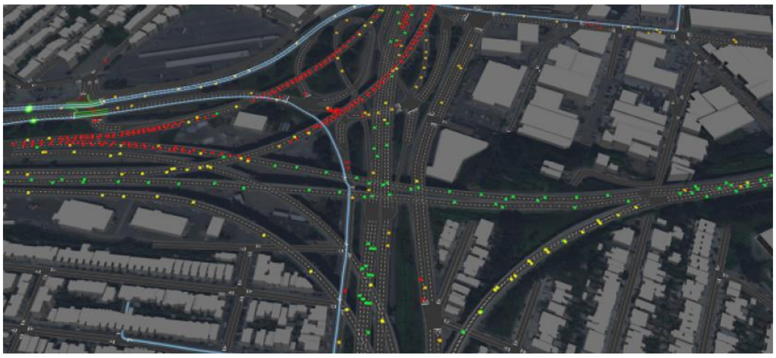
Off-corridor diversion

Induced demand

Project combinations

Site Development

Route choice



What can you do with Dynameq?

a. **Citywide Planning**

A city, regional or wide area DTA based model provides a unique ability to understand and evaluate not only individual projects, but cumulative systemwide impacts

b. **Construction Planning**

Evaluate project-specific and/or systematic work-zone related congestion impacts, validate mitigation strategies to support comprehensive transportation management plans.

c. **Tolling**

Dynameq's generalized-cost assignment makes it easy to implement fixed or time-of-day tolls by vehicle class. Evaluate variable pricing schemes like HOT lanes with customizable APIs for real-time simulation access. Dynameq models have been used to support investment grade toll studies.

d. **Transit**

Evaluate transit focused developments such as BRT and LRT, along with their impacts both on- and off-corridor, with a suite of features including transit system priority and preemption.

e. **Improve Traffic Flow**

Understand traffic breakdowns and identify innovative, cost-efficient solutions to reduce and eliminate bottlenecks. A well-formulated Dynameq model forms the backbone for a comprehensive decision support system.

f. **Freeways and Active Traffic Management**

Evaluate a wide range of freeway management strategies such as ramp metering, variable speed limits, and hard shoulder running.

3. MOVE Meter

This is webbased tool developed by Move Mobility, which is founded in 2012:

• Front office in business development for their partners in international markets Europe (Germany, UK, Georgie)

• Outside Europe (US, Uganda, South Africa, Mexico, Kenia, Iraq)

• Software development and applications

• MOVE Meter

• Monitoring tool

• Our ambition is to support cities in their transition toward a Smart Moving City

The MOVEMeter Facilitates Planning Processes It is a web-based tool that:

-let you play with different scenarios

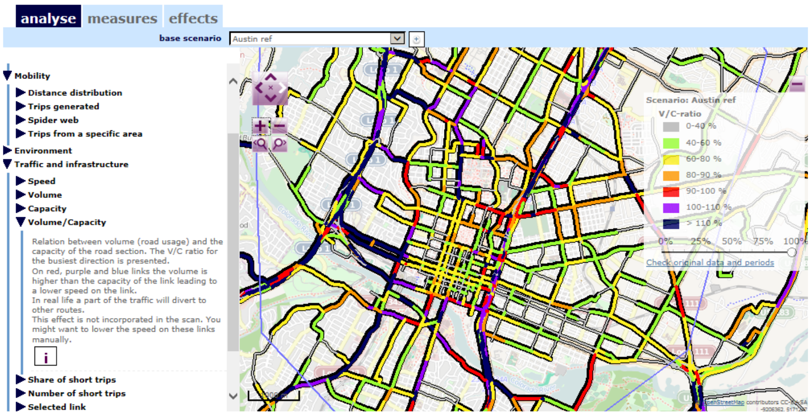
-is easy to use by all planners

-presents results quickly (<10 minutes per scenario)

The MOVEMeter results are based on your traffic data. For Houston, actual speed data (on and off-peak) was used.

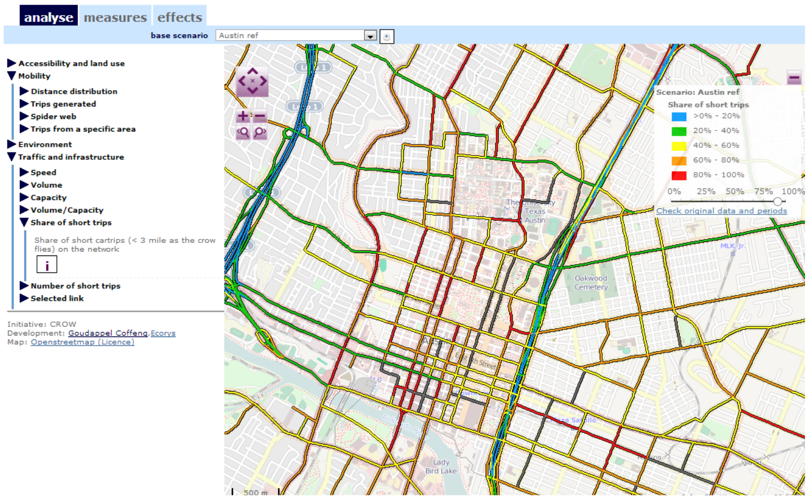
Where is my network congested?

A lot of capacity problems in and around the Centre



Who is using my network?

High percentage of short trips in the Centre

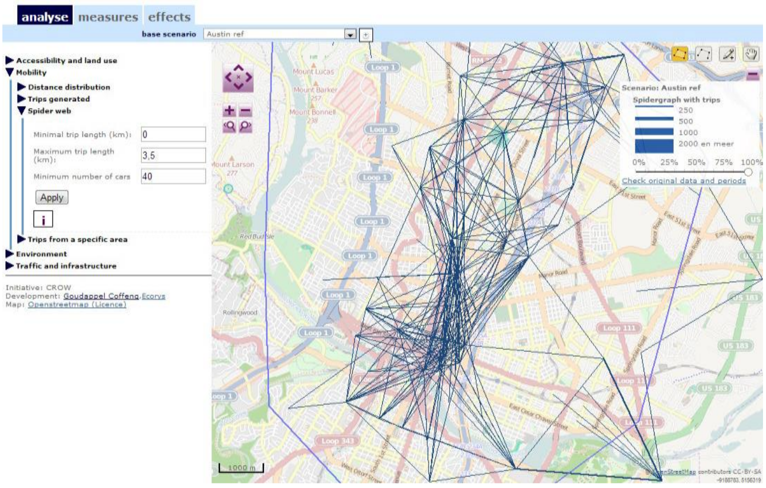


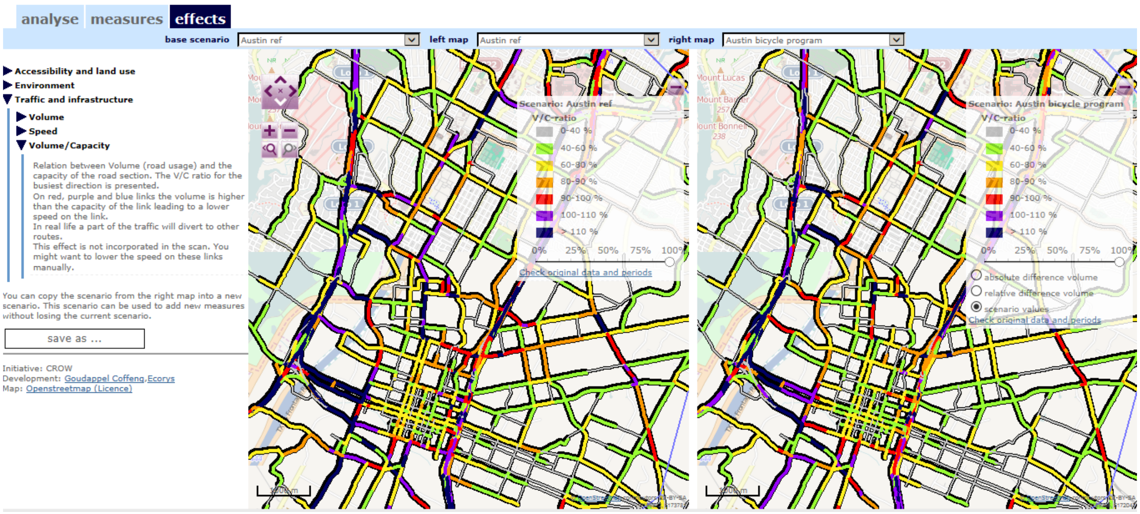
Where to invest in cycling?

Build your own spider net.

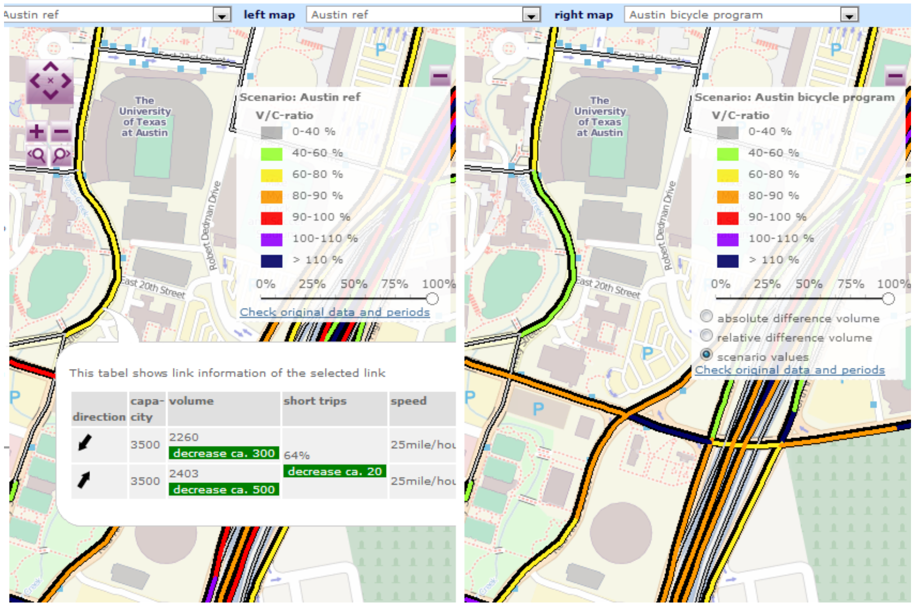
V/C ratio after replacing proportion of short trips

What is the potential impact of cycling?





Zoom in to get more detail



Difference with other transport modeling tools

Web-based (you can use any PC/laptop any where);

•Easy to use (no need to know Transport Planning Software);

•Quick scenario analyses;

•Based on data from your own Transportation Model;

•Scenario analyses ready after10-15minutes

Why is the MOVE meter so fast?

1.TheMOVEMeter works with less zones. It aggregates data from zones that are further away from the area you have pointed out as focus area.

2.The MOVEmeter focuses on the issues addressed. So when you want to assignan OD matrix to get ani dea of the effects on V/C ratios, the MOVEMeter assigns the OD matrix with out calculating new speeds or changes in the modal split.

Using this tool in kurdistna

Darbandikhan Mobility Plan

Together with View Pioneer, MOVE Mobility supports the Municipality of Darbandikhan with complete analysis of the current network and traffic situation resulting in proposed projects for the future that will make Darbandikhan a 'Smart Moving City'.

Our main activities and outputs of the project were: Analysing the existing situation related to all transport modes, coordinating data collection processes (counting, interviews, surveys), setting mobility visions and goals, organising workshops and consultation meetings with all concerned stakeholders, drawing up the urban mobility plan with recommendations, and communicating the results.

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