



## Transportation Networks: *Mathematical Tools*

Transportation is a very old activity – one of the oldest in mankind's history – and, as such, it is often treated in a very empirical manner. Our task is therefore to try to define the indicators which will allow an objective view. One should define the indicators first and come up with a solution only after that: this is common sense.

Usually, any transportation network has three players: the Collectivity which decides (for instance a city), the Company which operates the network, and the Community of users. So, we need three types of indicators; they are often contradictory!

### **1. For the Collectivity**

- Investment expenses.
- Working expenses.
- Environmental aspects.

### **2. For the Company**

- Data which are needed to submit an offer, in the selection procedure.
- Data which are needed for the daily operation, such as number of people in each bus, number of delays, and so on.
- Financial data.

### **3. For the users**

- Time required for transportation.
- Proximity of the stations.
- Regularity of the trains, buses, and so on.
- Waiting time.
- Quality of service.
- Security.
- Cost of the ticket.

Of course, all these indicators must consider all uncertainties (one never knows exactly how many people are in a bus) and the use of private cars. It may happen that the use of private cars is more flexible and less costly than a public transportation network.

On such subjects, our Company brings a scientific assistance. We realize critical analyses, study scenarios, comparisons, and our contribution is a comparative study: this type of solution has these advantages and these disadvantages, and so on. We usually give a quantitative information, in terms of costs and benefits. We study all situations, including the rare ones, and we come up with recommendations which are motivated, not just politically correct.

## **Our recent realizations**

- 2005-2009, Veolia Transport: Definition of a transportation network; application to a critical analysis of the network in the city of Amiens (north of France).
- 2008-2013, Réseau Ferré de France (French Railways): Study about the causes for the delays of the trains in the Paris Region; analysis of the investments which are needed.
- 2008, Société Vinci: Analysis and simulation of employment and living in a city, depending on the time for transportation.
- 2011, SNCF (French railways): Planning of investments.
- 2011, le Métro du Grand Paris (Metro in the Paris Region): White Paper for decision.  
[http://scmsa.eu/archives/SCM\\_Metro\\_Grand\\_Paris\\_2011\\_06\\_29\\_V2.pdf](http://scmsa.eu/archives/SCM_Metro_Grand_Paris_2011_06_29_V2.pdf)
- 2011, Auto Plus (newspaper): number of deaths in car accidents, as a function of regulations.  
[http://scmsa.eu/archives/Rapport\\_SCM\\_AutoPlus\\_2011\\_05\\_24.pdf](http://scmsa.eu/archives/Rapport_SCM_AutoPlus_2011_05_24.pdf)
- 2012-2015 IFSTTAR and Ministry of Transportation: Improving GPS positioning in an urban environment.
- 2012, Agence d'Ecologie Urbaine, Ville de Paris (Agency for Urban Ecology): Critical analysis of a software for the evaluation of air quality.  
[http://scmsa.eu/archives/SCM\\_AEU\\_Rapport\\_Aria\\_2012\\_12\\_10.pdf](http://scmsa.eu/archives/SCM_AEU_Rapport_Aria_2012_12_10.pdf)
- 2013, Speed of cars and CO2 emissions, by Sara Bisbe (Ecole d'Ingénieurs de la Ville de Paris), Damien Raffanel and Bernard Beauzamy (SCM SA)  
[http://scmsa.eu/archives/SCM\\_Vitesse\\_et\\_CO2\\_2013\\_08.pdf](http://scmsa.eu/archives/SCM_Vitesse_et_CO2_2013_08.pdf)  
Article by Auto Plus about this study (07/09/2013):  
[http://scmsa.eu/archives/AutoPlus\\_SCM\\_2013\\_09\\_09.pdf](http://scmsa.eu/archives/AutoPlus_SCM_2013_09_09.pdf)
- 2015, Ministère de l'Environnement, Direction Générale Energie Climat, Bureau Qualité de l'Air (Air Quality): Probabilistic links between traffic and air quality.  
[http://www.scmsa.eu/archives/SCM\\_resume\\_DGEC\\_2016\\_01\\_25.pdf](http://www.scmsa.eu/archives/SCM_resume_DGEC_2016_01_25.pdf)  
Article published by Auto Plus:  
[http://www.scmsa.eu/archives/AutoPlus\\_SCM\\_2016\\_02\\_12.gif](http://www.scmsa.eu/archives/AutoPlus_SCM_2016_02_12.gif)
- 2016, RATP: Scientific assistance for the planning of replacement of critical equipment.
- 2016, SNCF: Analysis and comparison of various scenarios for the definition of a new train line.
- 2016, Voyages & Business: Critical analysis of a software for "transportation on demand".
- Taxis G7, 2016: Critical analysis of planning algorithms
- RATP, 2016-2017: Analysis of the behavior of trains in critical situations
- RATP, 2017: Simulation tool for logistics

- SNCF/Transilien, 2017-2018: Analysis of general transportation needs near the "Paris La Défense" area.
- RATP, 2018: Safety analysis.
- Atlandes, 2018 (Highway, south of France): Counting the cars on an exit of the highway
- Home Office, General Secretary for Administration, East Region, 2018: Tools for the management of crises.
- RATP, 2018-2019: Probabilistic study, connected with speed increase and decrease of the underground railways.
- Transportation Company, 2019: Statistical analyses about the GPS position of containers.
- Atlandes, Highway A63, 2020: Statistics concerning trucks.
- SNCF, 2021: Critical analysis of safety demonstrations relating to the "Fuel Cell" (hydrogen).
- RATP, 2022-2023: Stability of old embankments, Archimedes' approach.
- Atlandes SA, 2022: Statistical analysis of HGV journeys.