Joint Conference on
SMART CO₂ REDUCTIONS
Non-product Measures for Reducing Emissions from Vehicles

TURIN
2-3 March 2000

Session 3: Technological Innovation and Infrastructure Optimisation

An Integrated Approach to Urban Traffic Management
Mobility Telematics Application in Turin - The 5T Project

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MOBILITY TELEMATICS APPLICATION IN TURIN:
THE PROJECT 5T

ABSTRACT
The city of Turin started in 1992 a large-scale project in mobility telematics named 5T (Telematics Technologies for Transports and Traffic in Turin), which embodies the conceptual framework and the results of the QUARTET Project financed by the EU and of the “Environment and Traffic project” financed by the Italian Environment Ministry.

The Turin 5T System has been developed and implemented right across the city of Turin. It comprises nine subsystems (Urban Traffic Control, Public Transport Management, Environment Control, Parking Control, Information Media Control, Collective Information (VMS), Automation Debiting, Maximum Priority, Route Guidance), together with an overall City Supervisor, which integrates all the other sub-systems actions into a general mobility/environment strategy.

Turin has focused on a comprehensive evaluation of the IRTE (Integrated Road Transport Environment) system. The 5T project was tested during a two-year experimental phase which ended in 1997. The measured effect of the 5T System was a reduction of the average O/D trip-time by 21% for the resident in the area affected by the system.

The 5T System has been maintained in 1998-99 at the functional levels reached during experimentation. In the same period the process of the transformation of the 5T Consortium – which has generated 5T – into a new company in charge of all developments of transport telematics in Turin has been accomplished.

1. URBAN PROFILE
Turin is the fourth urban area of Italy. The city can be inscribed within a circle of 10 km radius, while the metropolitan area within a circle of 20.

First capital of Italy, the city has grown in the twentieth century as a centre of development of industry and innovation.
It reached its maximum of population in mid seventies, 1.2 million inhabitants. Since then there has been a continuous decrease of population of the city, now slightly more than 0.9 million. The metropolitan area itself has decreased from 1.7 million in 1979 to 1.5 at present. In 20 years there has been a decrease of about 25% of the city population, and the weight of the surrounding area has increase from 30% to 40% of the metropolitan area population.

In the same period the personal motorised mobility has increased by about 65% (up to the present value of 1.97 trips/day) and the modal split has increased more than 40% in favour of the use of the private car (present modal split 27% public transport, 73% private car). The motorised mobility has grown (in the 80’s, while in the 90’s it has been steady) thanks to the diffusion of the private car.

Motorization rate has increased by about 50% in the period, to the present value of about 1.5 car per household.

2. BACKGROUND AND OBJECTIVES

In the early 90’s, when these effects where becoming clear and known, a mobility government policy was decided:

- calling for an integrated intervention strategy, both on private and public transport;
- aiming at the substitution of large part of private car trips by the use of public transport;
- requiring a public transport better service quality in order to reach the objective;
- recognizing the need of the development of public transport infrastructural interventions on the long terms, and of mobility telematics applications on the short period.

The city of Turin decided in 1992 the start of a large scale project of mobility telematics named 5T (Telematics Technologies for Transport and Traffic in Turin).

In order to manage the project, a homonymous Consortium was incorporated.

The total cost for the project, realisation and experimentation of 5T Project was 23.6 billion Lire (12.2 million Euros). The Project has been financed by the Consortium Partners for 14.2 billion Lire (7.4 million Euros). A contribution of 3.7 billion Lire (1.9 million Euros) has come from the
Italian Environment Ministry (“Environment & Traffic in Turin” project). The European Union has contributed to the Project by 5.7 billion lire (2.9 million Euros) (“QUARTET” project, its extension, and “QUARTET PLUS” project).

5T Consortium had seven partners. The public partners ATM, the Turin public transport company, and AEM, the Turin energetic company, had a share of 68%. The city of Turin conferred 1.5 billion Lire (about 0.8 million Euros) to support ATM effort.

The aims of the 5T Project were the following:

- Development of a strategic supervisory system for all Transport Telematics sub-systems
- Extension of the existing Urban Traffic Control and bus priority facilities over a wider area of the urban network
- Extension of the functions of the Public Transport Management System to include user information and passenger counting
- Development of a system for keeping citizens better informed about mobility services
- Functional integration of traffic and transport control systems with the environmental monitoring and forecasting system.

The 5T Project general goals where stated as it follows: when extended over the whole urban area 5T would grant:

- average origin-destination travel time: - 25%
- mobility related air pollution and energy consumption: - 18%

and improve modal split towards the public transport.

3. 5T IMPLEMENTATION

The 5T System in Turin came out of the integration of pre-existing and on purpose developed subsystems. The System has been designed with an open architecture, to fit with all existing development and to allow further applications extension.

The basic choices characterising this architecture have been:

- to have autonomous systems co-operating by a data network and a common data dictionary;
- to save costs by sharing common facilities;
- to implement a supervisory function in order to grant a common mobility/environment strategy to the action of all subsystems.

The 5T System has integrated 10 transport telematics sub-systems:

- City Supervisor
- Urban Traffic Control
- Public Transport Management
- Environmental Control
- Parking Control
- Informative Media Control
- Collective Information (VMS)
- Automatic Debiting
- Maximum Priority
- Route Guidance

The last two subsystems after having been fully tested, have not been retained in the configuration of 5T which is presently operating.

Actions of all the subsystems are co-ordinated by the “City Supervisor”. The 5T “City Supervisor” is the subsystem in charge to monitor and estimate on-line the mobility and environment state of the city of Turin and to provide a feasible and common control strategy to the other 9 subsystems of 5T that can influence directly the traffic behaviour.

For the Integrated Road Transport Environment (IRTE) in Turin it is considered to be essential to have an efficient and consistent estimation of the state of the traffic and transport system, for use in traffic control, information, demand management and network design.

The three principles for establishing the IRTE were:

- **Co-operative monitoring** of the state of traffic and transport. An efficient and consistent analysis of the state of traffic and mobility is best performed through an overall assessment of data from various sources.
- **Co-operative equilibrium**. The point of optimal mobility distribution that takes into account both users’ mobility needs and the state of the transport network must be the sole reference point for the whole integrated system.
- **Co-operative control**. The reference values calculated on the basis of the co-operative equilibrium principle must be used by application to elaborate joint control actions that reduce the difference between the equilibrium reference point and the observed traffic and transport state.

The realisation of 5T is widespread on the city area.
Urban Traffic Control manages on about 20% of the city traffic lights, located on several main avenues of the city and 3 street car lines, where waiting time has been displayed at stops. Variable Message Signs (VMS) for routing have been applied at the external ring of the city, while a number of VMS for parking at the downtown border, and information kiosks in 9 central locations.

The 5T application area, where the System effects are more intensive, counts for about 30% of the city residents.

The 5T system is currently operative, after having been extensively tested in 1996/97, and maintained in operation under contract with Turin City Council in 1998-1999.

4. 5T SUBSYSTEMS AND FUNCTIONS

- The City Supervisor grants the subsystems integration in order to generate the best service to the citizens’ mobility together with the urban environment protection. It is the most innovative development of the entire project.

Every few minutes it manages - thanks to the subsystems co-operation - the traffic monitoring, generates an hourly mobility forecast, tests the air pollution effects, and decides a general strategy for the following period in order to achieve and maintain user equilibrium, compatible with the
environment protection constraints. The subsystems co-operate to the general strategy taking the Supervisor decisions into their specific operating strategies.

- The **Public Transport Management** subsystem manages through SIS (the operation aid system of ATM, operating since 1994 on the whole fleet of 1350 vehicles) the public transport commercial speed and regularity thanks to the position monitoring and traffic lights priority, within the Supervisor strategies. It co-operates to the information to the citizens.

It manages 200 waiting time information displays at stops, 100 on board equipment announcing next stop, 100 passengers weighting-counting equipment.

- The **Urban Traffic Control** subsystem manages the traffic lights by a traffic-responsive regulation according to the on line local measurements and the area policies suggested by the Supervisor; and contextually provides the traffic light priority to public transport.

It manages 150 crossings in the urban area, with about 700 traffic sensors.

- The **Environment Monitoring and Control** subsystem, using the weather forecast, the data coming from 11 pollution detection stations and the traffic data, foresees at short term the environment conditions and make them available to the Supervisor so that this can adopt the mobility policies compatible with the safeguard of the environment.

- The **Parking Control and Management** subsystem, in connection with 8 automatic parkings, supplies forecasts on the places availability and enables the telebooking by Videotel to clients provided with smart cards.

- The **Variable Message Signs** subsystem provides collective dynamic guidance to the different city districts, and supply real time info on the available places at the automatic parking lots. It operates with 26 routing panels and 23 parking panels.

- The **Information Media Control** subsystem supplies, by Videotel (now dismissed) and Teletext (and in the experimentation phase Internet), real time information on the state of public transport, traffic, parking and environment. It helps people with on line information to make their pre-trip planning on the best mode and the best route through 10 PIA (automatic information kiosks) installed in different points of the city.

- The **Fares and Debiting** subsystem ensures that payments can be made without stopping at automatic parkings to the drivers provided with smart cards of 150 equipped cars. It also enables, through smart card use, the purchasing of public transport tickets at the parkings.

- The **Maximum Priority** subsystem assists the ambulances navigation trough the urban network and allows to clear the traffic lights intersections along the chosen route. It operates over 15 ambulances of the regional emergency call number “118”.

- The **Route Guidance** subsystem helps the driver of a specifically equipped car in navigating trough the route network, in order to optimise the trip time within the real traffic conditions. It operates over 5 intersections and 50 equipped cars.

5. RESULTS AND IMPACTS

The Project was tested during a two years experimentation phase, ended in 1997, with a cost of 1.8 billion Lire (something more than 0.9 million Euros). The experimentation has been realised
by subsystems observations and evaluations at the centre, by extensive on the field campaigns of
time measurements and on site interviews, and by a telephone survey on a panel of 500 citizens
resident in the area of application of the system.

5.1 TRAFFIC AND PUBLIC TRANSPORT MANAGEMENT IMPROVEMENTS

Trials have been carried out on 2 fixed routes
(the whole tramway line 3 and part of line 4).
360 trips have been made both by car and by
public transport, in scenario 1 (5T Off, that is
5T strategies not operating) and in scenario 2
(traffic control “on”).
The measured effect has been a decrease of the
trip time by 17% for the traffic and by 13% for
the public transport.

Reduction of waiting time at traffic lights and
greater efficiency in travelling conditions
causes a decrease of exhaust emissions and fuel
consumption.
The computed effect has been a reduction of 6%
in carbon monoxide emissions and 8% in fuel
consumption.

5.2 MANAGEMENT SYSTEM IMPROVEMENTS, ROUTING AND CITIZENS INFORMATION
EFFECT

Trials have regarded 9 Origin/Destination pairs. 1020 trips have been made by public transport
and 920 trips by car both in scenario 1 (5T Off) and scenario 3 (5T On, that is with all the
supervision, management, routing and information strategies operating). About 30% of the trips
carried out in scenario 1 had the destination assigned just before the departure, simulating the
“occasional trips”. The results have been separately computed for the O/D pairs mainly out of the
area controlled by 5T, and O/D pairs mainly within the 5T area, and for these last expanded by the
degree of influence of 5T to represent the “full coverage” achievement.
The overall effect has been a reduction of the average O/D time by 22% for the use of the car and 20% for the use of public transport. On the side of air pollution, the routing strategy has an additional effect to the control system only. The overall effect of the management system and the routing and information strategy has been simulated with real data from 5T systems. Concentration in critical links has decreased by 18%. The average concentration over the full city has decreased by 7.5%.

5.3 TELEMATIC TECNOLOGIES IMPACT

A panel of 500 citizens has been interviewed in the scenarios 1, 2, 3. Their trips show and increase of 3% of modal split in favour of the public transport. On the basis of this figure and of the previous reported effects, the general impact of the 5T system can be stated as a decrease of the average O/D trip time by 21%, equivalent to about 7 minutes per trip. The panel has perceived the public transport service quality improvement and has judged with particular favour the passenger information subsystem.

The general impact of 5T at the city level on the environment taking into account also the modal split effect, can be stated as decrease of 10-11% of pollutant emissions.
At the end of the trials the 5T Project has been consolidated into a configuration capable to maintain the results achieved at reduced costs. Two subsystems (Route Guidance and Maximum Priority) and few functions (Videotel, parking payments without stopping) have been stopped. The enhancement of SIS, the public transport operation aid system, by a new release and a further expansion of 5T in order to grant the priority and the information on the whole city tramways network can generate a sizeable decrease of the unit cost for the public transport operation together with perceivable improvements of trip time and service quality for the citizen.

The expansion of the system has been proposed by a specific project presented to the Italian Ministry of Environment for financial support.

The project calls for a new investment of 21 billion Lire (almost 11 million Euros) to extend UTC to 50% of the city traffic lights, add 400 VIA at stops, install 100 more VMS. Further extension of 5T, estimated of the order of 30 billion Lire (more than 15 million Euros) will allow the expansion of the Supervisor and the Environment Control over the metropolitan area, further increase of traffic light controlled by UTC, the integration of the peripheral highway for VMS traffic routing and the development of smart card mobility payment system.

A prerequisite of all these developments, financial capability a part, is the incorporation of a new 5T company.

The city has started in 1999 the process of the transformation of 5T Consortium into a new body which will be in charge of the management, integration and development of the mobility telematics in the area of Turin.

The new company, with the participation of ATM, AEM, FIAT CSST, and MIZAR, has been incorporated at the beginning of 2000.

7. TRANSFERABILITY

The project QUARTET PLUS was developed to demonstrate the potential benefits of an integrated approach to solving urban transport problems. All the demonstration sites (Athens, Gothenburg, Birmingham, Stuttgart, Toulouse, Turin) of QUARTET PLUS were convinced that integrated transport telematics application can increase the proportion of travellers using public transport, improve efficiency of both private and public transport, reduce the likelihood of environmental pollution and improve the quality and quantity of information available to the traveller.

The QUARTET PLUS project was conceived to follow and complete the work started in 1992 by the QUARTET project within the European Transport Telematics Programme (DRIVE II).
QUARTET PLUS has validated technical approaches and systems that can be applied throughout the European Union, contributing in this way to the standardisation and harmonisation that will lead to a pan-European market for telematics systems and will support the Common Transport Policy.

Since its inception in the DRIVE II QUARTET Project, Turin system served as a reference model and other types of IRTE have been designed and developed. Both Gothenburg and Stockholm have mapped the 5T architecture onto the broader scale of urban/regional traffic management. The 5T City Supervisor is being studied for application in Stockholm. 5T’s Multifunctional Outstations have been installed in a number of Swedish, Norwegian, Dutch and Italian cities. The first city equipped in the USA was Omaha (Nebraska) in June 1998. The SPOT unit is currently being marketed extensively in Europe and the USA. Interest has been shown by Sarajevo for SIS and UTC techniques developed in Turin.

The research results have also stimulated other Italian cities to adopt the same approach used in Turin. Implementations started in Bologna, Rome, Trento and La Spezia. Also, Napoli expressed its interest in implementing the integrated traffic management and control system.

8. PROBLEMS IN MOBILITY TELEMATICS APPLICATION AND LESSONS LEARNED

5T and the similar mobility telematics systems developed and tried under UE research contracts have demonstrated:

- the shift of mobility toward public transport - needed by all European city choked by traffic - can be encouraged by mobility telematics both by improving public transport performances and by enhancing the citizen’s perception of this improvement;

- telematics management systems, able to perform dynamic traffic-responsive regulation, are powerful tools in reducing congestion and pollution and improving convenience for the travellers;

- demand itself must be included in generating and keeping the best equilibrium solution by allowing travellers the necessary information, made available by mobility telematics.

Several problems of course have raised during the 5T experience: longer times, some developments below the expectations, early termination of some applications and two systems stopped right after the experimentation.

The main cause of delays, misunderstandings, low profile participation by some parts can be found in the incorrect interpretation of the user needs and in the under estimation of the level of agreement necessary to reach the goals.

The first lesson is that complex systems, like the mobility telematics ones, cannot be developed against the will of anyone of the actors. A common understanding is as necessary as the financial resources to generate integrated systems.
As anywhere, in some part of the project the interest for the technology has taken the leadership, and it has become clear that this approach can be a wasteful exercise of very little practical use for the city.

A third lesson learned in this 5T is: do not make application at too small scale, because they have a high probability to fail and to present justification to the failure in their “laboratory size”; and if they do not fail they have anyway difficulties in being kept alive; and if they are kept alive they will in any case be hardly significant.

Steering and co-ordinating the Consortium 5T toward its objectives has been quite a difficult experience, from which comes out that the organisation to realise mobility telematics must be as simple and clear as possible avoiding the splitting of responsibility for single tasks, and conferring real decision power and effectiveness where needed.

Complex systems must be continuously monitored to understand if they fulfil their promises in terms of availability and performances. Even if this concept was stated since the beginning, a large effort has been necessary to implement it in the 5T subsystems.

Finally each system must foresee a maintenance phase after the realisation and contractualise a period in which the manufacturer is called to maintain systems and equipment up to their specified availability and performances levels. After such a phase somebody predefined should emerge as in charge of the maintenance and development of the system, otherwise all the efforts to develop it will be in short time wasted.

As a final remark the work done in Europe on IRTE effect has cleared that mobility telematics applications are a new effective tool to generate additional transport capacity.

This tool can, and must, be carefully adapted to the needs of the users and the strategies of the operators. Telematics technologies must be integrated in appropriate planning framework and used together space allocation and fares system to fit the strategies and calibrated to reach the objectives set for the mobility and the city life.