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Position Paper

A National Roads Database of Sweden

A Future Scenario

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Purpose of the Position Papers

The Position Papers are intended to generate discussion within the Intelligent Transportation Systems (ITS) community. The community is defined in its broadest scope, and includes environmental and city planners and map and travel guide publishers, as well as the individuals associated with organisations that have thus far been the drivers behind ITS efforts. This widening of the forum for discussion is a recognition of the important role that can be played by those who are responsible for designing the environments in which ITS solutions will operate, and by those who have traditionally provided the tools used for human orientation and wayfinding.

Each paper expresses the personal views of the author, with a focus on the interrelationships between the design of the systems, services and infrastructure which are proposed to improve personal and collective mobility, and the planning and design of our habitat. The fundamental premise of these papers is that land use and built form policies are inseparable from traffic and transportation policies.

Traffic congestion in and around our cities is a symptom of ill-considered decisions about the placement of origins and destinations for the people who live, work, shop and recreate in city regions. The increased number of vehicles on our roads is the result of people moving between dispersed origins and destinations in a way that can no longer be accommodated by point-to-point collective transportation systems. Whether it was the automobile that enabled the dispersion, or the desire of families and businesses to move out of cities that created the need for more private travel, is a subject of debate. There is no debate on the simple fact that traffic congestion and its side effects are a problem in almost every corner of the world.

Unless an holistic view is taken to the problem of personal mobility, a view which accepts that where people begin and end their journeys must be addressed simultaneously with how they will move between these locations, ITS solutions will not be able to deliver their full potential benefits.

Introduction

There is a Latin expression: *Cogitati Incognito*. *Think the Unthinkable* or *Imagine the Unimaginable*.

A few short years ago a national roads database of Sweden was an unimaginable idea. The two national agencies sharing responsibility for Sweden's roads had their respective areas of control and authority: Vägverket for road building, maintenance and information about the national road system; and Lantmäterverket for map production and geographic information. Today, these two agencies, together with the kommuner of Sweden, are co-operating in a project which will deliver a fully attributed, geometrically accurate database of all of Sweden's roads which are accessible to the public. The unimaginable is about to become a reality.

A National Roads Database of Sweden: A Necessity

A national roads database is a necessity for the future of mobility of Sweden. We live in a country that is the fourth largest in land area in Europe after Russia, France and Spain, but we have a population density that is under twenty inhabitants per square kilometre. Most European countries have densities of over 100.

Viewed from another perspective, Sweden covers an area that is equivalent to the eastern region of the United States, from the southern edge of Maine to northern border of Florida, from the Atlantic coast five hundred kilometres inland. Yet Sweden's population total is equal to only that of the City of New York. We have a major roads system consisting of approximately 10% of the kilometres to that in the US, but with a total population that is less than 3% of the US. That translates into each person in Sweden financing the construction and maintenance of almost four times the length of roads as a person in the US (0.006km/person in the US vs 0.023km/person in Sweden).

With a population growth rate among the lowest in Europe, we have finite prospects for industrial expansion. We must be able to maximise the effects of our industrial, natural and human resources while preserving the quality of our environment.

Because of the size of Sweden and our dispersed population, Sweden needs effective mobility. Effective mobility must include a sustainable road transport policy that is co-ordinated with residential settlement and industrial location policies, and with other forms of transportation. A sustainable road transport policy is one that provides for the movement of people and goods between our dispersed population, commercial and employment centres, and within our urbanised areas. A sustainable road transport policy is one that we can pay for without destroying the economic viability of our industry or the economic freedom of the country's inhabitants.

Why do those of us who have worked hard for the creation of a national roads database of Sweden believe that it is an absolutely essential component of a sustainable road transport policy? Because future mobility will depend more on the planning and management of our vehicular journeys than on the independent and unrelated decisions taken by the drivers of these vehicles.

Today, cars and most trucks are driven in very much the same way as they were driven almost a century ago when they were invented. The driver decides where and when to go, and how to get there, at any time of day, in any type of weather or traffic conditions. Within the rules and regulations determined by the state, the driver has complete freedom of movement.

It is this freedom of movement which is the principal advantage of automobiles and trucks, compared to fixed rail and fixed route transportation alternatives. It is the comfort of being in a warm enclosure in the winter, or a cool one in the summer, shielded from the elements with only those one chooses for company, with one's own thoughts, one's own music, that makes the private car and truck such an irresistible choice for most adults in the industrialised parts of the world from the time we learn to drive and earn our license, until the time we are forced by age or infirmity to give up this right.

However, it is just this uninhibited freedom of movement that has created problems for vehicular travel. We have been making steady improvements in car and truck safety, vehicle control and drivability, increasing fuel economy and reducing environment impacts. We have improved road surfaces, lighting, signage and barrier safety. While the driving experience inside the vehicle has gotten better and safer, the ability to enjoy the experience has worsened. Traffic is a pervasive problem. We have a capital in Stockholm that has the same problems of traffic congestion that are found in most of the world's largest cities, and it is a growing problem in our other urban areas.

Traffic congestion is more than an irritant. It has costly side effects in wasted time and wasted fuel. In extreme cases, it can cause drivers to act in irrational and sometimes violent ways.

Responses to the problems caused by traffic congestion have been to restrict vehicular travel, to increase car and truck ownership taxes, raise fuel taxes and to institute road usage fees. These measures have the net effect of increasing the costs of mobility, with no consideration taken to the ability to pay or the need to use the roads.

Another response is to use advances made in technology to make cars and trucks an integrated part of the transportation infrastructure, not just users of roads. The automobile and car electronics industry is ready to do this. Over the past ten years, intelligent transport systems have been developed which attempt to increase mobility on our existing road network. By building the national roads database, Sweden has signalled that it is also ready to participate in these developments. A digital roads database of all roads, with a positional accuracy of several meters, and

with as much information about the roads which can be collected, will make possible the planning and management of vehicular journeys.

A future vision of vehicular mobility includes concepts that are already being tested in the market. It also includes ideas which are in the early stages of development. Some of them can be implemented by car and truck manufacturers working on their own, but to do the job properly, there must be close co-operation among all parties, including the national road administration and local traffic authorities.

The following are a few examples of how a national roads database of Sweden will contribute to safer vehicular travel while at the same time improving the performance of our existing road infrastructure.

Route Planning and Guidance

The route guidance systems we are seeing today in Europe from car electronics manufacturers like Bosch and Mannesmann/Philips Car Systems are mainly a novelty. They are the first generation of what will become really useful devices that will include two-way communication between the vehicle and a variety of information centres, including the home. Journeys within high traffic regions will be planned based on road utilisation, weather, construction and incidents. At the heart of this planning is the geographic database. Where the database is—in the home, in the vehicle or at some centralised location—is less important than what it will be expected to do.

Route guidance will be both dynamic and active: Dynamic in the sense that it will be based on current conditions on the roads to allow a route to be planned that is optimised for the traveller; and active in the sense that the route will consider the needs of all travellers with a region. This is a radical departure from the current autonomous approach to route planning and guidance, but it is an example of how vehicles will become an integrated part of the transportation infrastructure.

We have the technology at hand to allow a trip to be planned in the home or office, to assign an optimum time slot to the person planning the trip--like a staggered start in a race in which the time one starts is less important than the time it takes to run the course—to provide up-to-date information during the journey, and to re-plan the route if necessary. Time-based road access allocation is much more fair than the cost-based approach since it is not dependent on the driver's ability to pay. Road tolls do not reduce congestion unless they are so high that few are willing or able to play them. In those cases, vehicular traffic is simply channelled to local roads which are not built to carry the increased load.

If tolls must be instituted for fiscal reasons, a combination of time-based and cost-based pre-planning could be instituted with premium rates paid for prime time travel, and very low or no charges for off-peak journeys.

How will this happen? Through co-operative efforts among the auto industry, the state agencies responsible for roads and traffic, and the

inhabitants of each country. The alternatives are growing, uncontrolled congestion, or increasing restrictions and higher costs for vehicular travel.

Vehicle Control

There will be times when collective control of many vehicles will provide for safer and smoother traffic flow. This concept is already under development with variable speed control devices which sense the speed of the preceding vehicle and vary the speed of the car accordingly without the driver applying the brakes or the accelerator. The next step is to steer the vehicle automatically. This is being done now in tests using road sensors.

Possibly a more effective method of automatic steering in all road and weather conditions is to use the geographic database to first define the route and then to use the route as the primary road. This method is similar to automatic steering in its simplest form in ship navigation, and in its most complicated form in high-speed combat aircraft.

Another type of control is still in its early testing stages. It consists of controlled acceleration and de-coupling of the transmission to improve fuel economy in hilly terrain. It requires pre-planning which is made possible by an on-board digital terrain model combined with a digital road database. This technique has been successfully tested in races involving solar powered vehicles.

A third type of control is to match the vehicle speed to the accepted regulations on the road, called Intelligent Speed Adaptation. A recent test of ISA was conducted in southern Sweden (Eslöv) with very positive responses from the participants. Transponders were affixed to road signs that transmitted the speed limit to devices in the test vehicles which automatically controlled the maximum speed of the vehicle. One conclusion from the test was to put more effort in developing autonomous functions to minimise the need for transponders on every road sign. A digital map database in the vehicle with all speed limits would make this possible.

Telematics

Two-way communication between the vehicle and a central call-taking center offers increased security, safety and convenience for drivers. A telematics system in the vehicle consists of a telephone for making calls to and from the vehicle, a GPS receiver for identifying the vehicle's location, and connections between these components and the vehicle's internal data bus. The data bus transfers signals from the vehicle's sub-systems, like the airbag deployment sensors, theft detectors and wheel sensors, to the telematics system.

Several car manufacturers, including General Motors, Ford, Mercedes and BMW, have already introduced systems to the market, and we believe that most cars will have telematics systems as an option within the next two years. Many predict that these systems, rather than autonomous route guidance systems, will be first to capture the attention of consumers, and may provide the platform for other traveller information services, including route guidance.

The key to the functioning of these systems is a positionally accurate geographic database of all roads. The current systems are using GPS data sent from the vehicle to a call center. The positional accuracy of this data, in its raw form, is between 50 and 100 meters. Some system developers are post-processing this data using similar map matching techniques to those used in on-board route guidance systems to achieve positional accuracies equivalent to the base geographic data, placing the vehicle more exactly on the road of travel. Others are using differential GPS to achieve more precise locations. When Selective Availability is removed from GPS by the US Department of Defense, as it most surely will in a few years, post-processing of GPS will become unnecessary.

The types of services currently being offered with these telematics systems are emergency assistance, roadside assistance, notification of break-in, vehicle tracking in case of theft, automatic door lock and unlock, and traveller information services. A driver may call a service center to request any of the services, usually by pushing a special button in the vehicle, or the call may be made automatically in the event of an accident or unauthorised entry of the vehicle.

Driver Assistance

There is a wealth of statistics on road hazards that can be made available to drivers. Road signs warn drivers of risks, but certain risks are present only under certain conditions, for example, during particular times of day or year, or when temperatures are within a particular range. The largest number of vehicular accidents involve only one vehicle, and they result from the driver losing control due to a combination of high speeds and road hazards. We know where these types of accidents occur and why they happen. It is a matter of transmitting this knowledge to the driver and the vehicle.

With a digital road database in the vehicle, and the hazardous locations registered to their physical locations in the database, this information can be presented to drivers before they approach the hazards so that they can reduce the vehicle's speed. This information can also be used by the vehicle's control systems to automatically alter the vehicle's speed or other performance.

It is the road authorities and traffic agencies in each country, not the international database providers, such as Navigation Technologies or Tele Atlas, who are in the best position to integrate road hazard statistics

with geographic data. This is one very clear reason why a national roads database, created and maintained by a country's national and local authorities is essential for realising the promise of driver assistance.

Substance versus Form

Much has been made recently of announcements by Microsoft of the AutoPC, a radio-sized computer running its Windows CE operating system. It will supposedly function like a home or office PC, and provide the vehicle with access to Internet services and run similar programs to those of a desktop or laptop. Like the home PC, it will be an entertainment center. With appropriate add-ons, it could also become the platform for any of the applications of a digital road database.

The paradigm of the vehicle as a mobile office, or a mobile home entertainment center, is the result of the amount of time many of us are forced to spend in travel because of our profession or because of where we live in relation to everything we do. Reading the morning newspaper or a book, putting on makeup, shaving or brushing one's teeth, drinking coffee, eating snacks or an entire meal, talking on the phone, even operating one's laptop computer—these are all commonly seen activities on congested US highways. Such activities are becoming common in some European capitals as well. Productive activities, such as checking and responding to one's e-mail, reviewing the day's schedule, making a bank or stock transaction, booking a ticket to an event—these are all logical next steps for those who engage in such activities.

If PC functions distract the driver from the main task of driving, I believe this is the wrong vision for the future. Driving takes an enormous amount of concentration and co-ordination of eye, mind and body reflexes. Distraction not only can potentially harm the driver and the vehicle's occupants, but it is dangerous for other drivers sharing the road and to pedestrians.

The auto industry appears to be unified in its belief that computers have an important function to perform in delivering information to drivers that will help them drive safely and responsibly. We are trying not to become distracted by the form of delivering this information, but instead focusing on the substance of what is being delivered.

It is important that the providers of information, particularly those who provide the base geographic data that is critical for all of the applications I have described, also do not become distracted by the form of delivery, and concentrate instead on substance. Technologies are evolving very quickly. Entirely new industries are developing around the processing of driver information. Everything depends on the availability of accurate and reliable data referenced to a precise geographic database. This is the vision which Sweden's national roads database will contribute to and help to make a reality.