Prospective research in the technological and mobile society : new Demand Responsive Transports for new territories to serve

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SUMMARY
This paper follows and completes the one we presented in the AGILE Conference in 2001. Keeping in mind the operational Demand Responsive Transport we designed and installed in Besançon, France, we aim in this paper to handle the following questions. What are the trends of the urbanized territories, and the resulting mobilities, that would justify the spread of flexible transportation, such as DRT ? Under cover of the enlargment of the service Evolis to the whole communes of the Communauté d'Aggmomération du Grand Besançon (enlarged community of communes arround Besançon), how will become the DRT efficiency regarding new heterogeneous served territories, and how can we try to predict its evolution ? What new systems can we imagine to solve the difficult equation combining the more and more particular mobility demands that a survey seems to reveal, and the variety of territories where we begin to develop new research about DRT ?

KEYWORDS: *Demand Responsive Transport, mobility, prospective transport, geomarketing*

INTRODUCTION

This paper follows and completes the one we presented in the AGILE Conference in 2001 (Bolot J, Josselin D, Thevenin T., 2001). After having designed the concepts of a demand responsive service during a research pluri-disciplinary project, and developed a commercial dedicated software which manages, since 2000, the DRT called Evolis in Besançon (France), it is the opportunity to get a feed-back from this fruitful experience and to plan for the future generations of such a transport.

TRANSPORT EFFICIENCY AND FLEXIBILY TO RESPOND TO VARIOUS MOBILITIES

Ubiquitous mobilities in space and time in the technological society

In some parts of France and in many other European countries, the increasing of the geographical space occupied by human activities induces several effects on urban and suburban organization. The mobility is globally encouraged by a spread road network whose ubiquity and density make very accessible most of places. Timing and daily schedule for any activity, including leisure, force people to save time and to use the more convenient and efficient transport services. Traveled distances increase and peaks of traffic in the cities are more dispersed other the day.

Another focus shows that, while established towns claim and enhance their competitive attractivity, a quite substantial number of new centers emerge, closely linked (each/) to others. In France, this evolution is correlated to a process which inevitably empties the rural areas in favor of more urbanized areas. Therefore, the gap between rural and urban areas becomes more marked and the population distribution differentiates in many patches populated with different densities. One again, this argues in favor of a high level of transport adaptability.

On a third hand, people use to consume *just in time*, by reducing the delay between the reservation of a product or a service and its delivery. This behavior takes all its permanence because of the technology evolution : one can access easily and quickly to any information, and this unleashes the mobility capacities. People want to go from/to any place, at any time and appreciate when one propose immediately to them a wide range of service alternatives. Their supposed rationality leads them to arbitrate between several priorities : time, price, convenience... and to choose among those alternatives the one which better fits to their own needs.

How efficient is the public transport ?

In this context, it becomes more and more difficult for traditional public transport to compete with more flexible vehicles, because of its rigidity and sometimes its relative weak reliability (strikes, bus lateness, security...). Using it becomes a default choice for people dependent to the collective transportation whereas others in their car think they control the situation and even the traffic conditions. Thus, numerous persons complain about time constraints when waiting for the bus and during the journey. Consequently and unfortunately, the choice among all possible transport modes often sets on the car, most of times the individual and personal one, because of the high price of taxis. This generates a lot of nuisance in urban towns, such as air polluting, parking problems, traffic jams and unpleasant (sometimes unbearable) noise. This is noticeable in France, despite a rather (but not enough) efficient public transportation, which is considered, most of times, as inappropriate.

Nevertheless, public transport can succeed in the management of heavy flows by connecting efficiently several transportation modes (for instance in the Netherlands) including DRT (for instance in Switzerland). In France, this change must occur otherwise the public transport attractivity will decrease, inducing a loss for urban community. We start to feel this evolution, linked with recent laws edicted in order to control urban pollution and network congestion, to help communes dividing up the geographical space, and to group them in the same territory having a strong identity.
At the same time, the political position upholds a certain idea of eco-citizenship, supporting less polluting, more comfortable and more reactive transportation and sometimes recommending public transport and reducing/regulating car use. In this context, this paper aims to present some prospective research about a type of flexible transports : the Demand Responsive Transports.

What DRT can supply ?

DRT is a kind of public transport which combines the advantages of collective transport and individual vehicles. It is often considered as a versatile transport because it offers more flexibility for the users, and provides some saving for the carrier and for the decision maker. It generally serves an extended territory at various times from and to a lot of destinations, and sometimes with a door-to-place or door-to-door service, depending of the kind of DRT. This system is attractive because it reduces the wasted times and fits to demand. DRT states as a sharing transport which aims to group the passengers from different individual demands within a same or similar trip. For the carrier, the decision-maker or the decision maker, the cost is maintained at a reasonable level, because it runs only when it’s used (the system is activated by a demand from at least a single user) and because the system succeeds in grouping clients.
Different kinds of DRT exist in the world. According to the degree of development of the system, the DRT can propose different features: the travel can be optimized by a

person or a software. The service can be provided by minibus or taxis. The reservation delay varies according to the systems, and the service covers a more and less large territory at wide or restrictive hours. A first classification made from 153 DRT in France and Europe shows that there exist many various ways to impulse, build and manage a DRT, 5 main groups of experiences and 3 distinct processes of setting (political, financial and commercial processes). In the final paper, we shall present a more accurate typology based on this first classification and many experiences in the world.

TERRITORIAL SCOPE AND EXPANSION OF A FUNCTIONAL DEMAND RESPONSIVE TRANSPORT SERVING A CENTRAL STATION

Brief reminder of the DRT Evolis functioning in Besançon, France

For now two years, the French town of Besançon is served by a DRT called Evolis. That is the result of an applied research project, including several complementary partners, belonging to different domains : researchers in geography and computer science, carriers and a political organ which promoted and supported the research program. The decisional (political) organ is called the “transport organizing authority” and is composed of lots of urban or rural communes. In the case of Besançon, its name is the “Communauté d’Agglomération du Grand Besançon”.

The practical need that led us to develop this service was the following. It has to serve the whole population of Besançon by providing a time limited (30 min. max) access to the early high speed trains (TGV) leaving from the central railway station. Clients generally follows such a spatiotemporal sequence : walking to the Evolis station (max : 5 minutes), travelling in the vehicle (max : 15 minutes) and waiting for their train (max : 10 minutes). For the way back, the opposite sequence is proposed, with a shortest waiting in the railway station. The service aims to find the shortest routes linking a few of the 650 Evolis stations spread in Besançon to the train station, while maximizing the number of carried people by as few vehicles as possible. The customers have to phone the previous day to book their trip. Each evening, the routes are recomputed for the following day, according to the demand, using a dedicated GIS we developed (©ReSAD2). The taxis carry out the trips, according to the computed routes.

In its actual functioning, Evolis is somewhat a combination of the Shuttles, technological and reactive DRT operating in USA around the big towns and airports, and the “bush taxis” developed in Africa notably, whose aim is to group passengers, even if this may imply some timetable or paths modifications. In our case, DRT states as a public transport, managed by a private firm (a carrier) which is appointed by the territorial and political organ as a delegate to apply the transport system.

Results of Evolis, after two years of operating

Launched in 2001, this service is henceforth operating as a solution for a commercial " nest " : serving occasionally the principal railway station in marginal times, *i.e*. at early and late times (7 TGV to serve). Indeed, after two years of functioning, it almost raises the economic efficiency of a common regular public transport, even if it involves only specific and so quite rare flows. The service also encourages people to leave their personal car and to accept to share a vehicle for a short trip, so taking their own part to air quality improvement and urban noise reduction.

After more than two years operating, a few interesting elements appear clearly. In 2002 and 2003, the service involved about 1500 clients in Besançon, corresponding to nearly 3000 routes per year. The economical rate remains stable at a high level: about 40% of the price is afforded by the clients, when the community which levies the taxes pays the rest. This rather good result is due to the capacity of our system to group people, with an average of almost 2 passengers per vehicle. Globally, the use of Evolis increases (40 % of more trips between 2001 and 2002), even if it concerns only about 1 % of the population in Besançon, and about 10 % of the people who could use it for such trips (let us remember that the market is tight, because of the targeted nest). A recent survey on a sample of regular Evolis users (more than 150 individuals) reveals that 66 % of them are "satisfied", 32 % "very satisfied". We also asked to the clients what were their usual modes before Evolis was created. The results are very interesting, showing the goal to prevent the use of personal car is partially reached: 47 % percent of these client used before to go to station by car (21 % as drivers). This survey also enabled to identify the dominant profile of Evolis user : a middle-rank executive woman, very mobile, unsatisfied by the car and the bus, facing the (future) flexible or soft transport modes, motivated by the competitive price of the service.

Evolis in Besançon is also enlightening on some unexpected social relationship. There exist now a group of users, which have changed the way they moved in town, left aside their individual attachment to their own car, and claim their membership to the " Evolis Demand Responsive Transport Club ". These clients use to meet each others, to discuss in the vehicles and cannot come back to their old practice, because they consider the service as efficient, comfortable and cheap. We also noticed by a survey on 65 Evolis clients that these DRT users are more open than others to new flexible systems.

ADAPTABILITY OF A DRT SUCH EVOLIS TO NEW TERRITORIES

We start now several researches on new territories where the issues are considerably

differing.

Methodologies

Modelling and simulation knows a great interest in geography. The geographer know-how about the territory problems, their knowledge about GI(S) and the progress in simulation enables to develop new tools for decision making especially on a transportation networks and services. This approach allows social sciences to carry out tests in laboratory conditions. That is a very interesting tool for the research to test assumptions on complex systems. Several kinds of simulating models are described in scientist literature (multi-agent systems, micro-simulation, geomarketing, trends projection...). They must be discerned by their aim, their technical composition and by the way they include time and space. Generally used for reproducing the reality complexity, simulations improve the comprehension of complex systems and spatial organization, and consequently, may be used, with much discernment, for spatial prediction, planning and decision making.

The method we are actually working on is quite simple. We propose to use the software Resad2 as a flow and RDT simulator. A little modification of this software ensures it will be adapted to any terms of DRT functioning. From the actual situation of Evolis in Besançon, Resad2 can simulate an extension of a station-to-station service, not to say a door-to-door system with a hierarchical organization of centres and “flows generators”. Three stages are necessary to succeed in such a task: the numerical geographical data base must include the topological network, all possible points that represent the population spots, and the identification of the places and centres. On top of that, knowing the specific potential demand attached to any couple {space-time} is of great interest, even necessary. In other words, we have to estimate the probability that a transport demand occurs at any time and at any location. Processing these data, it becomes possible to assess what could be the potential demand, and how our system could group passengers and fulfil the solicited service.

Geographical extension of the DRT Evolis for the whole territory of the *Communauté d’Agglomération du Grand Besançon (CAGB)*

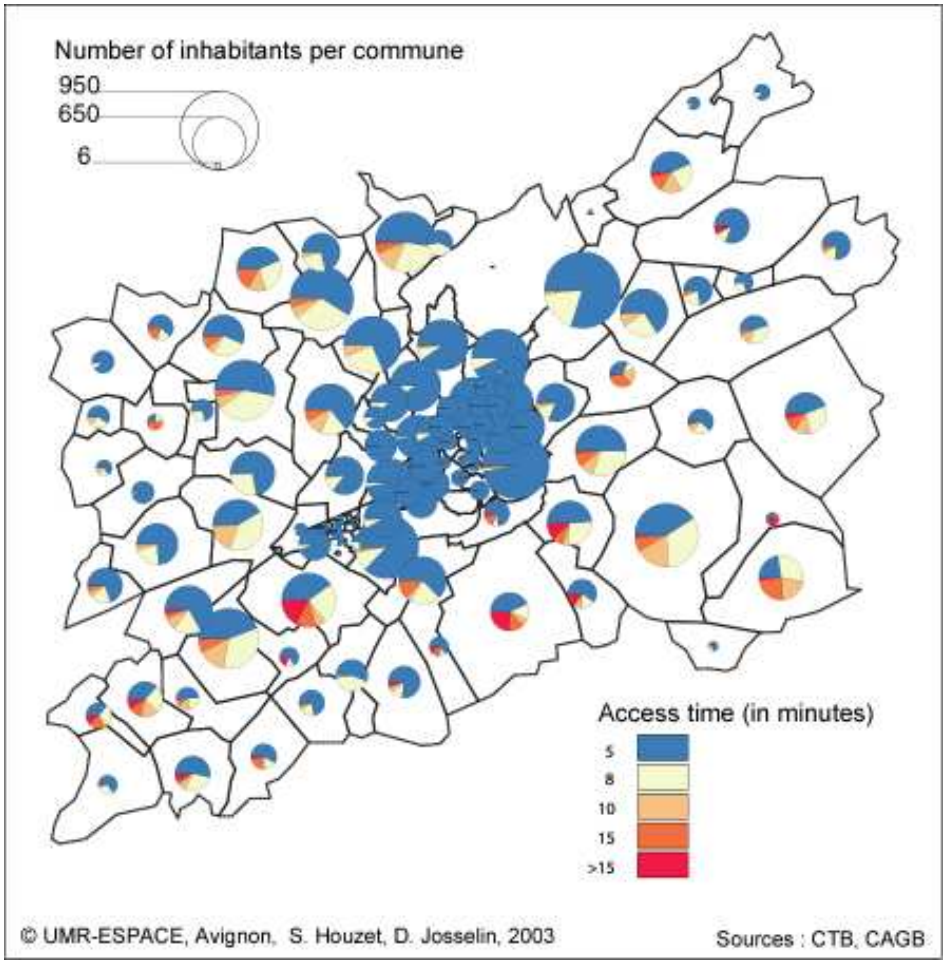

Figure 1: Access time to Evolis stations from housing for each commune in the Communauté d'Agglomération du Grand Besançon (CAGB), France

Extending a DRT to a large territory requires to evaluate and to adapt the service in order to maintain its economical productivity, its social appropriateness in respect with the contract (de)signed with the client. The CAGB ordered a study to evaluate the social and economical impact due to the change of the served territory and to (re)design the concepts of the service to fit to the new enlarged demand. This new territory (about 30 km long) covers 59 communes (170000 inhabitants), including Besançon (120000 inhabitants). New territorial characteristics induce several constraints : lengthening of

covered distances to access to the service in the added communes, decreasing of the potential market (population low density), deterioration in the service attractivity and in the Evolis stations accessibility within the periurban communes. This is illustrated by the figure 1, where we computed the time access to the service according to the new Evolis station locations. This is an important point : accessibility appears worse for some of the periurban communes. Population is much more spatially dispersed, so requiring supplementary Evolis stations. Indeed, it is clearly impossible to force users to walk more than 5 minutes, especially in peripheral areas. This would greatly impair the service attractivity and can depreciate its economical efficiency.

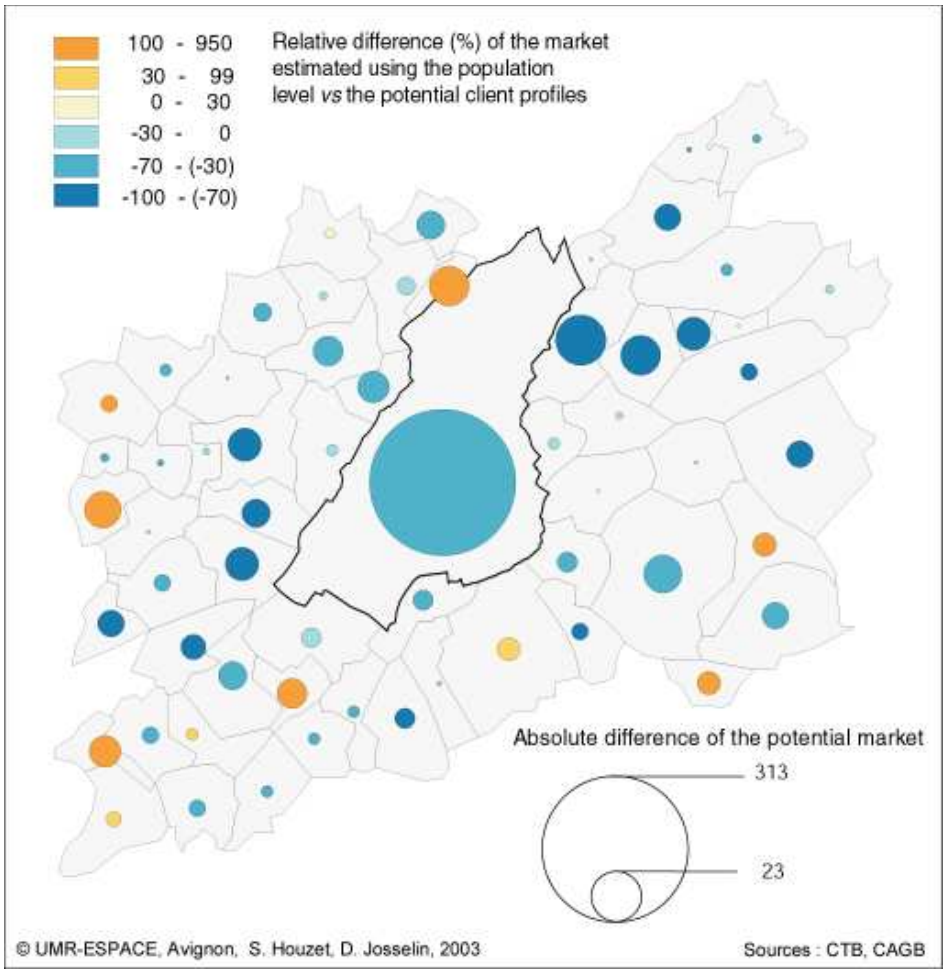

Figure 2: Evaluation of the potential market and difference between the market estimated from the population ratio and from the clients theoretical profiles in Besançon (center of the map), Communauté d'Agglomération du Grand Besançon (CAGB), France

The survey we presented previously allows us to estimate the potential market of transport customers. If we project a ratio of 1% of future passengers on the whole territory, we obtain a new annual market of about 500 new clients using the extended service Evolis. Another way to proceed from the user profiles deducted in the survey provides a lower market. Indeed, the population structure (data : General National Census 1999 of INSEE) of the additional communes (age, socio-professionnal categories and gender) doesn't seem really favorable if we assume the person behaviour to remain stable and coherent with the one identified in Besançon. Thus, we can consider that, globally, the market calculated from the ratio overestimates the market (Besançon keeps the leadership), while the one processed with the profile underestimates it (we can hope a more important need in the other communes, where only a few transportation exists). For each commune, we then find the minimum and the maximum of these two market values. We weight these values by a complementary coefficient of (-)30% to ensure the range to cover the expected market which will really occur. Let us not forget that our prediction must be reliable, rather than accurate. The figure 2 gives an idea of the (weak) potential market and shows the difference between the under/overestimated market. The range of the values is very large and can be used to give very large estimations of potential market, subsequent economical efficiency and induced costs, as our operational partners expect.

The DRT Evolis extension implies the average distances to be longer, the mean prices to become more expensive. Our first simulations show that the economical ratio may go down to 20 % (80% of the cost will have to be paid by the CAGB, and so, the community), due to a very weak grouping and a significant increasing of travelled distances. These first estimations will be refined thanks to the computing we are starting to run using Resad2. This software enables to simulate virtual routes according to the probability of occurring demand at each Evolis station, demand estimated from the potential markets presented above. These results will be detailed in the final paper. This methods also aims to anticipate what could be the necessary modifications of the "contract" (the design of the service, including the spatiotemporal features mandatory for the client), in particular for the remote communes.

Other complementary territories to depict and to serve

Two complementary projects are now being examined for improving and introducing

DRT on new territories : the conurbations of Avignon (a medium-sized city with 89000 inhabitants and 150 000 people living in its agglomeration, South of France) and Montbéliard (North-East of France, about 100 000 inhabitants). Avignon is an example of “scattered” and dense population, and Montbéliard shows a multipolar structure, with a hierarchy of territorial functions.

For these two territories, DRT can be an efficient solution for many problems of transportation, especially because the political demand is strong. We can foresee several possible solutions by associating the DRT to the regular public transport network to attempt the system to evolve. We shall test different levels of DRT integration (serving of a flow generator, "intermodal" system, or ubiquitous DRT) and study their advantages and limits. In this spirit, we shall simulate four hypothesis of combination from classic to flexible transport : a first one foresees the minimal use of a DRT, in periphery for low density and demand; a second scenario imagines a little more integrated, flexible transport for replacing deficient bus lines; the third assumption plans to test a judicious combination between bus and DRT; and the last scenario will implement a complete and ubiquitous versatile DRT.

CONCLUSION

As we see, due to information and communication technologies and GIS evolution, it seems pertinent to propose new services of Demand Responsive Transport. A survey made in 2003 on 1000 individuals allows us to imagine these concepts thanks to a study about the perception of spatiotemporal constraints by the potential users. When we asked people about some close future Demand Responsive Transport systems, able to group and move them when and where they want without any preliminary reservation, they say they would use it for 70 % of them, even if these kind of systems would require new constraints for them and a higher level of complexity (varying price scale fixing, time uncertainty, notably). These encouraging results lead us to feel that we may be at a turn of transport consuming and conception in France. As we have previously drawn the social context, that seems to change quickly and opens to new concepts, renewed services responding to the specific needs of other territories. This paper offers us the opportunity to develop a discussion by presenting in conclusion the design of these new services and the way we intend to make them operating, on new territories, such as Montbéliard and Avignon.

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