

PRAXITELE : PRELIMINARY RESULTS FROM THE SAINT-QUENTIN EXPERIMENT

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Abstract. The Praxitele system is the first large scale operational public individual transportation system (or station car system) based on self-service electric vehicles. It has been developed in France by a consortium of industrial companies and research institutes since 1993. Its operation started in the high-tech city of Saint-Quentin-en-Yvelines, near Paris at the end of 1997 with 50 electric vehicles from Renault. At midterm in the experimentation, close to 500 participants are using this system. This is the first report on the experiment which is due to last at least until the end of 1998. The preliminary conclusions show a very high level of satisfaction and a desire (from the users standpoint) to enlarge the system. However, no conclusion can yet be drawn on the economics of such a system which is still expensive and underutilized.

Keywords. Public transport, electric vehicles, self-service, station cars, Praxitele.

I- PRAXITELE SYSTEM DESCRIPTION

In 1993, a consortium of industrial companies formed by Renault, EDF (electric utility) and CGFTE (a public transit operator) joined with two French public research institutes (INRETS specialized in transport technology and INRIA specialized in computer science) to develop the concept of individual public transport. This concept is based on the use of public electric vehicles to complement mass transportation where or when it is not flexible or frequent enough.. The city of Saint-Quentin-en-Yvelines volunteered to host an experiment and the high-tech defense company Dassault-Electronique joined the project in 1994.

At the end of 1995, a technological demonstrator was presented to the city and to government officials and it was decided at the end of 1996, to launch a full size operation. In the fall of 1997, the service was open to the public with 50 electric cars delivered by Renault.

The city of Saint-Quentin-en-Yvelines

The Praxitèle pilot project is taking place in the New Town of St Quentin en Yvelines , some 20 km to the West of Paris city limits. It stands in the middle of a rural plateau and covers 70km² located in 7 municipalities.

The Praxitèle fleet

Praxitèle is based on a fleet of electric vehicles, a set of stations where cars are parked and recharged (and must be returned to) and a central management system which doubles as an information and fare collection system.

The vehicles

Why an electric car to develop the concept of public car? Although there is some debate about the pollution of electric cars (through generation of electricity, manufacture and disposal of batteries), it is certain that in city driving, small electric cars are much more efficient in energy usage than thermal cars. Besides, air pollution is becoming a very serious problem in many cities and it is necessary to, at least, delocalise the pollution. Also, this public system based on electric cars will allow politicians in large cities to forbid the use of internal combustion engine (ICE) cars in some areas while preserving the freedom of movement for people who cannot (or do not want to) walk long distances.

For these reasons and also because it is much easier to control and automate the operation of an electric car as compared to an ICE one, it has been decided in the PRAXITELE project that the public urban vehicles should be

electric. Also, since the public cars are meant to be used for short trips, the small autonomy of existing electric cars is not a problem, and indeed it can even be viewed as an asset (the car will not be used for long trips and has less chances of being stolen).

In the first phase of the implementation of PRAXITELE, and in particular for the Saint-Quentin experiment, the vehicles are the Electric Clios and therefore, fairly standard in their operation. However, developments are under way on a new type of vehicle (Parent, 1995) which would include several safety features such as speed control, intelligent cruise control, obstacle avoidance and some forms of automatic driving, for example in parkings (Parent, 1993). Developments are also under way to move several of these vehicles with only one driver by forming a platoon of automatic cars (Daviet, 1995). This would be specially suited to move empty vehicles from one location to another. These features have already been put in operation by Honda on an experimental basis (ICVS System).

During its operation, a vehicle can be in any of three states, clearly identified by LED displays in the windshields, at any given time :

- in use (even if not occupied, the user being charged for time),
- available for use,
- not operative (charging or in need of maintenance).

The entrance to the vehicle is made with a contact-less smart card which identifies the client. Inside the vehicle, the client must insert his/her card in a reader and type in his/her 4 digit code. Once this is done correctly, the car is available freely. If the user wants to stop on the way, this is possible and the car remains reserved for this one customer. The smart card is then used as a key to lock or open the car. The car can only be released at another station after correct parking. Of course, in emergency situations (or if no parking spot is available at a station, a special procedure can be used to stop billing.

Since each user is clearly identified, there should be no problem of responsibility in the case of an accident or damage to the vehicle. Besides, the vehicle has a radio link to the central control and any incident is immediately reported. The user can use the link for audio transtrip and assistance.

Each vehicle is under the control of an on-board computer developed specifically for this application. The computer controls the access to the car via the readers of the smart cards. It also dialogs with the regular car computer which runs the car, in particular to check its state (is it running correctly, what is the state of charge, do we allow recharging, etc.). The computers is equipped with a digital radio link to the central management system. The computer is also equipped with a positioning system (GPS) to tell the central management about the car location in case of emergency.

The Stations

The vehicles will be available at specific stations appropriately distributed throughout the city. In these stations, the public cars will be parked in reserved spaces where they can be recharged through a novel induction system developed by EDF (Bleijis, 1995).

Each station is equipped with an information terminal which is used by the clients to perform several functions :

- he/she can request the state of his/her account (after entering the smart card for confidentiality), or the cost of the last trip (a receipt can be delivered),
- if no car is available, one can ask for the delay to get the next car and reserve it or one can request a taxi,
- information about other transportation modes can be delivered,
- general information about the city and business can be obtained.

The information terminal has a direct link to the central management system which collects all the information about the cars, the customers and the city.

Since the number of spaces reserved for parking is limited at each station, a car may arrive when all the parking spaces are occupied. In this case, the user is allowed to abandon the car outside a parking space and the central management sends an employee to move the car to another station.

Each station is also equipped with video surveillance in order to prevent the cars from being vandalized. An image processing system developed by INRETS looks at specific areas around each car and sends a signal to the central management if someone enters this area. The central management requests the image to be sent if a regular customer does not initiate an action (such as entering or leaving the car) within 10 seconds. The operator then checks the image

(which can be stored) and takes action.

The management center

From the descriptions above, it should be clear that the central management plays a key role in the operation of the system. This management center consists of a central computer linked to all the stations (mostly through telephone lines) and to all the cars (through digital packet switching radio link), and personnel which man the center and service the cars.

The central computer is in charge of the billing and each customer has an account attached to the individual smart card. The fare structure can be as sophisticated as the operator wishes. Each fare can be based on duration or the length of the trip, the time the car is used, the time of day, the origin and destination, etc. This fare structure can be optimized in order to discourage the use of the cars at high demand periods and to facilitate the return of cars to where they are needed.

In any case, we know that it will be necessary at certain periods of the day to move empty cars from one station which has an excess of cars to another one which is in deficit. It is the central management which is forecasting these movements according to previous data on the demand and sophisticated algorithms. The dispatcher will then send a team of personnel to move the cars according to his/her experience and the availability of the personnel.

As we have seen previously, the dispatcher is also responsible for the surveillance of the stations with the help of the image processing units at each station.

II. THE EXPERIMENTATION OF PRAXITÈLE IN THE NEW TOWN OF SAINT-QUENTIN

Since the middle of October 1997, the Praxitèle pilot project is taking place in the New Town of St Quentin en Yvelines , some 20 km to the West of Paris .

The New Town of Saint-Quentin

From a total of 25,000 inhabitants in 1968 in the 7 original villages, the new town has grown to 150,000 inhabitants and 70,000 jobs, almost exactly the number of the local labour force. In spite of being self-contained (job-wise) in appearance, St-Quentin provides employment to only slightly over 40% of its residents, due to its immersion within the larger Paris Metropolitan Area. The other 60% work somewhere in the rest of that area. A broad range of income is represented in the local population but, on the whole, St Quentin is a middle class city, where lives a quite young population, often with young children (3,2 persons / household).

St Quentin, home of numerous hi-tech firms and research centers, is part of the “knowledge belt” (academic and R+D institutions) in Paris southwestern suburbs, and is linked to its establishments by two orbital roads : one local highway and one expressway.

St Quentin can be reached from Paris via the A12 freeway, or highway N10, or 3 different suburban railway lines and enjoys a direct rail connection to the regional employment center (i.e. Paris satellite CBD) “ La Défense ” in slightly over 20 minutes. Approximately 240 trains stop daily in its 2 stations. A hundred buses ply the 212 km of the local bus network, but the level of supply is of unequal quality and considered as bad during the off-peak hours and week-end by the inhabitants. Some parts of city (the newer and the lowest dense) are not served by the bus network.

As all new towns built in France in the sixties, Saint-Quentin is a town designed to the car use because of low density and multipolar configuration : the car ownership rate is particularly high (96% of households who live near a Praxitèle Station have at least one car, 36% have two cars) ; the modal split of car in daily mobility is 53%, what is quite high (44% for the metropolitan region of Paris). In this low dense city, there is neither problem of road congestion nor parking problems except at the main railway station where the park and ride is not free.

The experimental set-up

In Saint-Quentin, Praxitèle consists of a fleet of 50 electric compact cars (Renault cars called Praxicars) proposed for self-drive use to the general public. The concept is to complement conventional mass rapid transit, bus network and taxi services by an intermediate form of public transport (paratransit), hopefully an attractive alternative to the use of one's private car for a number of people.

Praxitèle is aimed at regular, recurrent users. Therefore, users register with the system Operator. The management

center (Praxicentre, of course) for information, subscription/registration, and customer relations is located near the main railway station in St Quentin. Payment is made through monthly invoicing. The fleet management system (real-time) in the Praxicentre can locate the cars (by GPS), communicate with them (radio). It monitors usage and issues monthly invoices to customers

In the Saint-Quentin experiment, the initial planned configuration was to have fifty electric cars and six stations. However, during the first six months, although the fifty cars were delivered by Renault, only around thirty were simultaneously in operation, the others being used for development or maintenance. Furthermore, the electronics for smart card access were not in place in the first six months (although the cars were progressively equipped with the on-board electronics) because the cards were not available in the final format decided by SNCF and RATP (the main public transport operators in metropolitan area).

In this configuration and during the starting phase of the pilot scheme (October 97-June 98) :

- The presence of operators in each station (branded as Praxiparc) was needed and this in turn imposed a reduction of opening hours and doesn't operate on Sundays. In the starting phase of the pilot scheme, the staff has numbered 12 station attendants, delivering the cars to and retrieving them from customers (see below), and 3 multi-task agents in charge of customer relations at Praxicentre, of occasionally "jockeying" cars between stations to compensate for possible imbalances, and of basic vehicle maintenance (rather simple for an electric car).
- Customers have to visit the Praxicentre at least once to register and sign their contract. They are asked an ID, a valid driver's license, a proof of address, and a bank reference. They are issued an Access Card (initially a barcode card, and now a smart card). This "Praxicarte" is to be used in all their transactions with the system, especially when retrieving a Praxicar.
- Pending the introduction of a fully self-service mode, based on recognition of the Praxicarte (now implemented), each station was manned by a "jockey", in charge of logging the customer's ID with an infrared reader (off-line terminal), but also of welcoming him, and of helping him with the system (in his initial trials). This commercial action has proven so successful that it will probably be continued, although on a smaller scale (i.e. not permanently), now that it is no longer a technical requirement. Some human presence turns out to be beneficial to counter the image of the de-humanized computer system.
- Out of the six Praxiparcs originally planned, only five were actually installed. Five stations were opened, one of which next to the main railway station, two within residential areas and two in or near research parks. These various stations being distant from approximately 7 to 8 kilometers, and a maximum 15 minutes is judged very reasonable for a trip between 2 stations. This configuration of the offer calls for an observation relating to the spatial level of service; it is clear that for the people living at proximity of a "residential" station, the only "interesting" destination is the main railway station. For the employees or professionals of the activities zones served by the system, the service offered is hardly more varied except for those which move between the two zones.
- Marketing assets of the experimental set
 - Market segments : Praxitele in St-Quentin is targeted toward three different market segments, the local residents, the employees of local companies and the visitors to these companies. Initially, it was thought that primary users might be professionals from outside the area visiting local companies, or working people from one local company visiting another local company for business reasons, or personnel temporarily assigned to a local establishment. Secondary users were deemed to be residents on shopping or leisure trips, residents whose car was temporarily unavailable, or young people getting together to use Praxitele.

Experience has shown that residents were at first much easier to attract to the system than employees and even regular visitors. Measures have been taken to balance the segments in the experiment (in particular information and motivation actions in the companies sponsoring the scheme), but their effect has not been very strong

In the initial phase of the pilot scheme there is no subscription charge although this may change in future applications. Pricing is based on the time the car is used : a flat fare for the first 30 minutes, followed by a charge of x Francs by minute : x is twice higher in peak hours than off peak in order to discourage competition with public transport.

Holders of a mass transit monthly pass are offered "courtesy rates" (50% discount) in order to incite commuters to use Praxitele as "feeder" mode in combination with trunk haul mass transit facilities. Residents of St

Quentin were also offered a 50% discount on fares in the hope of stimulating local demand. (See table 1).

Service hours : In the initial phase of the pilot scheme, the system operated from 7:30 AM till 7:30 PM during the week. On Saturday, only three stations are operating, the residential ones and the railway station , from 9:30 AM till 10:00 PM. On Sunday, the system did operate.

Table 1 : Rates Pricing of *Praxitèle*, October 97 -June 98

Rates Pricing	Peak hours*	Off Peak hours	
Inhabitants of St-Quentin and mass transit pass holders	francs per 1/2 hour	30 francs per 1/2 hour	15
Other people	50 francs per 1/2 hour	25 francs per 1/2 hour	
Each minute extra	2 francs	1 franc	

* Peak hours: 7h30 am-10:00 am, 4:00-7:30 pm / Off peak hours : 10:00 am - 4: 00pm. Off-Peak rates on Saturdays.

The project evaluation

The pilot scheme was to be evaluated on two accounts : 1/ technical operation and operating costs, and 2/ customer-related aspects.

- Technical aspects :

Throughout the first six month of the experiment, the electric cars from Renault behaved quite well with very few breakdowns. The electric induction chargers which were tested for the first time in live situation (and through a difficult winter) had a few teething problems.

The on-board electronics for smart-card access and communication with the center were not really tested during this first phase.

In the Praxicentre, however, the data was dutifully recorded every day and the management software behaved as planned (no complains from customers).

- Customer oriented evaluation :

There were two major objectives to the customer-oriented evaluation : analyze users and uses of the system in order to identify :

- a. the market segments most likely to support the system
- b. possible alternatives accepted by supportive segments as well as (initially) non-supportive segments

Monitoring customer mobility is based first on statistical processing of the station log files, in which each car retrieval or delivery is recorded : place, date, time, car number, user ID ; second on specific surveys linked to user's socio-economic situation, patterns use, mobility, reactions... The issue of this quantitative approach is a set of mobility descriptors such as : rate of use, frequency, purpose, circumstances of use, self-image and system image, satisfaction from system, fare paid and hierarchized customer's expectations.

Two qualitative approaches have been conducted : one, prior to system start, in order to fine-tune the concept ; an another one, at the end of the phase one, in order to appreciate how the system's image was shaping up, fare sensibility and system acceptability, and the relationship between the concept (self-service, self-drive) and actual system use by customers.

Throughout the project, a number of "quitters " have been kept within the evaluation groups in order to understand why and how people drop out of the system.

In the future, more of the same is planned, in order to keep track of the impact of system changes (that is part of the experiment) on customer behavior. Two surveys , however, will innovate :

- a {price vs. service characteristics} trade-off survey
- and an analysis based on a 4 group meetings with persons belonging to segments of potential system clients, but residing in places where they have not been exposed to Praxitele information or marketing actions. This will show

how “ brand new ” people react to the (improved) Praxitele-phase 2 concept after the results of both phases of the pilot scheme have been brought in.

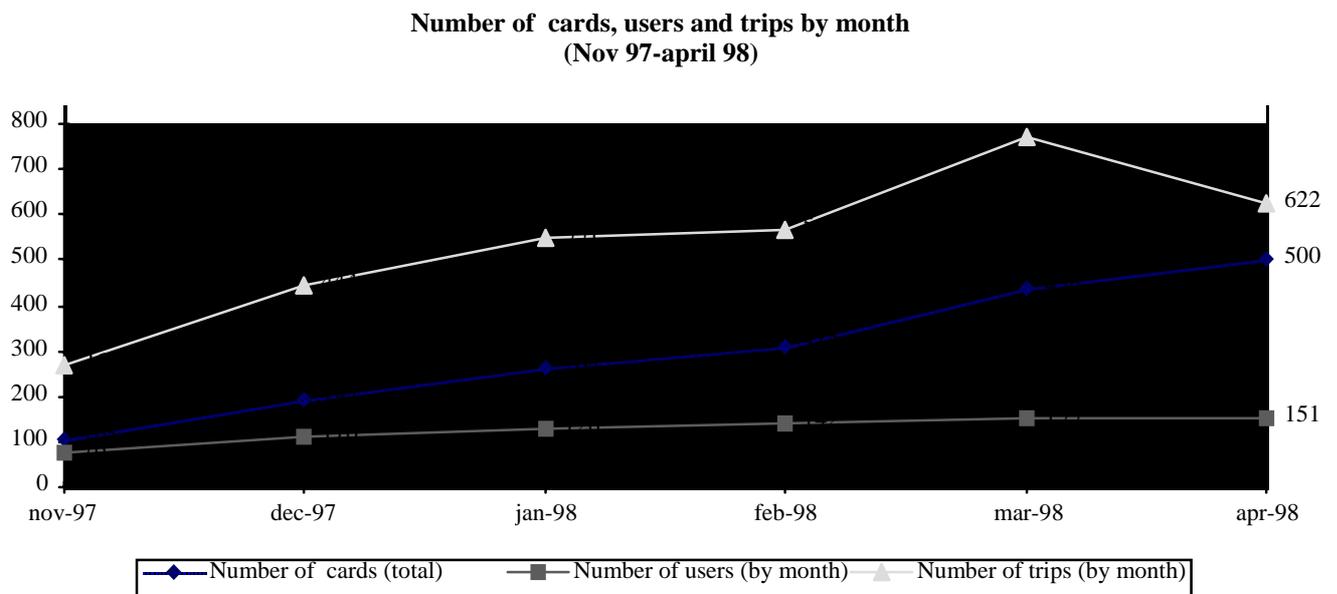
III - MID-TERM EVALUATION

After six months of operation, a number of qualitative and quantitative data has been collected and preliminary conclusion have been drawn on the uses and users of the system .

System Performance

The customers : Card carriers numbered around 500 at the end of March 1997. Figure 1 shows the number of cards given during the period under consideration. We can see that the number of cards on a monthly basis has increased more or less to reach a significantly high value considering the car ownership rate of the Saint-Quentin’s population. The curve of number of trips (or trips) on monthly basis shows also a growing trend. The number of effective users of Praxitele is quite flat, and inferior than the number of cards.

Figure 1 :



Frequency of use of the Praxitèle-card. The next table gives an explanation to the last curve. Table 2 gives the data relating to the rate of usage of the cards - that is, the number of trips made with each card (or customer). A part of the customers (30% of cards) made no trips either because they had only recently received the card or because more generally speaking, they had not yet been able to use the service either for personal reasons or because of the restricted spatial and temporal dimensions of service. Among the customers who have made at least one trip during the period, the percentage of customers who made only one is roughly 50% : these are trips made occasionally or out of curiosity. For trips numbering from 3 to 5 we have a percentage of 26; these are customers whose interest is more than just curiosity but whose need to use the vehicles is occasional. Finally, it is interesting to note that 11 % of the card-carrying customers make more than 6 trips per card and are therefore significantly regular; here we have special cases represented by systematic behaviors such as that of a particularly assiduous customer.

Table 2 : Frequency of trip by customer and principal characteristics of trips

% of users	% of trips
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1 trip	48	11
2 trips	15	8
3 to 5 trips	26	35
More than 6 trips	11	46
Average Number of Trip /day	27	
Average rental time /Trip	35 minutes	
% of trips with personal purposes (purchases, leisure, personal affairs..)		60%
Access mode to the system *	Foot : 80%, Public Transport : 35%,	
Personal Car Conductor : 12%, Personal Car Passenger : 7%		

* % on the access modes are higher than 100, insofar as the mode can vary at the origin and the destination of the use of Praxicar.

Overall trips. In the period being analyzed, 2670 trips were carried. These trips are equally distributed among the day (half of trips occurred during off-peak period), among the week. Roughly 60% of the trips are “station A to station B” trips, and 40% of trips have the same origin and destination station (loop trip). This last type of trip is quite important and is linked to the very poor spatial level of service served by the system in this first experimental phase, if we consider the spatial extent of this town. The most recurrent purpose in Praxitèle’s use is personal purpose, before commuting purpose and going to the railway station. The most attractive stations are, in the growing order, the two residential stations and the main railway station.

Daily trips. Average values around 30 trips per day were registered.

Single trips. The average trip involves in 35 minutes of rental time.

The Customers

The customers have been analyzed using interviews to verify composition, some behavioral aspects and finally, to gather opinions and assessments of the initiative. Some of the principal results of this analysis are described below.

a). Socio-demographic Profiles

Table 3 gives the distribution of the users by age; it can be noted that the maximum concentration occurs in the age between 25 and 34, followed by that between 35 and 49. Positive acceptance of the system by younger people can be attributed both to phenomena of a socio-cultural nature (greater attention to respect for the environment, curiosity, innovation etc.) and to more practical phenomena such as not having a car of one’s own. Furthermore, the majority of users are male (78%) and active ; figure 2 points up how the majority of the users belong to the category of working population (80%), among these working people the majority are managers (40%), followed by office workers and intermediate professions.

Table 3 : Distribution of customers by age

	18-24 years	25-34 years	35-49 years	50 years and more
% of customers	12%	38%	37%	13%

Table 4 : Distribution of customers by profession

	Distribution of customers (%)
WORKING PEOPLE	84%
Artisans, Shopkeepers	3%
Managers	40%
Office workers, Intermediate professions	33%
Blue collar workers	10%
NON WORKING PEOPLE	16%
Unemployed	4%
Students	4%
Retirees	5%

Mobility Behavior

The customers are divided into two groups: a majority group which uses the system little and a small minority which carried out a significant number of trips.

In the analysis of Praxitèle's use, two key variables make it possible to understand the adhesion and the frequency of the uses of the system (on the basis of customer having had a real use of the system, see tables 6, 7): the personal availability of a car and the proximity of residence to the station.

Customers without a car at their disposal, although a minority, are the most assiduous and regular users of the system: they constitute today the hard core of the customers. They, on average, make more trips, they mobilize the cars over duration slightly higher than the others and they go mostly from station to station (rather than loops). For them, Praxitèle answered a real need: very dependent on public transport (76% have mass transit pass, 40% use them every day), Praxitèle became for them "quasi required" to go shopping, for the medical urgencies, administrative and personal affairs, in off-peak hours and to go to places badly served by public transport starting from their residence.

The proximity of a station is less determining than for the other users, some use the bus to go to a station. The service had a positive impact on their mobility behaviors; they are the users who express strongest expectations with respect to the system. For this population with lower income than the average, the service and its "small" fare made it possible to remove constraints on their mobility.

The majority of the users have a car at personal disposal. Small users of the service, most often, they work or live near a station. For them, Praxitèle is a specific emergency mobility service. For the residents near a station, the use of Praxitèle massively replaces the car in the event of unavailability of the latter. The service constitutes also a reduction of the constraint of the parking of their car at railway station (for 12% of them), avoids borrowing a car, even raising the question of the purchase of a second car.

Between these two extremes, a third of the users has access to the household's car only from time to time. The frequency of their use of the system is in the average. They use the system to make shopping, purchases, accompaniments, or to go to work. The proximity of the station is determinant in their uses. Living within households with moderated incomes, the search for a better transport solution associated with a cost mobility management justifies their adhesion with the system. The majority of their uses replace the buses (75%): the system enables them to mitigate the deficiency of the public transport in time and space, to minimize the waiting times between 2 lines, or the ways too long. Among them, the employees who reside and work near a station profit fully from the concept: they have regular uses, uses "pleasure" or "breakdown service", they move from station to station. They are the most satisfied users of the service, petitioning for temporal extension of the service and flat monthly fares.

After 5 months of experimentation, one can retain that:

- Praxitèle increased the personal freedom of mobility with a public transport service unequal in time and space.
- Praxitèle met real needs for mobility of certain segments of the population: non motorized or occasional captive individuals of the public transport, two populations relatively under-represented in the context of the new city.
- Adhesion with the system and its uses are strongly dependent on the proposed fare levels and the proximity of the stations to the origin/or destination. The uses are generally complementary to a use of the public transport, specific and diversified in their reasons and their types (loops or of station at station).

It appears as clearly that:

- The users are mainly satisfied with the service offered, and this more especially as their use was regular and in phase with the concept.
- The electric vehicles was well perceived in the first tests of the system and this perception remained in latter uses.
- The concept of self-service was understood and appreciated. Freedom and **instant availability** are strongly appreciated just like the moderate price. The absence of concern of maintenance are also very appreciated. Praxitèle is associated with a service allowing the use and the sharing of a nonpolluting car in complement to the services of public transport.

Tableau 6 : Usage et Users of *Praxitèle* according to car ownership

	No car available	Car available from time to time	Car always	
available	Total			
% of users	20%	28%	52%	100%

% of trips	41%	31%	28%	100%
Nbr of trips/month*	4,8	2,9	1,7	2,7
Average trip duration	44 minutes	29 minutes	34 minutes	35 minutes
Type of trip				
-Only round trips (loops)	22%	17%	33%	33%
-Only station to station (no loop)	29%	46%	44%	67%
-Both	49%	37%	23%	
Total	100%	100%	100%	100%

* average number of trips per month of subscription

Tableau 7 : Usage and users of Praxitèle according to location with respect to a station

	< 400 meters from a station meters in a town with a station	Elsewhere in the new town	between 400 and 800 meters from a station	Outside the new town	> 800
% of users	30%	8%	23%	22%	17%
Nbr of trips/month*	4,2	3,1	2,5	2,2	1,3
Average length of trips	24	33	51	53	27

* average number of trips per month of subscription

NB : tables 5, 6 et 7 give the results of *Praxitèle* computed only on the customers really using the system (60% of total number)

IV. CONCLUSION

From the preliminary data collected after six month of operation of Praxitèle in Saint-Quentin, it can already be concluded that customers value the service offered and that the technology can meet the demand for a simple and efficient service. However, it is still too early to conclude that such a system can work efficiently under a full load which would be needed to have a balanced commercial operation.

Expectations of the users are on the extension of the service in time (week and Sundays) and space (opening of new stations). They are also expecting fares more in connection with their use (trips of less than one half an hour, fixed price for recurring longer trips). For the users, the number and the site of the stations, the schedules of opening of the service and the principles of pricing constitute the three elements to be combined to approach better the implementation of the concept of self-service. These expectations have now been met with the operation in full self-service mode which started in June 1998.

However, the effectiveness and the success of the system will rest on a better financial profitability and a good management of the fleet of vehicles. The capacity of the system to satisfy the very large majority of the customers, if not all, is an indispensable condition of its durable insertion in the practices of displacement. It requires, since one or more stations are more attractive than others, a service of replacement of the cars in the stations according to the relative levels of request on each one of them during the day. This challenge, which questions logistics and profitability, is intrinsic with all these types of services

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