AUTOMATION OF THE PARKING INDUSTRY:

A STRATEGIC AND MANAGERIAL OVERVIEW.

by

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ABSTRACT

Automation of the Parking Industry : A Strategic and Managerial Overview.

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Most large metropolis face the same problem: public transportation is obsolete or insufficient in responding to commuter demand. There are several reasons for this phenomenon. First, usage is cyclical and discontinuous. Second, municipalities have not been accurate in forecasting the growth of the central districts and suburbs. Third, the infrastructure of these large cities is often old and difficult to alter or improve without avoiding tearing down existing facilities. Finally, there is a lack of funds due to the unwillingness of commuter to pay high prices for public services.

As a result of these factors, public transportation is very constraining for people and encourages people to use their cars as a means of transportation. Unfortunately, these metropolis and large centers of attraction are not equipped with sufficient parking infrastructure to respond to the inflow of cars. This lack of parking spaces is a consequence of the following factors: conventional parking systems are by far too large in size because of their inefficient use of volume. Moreover, they require considerable land surface because space is wasted through, long alleys giving access to parking spots, large ramps, and high ceilings to account for people's height. Therefore, land scarcity in the central districts imposes cost and surface restrictions on the feasibility of new conventional parking projects.

In response to this urban dilemma, mechanical parking systems offer an alternative solution which have been explored for the past two decades. However, they all, with the exception of one, use sequential steps, and hence, are not adapted for the cyclical characteristic of parking demand. This leads to considerable queuing during rush hours.

Nevertheless, a new automated parking management system has been developed in France. It does not use sequential steps, but rather runs several procedures in parallel; thereby, overcoming queuing during peak demand. In addition, it does not carry the vehicles like most mechanical systems, but roll the cars by means of pushing. Hence there is no need for heavy mechanical devices allowing this system to become competitive with conventional parking systems.

This thesis will give a detailed description of the parking industry, and compare the advantages and disadvantages of this new generation of automated system with conventional and other mechanical parking systems. Moreover, the reader will be provided with a strategic plan for the implementation of the new parking concept. It will include marketing and technology strategy as well as the managerial aspect of construction. This thesis evaluates, promotes, and provides the necessary implementation instructions from a management consultant point of view.

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CHAPTER I

INTRODUCTION

SECTION 1.1

OVERVIEW

Most large metropolis face the same problem: public transportation is obsolete, or insufficient in responding to commuter demand. There are several reasons for this phenomenon. First, usage is cyclical and discontinuous, leading to a gap between peak and off peak demand. Second, municipalities have not been accurate in forecasting the growth of the central district and the suburbs. Third, the infrastucture of these large cities is often old and difficult to alter or improve without tearing down existing facilities. Finally, there is a lack of funds due to the unwillingness of commuters to pay high prices for public services.

As a result of these factors, public transportation is associated with unfavorable effects, such as loss of time in interminably long rides, discomfort due to overcrowding during peak usage, and unsatisfactory origin-destination networks. These constraints encourage people to use their cars as a means of transportation. Unfortunately, metropolis and large centers of attraction are not equipped with sufficient parking infrastructure to respond to the inflow of cars. This lack of parking spaces is a consequence of the following three factors:

i) There is a general trend in the world for urbanization and centralization of business districts leading to massive concentrations of people in the downtown areas. This continuously increasing influx gives rise to an ever climbing need for parking spaces. In the year 2000 it is estimated that 370,000 new parking facilities (lots), ranging from 200 to 5000 spaces, will be needed [1] in the world.

ii) Decisions for development of new parking lots are mostly reactive instead of proactive; therefore, there is a constant delay between assessment of a parking need and implementation of a solution to the problem. In addition, public funds are often scarce and thereby are the limiting factor for the development of new projects. These fundings are allocated according to decisions made by political authorities in power who are elected for a definite duration; therefore, they tend to favor short term solutions that solve the existing problem instead of solutions that will respond to future problems that may occur.

iii) Parking lots are rarely lucrative if small in size (less than 250 spaces), and thus are characterized by an economy of scale. Therefore, they need to be considerably large which leads to several problems in dense areas of development. Since land is scarce and in high demand for construction, it is expensive and therefore, with some exceptions, it is hard to find parcels feasible for parking lot projects. Moreover, one finds more vested interest for buildings than parking projects. One can blame this general trend on the higher turnover ratio associated with office buildings in central districts[2].

This thesis will further discuss in Section 2.1 the reasons why conventional parking systems are not adequate solutions for the growth of central urban areas. Meanwhile, demand for parking will increase accordingly, which makes it necessary to find an alternative parking system that is adapted for highly urbanized areas such as business districts.

SECTION 1.2

RESEARCH GOALS AND SCOPE

The goal of this thesis is to analyze and evaluate a high technology system based on robotics and its ability to meet future parking demand in urbanized areas. The scope of the study encompasses only central districts and densely developed zones where this high technology system appears to have a competitive advantage. My goals and scope are shown through issues outlined as follow:

First, a description of the conventional parking industry along with its advantages and disadvantages will lead to a demonstration of its inadequacy for central urban districts. Hence, the need for alternative parking systems will be pointed-out.

Then, a critical appraisal of alternatives such as mechanical and automated parking systems is provided, which shows their non-adaptability to the cyclical character of parking demand.

Finally, the thesis presents a detailed description of a new parking system, called Automated Parking Management System (APMS), developed in France, which uses an entirely new concept: computer aided robots. It then demonstrates how this new system constitutes a consistent solution to parking demand in highly urbanized areas. In addition, a strategic plan for the implementation of the new parking concept will be presented. It will include marketing and technology strategy as well as the managerial aspect of construction. In other words, this thesis evaluates, promotes, and provides the necessary implementation instructions from a management consultant point of view.

SECTION 1.3

ORGANIZATION OF THE THESIS

This thesis is organized as follows:

Chapter II presents a description of the parking industry as well as an appraisal of the different parking systems. It also reveals the evolution done in the field of research and development for the parking industry. The topics covered in Chapter II are:

Section 2.1 appraises public transportation and demonstrates their unfavorable characteristics which leads to the need for parking spaces in highly urbanized areas. Then it points-out all the problems associated with conventional parking systems, hence, revealing their non-adaptability to respond to parking demand.

Section 2.2 outlines the evolution and progress of R&D in the field of parking systems. Along with the historic comes an appraisal of the existing mechanical and automated parking systems.

Section 2.3 describes a new parking concept, developed in France, which utilizes computer controlled robots and artificial intelligence.

Chapter III Describes in detail the new parking concept called: Automated Parking Management System (APMS). Chapter III includes:

Section 3.1 describes the concrete work needed to realize an underground APMS. It will show that the new system does not really impose additional constraints on the construction process.

Section 3.2 describes the entire mechanical infrastructure involved in the installation of an APMS. Moreover, it demonstrates the simplicity of the assembling process of the system.

Section 3.3 unmasks the functioning of the robots as well as programming laying behind their artificial intelligence. In addition, it shows the decision making's hierarchy between the robots and the central computer.

Section 3.4 provides the dimension restrictions of the system which will demonstrate its flexibility in configurations and land contours. Then we reveal the cost of the system in general and for a specific case study.

Section 3.5 outlines the necessary operations for parking and retrieval of a car in order to help the reader understand and visualize the system.

Chapter IV compares the APMS to conventional and other parking systems. Chapter IV includes:

Section 4.1 provides a listing of all the advantages of using APMS with respect to other parking systems from which one can deduct that the system has a considerable competitive advantage.

Section 4.2 presents the disadvantages of APMS and demonstrates how the system overcomes the queuing problem usually associated with automated and mechanical systems.

Section 4.3 appraises the different factors exposed in the above sections and concludes that APMS offers advantages that render conventional systems non-competitive in central districts.

Section 4.4 provides, in a table, a comparative memorandum of the different parking systems.

Chapter V outlines strategic business planning for a company who would be interested in implementing one or several APMS in highly developed urban areas. The topics covered in Chapter V are:

Section 5.1 describes the purpose and the scope of the business plan. It will emphasize the fact that it should be addressed to venture capital investors and to the consumer which , in this case, are common drivers.

Section 5.2 points-out the importance of estimating demand before marketing a product, and outlines a short method which provides an accurate estimation.

Section 5.3 is a structural analysis, or environmental scanning, of the parking industry. It will address the nature, strength, and weaknesses of competitors as well as assess the difficulty to enter the market with a new product.

Section 5.4 describes how the implementation of APMS would alter the forces that shape the parking industry. Hence, revealing the first mover advantages of the system.

Section 5.5 outlines the steps to formulate a marketing strategy toward both the capital venturers and the consumers. The steps are as follow: analyze the marketing environment; analyze buyer behavior, determine competition's marketing strategy, and marketing high technology.

Chapter VI concludes the strategic implementation of the APMS.

CHAPTER II

DESCRIPTION OF THE PARKING INDUSTRY

SECTION 2.1

PROBLEMS ASSOCIATED WITH CONVENTIONAL PARKING

In this thesis, conventional parking refers to parking facilities that do not use mechanical devices, automated systems, or robotics. There are various types such as open lots, above ground, under ground, on-street parking, etc... The following problems are often associated with these conventional parking concepts:

- **They are large in size because of inefficient use of space:**

It is difficult for municipalities and the private sector to further parking development in central business areas due to the characteristics of conventional parking systems which are by far too large in size because of their inefficient use of volume. Space is wasted through long alleys giving access to parking spots, large ramps, and high ceilings to account for people's height.

- **Low feasibility in central districts due to size:**

Moreover, conventional parking systems give rise to additional problems. As stated before, land scarcity in central districts will impose cost and surface restrictions on the feasibility of new projects. It is very frequent for people using their cars as a mean of transportation to still walk considerable distances from the place they parked to their destination of interest or to work.

- **They constitute capital intensive projects:**

In addition, the cost of above ground parking construction is high because the land is rarely used for any other purpose; this is commonly called "lost use of space". Maximum height often being imposed, there are not many floors left to be built on top of the above ground parking. For example, if local construction regulations allow you to build 8 floors, and you decide to use 3 floors for an above-ground parking, you would only have 5 floors left to be utilized for another purpose.

Similarly, conventional underground parking construction projects are capital intensive because of the very high cost per volume excavated (typically $10 per cubic meter in developed countries[3]), and their inefficient use of space.

- **They are viewed as visual pollutants to the environment:**

People are also environmentally concerned with above ground parking lots; they are considered to be visual pollutants to the surroundings. The reason for this collective consensus is the lack of symbiosis between this bulky and usually unaesthetic structure and its environment.

- **They are unsafe for the driver as well as for the car:**

Conventional parking systems have other disadvantages. They are unsafe because they are situated in remote and deserted areas as well as being difficult and expensive to monitor. Police around the world receive numerous complaints of mugging, aggression, and car radio thefts which often take place in parking lots.

On street parking, another alternative, is also very unsafe and does not provide protection from corrosion and fading due to harsh weather conditions. Likewise for off-street parking lots, exhaust residue dust dirties cars, and in case of a fire, all the cars, even those which are not endangered, will be sprinkled with a highly corrosive anti-fire product .

In the above assessment of existing conventional parking systems, it is clear that one has to explore and develop new alternative systems to fulfill the driver's needs as well as the increasing demand for parking lots in densely developed urban areas.

SECTION 2.2

ALTERNATIVE PARKING SYSTEMS

Extensive research started in Japan in the late sixties. The purpose was to develop new concepts that would respond to the parking problem which had reach catastrophic proportions in Tokyo. Many attempts were made to reduce required surface area and also to maximize usage of space.

The first models of alternative parking systems were regular platform structures with elevators instead of ramps. Since European and American metropolis were facing the same type of problem and became conscious of the potential market for alternative parking systems, they engaged in a technological race with Japan. The first generation of mechanical systems were very primitive and capital intensive. Some of them had elevators and rotating floor levels in order to align a free spot with the elevator. These were incredibly expensive because of heavy mechanical devices required to have a whole floor move. Others would have the elevator floor rotating instead and thus would move less dead weight and require lighter mechanical structures. However, when elevators are involved, it is advisable to have valet drivers rather than average drivers do maneuvers.

The next step in the evolution of parking systems was the concept of automation. The idea was to process the car automatically without requiring the presence of a driver. This would result in a more efficient use of volume through reducing space for maneuvers. Most concepts were adaptations of existing civilian as well as military storage systems. Up to today, we have witnessed a great deal of research and progress in the field of automated parking systems. They seem to have become more credible in the eye of the parking expert because they seem to provide solutions to the problems associated with increasing parking demand and inadequate conventional parking systems. Unfortunately, new concepts always give rise to new problems; automated and mechanical parking concepts are not an exception to the rule.

There are 82 patented (automated and mechanical combined) systems in the world, of which a large majority transports cars to a pre-assigned spot by carrying them; hence, they require heavy mechanical structures and devices that increase cost and limit their financial feasibility to very capital intensive projects. Their cost range from $15,000 to $35,000 (not including concrete work) per parking space for a mid-size lot of 500 cars[4].

Moreover, they all with the exception of one, use sequential steps and therefore can not process a car before the previous one has been put into place. This characteristic literally annihilates the acceptability of such systems since demand is predominantly cyclical, which leads to drastic queuing during peak usage. People spend hours in traffic jams because the alternative, public transportation, is often worse. They have to choose between waiting in line to enter an automated parking lot (we are talking about 10 to 30 minutes in some cases in Paris), or parking farther away and walk to their destination of interest. The choice the customer would make is unclear; it would depend on numerous parameters such as local behavior, age, social rank, necessity to find a parking, etc... Thus it would be hard to model.

SECTION 2.3

PARKING ROBOTS: A NEW ERA

A new parking system has been developed in France by SARAH Co. This company was founded 12 years ago by a group of five dynamic and successful engineers who, from a business point of view, shared common enthusiasm and philosophy, but were knowledgeable in different fields. As of today, 70 engineers are employed and devote most of their time towards developing this new parking system. It is an entirely new concept; there is no doubt it will define a new era in the parking industry. Their system, called "Automated Parking Management System" (APMS), provides a solution to many of the previously mentioned problems that characterizes automated and mechanical parking facilities.

First, it does not carry cars but rather rolls them by mean of pushing. Hence there is no need for heavy mechanical devices, which enable the cost of the mechanism to become competitive ($7000 per parking space for a mid-size lot of 500 cars[5)] with conventional parkings. Second, SARAH's system utilizes artificially intelligent robots which can work in parallel, rather than sequentially. In other words, several cars can be processed at the same time, therefore it greatly reduces the parking procedure's duration and avoids drastic queuing during peak hours. In Chapter III, this system will be described in more detail and critically appraised.

SARAH Co. developed this advanced technology in collaboration with MATRA, IBM, and SCHNEIDER (more information about MATRA and SCHNEIDER are given in Chapter III).

CHAPTER III

DESCRIPTION OF THE AUTOMATED PARKING MANAGEMENT SYSTEM

SECTION 3.1

CONCRETE WORK

The APMS is an underground off-street parking system; it is characterized by its flexibility in shape and configuration (described in Section 3.4), and also by its variable depth depending on its capacity. In other words, it accommodates the shape of the site of investigation.

Its construction is similar to a regular underground parking garage. The first step of the construction is to put in place the slurry walls and foundation columns for the structure itself and for an eventual above ground project. Bentonite is then injected in the ground at a certain depth in order to hermetically seal the cylinder (watertight), at which point excavation can start (see Figure 1 and 2).

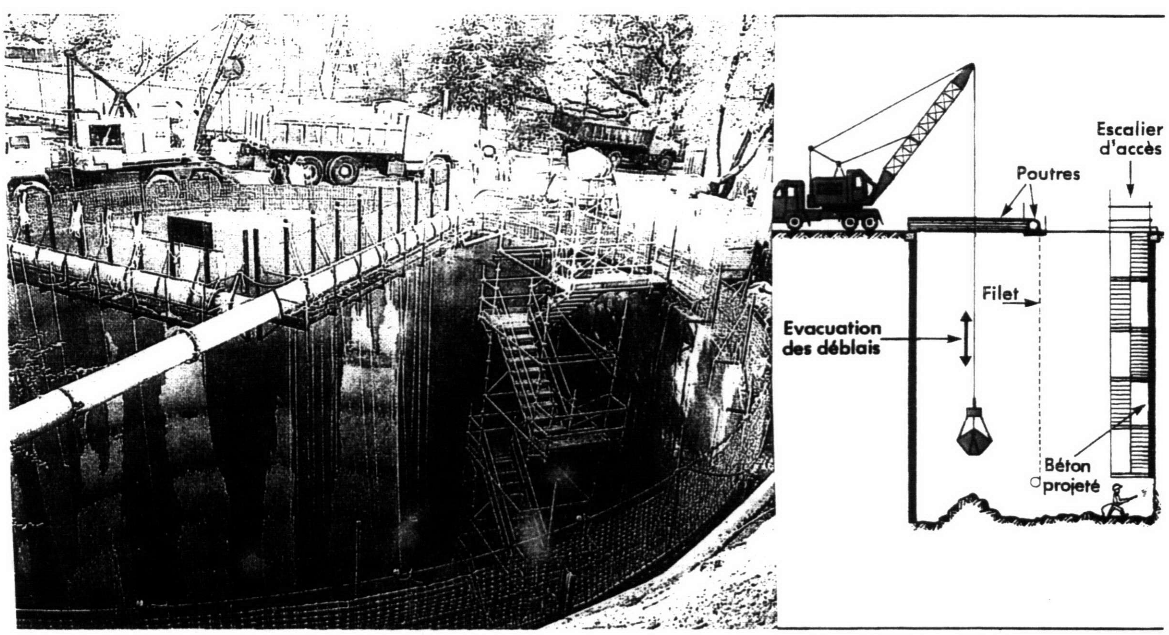

***Figure 1** : Construction and Excavation Process* [8].

***Figure 2** : Construction and Excavation Process*[8].

The shell being completed, one can start the interior concrete work. Each floor is a prefabricated slab supported by the columns and the shell itself. The construction method is simple and the assembly process is repetitive due to the symmetry of the structure. The entire concrete work takes three to six months depending on soil and weather conditions.

Since only authorized personnel can enter the APMS, the primary concrete can be left in its crude stage. Thus, there is no need for either finishing the concrete or internal aesthetic work. Constraints such as alignment accuracy on prefabricated elements are not problematic. The slabs must have a precision of ± 0.5 cm.

In addition, the columns for an eventual above ground project can be placed anywhere except in the central alley where the system's robots would pass. The location of these columns as well as the overall design pattern are input into the computer's data-base. Thereafter, a software program will take into consideration all the variables before designing the configuration of the parking and the assignment of spaces for cars.

SECTION 3.2

MECHANICAL INFRASTRUCTURE

Installment of the APMS comes after the concrete work. The mechanism is constituted of one, two, or three high speed elevators (depending on the size of the parking, its surface area, and the peak demand) which are positioned according to configurations shown in Figure 3. The elevators distribute incoming cars from the ground level to an assigned underground level (and inversely for car retrievals).

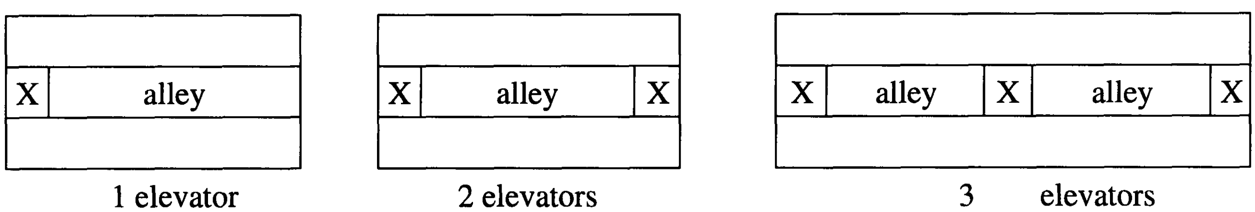

***Figure 3**: Position of Elevators According to Configuration (X=elevator).*

Car maneuvers are performed by autonomous robots which are composed of two superimposed wagons. The first one moves along the alley's longitudinal direction and onto the elevators (refer to Figure 4); it is called the robot carrier. The second one pushes the car into and out of the pre-assigned space as well as moves it from the elevator to the access or exit chambers (refer to Figures 5 and 6); it is called the robot shuttle.

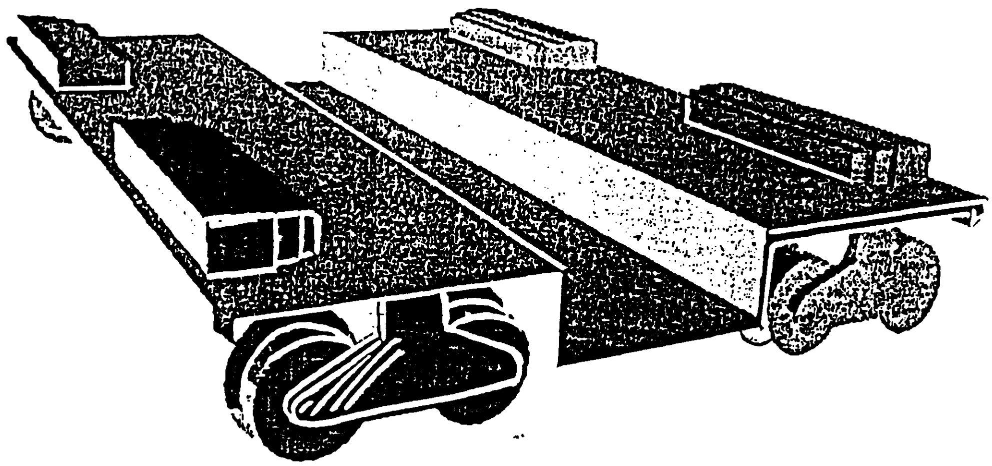

***Figure 4**: The Robot Carrier*[9].

The robot shuttle (Figure 5) is fairly complex. It moves under the car along a predetermined furrow in order to have a lower elevation than that of the car's tires. This will prevent the robot from touching the car's body so as to inflict any damage. Once it is adequately positioned under the car, it extends in length until it exceeds the car's length both in the front and rear (up to 6.5 meters in length). Afterwards, two arms padded with foam will rise vertically. Subsequently, the robot will retract in length until its foam cushions perfectly enclose the car.

The robot shuttle is also equipped with a system that will align the car's front wheels in case they are not parallel to its longitudinal axis. In addition, the foam has incorporated pressure sensors for security purposes. Therefore, if the vehicle's resistance to movements, due to a forgotten hand-break or an engaged gear, is too high, the central computer and the driver thereafter, will be alerted. Hence, no damage can be inflicted to the vehicle. Moreover, every robot is equipped with a sophisticated ionic fire detection device and is fire resistant for 20 minutes.

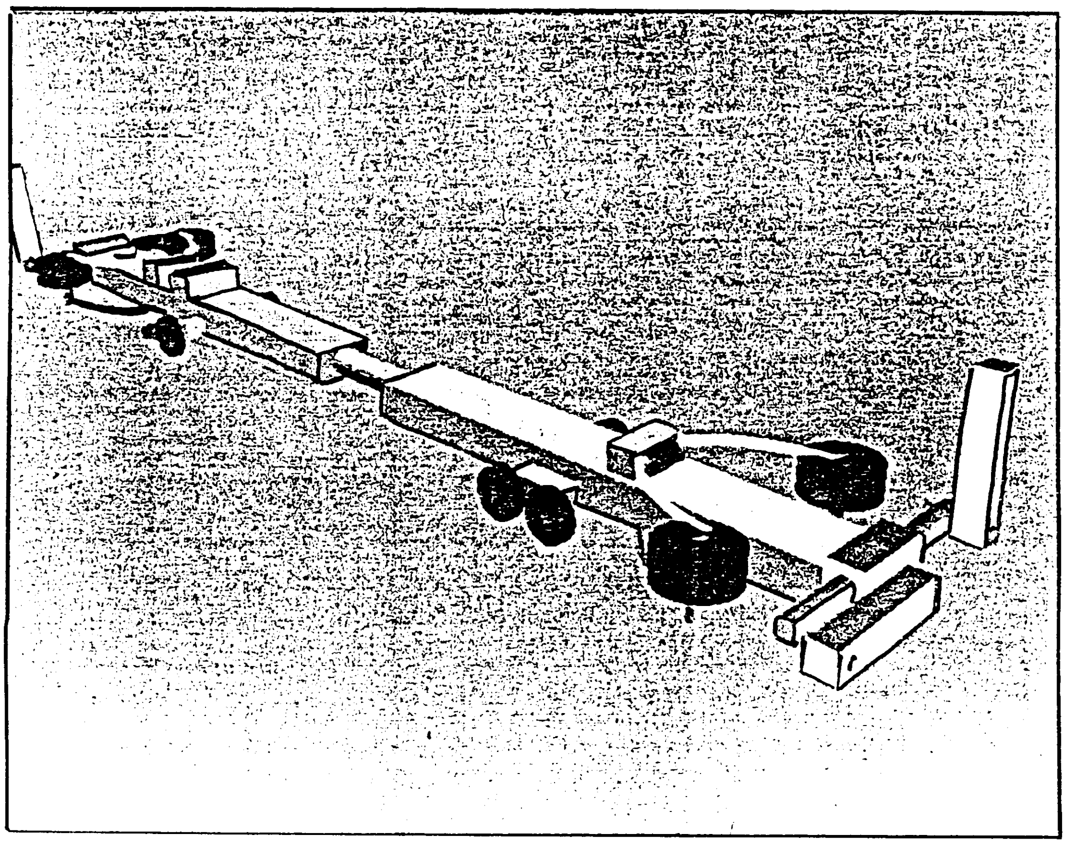

***Figure 5**: The Robot Shutlle*[10].

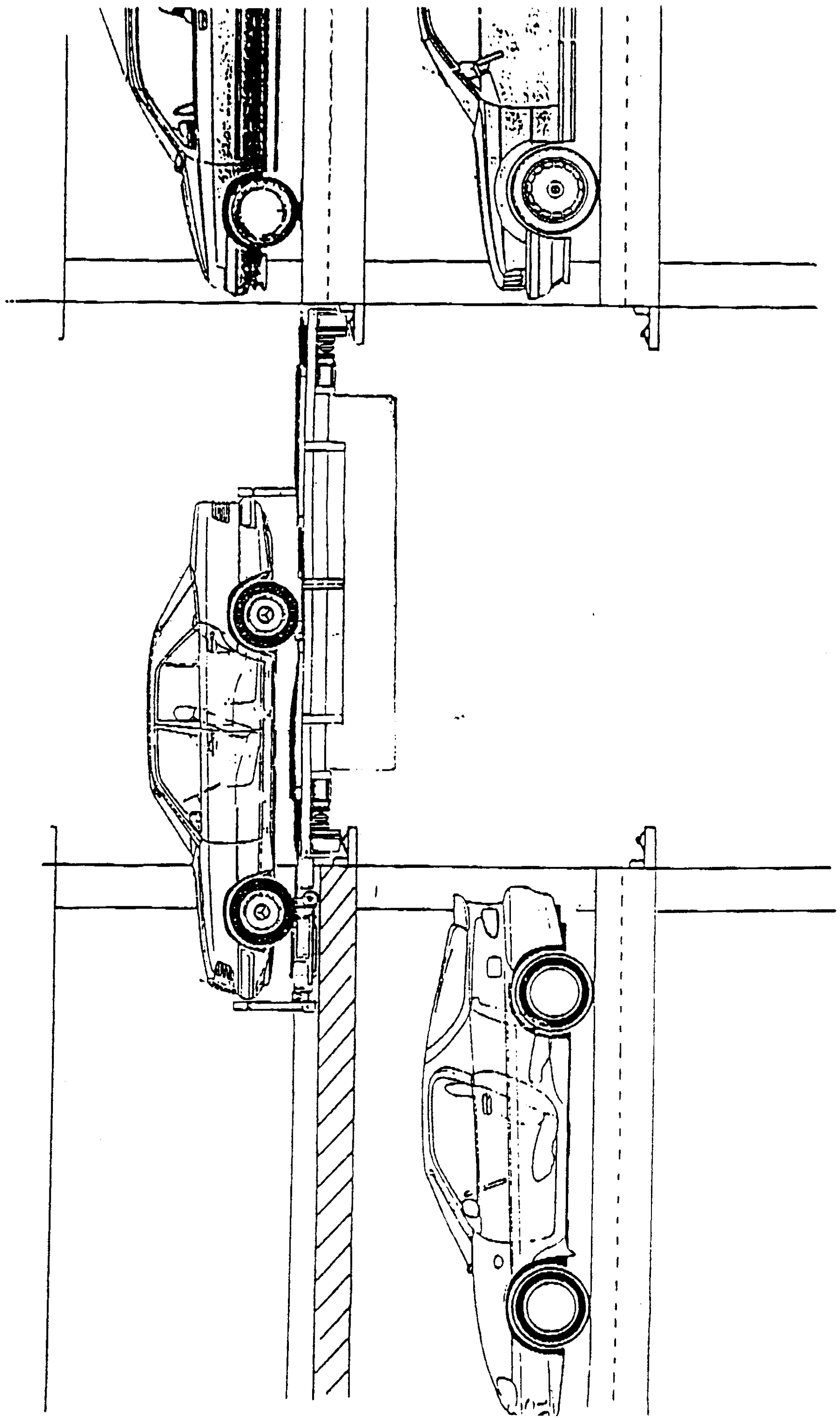

***Figure 6**: The Robot Shuttle Pushing a Car in a Spot*[11].

Since queuing is a deterministic factor for the acceptability of an automated parking system, it is essential for all these maneuvers to be performed as rapidly as technically conceivable (refer to Section 4.2). Meanwhile, since such system necessitates high maintenance, SARAH Co. had also to be concerned with reliability and durability. SCHNEIDER's line of products seem to best fulfill these requirements. This German company has become one of Europe's leaders in household appliances and industrial apparatus. It provides SARAH Co. with all the mechanical devices, including, elevators which have a 3700 kg load capacity and are capable of a top-speed of 1.6 m/s with an acceleration of 0.7 m/s2. Speed also being essential for the robot carrier and the robot shuttle, they have top-speeds of 5 and 1m/s respectively, with an acceleration of 1 m/s2 for both.

The entire system is run by a central computer, which will be discussed in detail in Section 3.3. However, for safety's sake, one employee manages the step sequencing from a control booth. Every floor, and entrance and exit chambers, are monitored surveillance cameras. Moreover, the employee can communicate verbaly with the driver; this measure handles emergency cases as well as prevents the user from leaving a person on board the car, forgetting the hand-break on, or leaving a gear engaged.

There are numerous devices that emphasize safety such as a generator in case of power shut-down, infra-red lasers to calibrate the exact dimensions of the vehicle, security barriers, etc...(refer to Appendix 1).

The ticket handler at the entrance chamber has many features. It distributes tickets with a magnetic code bar which carries information. For example, the user is asked to input a two digit code in order to prevent any thief from retrieving the car in case the owner's magnetic ticket is stolen. Moreover, such data as the time and date of arrival, paid, unpaid, etc., are also stored on the ticket. Payments are performed at automatic tellers that accept subscriber cards as well as cash or credit cards. Once the ticket is paid, the car will be retrieved automatically.

APMS's infrastructure is quite simple to assemble because all the parts are put into gear together (similarly to "Lego" toys [12]), and the characteristics of the concrete work are tailored to match the mechanism's requirements. Installment of the entire system, including additional concreting, is estimated to take about 5 months for a 500 car parking lot.

SECTION 3.3

COMPUTER AIDED ROBOTICS

SARAH Co. outsources all the computer programming as well as the manufacturing of the robots to the French group MATRA. This group is one of the European leaders in the high tech industry [13]. It has a large market share in the military (missiles, electronics, detection systems, and nuclear heads) as well as in aerospace (satellites, and Ariane space shuttle program). For the past 25 years, this group has devoted a great deal of research to robots with artificial intelligence. It first started developing robots for nuclear submarines which would interchange the missile head in accordance to the target. Then, MATRA applied this technology to a civilian application with the collaboration of Renault (the French automobile maker). The program was to develop cars which would not need a driver for any origin-destination.

The collaboration between MATRA and SARAH started in 1983. The goal was to adapt this technology to robots that would have the task of parking cars. It is only since 1992 that the R&D has come to an end, and the first test model will be operational in june 15, 1994. Section 3.2 described the functions assigned to these robots.

Sophisticated software coordinates and manages the overall decision making of the parking system with individual robots. It also supervises the interactions among all the units. Moreover, each robot acts independently and controls its own movements as well as makes decisions on its hierarchical level. All this, of course, is supervised by a central computer for safety.

SARAH's concept is incredibly flexible because all the robots work in parallel and interact with each other. Therefore, one can install as many robots as demand requires. The company advises one robot for every 100 parking spaces[12]. Less than 75 spaces per robot would create internal congestion problems and more than 150 might create queuing problems during peak demand. In addition, you can add or remove robots to match demand if it is seasonal (as at a tourist location). Each robot has an internal scanning to check for possible errors. If any misfunction or defect is detected, a back-up processor will take over command of the robot and take it out of service. There is only 0.001% chances of both processors failing[13], and if that were the case, the central computer would shut it down and send another robot to take it out of service.

As stated before, each robot is fire resistant for 20 minutes and is equipped with a sophisticated ionic detector that allows it to notice a fire even before real flames appear. Hence, if a car was burning, it would first prevent other cars from catching fire by spraying CO_2 gas, then it would take the car to a fire proof room (one on each floor) where it would be sprinkled with an extinguisher.

The management system of APMS parking has remarkably flexible features. For instance, since the robots measure the dimensions of the car, it can perform a selection by size. In other words, one can assign a floor or a section of the parking for larger or higher cars.

Moreover, it takes more time to process a car to a pre-assigned space on the fifth floor than on the second. The management system makes use of this characteristic to level down waiting time during peak demand. For example if, on one hand, a car arrives within an off-peak period, it will be assigned to a space which requires a longer processing time. If, on the other hand, it arrives during a peak period, it will be assigned to a space near the entrance and exit chamber.

The system further emphasizes alleviating queuing congestion during peak demand. Indeed, the central computer recognizes cars which have been left for a long period of time and reorganizes them in order to free nearby spaces. Hence, these cars are removed and placed in spaces that are more remote and require greater processing time.

The management system can operate according to a checker configuration (Figure 7). Therefore, before retrieving the car assigned in space 1, the robot has to move the car in space 2 to a free space (for instance space 3), then it can proceed. This enables the APMS to be very flexible in shape and accommodate any site contour as shown in Figure 8.

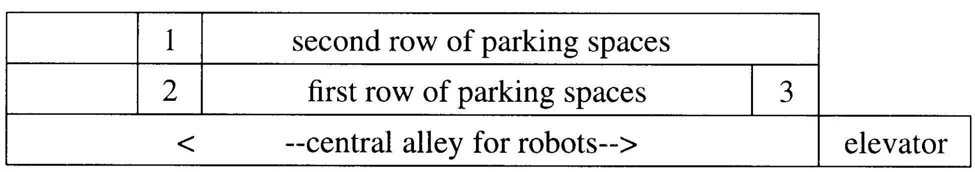

***Figure** 7: Checker Configuration For Parking Spaces.*

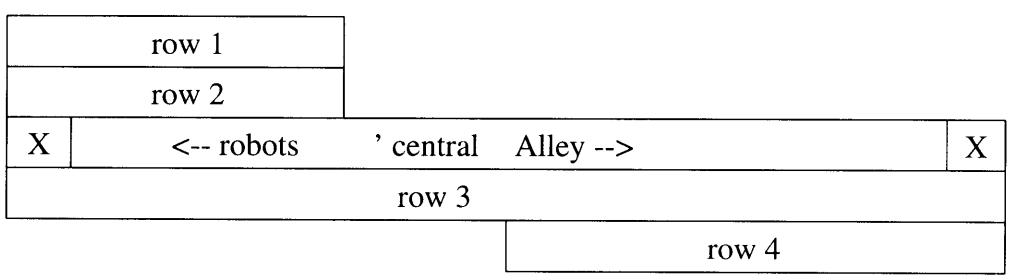

***Figure** 8: Example of Parking Configuration (elevators=X)*

SECTION 3.4

DIMENSIONS AND COST

• Dimensions.

The APMS is extremely compact compared to conventional parking systems. There are several reasons for that. First, there is no space lost to access ramps and long alleys. Second, conventional parking facilities have to allow for space for a driver's maneuvers, which in the case of the APMS, is not required since all operations are made by robots. Moreover, these robots serve perfectly on any site because of their translation movements in the x and y-direction. Third, as explained in Section 3.3, the APMS is very flexible and can efficiently accommodate any site by using previously unusable land. Fourth, all the dimensions of the vehicle are known by both the robots and the central computer. This characteristic allows the system to place cars 7 cm. apart from each other[14]. For conventional parking systems, cars are placed 90 cm. apart to allow exiting and entering from the vehicle[14]. Fifth, since only qualified personnel can enter the APMS, The parking design does not have to account for people's height. Some floors will have 170 cm. in ceiling height and others 190 cm. for higher cars[15]. In the case of conventional parking, 200 cm is standard[16].

As a result of these factors, APMS is very compact and uses volume efficiently. For instance, it necessitates only 60 cubic meters per space for a mid-size parking with a capacity of 500 cars. A similar conventional garage requires 100 m3 per space[17]. Therefore, APMS reduces the excavation volume by 40% and implicitly reduces concrete volume by 30% [18].

Moreover, the APMS compactness is also characterized by a smaller land surface. Indeed, to build a mid-size parking project, one only needs a site of 1000 square meters [19]. Whereas for a conventional parking, a site of 2,500 m2 is needed [20].

It was demonstrated in Section 3.3 how little constraints APMS imposes on land acquisition. The only constraints are the width of the rows of parking spaces and the central alley (6 m.), and the dimensions of the elevators (6 by 4 m.)(refer to Figure 8).

- **Cost.**

Again, because of APMS compactness, the project would need 30% less concrete volume and 40% less excavation volume than traditional structures. Hence, compared to a conventional parking project, the cost of the concrete work is significantly reduced. In addition, since only qualified personnel can enter the parking structure, there is no need for aesthetic work on the concrete walls and columns. Therefore, the concrete can be left in its unfinished stage which results in further savings.

If we consider a specific mid-size parking project with a capacity of 500 cars and we assume that we have a land of 30 m. by 40 m. In such a case, the best APMS configuration is shown in Figure 9. It would have 4 rows of parking spaces in a "checker pattern" and two elevators at each end of the central alley.

	ROW 1	
	ROW 2	
X	<---Central alley--->	X
	ROW 3	
	ROW 4	

***Figure 9**: APMS Configuration that Would Best Fit a 30 by 40 m. land.*

With these given dimensions, it would accommodate 84 cars per floor, and therefore it would have to be 6 levels underground. Whereas a conventional parking of the same size would require a surface of 2,500 m2 and would be 4 levels underground. Table 1 shows a concrete work cost comparison between the APMS of 1,200 m2 and conventional parking of 2,500 m2.

APMS			
CONCRETE	VOLUME	$/m3	COST
Slurry Walls	1800 m3	$200	$360,000
Excavation	14,000 m3	$10	$140,000
Slabs	900 m3	$500	$450,000
Miscellaneous			$75,000
Concrete	finishing		$0.00
CONCRETE	TOTAL	COST	$1,025,000

Conventional			Parking
CONCRETE	VOLUME	$/m3	COST
Slurry Walls	2600 m3	$200	$520,000
Excavation	22,500 m3	$10	$225,000
Slabs	1900 m3	$500	$950,000
Miscellaneous			$60,000
Concrete	finishing		$120,000
CONCRETE	TOTAL	COST	$1,875,000

***Table 1** : Project cost at completion*[21].

For this specific case, the total cost for concrete work is $1,025,000 for the APMS project and $1,875,000 for the conventional parking. To these figures one has to add the cost of the parking mechanism and the cost of land.

The combined cost of the mechanical installation and the electronics comes out to $7,000 per space for a parking with a capacity ranging from 400 to 600 cars [21]. Hence, in the case of the APMS, there is an additional cost of $3,500,000 for the mechanism.

Let us take into consideration the cost of land in highly urbanized areas such as business districts. For instance, in central Beirut, a constructible square meter is sold at $3,000[22]. Since conventional parking requires 2,500 m2, one would have to add $7,500,000 of cost for land. Whereas the APMS only requires 1,200 m2 resulting only an additional cost of $3,600,000 for land. Therefore, the total cost of the project using the APMS is $8,125,000, and that of the conventional parking is $9,375,000. In conclusion, implementing the APMS in Beirut would result in $1,250,000 of savings.

Let us take a more extreme case where land is very expensive: Monaco, where it is common to pay $8,000 per square meter [23]. In this case, total cost using APMS is $14,125,000, and that of the conventional parking is $21,875,000. Here, implementing the APMS in Monaco would result in a considerable saving of $7,750,000.

SECTION 3.5

OPERATION PHASES

• Entrance and exit of a vehicle.

When the owner brings his car to the entrance of the APMS, the entrance chambers are closed and a red light signals if they are already occupied by another user. The waiting time depends on how long it takes the occupants of the previous car to step out of their vehicle and leave the chamber.

As soon as a car in the entrance chamber is processed, the signal changes to orange for a short time. When the chamber is available, the access door rises and the signal becomes green. An LCD screen situated at the end of the chamber announces the following message:

"MOVE FORWARD"

The driver moves his vehicle forward and engages the wheels in U-guides (similar to those found in most car wash). A sound and a blinking visual alarm signal any "outflanking" of the car. Then the LCD screen will clearly indicate the cause of the alarm and will ask for a remedy. In case of non-compliance with the instructions, the driver would be held responsible. Hence, any resultant damage would be at his cost.

The driver moves his car forward until the message "MOVE FORWARD" is turned-off. The door to the entrance chamber closes and the exterior signal turns to red for the next car. Then, the following messages appear on the LCD screen:

M1 "Stop the engine"

M2 "Release handbreak"

M3 "Make sure you are in neutral"

M4 "Align the wheels with the car. Leave the steering in straight position"

M5 "Do not forget anybody in the vehicle"

M6 "Present yourself at the ticket handler"

"Take your ticket and punch in your secret code #"

These operations trigger several verifications from the system:

A hydraulic jack, equipped with an effort limitator, pushes the car for a distance of 20 to 30 cm. A sound alarm and M2, M3 and/or M4 will appear on the LCD screen if the car's resistance to movements is too great. Moreover, the employee in the control booth will be alerted and the surveillance cameras of the chamber are activated. The control screen will automatically show images from the appropriate chamber and a microphone will transmit the sounds. Then, the employee verifies that nobody remained on board and that the engine is shut-off. He can eventually communicate with the user as well as manually trigger messages M1, M5 and or M6.

After the exit of all occupants, by pressing on a button, he authorizes the system to process the car.

CHAPTER IV

COMPARISON OF APMS AND CONVENTIONAL PARKING

SECTION 4.1

COMPETITIVE ADVANTAGES OF APMS

The APMS system has many benefits compared to conventional parking systems. The advantages are as follows:

No existing parking system offers better packing efficiency. Wasted space is minimized to the highest extent since it requires only 60 m3 per car, while a regular parking lot requires at least 100 m3 per car [17]. This high packing efficiency is due to the fact that no space is lost for ramps, corridors, and maneuvering of the driver.

The compactness of the system leads to another advantage: construction cost. Not only is the excavation volume smaller by 30%, but the total volume of concrete used is also considerably lower, 2,700 m3 for APMS and 4,500 m3 for a conventional parking (as discussed in Section 3.4). In addition, the repetitiveness of the construcion allows standard lines of production to be used for prefabricated elements. Moreover, workers perform specialized tasks which enhances the learning effect and increases productivity. Therefore the construction completion time and its corresponding total cost is lower. From Section 3.4, the APMS is estimated to require an investment in the construction process of $1,025,000 whereas a conventional garage of that size would have a budgeted cost of $1,875,000.

Moreover, the project final cost is highly dependent on the cost of the land. This is where APMS clearly differentiates itself from other systems. It requires only a land surface of 1,000 m2, that is to say 25 by 40 m. An equivalent 500 car standard underground garage would have a minimum construction cost dictated by the need to have 4 floors [20]. This would require at least 2,500 m2 of land, for instance, more than twice that for APMS. Since land is scarce, hence expensive in a metropolis' central districts, this factor can play a key role in determining the required budget. As already discussed in Section 3.4, the figures of $14,125,000 and $21,875,000 for the specific case of Monaco, clearly emphasize that argument.

Two other advantages, one inducing the other, are a consequence of the fact that little land is required to implement the APMS system. First, its feasibility in densely developed areas is much greater than that of a regular garage, since probabilities of finding small exploitable land is greater, and also since the system is so flexible. The facility can have 300 parking spaces or even 3,000; it would just require more floors and different computer data inputs. Second, users' walking distance to their destination of interest is reduced because it is possible to implement this system in downtown areas. Therefore, they would be willing to pay a higher price for parking their vehicle.

Not only is APMS flexible in size, it is also very flexible in shape, and thus can accommodate any site considerably reducing unused surface. This characteristic increases the probability of finding a feasible site in central districts. Furthermore, the system's processing capacity is flexible because one can add or remove robots in order to match seasonal demand changes.

In addition, the management system is proactive through adapting its organization to the cyclical character of demand. This is done by interchanging and removing cars, assigning parking spaces according to the periods of arrival, and shifting emphasis on processing cars that arrive with cars that leave.

Above-ground parking represents no competition for APMS mainly for four reasons. In the first place, it requires a larger land area which induces higher fixed costs. In addition, the financial feasibility of contracting a facility above the parking lot is much lower than for an underground system since above ground space is already used, hence inducing lost earnings. Moreover, the presence of an APMS parking lot in a central district will induce value added to the land. Second, underground garage structures are environmentally friendlier; they do not obstruct views or pollute aesthetically.

APMS stresses security because it is a closed structure monitored by cameras, and inaccessible to people except for responsible personnel; therefore, risks of mugging or car theft are practically non-existent. One can safely leave cars unlocked, convertibles uncovered, and valuable objects in sight, without having to worry. APMS acts like a safe, the only way to retrieve your car would be to have your parking ticket and know the secret code you assigned on its magnetic band.

The system is made in such way that, if somebody steals your ticket and tries to enter different numbers, the control booth will be alerted after 3 trials. Then, the employee can compare the appearance of driver who brought the car with the one who wants to retrieve it. This is possible because, for each car entering the APMS, five different angle pictures of the vehicle and a picture of the driver are stored in a data base. This also enables the company running the system to keep track of the condition of each car entering the system, and therefore uncover fraud claims about "so-called" inflicted damages.

Cars are not exposed to any dust or corrosion damage since engines are turned off before entering the high speed elevators. Hence, they will remain clean and won't be covered by the black dust usually found in conventional parkings. In addition, SARAH is currently trying to adapt a car wash into the system. This will increase the propensity of the user to utilize APMS because he will be able to have his vehicle cleaned during its storage, according to different washing-programs.

The fire safety technology has already been described in Section 3.3. It is very advantageous because it allows robots to detect fires even before any appearance of flames, and to bring the car into an isolation chamber where it will be extinguished. Thus, other cars wont be harmed, whereas, in a conventional parking, all cars are sprinkled by a highly corrosive extinguishing liquid.

Another advantage the system provides is that parking procedures do not require any maneuvering from a driver. This aspect is very convenient for old people and for novice drivers who are not comfortable with car manipulations.

Prestige associated with technology concludes APMS' advantages. Most people are very fond of highly technological apparatus; they are synonyms of progress which, in the eye of the general public, does not really prevail either in the construction or in the parking industry. Therefore, this technological differentiation might provide people using cars with the incentive to choose APMS over other systems.

SECTION 4.2

DISADVANTAGES OF APMS

There are two major disadvantages to the APMS parking system: queuing during peak usage and maintenance.

Delay may occur during peak hours because each elevator can process only one car at a time. However SARAH Co. has stressed reducing access time by minimizing durations wherever possible. Furthermore, duration of processing will depend on many factors such as number of elevators and robots, as well as configuration and size of the parking. The computation of waiting time is very complex and utilizes advanced queuing theory. Table 2 provides a description of mean durations for a specific parking facility of 500 spaces and 2 elevators.

RPMS STEPS	MIN. TIME	MAX . TIME	MEAN TIME
Initial Manoeuvres	15 s	15 s	15 s
Elevator (loaded)	0 s	17 s	8 s
Central alley	2 s	20 s	10 s
Robot unloading	5 s	5 s	5 s
TOTAL	22 s	57 s	38 s

***Table 2 :** Detailed Durations of a Specific APMS Parking* [24].

Queuing diagram: {_______15 s_______}{ 8 s }{ 10 s }{5 s}
{_______15 s_______}{ 8 s }{ 10 s }{ 5s}
{_______15 s_______}{. . .

The above queuing diagram is a simplification of reality and shows that the system will perform certain steps in parallel. For example, if 5 cars come in a 30 second period, the last driver would have to wait 1 minute and 32 seconds[25]. A worst case would be 10 cars in a 10 seconds period. Then the last driver would have to wait 2 minutes and 18 seconds[25]. These delays might decrease the driver's propensity to use the APMS garage. However, the waiting time is not significantly large. Furthermore, in the case of a conventional parking with 10 cars arriving within 10 seconds, one can expect each car to use 7 seconds. to get a ticket. This would lead to a 1 minute wait anyway.

Maintenance is the second major problem of the APMS. Certain elements will undergo wear since there are many mechanical moving parts, and therefore will need monitoring and replacement in case of breakdown. However, all mechanical devices are quite simple and do not require specialized labor from SCHNEIDER. Moreover, in case a robot malfunctions, it will remove itself or be removed by another one and then replaced. In addition, it is strongly advised to opt for a parking configuration with more than one elevator in order to prevent complete jamming of the system.

SECTION 4.3

BRIEF APPRAISAL OF THE COMPARISON

An overall comparison of APMS advantages and disadvantages leads to the conclusion that it generally outcompetes other existing conventional parking system for densely developed areas such as central districts of metropolis.

Drawbacks like higher running cost due to maintenance are counterbalanced by lower total project cost at completion. Moreover, we have demonstrated that this new generation parking system can perform several tasks in parallel and does not obey by sequential steps. Therefore, queuing is not a critical issue anymore.

It is obvious, from Sections 4.1 and 4.2, that APMS should be implemented in cases where it enjoys a competitive advantage. There would be no point in constructing such a system in a suburb where land is not scarce and expensive, and where people are not willing to pay high prices for a parking space.

It should be implemented in locations where there are no other alternatives, meaning, business districts, downtown areas, and even some old high income neighborhoods where only small pieces of land can be bought (eg, Backbay in Boston).

SECTION 4.4

A COMPARATIVE MEMORANDUM

This Section provides a comparative memorandum between the different types of parking systems: conventional, semi-automated, automated, and APMS. It is presented in a table format which is divided into the following categories:

- **Safety.**
- **Comfort of the user.**
- **Environment.**
- **Installation constraints.**
- **Management Constraints.**
- **Miscellaneous.**

The answers "**YES**" are not favorable while the answers "**NO**" are favorable.

SAFETY

A) OF THE PEOPLE	Conv-entional	Semi-autom.	Auto-matic	APMS
Presence of people in the parking	YES	YES	NO	NO
Presence of people during the processing	-	YES	YES/NO	NO
Damages due to maneuvering by drivers	YES	YES	NO	NO
Accidents due to malfunctioning of the system	-	YES	YES/NO	NO
Risks of fire due to turned-on engines	YES	YES	NO	NO
Risks of asphyxia due to exhaust gas	YES	YES	NO	NO
Risks of aggressions	YES	YES	NO	NO
Possibility for someone to penetrate the parking	YES	YES	NO	NO
B) OF THE VEHICLE AND GOODS				
Possibility to steal vehicles	YES	YES	NO	NO
Possibility to steal valuable objects in the cars	YES	YES	NO	NO
Possibility to damage vehicles	YES	YES	NO	NO
Possibility to vandalize the parking system	YES	YES	YES/NO	NO

COMFORT OF THE USER

	Conv-entional	Semi-autom.	Auto-matic	APMS
Inconvenience due to maneuvering of the car	YES	YES	NO	NO
Inconvenience due to the search for a parking space	YES	YES	NO	NO
Inconvenience due to waiting	YES	YES	YES/NO	NO
Inconvenience due to the search of one's vehicle	YES	YES	NO	NO
Inconvenience due to walking in the parking facility	YES	YES	NO	NO
Obligation to lock the doors of the car	YES	YES	NO	NO
Obligation to hide valuable objects	YES	YES	NO	NO
Nuisance due to pollution, noise, and odors.	YES	YES	NO	NO
Possibility of aggression in the parking facility	YES	YES	NO	NO
Possibility to leave people on board the vehicle	YES	YES	YES	NO
In case the parking ticket is lossed, will the user be penalized with the maximum duration	YES	YES	YES	NO

ENVIRONMENT

	Conv-entional	Semi-autom.	Auto-matic	APMS
Presence of exhaust pollution in the parking facility	YES	YES	NO	NO
Necessity to have fume extractor	YES	YES	NO	NO
Necessity to arrange the site according to parking infrastructure	YES	YES	YES	NO
Necessity to accomodate emergency exits	YES	YES	NO	NO
Impossibility to implement the system in central districts	YES	YES	YES	NO
Is it difficult or expensive to rearrange a conventional parking into an automated parking system?	-	YES	NO	NO
Limited number of entrants and exits during a period	NO	YES	YES	NO
Risks of queuing during peak usage	NO	YES	YES	NO
Necessity to close the facility at night for safety	YES	YES	YES	NO

INSTALLATION CONSTRAINTS

	Conv-entional	Semi-autom.	Auto-matic	APMS
Necessary surface for each vehicle greater than 15 m2	YES	YES	YES	NO
Necessary volume for each vehicle greater than 25 m3	YES	YES	YES	NO
Necessity to signal or materialize the location for each vehicle	NO	YES	YES	NO
Would a 45% reduction in slab surface area decrease the capacity of the parking facility	YES	YES	YES	NO
Would a 50% reduction in total volume decrease the capacity of the parking facility	YES	YES	YES/NO	NO
Cost of concrete finishing represents more than 10% of total project cost	YES	YES	NO	NO
Necessity to use concrete slabs	YES	YES	YES/NO	NO
Conception of the parking is dependent on the site	YES	YES	YES	NO
The number of parking spaces is limited by the system	YES	YES	YES/NO	NO

MANAGEMENT CONSTRAINTS

	Conv-entional	Semi-autom.	Auto-matic	APMS
Necessity to have more than one employee	NO	YES	YES/NO	NO
Necessity to have police surveillance for safety	YES	YES	NO	NO
Necessity to have a maintenance team	NO	YES	YES	YES
Necessity to repaint the signage every 5 years	YES	YES	NO	NO
Necessity to close the parking in case of break-down	-	YES	YES	NO

MISCELLANEOUS

	Conv- entional	Semi- autom.	Auto- matic	APMS
Access ramps	YES	YES	NO	NO
The vehicles are carried mechanically	-	YES	YES	NO
The system requires a specific infrastructure	-	YES	YES	NO
The system is sequential	-	YES	YES	NO
Sensors are necessary in the concrete structure	-	YES	YES	NO
Impossibility to move several vehicles in the same space and at the same time	NO	YES	YES	NO
Impossibility to use a "checker" configuration	YES	YES	YES	NO
The system utilizes synchronized mechanisms	-	YES	YES	NO
Is it necessary to light the interior of the parking	YES	YES	NO	NO

CHAPTER V

STRATEGIC BUSINESS

PLANNING FOR THE APMS

SECTION 5.1

PURPOSE AND SCOPE OF THE BUSINESS PLAN

Purpose:

In most cases a business plan is a document written to raise money for a growing company. It can dramatically increase the chances of success in business. The most popular types are written for entrepreneurial firms seeking a private placement of funds from venture capital sources. "No business is too small for a business plan. If you are starting a business, it will help you define your concept, evaluate the competition, estimate your costs, predict your sales, and determine your risks"[26]. Anyone of the following reasons can justify the time and energy required to write an effective business plan:

- To raise venture capital.
- To determine if a new business is feasible or desirable.
- To analyze the existing business.
- To learn about your industry and competition.
- To develop a detailed marketing and operation plan.
- To establish milestones.
- To define agreements between partners.
- To set and keep goals.
- To keep the vision in your business.

Though no two business plans are alike, most follow a tested formula that includes most or all of the elements in the following outline:

1. **Executive summary.**
2. **Company analysis.**
3. **Product analysis.**
4. **Market analysis.**
5. **Strategic plan.**
6. **Management profile.**
7. **Financial analysis.**

The entrepreneur's job is to demonstrate his success in a way that a venture capitalist will understand it. That's why the seven step process is so important. By striking just the right balance between patience and persistence, it may not make the process of raising capital any easier, but it will make it more efficient.

Scope:

Prospecting is one of the hardest part of preparing a business plan. As much as 50% of your time should be spent on prospecting. One of the biggest mistake an entrepreneur can make is to write a very good plan and spend his time presenting it to the wrong venture sources. Not only do you have to match yourself to your business, you have to match your business to your financial source. The process of prospecting venture capital will be described in detail in Chapter 5.4: Marketing Strategy.

It is essential to set the scope of the prospecting process. One has to define which investors would have the propensity to invest in a parking project utilizing SARAH's system. Moreover, it is important for the company to perform a selection among these potential investors according to its own interest. For instance, if the company is just entering the market, it might be wise, at first, to target short-run expansion and thus consider one time investors. Whereas, if the company has proven itself to have reliable products and services, it might consider targeting long-run expansion through funds from repeat investors.

The scope of the prospecting effort should be extensive, hence, very broad so as to include all sectors with potential capital such as private initiatives, banks, public departments, etc... Moreover, most large metropolis have a developed real estate economy with numerous entrepreneurs and real estate promoters. These men/women would most probably show interest in the construction, in the downtown areas, of a parking facility which would allow a complex to be built on top of the garage. Furthermore, they have been in real estate business for a while, thus opening doors to building strong connections with bankers and other private investors.

SECTION 5.2

ESTIMATING PARKING DEMAND

In order to attract venture capital investors, the company must show that there is a demand for its services or products. This is difficult to achieve with respect to parking but necessary because it will determine two important issues: first, the size of the parking facility and therefore the total cost of the project (described in Section 3.4); second, the pricing strategy in order to obtain an interesting turn-over ratio in the eye of venture capitalists.

Estimating the demand for parking spaces is a critical process in promoting the development of a parking facility. Unfortunately, parking demand estimation is complex and can become a time-consuming process if done properly. In most cases, very accurate forecasts are neither justified nor economical. Since the estimation process is so tedious, "magic"[6] factors are used by engineers as short-cuts in determining parking demand. However, the limitations of these factors are often ignored or misunderstood which generally leads to an overestimation of demand and leaves a huge portion of the structure virtually idle.

However, determining parking demand does not have to be a tedious process to provide accurate data nor sacrifice accuracy to provide quick results. What follows is a proposed methodology for estimating parking demand that balances the trade-offs between time and accuracy (refer to Figure 10).

4-3 Parking Demand Estimation Process

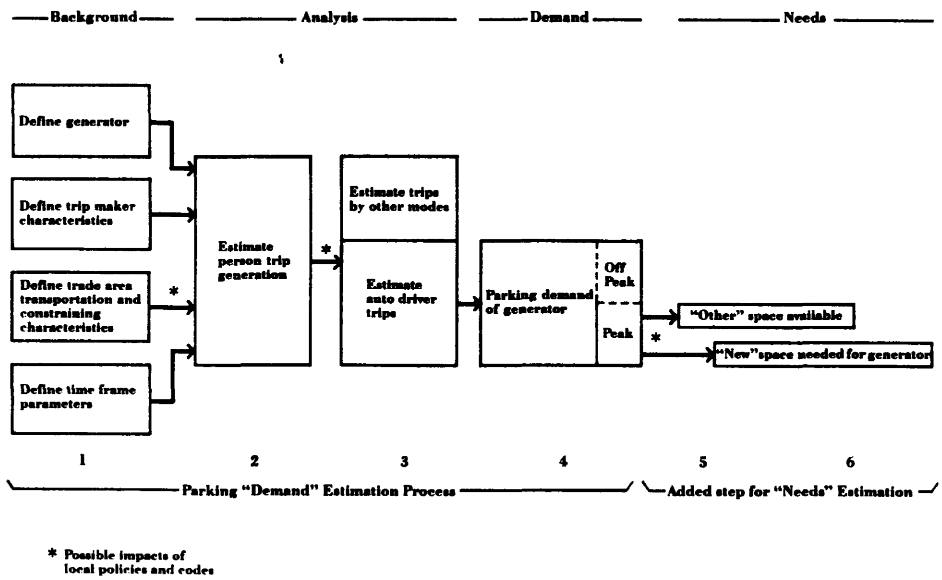

Figure 10: Diagram of Parking Demand Analysis [6].

Description of the steps in figure 1 :

i) Background.

<u>Generator :</u>

Generator stands for the projects or built facilities that generate parking demand, such as stores, office buildings, hospitals, recreational facilities, etc. The first step is to identify all the important generators existing at a certain distance from the prospective site. The second step is to group those generators by type and degree of influence which is inversely proportional to the distance from the site. The next step is to establish the size of each group of generators in terms of employees, square footage, seats, or other parameters in order to estimate the number of person-trips that would be attracted to the location of interest. Finally, one must evaluate the synergistic effects between the different groups.

Trip maker characteristics:

In some instances, characterisitics of the conceivable consumers such as income, willingness to pay, age, sex, and many others, may be significant factors in evaluating parking demand.

Trade area transportation:

It is essential to assess the degree of availability, attractiveness, and use of public transportation or any mode of travel that forecloses the need for parking within a site.

Constraining characteristics: it is necessary to review all local policies and codes that restrain parking availability or use. In conducting this research, the planner or engineer might find historical data of parking demand estimation made by other consultants. Those are generally left in libraries or archives of local departments of transportation. This kind of data will generally guide the efforts of the planner or engineer to tackle effectively local discrepancies that might exist when applying a general method to a specific problem.

Time frame parameters: One has to evaluate peak versus daily relationships, periodic (daily, monthly, seasonal) and non-periodic (long-term changes, abrupt changes) fluctuations, and expected future trends.

ii) Analysis

Estimate person-trip generation:

The planner or engineer should refer to the local departments of transportation (state or municipality) as sources of information for estimating person-trips. In most instances, it is helpful to divide the trips into work and non-work purposes. Depending on the area under investigation, the planner or engineer might find it appropriate to further carry on the subdivisions of trips. The time period of each count is twenty-four hours divided into generally three shifts of eight hours each. Again, depending on the area under investigation, the planner or engineer might find it appropriate to define another time period or to divide it differently.

Estimate trips by other modes:

A thorough assessment of the modal split figure is needed. In general, demand forecasting errors occur because of a subjective perception of the attractiveness of other modes of transport when compared to the car. This leads to a lower modal split value than in reality. Therefore, accuracy of this figure should be emphasized by the planner or engineer. Typically, the comparison of previous work and actual data is very helpful for enlightening the thinker about the possible errors and traps he might fall into.

Estimate auto driver trips:

The auto driver trips are obtained by subtracting all non-auto person trips from the total number of person-trips. At this stage, a common error is to mix all the numbers together. It is highly recommended to keep the figures subdivided into their appropriate trip types.

iii) Parking Demand.

Evaluate auto trips:

The number of car occupancy should be determined according to trip purposes. The number of auto-driver trips is then divided by the car occupancy to obtain the number of cars commuting to the investigated area. The general range according to trip purposes are: work-1.1 to 1.5; shopping-1.3 to 2.5; recreational trips-2.0 to 3.0.[7]

Evaluation off peak v/s peak parking:

The percent of total users parking at peak periods is estimated since it controls the number of parking spaces required. Appropriate local data should be used for making such estimates. Nevertheless, the following general ranges are satisfactory: employees of retail and office establishments-85 to 90% at peak; short term parkers and retail patrons-20 to 35% at peak.

Evaluate space demand:

A thorough investigation of the number of parking spaces available in the area should be done. The demand for new parking space is derived by subtracting the peak parking demand from the existing parking supply.

SECTION 5.3

MARKET ANALYSIS

In addition to an analysis of demand, a business plan must also address the nature, strength, and weaknesses of competitors. This is done through a structural analysis, or "environmental scanning", of the industry. There are few businesses that would not benefit from an in-depth market analysis. It enhance an understanding of the size of one's product market and of the forces that shape it.

The five forces analysis is a method developed by Michael Porter[27] to assess the state of competition in a given industry. This "industry structural analysis" is a framework that is divided into five primary forces; namely the threat of new entrants, the threat of substitute product, the bargaining power of buyers, the bargaining power of suppliers, and the rivalry among existing firms (refer to figure 11).

After accurately appraising the strength of each of these five forces, a firm can improve its competitive advantage by either positioning itself in the industry such as to minimize the effect of these forces, or the firm might choose to be aggressive thereby directly trying to shape the forces to its particular needs and advantages. By conducting a structural analysis of the existing parking industry, the following results were obtained:

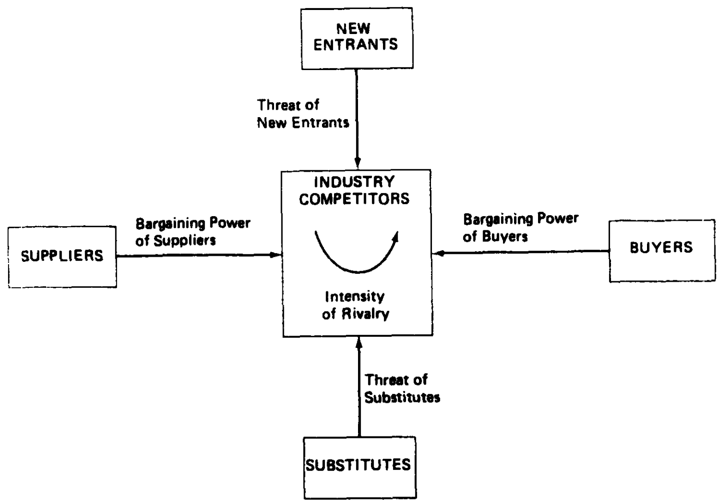

Figure 11: Forces Driving Industry Competition [27].

FORCE 1: Threat of New Entrants

The threat of new entrants is governed by two factors; the barriers to entry and the expected retaliation.

i) Barriers to entry: the capital requirements for entering the industry are high. In the first place, one has to rent or buy a piece of land, then construction can begin and will cost several million dollars[28]. The cash flow becomes positive no earlier than after completion of the parking's construction. Moreover, the cost disadvantages independent of scale, such as favorable location and learning curve effect, are substantial. Furthermore, government policies play a significant role in the parking industry. In some cities, where motorization is low and congestion is not a problem, parking structures are viewed as modernization and thus supported by politicians. Conversely, in metropolis where public transportation is ineffective or insufficient in responding to commuter demand, government policies tend to oblige developers to build parking structures as they build new projects. The extreme case is when a city is experiencing huge problems of congestion even though the public transportation system is very effective. In such cases, the local government generally imposes restrictions on parking facilities in order to decrease the inflow of cars in the city. All kind of policies are made to discourage investors from building parking garages even though they could be very profitable. In Cambridge for example, permits for new parking constructions are rarely issued.

On the other hand, economies of scale are practically non-existant in the parking industry, product differentiation and access to distribution channels are null; hence, it is possible to have new competitors entering the market, provided that they have a strong capital and that local policies give out permits for construction of parking facilities.

Therefore, barriers to entry can be assessed as medium to high.

ii) Expected retaliation: The parking industry is similar to the construction industry. It is primarily a fragmented industry and the information systems are technologically obsolete. Hence, the entry of a new competitor is likely to remain unnoticed for a long period of time. Even then, the lack of organization among existing firms will make it unlikely to have an adequate union in order to retaliate effectively against a new rival.

Therefore, expected retaliation can be assessed as low.

By averaging the intensity factors given to barrier to entry and to expected retaliation, One come to the conclusion that threat of new entrants can be given a medium to low magnitude in the overall industry structure.

FORCE 2: Threat of Substitute Product

The threat of substitute products results mainly from the propensity people have considering different available options before choosing. With the development of more effective and comfortable public transportation systems, the high price for parking places in cities, and the cost associated with running a car (gas, maintenance, accident risk...etc), people are becoming convinced not to use cars as a means of transportation. This is without stating the marketing effort that is going into improving the public transportation image, the government's parking policy tactics rendering car usage ultimately inconvenient, and the environmental awareness of car users. Moreover, with the continuing success of small cars, people are finding it convinient and more economical to use on-street parking.

Therefore, it can be safely stated that the threat of substitute products is increasingly gaining leverage and that as a result of all these factors, interested parties believe that this force will, in the far future, have a tremendous effect on the relative performance of the industry.

However, it will be a while before cars are replaced by public transportation because the latter is still far from being efficient and convenient. Hence, parking demand is expected to considerably increase in the medium-run.

FORCE 3: Bargaining Power of Buyers

The bargaining power of buyers in any industry is governed by two factors; the bargaining leverage and the price sensitivity.

i) The bargaining leverage: Generally, in large metropolis, the existing parking supply is much less than demand. Car drivers strive to locate a place to park near their destination. In the event that a parking is located nearby their destination, the buyer will be willing to pay high prices for a spot. As the distance increases, the bargaining leverage of the buyer increases accordingly.

Therefore, bargaining leverage can be assessed as low.

ii) The price sensitivity: Parking in a garage is often seen by car drivers as a luxury rather than a necessity. In fact, as high as the scarcity of parking places might be, on-street management tactics are often implemented to ensure a high turn over ratio. Therefore, if a car driver waits long enough, he will eventually find a place to park (albeit chance and providence play an outstanding role).

On the other hand, for some car drivers, security is a priority. Even though parking garages are not highly secure against theft, they are safer than on-street parking as violence persists in cities. These buyers lose their price sensitivity and are willing to pay for security especially when the car in question is in high demand on the black market.

In addition, two types of buyers are found in the parking industry; regular users and opportunity-based users. The regular users are the car drivers that commute daily to a place located nearby the parking. These users are further divided into two sub categories: the long-term and short-term users. The long-term users are those users who do not use their cars during the parking period, ie. they park their car, and only come back at the end of the period to take it. Generally, these people tend to have to use the public transportation system (if it is effective enough). The short-term users are those who need to make a lot of short trips during the parking period, ie. they spend their time taking the car and coming back to park it again. They make extensive use of the parking facility and are thus highly sensitive to the price they are charged.

The opportunity-based users are those who actually come to a place on a non-regular basis . These users are sensitive to the price and will generally leave their cars at the parking garage facility as a last resort after exhausting all other kinds of on-street parkings.

Therefore, price sensitivity can be assessed as medium.

From our analysis, it is easily seen that not much attention is given to drivers and that, overall, their bargaining power is low. This force can be shaped by using management tactics and pricing strategies aimed at the different groups of users. These strategies and tactics will be developed in part III of this thesis.

FORCE 4: Bargaining Power of Suppliers

The suppliers in the parking industry are represented by three main groups; the land owner, the contractor (for purposes of simplicity, this party is assumed to represent the engineering, construction, and architectural firm), and the local authority.

The land owner has a high bargaining power since generally the land is rare and the prices are high, especially in central districts. The cost of land is a major portion of the total cost of the project. Developers tend to reduce as much as possible the magnitude of the bargaining leverage of the land owners through tough negotiations. Unfortunately, conventional parking systems offer few options for shaping this force.

The contractor party has very low bargaining power. This is mainly due to the standardized parking design systems, very little concern for the architectural aspect, and the simple construction process. In addition, the construction industry being so fragmented, competition is fierce and therefore any developer can get a decent design constructed for a low price.

The local authority can be considered as a supplier to the extent that it provides the developers with the needed permits and regulations to start new projects. The magnitude of the local authority leverage depends on the city and on the willingness of the government to regulate the parking policies in the region. In general, local authorities exert much power through political leverage and little can be done to minimize it. Developers just learn to play by their rules.

Therefore, except where local regulations exist, the bargaining power of suppliers is assessed as having a medium magnitude.

FORCE 5: Intensity of Rivalry Among Existing Competitors

The rivalry among existing firms varies from one metropolis to another. For example, in Monaco, few firms are specialized in the parking industry[18]. Thus, the competition is practically non-existent. In Boston, firms are much more specialized in the parking industry (around 15[30]); hence, competition is more pronounced than in Monaco. However, generally the rivalry among existing firms can be assessed as low.

This is mainly due to the lack of differentiation or switching costs, non-existent brand identity, and stagnant market. Many firms are finding it more appealing to diversify into other lucrative businesses than to further invest in the parking business.

The industry has a slow market growth and firms generally hold a small market share (except in Monaco's case). Hence, according to the Boston Consulting Group market share growth matrix (refer to Figure 12), the parking business is a "dog" [31]. When found in such a position, firms divest or harvest the business. Unfortunately, exit barriers are quite high because you have to tear down the existing parking structure and build instead a higher income project or sell the parking lot at losses. This further accentuates the lack of incentive to competition within the industry.

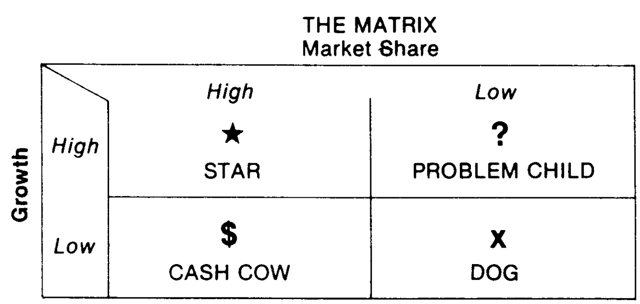

Figure 12: *The Boston Consulting Group's Growth Share Matrix* [31].

Table 3: *Wrap-up summary of the parking industry analysis.*

FORCES	MAGNITUDE
Threat of New Entrants	medium to low
Threat of Substitute Products	medium
Bargaining Power of Buyers	very low
Bargaining Power of Suppliers	medium/ high (if regulations)
Intensity of Internal Rivalry	low

Conclusions from Table 3:

The chances for new firms to enter the parking industry are medium because it would require a considerable capital and there are few pieces of land left to be built in central districts. However, since competition is, above all, dictated by land availability, there is little hostility among firms and thus toward new entrants. Moreover, substitutes, such as public transportation, are not convenient at the present time and thus are not threatening in the medium-run.

Despite the price sensitivity of drivers, their bargaining power is insignificant. This can be attributed to the fact that demand for parking spaces exceeds by far supply. Meanwhile, the parking industry has on the one hand, little leverage where parking restrictions are imposed, and on the other, tremendous leverage on subcontractors since competition is fierce in the construction industry.

The above market analysis leads to the following conclusion: the parking industry is very profitable and easy to enter if one can over come the problem of land availability.

SECTION 5.4

HOW THE APMS SHAPES MARKET FORCES

Introduction of the APMS technology in the parking industry will severely alter the market's environment and thus the five forces shaping it (discussed in Section 5.3). The effect on each of these forces will be appraised in this chapter and a summary of the changes will be provided at the end.

FORCE 1: Threat of New Entrants

The threat of new entrants is governed by the barriers to entry and expected retaliation.

The barriers to entry will increase mainly because product differentiation will be accentuated. In order to penetrate the industry, a firm must be capable of competing with this new high-tech product. Hence, a newcomer will have to develop a similar concept but with somewhat different technology since SARAH's system is a patented French technology. This increases the capital requirements for research and development. Furthermore, learning curve effects become increasingly important and the newcomer has to deal with well experienced competition in the field of high-tech.

The expected retaliation of existing companies will slightly increase since the new system will reduce their market share and thereby their profits. The only alternative they have is to lower fees which, in turn, might hurt their profit margin.

Therefore, the threat of new entrants decreases in magnitude and can be assessed as low.

FORCE 2: Threat of Substitute Product

The threat of substitute products gains in intensity as government tends to regulate parking in central districts to reduce congestion. However, in Regions where these regulations do not exist, the implementation of APMS might alleviate the difficulties and inconveniencies associated with conventional parking. Moreover, if pricing strategy is effectively elaborated, parking will become more attractive than it is in the present time thus lowering the threat of substitute products.

Although the above causal effects would eventually occur, the propensity of buyers to substitute will still prevail. Objectively, APMS will have a mild effect on this force on the long-run.

FORCE 3: Bargaining Power of Buyers

The bargaining power of buyers is governed by two factors; the bargaining leverage and the price sensitivity.

1) The introduction of APMS will have two opposite effects on the bargaining leverage of buyers. It will increase bargaining leverage because the product will be differentiated in some manner. Buyers have the ability of choosing whether to park in a conventional garage or in APMS. However, due to its numerous advantages, this increase will be beneficial to APMS.

On the other hand, APMS will decrease the bargaining leverage of the buyers. The characteristics of this new system and its advantages (described in Section 4.1) will make it more beneficial to the parker to use it instead of going to a conventional garage. Security, relative proximity to destination (because it can be implemented virtually everywhere), and less time wasted maneuvering to find an empty spot, are some advantages the system offers.

By carefully studying and implementing the appropriate strategy, the total effect of APMS' implementation will be a decrease in the bargaining leverage of buyers.

2) The price sensitivity of buyers is expected to decrease for the following reasons: First, the emphasize on safety is much higher, thus some buyers are willing to pay a premium. Second, corrosion damages, dust, falling objects, accidents -while the car is stopped, an unconscious driver bumps into your car and runs away (this happens a lot in congested areas of large metropolis), and vandalism acts are a succinct enumeration of the avoided contingencies when parking in an APMS garage. Furthermore, if the marketing promotion of the system is done effectively, some people will be willing to pay a premium when using the high-tech product. Others will find it "normal" to pay more when high-technology is involved.

As stated in Section 5.3, not much attention is paid to buyers and their bargaining power is very low. The effect of SARAH's system on the market will be perceived as an answer to the needs of buyers which have been ignored for a long time by the industry. On the other hand, the buyers' bargaining power may sink to a lower level. From the marketing point of view, this effect is very appreciated. The perceived reality of the buyers distracts them and makes them unconsciously lose their bargaining propensity. Therefore, increased profit margins are easily achieved.

FORCE 4: Bargaining Power of Suppliers

Referring to Section 5.3, the suppliers in the parking industry are the land owner, the contractor, and the local authority. For the APMS, a fourth supplier is introduced; the vendors of the mechanical elevator, the computerized system, and the automatic billing machine (for purposes of text alleviation, these vendors are considered as one).

The APMS reduces the land owner's power since the amount of land area needed for parking is now much less than before and thus more probable to be found in central districts. Also, strategic alliances are possible with the land owner since the above ground is still free for any kind of project.

The contractor's power increases again with the implementation of SARAH's system since more skilled construction techniques are needed. Also, the engineering firm's bargaining power increases because of difficult design procedures involved in assessing the terrain's underground characteristics. Even though the bargaining power of the contractor theoretically increases, its overall effect is diminished because of the fragmented construction and engineering industry and because the cost of the construction is small relatively to the total cost of an APMS project (refer to Table 1).

The local authority power is generally high in large cities. APMS effect on this force is of low impact if not completely null. Although little can be done to influence transportation policies, APMS offers considerable advantages from the construction perspective. In general, local authorities have tight policies on the maximum height of a structure (called "zoning policies"), and more freedom exists for the amount of underground "exploitation" by developers. Thus, where parking policies do not exist, APMS offers more economies of scale than conventional parking garages.

The vendor has a very high bargaining power. In a decreasing order of importance, the reasons for this high bargaining power are:

i) SARAH is not an important customer in the supplier group. The computer and robotic industry is a fast growing one with a huge market. The elevator industry is smaller than the previous two; nevertheless, it has a big market to serve and the system's mechanical devices are not a critical addition to its product chain.

ii) The supplier's industry does not compete with a large number of substitute products. The APMS requires very specific, highly specialized components to run effectively.

iii) The supplier group poses a credible threat of forward integration: if the APMS proves to be successful, and the vendor supplier aggressive enough, it should be easy to integrate downstream since the construction cost is a small portion of the total cost and the vendor could gain competitive advantage in the APMS industry by having lower initial costs due to the preferred transfer prices through the company's value system.

Therefore, the overall effect of the APMS is to increase substantially the bargaining power of the suppliers.

FORCE 5: Intensity of Rivalry Among Existing Competitors

This force was assessed a low magnitude in Chapter 5.3. The introduction of the APMS should accentuate the rivalry. The existing firms are expected to respond in two major modes: one mode of behavior will try to reduce the price of existing conventional parking so as to effectively compete with the APMS; the second mode of behavior will be to develop similar parking systems, implement them with lower initial cost and better advantages than SARAH's system.

Therefore, the APMS will increase the intensity of rivalry among existing firms only after a considerable number of vendors switch to similar automated garages. This will take time. Thus, at the beginning, the intensity of rivalry among existing competitors will be low and will exponentially increase with time (this is a characteristic of a first-mover advantage).

Table 4: *Wrap-up summary of the parking industry analysis after the introduction of RPMS*

FORCES	PREVIOUS MAGNITUDE	UPDATED MAGNITUDE
Threat of New Entrants	medium to low	low
Threat of Substitute Products	medium	medium to low
Bargaining Power of Buyers	very low	low
Bargaining Power of Suppliers	low or high (if regulations)	high
Intensity of Internal Rivalry	low	will increase with time

Conclusions from Table 4:

Introducing APMS in the parking industry will have several beneficial effects. First, it will be harder for new comers to enter the competition since R&D investments will become greater and since competitors will undergo a learning effect due to new technology. Second, Since APMS can be implemented in highly developed urban areas, it will decrease the bargaining leverage of the driver who will be willing to pay for better services. Third, threat of substitute products like public transportation will decrease since it will be more convenient to find parking spaces in central districts.

On the other hand, a company adopting APMS will have low bargaining leverage on SARAH, SCHNEIDER, and MATRA who are the exclusive suppliers of the system.

SECTION 5.5

MARKETING STRATEGY

SARAH's automated parking system utilizes new concepts of robotics, still unfamiliar to common drivers as well as parking experts. We have demonstrated that APMS, along with its numerous advantageous characteristics, has a strong potential for entering the parking industry and will most probably succeed financially. However, It is not enough to have a good product because it might stay unperceived or unnoticed. One has to back its production with a well planned marketing strategy to attract consumers' attention. This section will structure a marketing strategy toward venture capital investors as well as common drivers which, in our case, are consumers of services. But first let us define marketing:

Philip Kotler defines marketing as "... a social and managerial process by which individuals and groups obtain what they need and want through creating and exchanging products and value with others." Marketing is essential for any business for the following reasons.

First, Marketing represents the business function that identifies unfulfilled needs and wants, then defines and measures their magnitude. Second, it determines which target markets the organization can best serve. Third, it decides on appropriate products, services, and programs to serve these markets. "From a societal point of view, marketing is the link between a society's material requirements and its economic patterns of response"[32].

We demonstrated, in the previous chapter, the importance of defining the scope of prospecting venture capital investors. One need to know who the business plan is going to be addressed to, and from there, create a marketing strategy to catch the interest of these potential investors.

In a similar manner, it is essential to analyze and define the characteristics of the potential customer for an APMS project. One need to know who is going to use the parking in order to formulate also a marketing strategy towards trip makers.

Whenever a site or land appears to be technically feasible, one has to start investigating characteristics and behavior of nearby conceivable users to determine the financial feasibility. Walking distance to destination of interest, competing local parking facilities, likelihood of using local public transportation, driver's social rank, income, willingness to pay, etc, may be significant factors in evaluating parking demand as well as what marketing strategy to adopt. Moreover, determining the behavior and trend of these potential customers will provide important information on what type of marketing would reach their interests. What follows is a detailed procedure for an analyze of above mentioned issues.

- **Analyzing the marketing environment:**

The first step in structuring a marketing strategy is to analyze the company's marketing environment which "...consists of the external actors and forces that affect the company's ability to develop and maintain successful transactions and relationships with its target customers."[33] These actors and forces are shown in Figure 13.

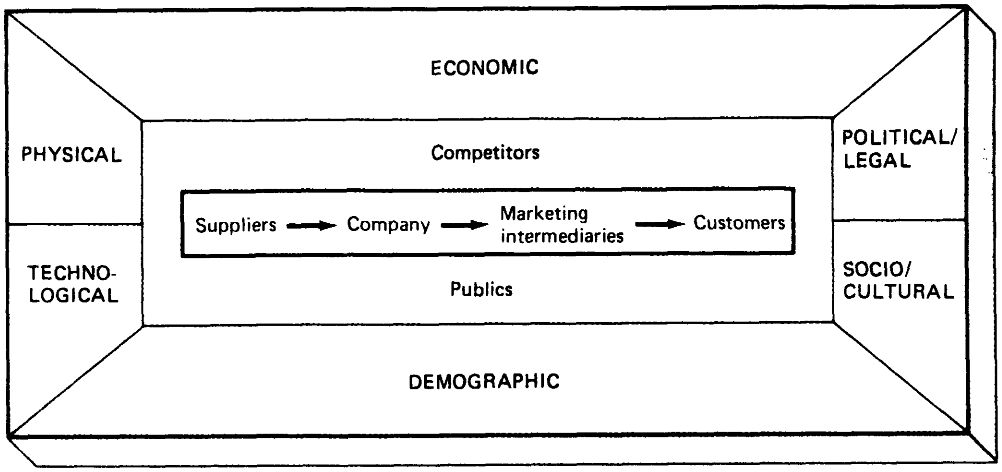

Figure 13: *Major Actors and Forces in the Company's Marketing Environment.*[33]

One has to define the potential actors for the APMS to better focus marketing. For instance, the suppliers are mainly venture investors since they provide the required capital for a parking project, and the customers are defined in the next paragraph. In the case of SARAH's product, the major marketing forces are as follow:

- Demographic, the parking will have a localized effect since customers are not willing to exceed a certain walking distance every day.
- Economic, the total purchasing power is a function of local incomes, prices, and living expenses.
- Technological, the company must define which technologies represent a threat to APMS in order to target their marketing effort.
- Social/cultural, it is important to understand the behavior of local people towards high-tech and try to shape their views through marketing (examined thoroughly in next paragraph).

• Analyzing buyer behavior:

Cultural factors, which can be subdivided into culture, subculture and social class, exert the broadest and deepest influence on consumer behavior. Then comes, in order of magnitude, social, personal, and psychological factors (Figure 14). One has to evaluate how these factors would influence buyer behavior before implementing an APMS in an area.

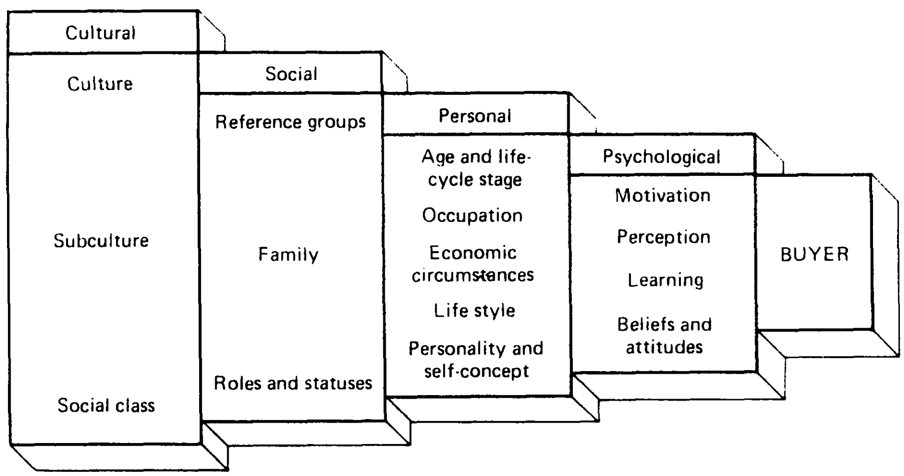

***Figure 14:** Detailed Model of Factors Influencing Behavior.*[34]

• Competitors marketing strategy:

The marketing strategy is virtually non-existent in the parking industry. Indeed very little concern is given to the marketing aspect because generally demand exceeds supply. In order to effectively promote our new product, marketing theories and applications should be used extensively and wisely.

The parking "product" has reached the stable maturity stage of its life cycle (Figure 15). This means that most potential consumers have tried the product, and future sales are governed by population growth. The introduction of APMS will push the conventional parking product to its decaying maturity, bringing it to the declining stage of its life cycle.

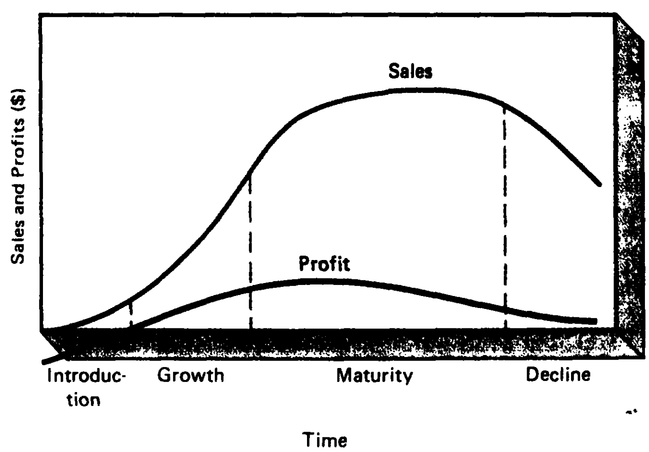

Figure 15: Product Life Cycle[34]

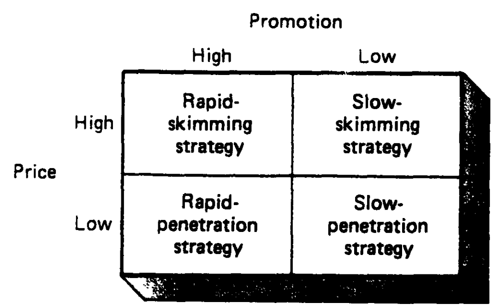

Figure 16: Introductory Marketing Strategies[34]

Four marketing strategies exist when launching a new product: rapid skimming, slow skimming, rapid penetration, and slow penetration strategies (refer to Figure 16). A modified version of the rapid penetration strategy is the most intelligent choice for SARAH. The rapid penetration strategy consists of launching at a low price and spending heavily on promotion. However, in the case of APMS, it is not necessary to charge low prices since demand exceeds by far supply. Indeed, people will be willing to pay a premium for the services and convenience provided by APMS. The reasons for the choice of this strategy are as follows:

i) The market is large: after the demand estimate, as formulated in Section 5.2, is done for a particular city or piece of land, the market need for APMS should be large or the project should be dropped because it will be financially uninteresting in the long run;

ii) the market is unaware of the product: generally, conventional parking lots are old and well known by the population. An APMS garage might remain unnoticed if there is not adequate promotion. Furthermore, being an underground parking lot with only the entrants and exits chambers apparent, does not help the product in advertising itself by mere visual location. All kinds of information technologies might be used to promote APMS. The traditional methods are to advertise in the local newspapers, send brochures to businesses located nearby, provide introductory offers, etc;

iii) most buyers are price sensitive: even though the price sensitivity is less than for conventional parking garages (discussed in Section 5.4), it still exists and should not be ignored. Different pricing strategy pricing are formulated in the following paragraphs.

iv) there is strong potential competition: if APMS proves to be successful, strong competition from suppliers -by forward integration- and companies switching from conventional systems should be expected (for more details, please refer to Section 5.4). Therefore, SARAH should try to get the largest market share at the beginning to retain a competitive advantage. This is referred to in the literature as the market pioneer "advantage";

v) learning curve effects are important: unit cost of production is expected to fall as manufacturing experience grows.

When implementing the rapid penetration strategy, promotion plays a crucial role to offset the lost earnings from charging a higher price. In order to effectively promote the "product" SARAH should conduct a marketing analysis of the product concept. Our suggestion is that top management at SARAH meet and perform brain storming to assess the generic, expected, augmented, and potential values of the product vis-a-vis customers.

Another crucial issue in the marketing is pricing. A different approach to the different clusters of users is recommended. The two main clusters of users defined in Section 5.3 are regular users and opportunity-based users.

A special plan for regular long-term users should be established to provide them with the incentives to use APMS, and therefore reduce their propensity to use other modes of transportation or conventional parking facilities. The short-term regular users might use APMS extensively during peak demand and cause queuing problems. If this is the case, these users should be charged a high price to reduce their number. On the other hand, if they do not cause queuing -either because of less entrance and exit operations, or because of their small number in comparison to the system's capacity-, they should be offered a similar pricing plan as the one for long-term regular users with an additional premium depending on the number of entrance and exit operations during that period (usually a day-shift).

For opportunity-based users, the meticulous marketing study performed previously will provide an evaluation and quantification in dollar amounts of the added values offered by APMS. Moreover, a price based on the size, type, make, or other pertaining factors can be established. The technology required to make this possible is available through the central computer processing software.

• Marketing high technology:

Technological developments and progress do not really prevail either in the construction or in the parking industry. This lack of dynamism is a consequence of an inbalance between the high cost of R&D and the low margin of profit associated with construction. Hence, the company's marketing mission must be to overcome the stagnant character of the industry.

APMS provides an answer to that problem through outsourcing technology, not only from within the construction industry, but also from other engineering firms which have a dynamic character. Introducing mechanical and computer technology has a synergistic effect by accenting progress in the field of parking system development.

The company's choice to be a first mover, in using advanced technology to respond to the parking need, is a well-thought-out move. Section 5.4 described in detail how APMS' use of technology alters Porter's five forces in the parking industry. Being a leader will provide the firm with a reputation as high technology pioneers which can be exploited to create a brand name. In addition, being a first mover, they have the opportunity to shape the way the parking market is defined in their favor. Moreover, this move will enable them to purchase land having the best feasibility at low cost, and therefore, bring about considerable earnings.

CHAPTER VI

CONCLUSION

As a general trend of centralization, metropolis have witnessed a great deal of urban development. These large cities have become poles of attraction for businesses because of the proximity and concentration of goods and services. However, since their infrastructure is old and already in place, it is difficult, if not impossible, to alter and update transportation networks which, in the long run, have become obsolete. Therefore, people find the incentives to use their cars as a means of transportation. This phenomenon has lead to the problem of increasing demand for parking spaces in central districts.

Since conventional parking systems require considerable land surfaces and do not make efficient use of volume, they are not appropriate for central districts where land is scarce and expensive. Experts realized the potential market induced by the schism between demand and supply in the parking industry. They triggered a great deal of research which led to the development of mechanical and automated parking systems.

Even though these new concepts alleviated many of the previously mentioned problems, they used sequential processes which were still not adequate for the cyclical character of parking demand. In addition, they were very expensive and could only be implemented in certain extreme cases. Thus, mechanical and automated systems responded only partially to the needs and problems encountered by people using their car as a means of transportation. It seemed clear that one had to explore new concepts.

The parking industry is entering a new era of technological progress through the adaptation of research and development accomplished in the field of robotics. SARAH was aware that artificially intelligent robots could work in parallel as independent entities, and therefore, overcome the sequential characteristic of former automated systems. This is a breakthrough because the concept of robotics can perfectly respond to cyclical variation between peak and off-peak demand.

The appraisal and comparison of the system clearly shows that the system offers numerous advantages. First, it has a very good packing efficiency. Second, It only requires a land surface of 1,000 m2. Third, it is very flexible in size and configuration which allows it to accommodate the contours of any site. Fourth, its technical feasible is greater in central districts since it imposes fewer constraints. Fifth, construction cost as well as total cost is lower where land is expensive. Sixth, it is very unlikely to have queuing during peak hours. And finally, the system stresses issues such as safety and ease of parking procedures.

The concept of adapting robotics in the parking industry has lot of potential for penetrating the market. Moreover, SARAH's system has a considerable marketing advantage because it is client oriented instead of owner oriented. In other words, its characteristics are tailored to perfectly match the need of the driver.

Municipalities and parking associations have tried to reduce cost through centralizing parking facilities in the suburban areas. The user would have to park far away from his final destination and walk or use public transportation for the remaining distance. This philosophy imposes constraints on the user and therefore is owner oriented.

APMS on the other hand is client oriented because it is meant to implemented in a network of mid-size parking facilities (400 to 1,000 spaces) which would cover the entire central business district. This decentralization would greatly reduce the walking distance of the user, and thus, increase his propensity to become a repeat-customer of the system.

APMS can be characterized as a highly technological system, which in the eye of the general public is synonym of progress. And since people in general seem to demonstrate a fascination for technology, the product and services will rapidly become appealing to the user, hence rendering the marketing effort easier.

SARAH enjoys a first mover advantage but lacks capital investments. It is important to attract venture investors for the following reason: Once the company has built-up a strong financial base, it can adopt a modified rapid penetration strategy which consists of launching at slightly above average price and spending heavily on promotion.

As it enters the market, competition will need time to react because of the learning curve effect and also because of the time consuming character of R & D. This lapse of time will allow the first mover to monopolize the scarce resources which, in our case, are central districts' land parcels that are feasible for an APMS project and demonstrate high turn-overs. At this point, competition will represent no threat because the best sites (resources streams) have already been bought, and the parking facility network can be implemented.

APMS is a good investment since it exploits a new market where demand exceeds by far supply and competition is virtually non-existent. However, the company has to pursue research and development in the field of robotics in order to maintain the first mover advantage.

APPENDIX 1

LIST OF DEVICES OF APMS

Entrance chamber:

-Control of presence by surveillance camera
-Phonic communication with the control boot
-Security barrier
-Calibrating barrier (infra-red laser)
-Opening and closing doors of the chamber
-Magnetic card reader
-Automatic teller for payments
-Hydrolic jack and effort limitator
-Visual screen and signalization lights
-Sound and visual alarms

Command computer material:

-Industrial PC
-Hertzien communication card
-Acoustic communication card
-Cables

Command electrical material:

-Electric box for general distribution of low tension
-Box for entrance chamber
-Box for exit chamber
-Emergency light
-Security light
-Electrical distribution trolley
-Cables

Video surveillance:

-1 supervision console
-2 control screens
-4 cameras
-1 speaker
-cables

Electric elevator:

-Engine 37 KW
-Poulie 700 mm
-Counterweight 200 kg
-Dampeners
-Plate-Form
-Guide + H maintainer
-Speed variator
-Position sensor

Transport shuttle:

-2 coupled synchrones engine 2x7 KW
-2 elevator controles
-2 electrical feeders
-The chassis
-Pulling system and the 4 rolling systems.
-Electrical trolley

Superior shuttle:

-Guidance and traction system, motorized by 2 synchrones of 1KW
-4 retractable lushers
-Engine with never-ending screw for retraction and ellongation of shuttle
-groups of metrologic cameras
-Automatic pilot with radio transmission.
-Enroller of feeding cables
-Extinguisher at each level
-Video surveillance at each level

Fire Security:

-Ionic smoke detectors
-Extinction rampes
-Smoke extractors
-Firemen access escalator
-Extinguishers at each level
-Video surveillance at each level

Miscellaneous equipments:

-Controled mechanical Ventilation

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