JULIO ARBESÚ

THE COMPUTERIZATION OF TRANSPORT

FORECAST AND PROPOSAL FOR 2050

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PROLOGUE

Human beings have always tried to know the future, although with little success. We have indications about what may happen within days and years; but the factors that affect history are so numerous, such unexpected and even improbable events may happen, that any forecast has to be prudent. In this book we will often affirm with emphatic future tenses, such as: "the new vehicles will be…", "the computerized transport network will manage…", "the new routes will have…" We write this way so as not to tire the reader with continuous calls for prudence. We wish to state that we are aware of the inherent limitations of any forecast about the future.

The first risk of the futurist researcher consists of letting oneself be influenced by ones desires: "I would like the future to be like this, therefore, it will be like this". This is a big mistake. The cord of history is woven as much with evil as with good. The episodes of sanity, peace, justice, freedom, prosperity, make their way amongst wars and abuses of all kinds with great difficulty. The wishes of any good willed person are not very often and only very partially fulfilled.

However, as far as technological development is concerned, starting off from an orderly principle seems feasible: "Since this technology is practical, effective and available it will be developed". Here we risk saying it, knowing full well that such a principle is also subject to distortion. Scientists do not form a separate world far from the influence of human passions. The eagerness for profit, power and prestige, motors of many human injustices, handles the threads of science and their applications with as much strength or more than the eagerness for knowledge and the interest in progress. In any case, the principle of order in technological progress in the last few centuries has demonstrated its validity over all types of wars and catastrophes.

We risk affirming that in the first fifty years of the 21st century the full computerization of land transport will be developed. And we also say that practical and effective systems and programs will be applied, although computer science is not synonymous with human rationality, far from it. The existence of viruses, released even

with no personal benefit to their creator, must make us reflect on the power of irrationality and its evolution in the computer era.

The computerization of transport often has the appearance of a utopia, that is to say, a vision much too attractive and ordered to be likely. The person who considers this is in his right. In any case, for centuries utopias have helped society to develop. But we, rather, have tried to start off from a set of very likely social trends, some of them positive and others with significant risks, and we have combined them prudently to draw realistic conclusions. Utopia or no, the readers will find a proposal that will help them to think and to make decisions.

"Free of roads", proclaims the title of the first chapter, with the appearance of a naive militant environmentalist. Tens of pages follow, with the aim of demonstrating that there is no such naivete, but rigorous study. This complex vision of land transport around the year 2050, at least for developed countries, consists of a set of more elementary forecasts:

- Transport will be gradually computerized in all its aspects, including the control of vehicles and the management of trips.
- The routes of passengers and those of merchandise will be separated in the majority of cases.
- Merchandise will generally be moved by underground conduits.
- The transport of passengers will be lightened so that there will be no vehicle of more than fifteen seats.
- The long-distance transport of passengers will circulate at high speed on routes raised with columns on a continuous bridge.
- Transport companies will supply their services having combined the data of the demand for trips requested through the computerized network.
- Public transport companies will solve the door-to-door concept from origin to destination for their users.

Combining all these points, which we will be explaining in detail, we arrive at the forecast of a world in which neither in the cities nor cutting through the fields will there be roads or train tracks generating a barrier of speed and continuous danger at

ground level. It is possible that around 2050 the first, developed country will be able to abolish high speed where it is in conflict with the level where human, animal and vegetable life develops. Every city street will be pedestrian; along them delivery vehicles or vehicles at the start or end of their trip will circulate at very low speed giving priority to pedestrians. The fast traffic of passengers, as has already been said, will generally go on columns and sometimes below the ground. That of merchandise will often use an underground level.

Incredible? More incredible things in 1900 were seen daily in 1950.

Unlikely? The technology is already available to reach this point. Social trends and scientific development are moving in this direction, as we will see.

The author isn't a specialist on transport systems, infrastructures, computer science or sociology. A subtle combination of his training as an economist, his long environmental militancy, his literary works, particularly those of a historical nature, his futurist research, his study of diverse means of transport, all this seasoning with a deep concern for mankind's destiny, lead him to the scenario here presented. In any case, to glimpse a detailed reality beyond the strong brightness that our here and now emits, what is necessary above all is a certain detachment, a great independence in the way of seeing and foreseeing things.

The author is not a prophet either. He knows that if he guesses a few aspects of his forecasts right, he will be satisfied, in the case he gets to see them happen.

This book mainly tries to spread the opinion that we are dedicating enormous efforts to invest in means of transport that have a huge ecological impact, and they are means that will soon be outdated. It is urgent that the people in charge of large public projects and the business initiative be abreast of the real possibilities of the transport of the near future.

CHAPTER 1
FREE OF ROADS

In the middle of the 21st century the previous century will be looked back on as a period marked by the intolerable danger of transport. In the same way a European imagines life in a village in a tropical forest conditioned by the continuous danger of serpents, poisonous spiders and insects that transmit awful diseases. It is done with a sense of under-development, and in this way an inhabitant of the future will conceive urban life at the end of 20th century. How can a family live in a street through which cars and trucks continuously pass with such speed that they will not have time to stop if a confused child crosses the road? In many towns and cities people have lived like this for decades, accepting a risk that costs too many lives. We have adapted to it, we consider that situation ordinary, we perceive a psychological barrier of great power between the pavement and the road. We teach our children the importance of that sort of magical barrier from their first years. How was it possible -they will ask in the future- that in the 20th century people got into high-speed vehicles with such huge probability of an accident that everybody knew relatives or well-known victims of traffic accidents? Well, it is possible, since it has happened and it continues happening. People of our time accept extraordinarily high risks in their car, risks which are often useless due to imprudent driving when we have no real haste. They accept, without thinking about it, dangers that they would not support at all in any other area.

When society frees itself of fast-traffic roads, a lot of people will wonder how they could have put up with them for so long. This is the utopia that we will explain in the following chapters. Will we convince the reader that it isn't in fact a utopia, but the solution of a futurist equation from verified trends? We must do a simple exercise of very realistic imagination, though still imagination after all. Let's reject the images of broad motorways, large bridges and tunnels, heavy high-speed trains. Large vehicles are 20th century technology. The era of the microchip has created new conditions. Computerization aims towards the superiority of small, narrow, frequent and

customized means. In the same way that in communications we try to obtain a narrow, manageable and cheap cable around which the greatest possible amount of bytes per second circulates, in transport to secure that manageability, lightness and low price are also necessary without decreasing capacity or speed. In 2050 a density of circulation three times greater than the one of a motorway in rush hour will be supported by continuous, light and narrow, bridges elevated on columns. Automatically driven vehicles, with never more than fifteen seats, often forming a train or practically stuck one to the other, will move along them at speeds superior to 200 kilometres per hour on normal lines and much higher on special routes. The cost of light elevation will be lower per kilometre than that of current infrastructures. A great part of that cost will be compensated by the value of released land, in addition to the improvement in security and to the greater developable speed.

Once the realistic imagination to work without prejudice is available, we are going to start from the beginning to set down the terms of our futurist equation.

CHAPTER 2
THE CONDITIONS OF 21ST CENTURY TRANSPORT

When Marco Polo took several years to arrive in China by horse, crossing mighty rivers, barbarian regions and deserts, his imagination did not conceive that someday people could arrive there in a few hours by plane.

Now, on the contrary, our imagination can conceive of everything. The technical advances of the last few centuries have made us used to vertiginous change. We can, without problem, forecast space travel at the speed of light. Science-fiction literature and cinema have done it hundreds of times. And, although the theory of relativity, the major authority of our time, assures that no object can be moved at a speed superior to that of light, our unbound imagination no longer admits limits. Perhaps one day we will be able to travel by thought in space, and in time!

But it is not probable that this will occur during the 21st century. If we want to make a prediction about the immediate future, we must be reasonable. We are going to carefully study the conditions that will guide this process towards the situation of transport in 2050.

1st. CHANGE WILL BE GRADUAL

It seems a platitude, but it is necessary to start off from here. The present motorway system will coexist with the new systems for a good many years. The new ones which will first appear as pioneering projects in countries with a strong technological initiative, will soon be extended to the main lines between great cities and the large metropolitan areas, and little by little will marginalize the automobile with a steering wheel as the latter once marginalized the horse-drawn carriage and as tractors replaced oxen, just as personal computers pushed typewriters to the sidelines.

2nd. THE MOST ADVANCED TECHNOLOGY AVAILABLE WILL BE APPLIED

The gift of prophecy is not necessary to make this forecast either. Investments in transport are so fundamental to modern human activity that thousands of companies will continue competing with new materials; better power, connection, security and control systems; more advantageous supplies in communication, comfort and velocity in order to obtain a share of the market. The development of greater speeds, whilst maintaining an acceptable level of safety and cost, has been a primary goal since the invention of the first steam engine.

These companies will also compete using the most developed software. As in other areas of industry, transport will tend towards automation. Everything that an automatic process can usefully do, will stop being done manually. If guiding vehicles without a human driver is possible, it will be done, as already happens on certain trains that do not need one, but with one person in charge, at most, to watch the automatic guidance system.

3rd. SAFETY WILL BE ESPECIALLY VALUED

This statement needs a lengthy defence. In the year 1900 in the mines and factories great numbers of workers died. There were so many of them, it was not worth the owner spending money on better wood to prop up the underground galleries. Safety was not then especially valued. But during the 20th century this began to change. Workers acquired union power as strikers, political power as voters and economical power as consumers. Their life and their health were made increasingly important. Pension and medical-aid systems channelled resources towards safety. In this way, we arrived at the start of the 21st century. Currently, every company must respect a strict norm to avoid labour accidents and diseases; public health is ready to undertake intensive efforts for the life of any person; a lot of insurance companies cover all types of risks in the daily life of their clients.

The graphical line of safety valuation during the last hundred years has been rising. It is a sign of development. There is no doubt that the same trend will continue for many years, at least where a certain economic prosperity exists.

There is only one black point in this rising graphical line. The three Spanish “cs” of mortal statistics are those of *cáncer* (cancer), *corazón* (heart) and *carretera* (road). Within these three risk factors, people have a positive or negative influence depending

on their attitude. However, it is obvious that influence is small on cancer, medium on heart problems and great on road dangers. We all know that certain carcinogenic substances and customs, like smoking, can be avoided; we also know that a sensible diet and abundant exercise are healthy for the heart. What it seems that we ignore is that driving at 140 kilometres per hour to take less time to arrive at our holiday destination involves a very high, useless risk. In great contrast, the human beings of the beginning of the 21st century run the greatest easily avoidable or lowered risks when they enter a car.

Will the road continue being the only site where modern people forget their fear of danger? No. The human brain, as soon as it becomes a driver, is victim to a suggestion of safety and power that distorts its perception of reality. That is the main cause of the survival of the steering wheel. But when it is not that which takes control of the vehicle, caution will increase. It is possible that in the year 2050 the scandalized clients of a certain transport company put their head in their hands when they know that their risk levels are only ten times smaller than the present ones.

4th. THERE WILL BE A TREND TOWARDS ENERGY SAVING

Waste is not usually a behaviour model for any human activity that works correctly. Scarce goods have been always administered in moderation. However, for complex reasons that deserve separate study, petroleum has been wasted for decades, as if it were an abundant good. Manufacturing countries lived their economic present with a large income, without worrying about the future; consuming countries spent unthinkingly on their growing industries and transport because the price was low. But the 21st century has come with energy limitations. Petroleum is running out, nuclear power generates panic, renewable energies offer not very plentiful resources. On the other hand, the situation of the planet as an ecosystem adds a growing worry. Environmental criteria influence policy and the economy. All these issues take us to two complementary conclusions: We must avoid the wasteful use of energy and we must efficiently take advantage of the energy consumed.

This situation is completed with a parallel factor: The control of energy usage for obtaining better effectiveness finds an excellent ally in computer software. The computerized transport network will be able to calculate exactly which is the passage

that offers most saving, at what moment, with what means and under what circumstances.

5th. TRANSPORT IN THE 21ST CENTURY WILL BE ALMOST ENTIRELY ELECTRIFIED

Why? Because the combustion engine does not adapt to the conditions set out, nor those that follow. It is an archaic, polluting device. The superiority of the electric engine is demonstrated with the statement that practically every engine, for every type of use, installed where it can be plugged into a socket, is electric. The combustion engine is only advantageous where a source of electricity does not exist, which happens mainly with the engines of diverse vehicles. Whereas with trains, whose route, unlike the one of airplanes, ships and road vehicles, can be covered by an electric cable, this solution by and large has been chosen.

Electricity that circulates along a cable can receive energy from any source: hydraulic, from combustion, wind, solar, nuclear, et cetera. If to date the diverse prototypes of electric vehicles have not been able to gain in popularity over the combustion vehicle, it is because time and time again thinking according to the current standard is insisted upon, without opening the mind to other possibilities, which are however very evident. The independent vehicle with a steering wheel is no longer of use. Let's rather think about a vehicle that is integrated into an electric and computer network. We're not talking about any technological novelty. We have been used to electric trains for many years. This statement does not mean that 21st century transport will be based on the electric trains that we currently know. The following condition will clarity this.

6th. SMALL UNITS WILL PREDOMINATE

The road overtook the train in the second half of the 20th century because it adapts better to small units. Motorcycles, cars, vans, trucks and buses offer a high facility of movement in all areas; trains cannot compete against them since they are too large. Nobody possess their own train, nor is it possible to deliver the press to news-stands or bread to the home by means of the train. Small units are essential for making

motorised transport universal. And since humanity will not give up making motorised transport universal, small units will continue being essential in the 21st century.

Although the statement of this 6th condition by prudence uses the words *will predominate*, it would have to be said that all land passenger vehicles of more than fifteen seats will become obsolete. Buses and trains are dated technology. It is a question of development. In the same way that a class with fifteen students is more advantageous than one with forty, in the same way that a hospital where each doctor has fifteen patients in his charge is preferable to another where he has one hundred, a fifteen-seat vehicle will offer a better service than a sixty-seat one. For the same reason: the service for each traveller will be more customized, more complete and more intense.

Therefore, when we talk of electrification we do not talk about an electric train network, but about a network of small, electric vehicles.

7th. COMPLETE-SERVICE TRIPS WILL PREVAIL

We call complete service trips those in which the travellers start off from their door of origin and go to the door of their destination using a schedule suited to them. This is what any client of a public transport wishes, but that at present only the user of a private vehicle or the client of a taxi called by telephone can obtain. If some companies offered that type of trip at a public transport price, passengers would come like bees to honey. Computerization is able to progress in that sense by means of advance agreement and the combination of the supply and demand data of the trips of many passengers.

8th. URBANISM WILL TEND TOWARDS PEDESTRIANISED STREETS

It is what we have been seeing in the cities of developed countries for two decades. More and more streets have become pedestrianised. On them, vehicles with wheels have to respect the pedestrian's right of way and must move slowly and carefully. Even parked cars hinder the new conception of urban space. We try to dissuade drivers from leaving their vehicle on public ground for a long time. Underground car parks are constructed and the use of public transport is promoted.

This trend does not have to be considered a fashion, but a mature choice of citizens after decades in which speed has invaded the streets until it makes urban life difficult to bear.

9th. FAST ROUTES WILL BE SEPARATED

This condition is complementary to the previous one. Motorways and fast roads, as well as many railroad lines, are currently already flanked by strong and tall protective fences to prevent intruders, as much people as animals, generating danger where vehicles circulate quickly. Also, in the surroundings of cities and some thoroughfares we find fences, walls or changes of level that serve to separate speed. A fast vehicle is a source of danger for people outside and inside. It is indispensable for its safety to make access for animals, children, confused people or abandoned objects to its route difficult.

10th. THERE WILL BE A CENTRALIZED CONTROL OF TRAFFIC

Why? Because it derives from other conditions, particularly the second (The most advanced technology available), the fourth (Energy saving) and the fifth (Electrification).

We are going to call to the centralized control of traffic by its name: network. It is not an unusual idea in our time. Both a telephone and computer network exist, among many others that will help us to understand that of transport. Chapter four is dedicated to its study.

CHAPTER 3
AUTOMATIC DRIVING

In the previous chapter we talked about the unstoppable trend towards automatization, but it is difficult to conceive a method of replacing the human drivers at the steering wheel of millions of small vehicles that go everywhere. Although this change will take many years, we can predict that in 2050 there will already be some countries where human driving at speeds superior to 40 kilometres per hour will be forbidden, except on race tracks. This statement means that a system of automatic driving for fast vehicles will be widespread.

For centuries we have been acquainted with a simple method to maintain a vehicle on a route with impeccable precision: the track. As much automatization as the development of high speeds demands that vehicles circulate held in place by a mechanical constriction that prevents them from moving from one side of the route to the other.

In the same way that in today's modern society cables transferring electrical energy and telephone or computer communications are everywhere, that water circulates through pipes and that petroleum or diverse gases move by specific conduits, a network of routes that guide the vehicles of future will be developed in practically every place where an asphalt road currently exists.

However, we must not imagine train routes like those which were common in the 20th century. There are very different alternatives that will adjust better to the new conditions. Diverse types are possible: tracks with two rails or one, metallic or not, vehicles below or above them. A cylindrical vehicle fitted within a tube also travels along a type of track, like a cannonball in a cannon.

Any automobile, however small it is, can be driven by a system that physically defines its route. Also track-guides that do not connect to the wheels, but with another part of the vehicle, can be applied. A track-guide that is an elevated horizontal bar which connects to a vertical appendix of a vehicle, can serve to handle driving from

above, replacing the human driver. The most useful system of wheels: the one of non-rigid material (rubber with an air chamber, or something similar) on flat ground is kept.

In the fifth chapter we will try to solve the enigma of the track types which best adapt to the conditions of the transport of the near future established in the previous chapter.

At the moment, we insist on the previously announced forecast: Whatever that track is, fast vehicles for passenger transport will circulate separated from ordinary human and animal activity, and the most widespread solution will be the continuous light bridge. The elevation of fast traffic is an evident consequence of the aforesaid conditions.

The cables that transport electricity between power stations and the grid are always elevated using columns or posts, due to their danger. On ground level they would be more accessible when being handled by technicians, but there they would entail a unacceptable risk of electrocution. Every country has made the economic effort to elevate them. This is an example that we can use for our discourse. The danger of accidents for the occupants, as well as for the nearby population, that a vehicle travelling at more than 200 kilometres per hour at ground level involves is huge if a physical barrier does not exist to separate it. Elevation will be the definitive solution to this problem for light routes, which in the long run will be all the fast interurban ones and many medium speed urban ones.

We have an example that can illustrate the issue. Who has not ridden on a roller coaster? It is a light structure able to support a track on which units forming a train quickly circulate. The number of passengers that fit into thirty metres of that train is superior to that of the passengers who fit into one hundred metres of motorway with two lanes occupied by cars travelling at the same speed. The continuous bridge which will be widespread in the near future, will look more like the final, level and not very high part of a roller coaster, than like the massive current motorway bridges.

However we must quickly go beyond this image that has served to illustrate a first contact with light elevation. Vehicles that travel on the continuous bridges of the future will probably seem like current automobiles of the people carrier type, not only in their indoor space, that will be between one and fifteen seats, but also in their wheels. In addition, on a roller coaster a single train moves automatically on a simple and short

circuit, whereas the automatic driving of the future will have to look after millions of vehicles on a very complex network of routes with crossroads.

The computer network that will drive the vehicles of the future will have solved the main difficulty of driving, that of determining an exact route by means of the track. Even so, the centralized network control still has the following driving functions: to choose the suitable speed, to make decisions at crossroads, to recognize occasional obstacles on the route and to brake quickly in case of danger.

The bat can fly quickly without using eyes. It owns another well-known way of finding direction, the emission and reception of ultrasounds. The transport network *will see* likewise. Sonar, radar and other similar methods of detection based on laser rays are very developed. Their application to the vehicles fitted to a track does not raise great difficulties. If the unit at the front breaks down and is forced to pause, if a person or an animal crosses the route, if a big stone has fallen from the slope, the sensor will detect the anomaly and will transmit it to the control program. In a thousandth of a second the programme will order a decrease in speed or urgent braking, according to the distance to the noticed obstacle. In addition, this command will also be passed, in unison, to every vehicle that follows.

Obviously, a trustworthy detector system has a price. Will society as a whole be able to provide a radar for all the millions of vehicles that will continue to travel on hundreds of thousand of kilometres of tracks or roads? It is not too imprudent to predict that in 2050 it will. For several decades, all types of electronic device have proliferated in the home and places of work and leisure in developed countries. The phenomenon even occurs that in many developing countries it is easier to find computers than potable water. Powerful calculators abound in the market at a price inferior to that of the average daily food for one person. When an electronic device becomes popular, its price decreases. The same will happen with the detection systems for vehicles.

However, the travellers of the future would accept paying high prices for them. The first reason for this statement is that they are accustomed to dedicating a high percentage of their income to cars. Also governments spend huge amounts of money on motorways. But, above all, detectors of obstacles will prevail thanks to the important services that they can offer together with the central computerized transport network. The capacity of electronic detection, even in the dark at night or in the fog, as well as its

quick reaction, can surpass by far the human eye and brain. Consequently, it can improve safety at greater speeds.

We must also consider that when every fast route is separated from the ground level, two new situations will occur. Firstly, the quantity of obstacles on the route will drastically diminish. Secondly, fixed control systems for the route will be developed. The route itself will be aware of any anomaly. If a damaged vehicle stops the network will be informed by three sources: the control system of the vehicle, the detection system of the following vehicle, and the sensorial system of the route.

CHAPTER 4
THE TRANSPORT NETWORK

Science-fiction literature and cinema have been influenced by two opposing optimistic and pessimistic trends. For the former, the advance of science will solve mankind's main problems: it will guarantee the feeding and the health of everybody, which will lead to increasingly widespread fairness, and to worldwide peace. Great enthusiasts of progress have existed, but perhaps because of the inherent necessity of conflict in every story, the major source of predictions is the pessimistic one. *A Brave New World*, by Aldous Huxley, describes an apparently happy future society, but it is without freedom or meaning. The vision that George Orwell titled *1984* is even darker. Atomic catastrophes, overpopulation and all types of tyrannies based on machines, constitute the axes of this sort of cinema. Humanity, which had started the 20th century seduced by the idea of progress, after two world wars and the nuclear era sadly understood that the destructive capacity of technological development will always predominate as long as there is no profound change in the human condition.

Transport, that plague on wheels which has made life in cities intolerable, is a good paradigm of this statement. Everything would have worked better if human beings had used their vehicles rationally; if they had walked more, as is healthy; if they had not been obsessed by the possession, use, abuse and ostentation of the private car; if they had used the diverse means of public transport more often. The best ideas can be frustrated by the worst applications.

The same can be said about the idea that we are defending here: the transport network. A first factor of distrust opens the debate. Will it not entail a loss of freedom? Nowadays, in a car with a combustion engine we can travel freely from any place to any other without strangers controlling the route or even knowing it.

The best reply to this argument is that we also phone who we want to yet, we are nevertheless integrated into a communication network. Usually we do not distrust the network; as a rule we do not speak with the suspicion that somebody is listening to our

conversation, although we know that on occasion the police intercept some telephone lines. This is as certain as them often stopping or regulating traffic.

Whatever the continuation and the outcome of this controversy, we must imagine the transport network in comparison with the telephone one. Each user will have a number or a code that will serve to communicate with the network. This communication will be by telephone or by computer; both options will come together in the near future. Every possible origin and destination will also have a number or code. Every door to a house, institution, office, shop, company or any other point identifiable as an origin or destination, will be a station for the network. As a rule the vehicles of the network will pick up the users at the door of their origin, perhaps their home, their place of work or leisure or where they have gone to run errands. Immediately, they will take them to the door of their destination, in the same way that the telephone network *picks up* the words from the person who is calling and takes them right to the receiving telephone.

We are now going to study in detail the capacities of the network, the way of working that will revolutionize land transport.

1. THE CAPACITY FOR DATA COMBINATION

The network will drive every vehicle simultaneously. It is a single brain for traffic as a whole. It knows the routes in depth; not only each city's layout and the street map as they are seen on paper, but also what it is happening at every point of them. Where a vehicle stops, the network knows that something is occurring. It receives news about accidents, road works and all types of obstructions: demonstrations, celebrations, floods, snow, et cetera. If there is a pot-hole in a road, the network knows and considers it when each vehicle passes. If there is a curve prone to ice, it knows the temperature at which special care must be taken for that reason.

The network also has at its disposition all the data concerning the vehicles' journeys. It knows where everyone is going; it knows if a vehicle is going to turn right, left or carry straight on at the next junction. When several vehicles travel in line, the network will transmit the order to brake to the engines and brakes of every one because there is an obstacle on the route.

In addition, the network will hold previous information about trip expectations, since in the future only urgent unforeseen trips will be taken without advance agreement. We are going to immediately study the vast consequences of this new custom. The network will award the clients' advance request with a price reduction.

The application of customized prices, different for each trip according to the length of time between the booking and the journey, duration, number of seats, frequency if relevant, and several other factors, is not indeed the most despicable part of the network's capacity for data combination.

2. THE CAPACITY FOR THE ADVANCE AGREEMENT OF TRIPS

This is no novelty. For decades, air, train and bus companies have worked like this. We are now going to begin to see the revolutionary consequences of the wide-spread advance request for all types of short and long trips. Communication between the network and its users through fixed or mobile telephones and through computer connections will be swift. Even children will be able to quickly respond to a questionnaire, spoken or written on screen, about the place and time of departure, destination, number of seats and other factors.

What use is it to the network to know that I want to start off within half an hour to go the other side of the city, and that my neighbour goes from his house to his workplace at 7.35 in the morning every working day, unless he advises otherwise, and that the Gómez family is going to travel from Seville to Valencia the day after tomorrow?

This information serves to develop the capacities that follow.

3. THE CAPACITY TO OFFER FLEXIBLE PUBLIC TRIPS

This capacity, that presented in this way seems a secondary improvement, will result in a set of far-reaching changes, since it will create the necessary conditions for lightening transport. It will mean that heavy vehicles for public service, buses and trains, are reduced in size and, therefore, will weigh much less.

We consider a public trip to be one in which the client shares a vehicle that belongs to a company dedicated to public transport with other, unknown, clients. And

we consider a flexible public trip to be one that does not follow a fixed schedule and route.

When the network offers a fleet of taxi-buses with 8, 12 or 15 seats, able to carry their passengers from the door of their origin to the door of their destination, according to times decided in advance by means of the combination of interests between the network and its clients, the urban landscape will be very different from the one of the last fifty years of the 20th century. The use of the private car will greatly decrease and the streets will not be filled with parked vehicles.

4. THE CAPACITY FOR LIGHTENING TRANSPORT

Sometimes it seems that what is advanced and modern has to be large. It usually happens with bridges and skyscrapers, but not with calculators, pocket radios or the systems for the computer storage of data. As we argued in the second chapter, a school classroom with forty students to a single teacher is not more advanced than another one with fifteen, but quite the opposite. For the same reason, a 60-seater bus will seem an antediluvian monster in the year 2050. Transport companies will be able to grant a more customized service to their clients with 15-seater units.

Also the train that we currently know will pass into history. It is very rare that a thousand passengers have the same precise route. The four or five members of a family in their car usually do. Sometimes, sixty hikers on the same bus also leave from the same site and arrive at the same place after passing the same stops; but the most frequent case is that public transport users come from and go to different buildings and streets. Several full trains travel between Paris and London each day, but this does not mean that the hundreds of passengers on each train have the exact same route. Some come from Saint Denis and go to Greenwich; others start off from Versailles with their final destination in Oxford. Then there are those that go from Versailles to the City or Greenwich and from Saint Denis to Oxford, Wimbledon and many other points of the great metropolis and its environs. They have met on the main part of their route; but they would prefer, if they could choose, that the train picked them up from home and took them to the door of the hotel where they are going to stay in London. If each train with six hundred travellers were divided into forty vehicles with fifteen seats, the route of each group of fifteen would be much more similar. There would be a trip from

Versailles to Oxford, another one from Versailles to Greenwich, another one from Saint Denis to Wimbledon, and so on up to forty different offers from the transport network.

This is the key phrase: "In the computer science era it does not make sense to make an effort to reunite more than fifteen people to undertake the same journey". With the advance agreement of trips, the data combination of many travellers and the use of small vehicles, the network will even be able to collect every passenger in a Paris zone at home and to take them, also in a tailored way, to a London zone. With six hundred travellers, that operation, if possible, would take hours, but with fifteen travellers it will perhaps occupy about thirty minutes.

An important consequence of lightening will be the success of the routes raised on a continuous bridge. We will consider this later.

5. THE CAPACITY FOR GENERALIZING PRIVATE TRIPS IN A PUBLIC VEHICLE

We regard a private trip as one in which the traveller decides the points of origin and destination, the moment for starting off and the trajectory of the route, without sharing the vehicle with strangers. Currently we call the public vehicle that offers private trips a taxi. In all cities there is a multitude of taxis responsible for an important part of passenger traffic, but it is always lower than that of the bus and underground, and still lower than the part made up by private cars. When travelling between cities it is rare that the user goes by taxi. It is too expensive. A few people, five at the most, must pay for the driver's work. The private car is also expensive, and often troublesome to drive and to park in streets filled with vehicles, but their owners feel very comfortable in them, and they usually travel like this with great freedom of schedule and route on the outward as well as the return journey.

When the network drives every vehicle, public as well as private ones, two things that are currently unusual will happen:

First of all, the trip by neotaxi will be cheaper than the trip by private car, since, as driving is automatic in both cases, the private automobile will be parked when arriving at its destination, and perhaps the owner will have to pay for this, whereas the neotaxi will continue carrying passengers for many hours and thus it will multiply its yield.

Secondly, advance agreement will guarantee the punctual presence of the neotaxi both on the outward and return journey. This will give the users as much freedom in their movements as does their private car.

Who will choose their own vehicle to travel daily to their place of work, being forced to look for a problematic parking space, if they have the option of going by a neotaxi that will cost less, and returning by another one that will arrive at precisely the established time?

We have already talked about the public door-to-door trip, in what we call a taxibus. Its only difference to a neotaxi is that in a taxibus the passenger shares the trip with other passengers and needs to offer a certain margin of time to the network so that it can combine the interests of different travellers. Actually, both services will eventually be very similar. It is foreseeable that the number of private vehicles in movement or parked in streets will decrease radically with the use of neotaxis and taxibuses.

6. THE CAPACITY FOR THE REGULATION OF TRAFFIC INTENSITY

In the final years of the 20th century new technologies were developed that can know instantly the intensity of traffic at diverse points of the road network and then inform drivers as quickly as possible in order to avoid traffic jams due to accidents, road works or the accumulation of vehicles in rush hours. By means of sensorial cables placed across the roads and video cameras placed at strategic points, the traffic control soon knows where the standstill is and also where there is a risk that it will happen. With illuminated panels at the entrance to underpasses, at junctions and other well-chosen points, drivers are informed about what is happening, and they are advised or required to take alternative routes. Also, the radio is used to transmit that information. The following step consists of equipping every vehicle with a direct system of communication with the control centre.

But all this will be old fashioned when the network drives every vehicle. Not only it will avoid the worst traffic jams, but it will have the means to dilute the intensity of traffic throughout the day. The exhausting intensity that occurs during three or four hours of the working day or around holiday periods in so many urban and semi-urban zones, will be distributed by the network throughout many more hours thanks to its

capacity for arrangement. The means to obtain it are: the simultaneous driving of every vehicle, forecast using confirmed data and statistical knowledge, advance agreement, and influencing demand through price changes. Travelling in rush hours will be more expensive in the future.

Great possibilities to save on public works will be possible thanks to this capacity. Investments in infrastructure and vehicles in the 21st century will not be based on the needs of traffic at its moments of greatest intensity, but they will adapt to the average circulation. This means that there will be a reasonable limit for the traffic density on each route. The new routes will be designed with the intention of absorbing a maximum intensity set at a certain proportion of the average, say, three times superior to the average, but no more.

7. THE CAPACITY TO FORM TRAINS

Five, seven or more units automatically driven along the same route, if they have the necessary attachments at the front and back, can form a single train. We can imagine several cars or several vans like this. They will take better advantage of the energy consumed by their engines. It is even possible that only two engines will be sufficient for five vehicles on long, flat journeys.

The network, which knows the origin and the destination of every vehicle, can reunite the groups in strategic places in the city so that the longest part of the trip is spent together, for example an interurban journey. When arriving at the destination city they will separate and disperse independently.

8. THE GLOBAL MANAGEMENT OF FREIGHT

The comparison that is going to help our imagination here is the one with the post service. How does the post office work? We write a letter, we put a stamp on it to pay in some way, we indicate the destination address and, just in case, that of the sender; finally, we leave the letter in a post box. Nothing else. This letter will arrive within a certain time at the indicated address.

There will be normal and urgent transport. For the normal one it is likely that the network will decide to wait until night, when trips with passengers are fewer and electrical energy is cheaper. It will form trains with groups of units in certain sections;

then they will separate so that each unit continues on its own route, perhaps being joined to a new train.

The following step in freight transport will be the creation of specific conduits, underground as a rule, not very wide, we will soon see why, perhaps one metre in width, through which merchandise will move at great speed without disturbing passenger traffic.

* * *

Once we have studied the network capacities we must consider that, like any transport system, this one will not be able to serve every place. The transport network will have a centre and a periphery, or to put it another way, routes with maximum intensity, others with medium intensity and other rural ones. This is what happens with roads. There will be also sections external to the network: mountain trails, zones with public works, cultivated fields, private areas. When we say external to the network we mean without electrification and without track. Vehicles with a combustion engine, such as cranes, tractors, all-terrain vans, some trucks and some motorcycles will be restricted to these sections. It is possible that even these special vehicles could, thanks to opportune features, join the network to be transferred from one work zone to another. Also it is possible to foresee that to deal with emergencies or power cuts the network has some combustion engine units distributed at strategically important points.

But there still remains a redoubt for the free car: leisure combined with the attraction of speed and competition. This activity currently performed on every road, with the danger of one's own and other peoples' death, will be done on restricted circuits for sport, like horse racing. And thus the inhabitants of 21st century will ignore one of the most intense and reckless pleasures of their grandparents. Nobody will yearn for them. Trotting and galloping is sometimes also a pleasure, but humanity as a whole does not yearn for the time when it was not possible to travel more comfortably and more quickly than by horse. Current drivers' grandchildren will see the old films and they will shudder to think that sometimes it was possible to travel in a free car at one hundred kilometres per hour, as any woman shudders when imagining childbirth without modern medicine or any jurist shudders when learning of the ordeals with a white hot iron that decided culpability or innocence in the Middle Age.

CHAPTER 5
FUTURE TRACKS

We are going to do an exercise in futurist projection.

Spring of 2063. It begins to rain in a mountainous zone in central Africa. The wheels of a small lorry form two furrows in the mud of a very little-travelled road. It is a lorry like the old ones, with an internal combustion engine, steering wheel and driver; but it is loaded with sophisticated machinery. From the tarpaulin a high antenna stands out like a long stamen that extends outwards from a parabolic metal flower. It is an exploratory vehicle. It is mapping the route as it travels. The antenna issues the route data, a satellite receives it and sends it to one of the central offices of the African traffic computer network, located in Nairobi. With each metre advanced, the details of a new metre will be written in its memory: Exact longitude and latitude, unevenness, the type of land, the surrounding vegetation, the distance to the nearest city, et cetera.

In fact, the network computer does not work in square metres, but in square centimetres. It controls every square centimetre of the approximately 4.500.000.000.000.000.000 that the surface of our planet has. If, anywhere in the world, we put a finger on the ground and question what square centimetre it is, the network computer will respond, for example: “It is number 1234567890987654321, it is located on such a continent, in such a country and at so many kilometres from such a city”. And, if indeed that centimetre belongs to a route, it will be able to add as well as which one it is, what the ground is like, the direction of the vehicles that are using it, how long it is since the last one has passed, approximately how many seconds the next one that is approaching along the route will take to arrive, how many centimetres until the next curve, and what its radius is.

Although being able to deal with so much data seems inconceivable, we must accustom ourselves to this idea, because what current computers achieve is already inconceivable.

What was the exploratory lorry doing in a remote African region? It was laying the rails of the route in one of the few zones that were without them. They were not rails of metal, nor even of the most modern synthetic material, but they were virtual rails, a route of data so that the next vehicle passing by that way could travel without a driver.

This is a science-fiction idea. We will forget it for the moment. It is enough to understand that many types of route are possible and that future years will provide great surprises for us.

We have affirmed so far in this book that the free car with an engine that uses derivatives of petroleum and a human driver will soon be outdated. Now, in this chapter dedicated to the rail track, we will begin by affirming that the train we have all known until now also doesn't have a future. We have already explained why: It is too big.

We know that the land transport of the middle of the 21st century will be driven by a computer network in small units that will run on tracks. We can affirm it without hardly any reservation, almost with certainty. But, what will those tracks be like? From here on we are entering unknown territory which is much more difficult to predict. But we have an indication: they will be light. They will not need to support the weight of great units, not even for freight, which will mostly circulate in specific conduits.

What will the rails of those light tracks be like? Parallels steel bars joined by crossbeams with a bed of stones or inserted into asphalt? Monorails adapted to magnetic or pressured air levitation? What will the wheels be like, metallic or pneumatic? Will routes with suspended vehicles predominate?

In order to glimpse an answer, we will focus on the time of transition. Although we are talking about track, we must remember that the transition will start off from the main, present-day transport, that of the road, not of the railroad. What we are saying is that small units such as those of the road will circulate on some type of track. This means that on all the city streets and rural lanes that at present are used by private cars there will be a track that does not provide a smaller service, since that change does not interest anybody, but will offer an even more complete, safer, faster and more effective service. We have said that we do not know which track it will be, but we refuse to imagine annoying iron rails spread along the millions of kilometres of asphalt on which tyres circulate nowadays. The pneumatic rubber wheel has demonstrated its utility. It adapts to any type of ground, or asphalt, concrete, earth or gravel as long as it is not too

steep. It is quiet and cushioning. It grips the ground, an essential feature on hard slopes up which the metallic wheel on a steel rail is not able to go.

We have also foreseen that fast routes will be separated from the ground level, normally by means of elevation, although we can imagine some underground sections. There will be routes with diverse classes of track, but without a doubt compatibility will predominate. It is likely that some long-haul routes will be built, perhaps an international European one between Lisbon and Moscow, in whose construction high speed using specific systems for that line is valued above all, for example systems of magnetic levitation or tube. In these exceptional cases vehicles will not be compatible with other routes, in the same way that a current train cannot circulate on the motorway nor a bus on train tracks. But in the majority of cases, transport companies will be interested in offering vehicles that can move not only on almost all the elevated fast routes, but also on the departure or arrival sections outside the continuous bridge. An uncomplicated, practical possibility exists to guarantee the compatibility between the circulation of a vehicle on any type of track and its secondary circulation for the short and slow distances of departure or arrival. For decades we have been seeing it with airplanes. All planes that take off and land in a horizontal position require wheels, although once in flight there is no need for them, they are even a hindrance. Undercarriages usually are folded into the body so that in flight they do not offer resistance to the air. In the same way, many vehicles of the future that are able to circulate on a continuous bridge with diverse types of track apt for high speed, will have small folding wheels of non-rigid material for use on flat ground. Such wheels will be small, since, unlike those of airplanes, they will not have to withstand high speeds, but quite on the contrary, short distances at less than 40 kilometres per hour.

Concrete predictions are the most dangerous. However, the moment has arrived to risk making them. We can imagine a vehicle similar to what we nowadays call a van. It has ten seats. It has wheels of non-rigid material like those of current vans. The wheels move on the elevated flat floor of a continuous bridge. On interurban, level journeys the van reaches a speed of 250 kilometres per hour. It has not got a steering wheel nor a human driver, since a guide-track drives it.

Generally, we link the concept of a track to a system that holds the vehicle's wheels. But there are other ways to determine the direction of movement without acting

directly on the wheels. Let's think of a carriage driven by horses. Which part of the carriage is connected to what determines the direction, that is to say, the horses? One or two wooden sticks. This is the key idea of guide-tracks. However, for developing computerized transport the opportune feature of the vehicles will not connect to any animal, but to a special type of rail.

The mentioned van has a feature in its central underneath part that connects to a certain form of rail on the road. Is it necessary that we risk more with the concretion of the connection system so that the reader understands this type of guide-track? It is better that we leave that task to the engineers of the next few decades. The theoretical exposition is sufficient. The guide-track technology has been available for many years and can solve crossroad difficulties as effectively as the currently known tracks.

This type of guide-track on the floor is only suitable on elevated routes, where it does not interfere with other human activity. But we have stated that companies will be interested in taking the travellers to their door of destination, and, by definition, these doors will never be situated at the level of the routes raised precisely to separate speed. They will be at street level, and often many metres, even kilometres, away from the next elevated route. So, let's remember the magical word: compatibility. When the described vehicle leaves an elevated route it will be driven in another way. But slowly, at less than forty kilometres per hour. We have said that rigid safety legislation will separate speed from the ground level as much in cities as in fields.

The easiest, and most primitive, possibility available to slowly cross distances that will rarely surpass a thousand metres is a battery in the vehicle with sufficient reserve energy to cover such distances, and that a human driver guides it by means of an auxiliary steering wheel.

Another, more advanced, possibility exists, the elevated guide-bar. It is a hollow and rigid horizontal bar, maintained by columns or supports anchored to buildings, to which a mast, rising from the central part of the vehicle, is connected. This species of light rail simultaneously serves as carrier of electrical and computer-connection cables, so that a vehicle will not need to accumulate energy for short distances.

Actually, many slow vehicles will undertake all types of task necessary for urban life under a network of guide-bars: delivery vans, cleaners, rubbish collectors, the cars of the disabled, et cetera.

In this way, we have, as a risky, concrete forecast of compatibility for elevated fast routes and slow ones at street level, two systems of guidance in the same vehicle, one system underneath when the vehicle circulates on a continuous bridge, and another one above when it circulates on the ground. But it is possible that in the long run the high guide-bar is more useful for all routes, including the fast ones, thanks to its compatibility and its technical advantages. Imagine a light and narrow continuous bridge on which small vehicles circulate in a single direction (There will be another bridge alongside for those travelling in the opposite direction). Imagine that its floor is absolutely flat between the two wheels of each axis, with gradually sloped borders to prevent vehicles falling over one side or another in case of the failure of the guidance system. Imagine a vertical feature that we call a mast, very solid, fifty centimetres in length. This mast will rise from the centre of the vehicle's front towards a guide-bar as horizontal as the electrical cables of trains. The bar will be sustained by means of light columns located on both sides of the bridge and joined from above.

We have already offered two different concretions of guide-track on elevated routes, one below and another above. But perhaps the "era of guide-tracks" will never arrive. It may be a mistaken prediction. At the moment we will grant much more importance to the basic prediction: Fast routes will be separated from ground level through light elevation.

And so we continue.

A road or a train track on a continuous bridge is an infrastructure that has one disadvantage and many advantages. The disadvantage is its price: It is more expensive than a road or a track at ground level. The word independence summarizes the advantages. Traffic becomes independent from the ground, from everything on the ground: people that come and go, other roads or tracks, animals, public works, fallen trees, diverse objects, snow, floods… On becoming independent from the ground it stops disturbing and being disturbed. It is safer and faster, nobody gets run over, it does not constitute a latent danger or a barrier. On the other hand, it occupies a space, but only partially; underneath its bridges vegetation can grow in the fields and people can walk in the cities.

Currently, to avoid abrupt slopes, to circumvent very populated urban zones or intersections with other lines of transport, we build very long and wide, sometimes also

very high, bridges. They support motorway traffic with double or triple lanes in each direction. This is ridiculous in cost and environmental impact. This is an out-of-date technology. When we build narrow structures to hold little weight we will obtain all the advantages whilst avoiding the great disadvantage: the price. With the investment required for one motorway bridge, one hundred metres in length, several light kilometres can be elevated. They will be so light that they can be formed with metallic or plastic pieces that are detachable and reusable in case of changes in the route, extensions, temporary interruptions for works, et cetera.

Blood circulation in a body forms a network of channels that adds up to many metres in length and reaches every part with very narrow conduits. We must learn from that lesson: All transport lines must obtain the suitable intensity occupying only the essential space. If that line is a track, it has an advantage unthinkable in a motorway with several lanes for each direction: Where average traffic intensity is high, the line can be multiplied like electrical cables within a tube, each one independent from the other. This means that two lines in the same or the opposite direction are not forced to always go parallel. To negotiate a narrow city or mountain route on some sections they can be placed one above the other, or can separate to go through different streets and meet further ahead.

From the point of view of their environmental impact, elevated lines also offer many advantages. They affect the landscape to a lesser extent than the lines at ground level since they do not break the continuity of vegetation. For the same reason, they hardly disturb wild or domestic fauna. In populated zones they operate discreetly without interrupting the pace of life of children, pedestrians or workers. As far as noise is concerned, they at least do not make things worse. In cities, vehicles will be able to pass through a soundproof tube of transparent or translucent plastic.

The earthworks necessary to construct a line of this type will be insignificant in comparison with those that the conventional fast lines cause. These are much wider for tunnels, embankments and ditches. Elevated transport offers, with the height of its columns, a great margin of manoeuvrability to evade small irregularities on the ground that for ground level routes cause continuous clearing and filling.

An old pending subject of the Italian transport network consist of linking, by means of a bridge, the island of Sicily to the continent. It is a work of gigantic

proportions, as advantageous as it is difficult to carry out. Difficult for 20th century technology, that only thinks in terms of greatness and width. If ten prisoners want to escape from a jail they do not need to make a hole in the wall that fits all of them simultaneously. A small hole, through which they can fit one at a time, is enough for the ten of them. Why insist on building a bridge where twenty people seated next to each other would fit, when they can pass in rows of two? In the chapter dedicated to merchandise we will see that the most suitable reasoning is the same. The solution for the Straits of Mesina involves a light bridge along which as much people as well as oranges, bricks, computer pieces, jackets and all the merchandise that does not form large indivisible units, i.e. more than ninety percent of it, passes in narrow vehicles.

In the same way that a piece of wood floats in water, fast traffic will float over the ground of cities and fields. It is a question of lightness. Just as electrical cables are raised with posts and columns, so too will fast routes be raised. It is a question of safety.

So then, let's look at the different contemplated routes together.

NORMAL INTERURBAN ROUTES.

They will be based on light elevation. What at present is a road with a lane for each direction and wide borders, will become a continuous double bridge, that is to say, with a track for each direction.

In many sections, mainly on the periphery of cities and the great urban arteries, a guide-bar below the bridge will be used for traffic at ground level. On others, there will be an avenue, a lane for cyclists or both. We can presume that many kilometres of these routes will go over cultivated or uncultivated land.

Where at present there is a motorway with several lanes, in the future a continuous bridge with two or more light tracks by each side will rise. We can also imagine long sections which, to avoid an excessive bridge width, will be constructed with two levels, one for each direction.

These routes will be able to absorb an intensity of traffic much higher than that of current motorways, since the units will travel forming trains of trains: to a train with five vehicles another similar one will be coupled, and to this yet another. Many vehicles will circulate together over long distances. The necessity to brake quickly in case of a

problem will not be an obstacle for these caravans controlled by the network, because at a signal every unit will brake in unison.

HIGH-SPEED ROUTES

This is what we can call the raised routes with engine systems or steering that is different from the normal ones, for example, those of magnetic levitation. They will constitute the extension of the existing high-speed trains, and they will be dedicated essentially to public transport, although with units never superior to 15-seater ones.

MINOR ROUTES

They will be limited to circulation at ground level with a guide-bar. There will be two-lane ones in the main streets of the cities and their surrounds, but it is foreseeable that the single-lane ones will prevail: single bars in one direction, like in the present-day one-way streets; or single bars with two-way traffic in the countryside or for access to residential areas, like much of the classic railway tracks. The passing of two vehicles travelling in opposite directions will be solved by means of splitting the track every 200, 500 or more metres, according to the average intensity of the traffic. Driving on these routes will be slow for safety reasons.

CONDUITS FOR FREIGHT

Here we progress to the subject of chapter 6 only to say that the special characteristics of merchandise will make new specific channels of transport and distribution profitable and effective. These will be used to move ninety percent of the loads and this will leave the routes free for passengers.

With time, signal routes will be developed. They will have no mechanical contact with the wheels or any other projection of the vehicles. These will be guided via short-distance communication between their sensor–emitter system and another one on the route. There are several alternatives in signal routes: A sensitive tape hanging like electrical cables or placed on the ground in the middle of the lanes; it is also possible that the sensor-emitters are placed at the top of columns every ten or twenty metres. The technical hitches that the signal routes presents are big. In any case, the physical

independence of vehicles will not be a priority while contact with the power supply is required. We think that this type of route will be reserved for the second phase of the computerization of transport, which will be developed from the experience of some decades using guides-bars.

* * *

Once the types of routes are established, it is important to solve some problems. How to remove a vehicle that has become useless because of a breakdown or accident from the route? How to park on the side of it? How to leave the vehicle in the heart of the city?

Evidently, the units that circulate on tracks do not have, in this aspect, as much freedom of manoeuvrability as the free ones with a driver. It is a disadvantage. Cars also have disadvantages in comparison to horses on uneven ground, very steep slopes, leafy paths…, and in comparison to sleighs on snow-covered surfaces. Nevertheless, their four wheels have managed to stimulate investment that opens roads to mountain tops and into the heart of forests; also to clear snow from roads using special machines. This teaches us that when a means of transport offers abundant advantages, it is worth making an effort to lessen its disadvantages in some secondary aspects.

When a vehicle undergoes some anomaly that prevents it from moving, an obstruction will form on the route. The computerized network has several methods to combat such incidents:

First of all, it knows the problem right away because it drives every vehicle. This means that it is able to divert the traffic to other sections while the obstacle remains.

If the affected vehicle can be rolled, the network has the resource to push it using the vehicles that are approaching on the same route until it splits or there is space to park.

If it cannot be rolled, the network must send a crane to remove to the broken-down vehicle from the route.

In any case, the probability that this incident occurs on future routes is not comparable to that of roads with free-moving vehicles. We must expect a much smaller index of accidents, due to computerized driving and to the absence of overtaking or other possibilities for head-on collision. As far as breakdowns are concerned, it is rare

that they occur suddenly, without any previous sign. The network, faced with any indication of malfunction, can prevent it moving the vehicle to one side before it is completely unusable.

For parking in the city, we can presume that marginal tracks will be needed; but we do not have to imagine long lines of cars parked in the streets between the road and the pavement. This will be an image of the past. The curb that separates the level between pedestrians and traffic is condemned to extinction. An opposite trend to that urbanisation of streets full of vehicles, moving as well as stopped, exists already. It is common in congested urban centres that whoever uses public space to park must pay according to the length of time. Even this is limited to prevent a car indefinitely occupying the place that others need. This is another reason to add to the many that will favour the predominance of the private trip in a public vehicle (neotaxi), and of the shared trip from the door of origin to the door of destination (taxibus).

However, there will be private vehicles parked in established places, often underground, since obviously some people will arrive in the city for tourism or business after a long trip with the luggage, the comforts, the instruments of work, the privacy or even the luxury that their own car offers. This does not cause any special difficulty for the new system. The users who undertake urban trips with many stops will present a greater difficulty: newspaper men, postmen, notifiers, business representatives, delivery drivers… All those people who nowadays double park, or usurp ground on sidewalks or obstruct narrow streets. What will they do with their vehicle, be it private or public, while they carry out their management at each stop? The solution consists of separating it from the route by means of human driving. A battery will store sufficient energy so that the vehicle can move at very little speed, driven with a small auxiliary steering wheel in short marginal sections; not only on the city streets, but inside private properties, in the countryside, in works zones, et cetera. The tracks will not serve all areas, as neither do asphalt roads nor unsurfaced paths currently.

CHAPTER 6
THE SEPARATION OF MERCHANDISE

Commerce, often with an unsustainable economic criterion on a global scale, fills roads with wheels that come and go. Wasting petroleum to move merchandise from A to B and another similar one from B to A does not seem very sensible. In regions where there are many cows, milk is sold from other regions in which milk arrives from the first ones. A calculator, a pair of trainers or a simple plastic toy cross half the planet before being united with their owner. The last few decades of the 20th century have been like this, and we cannot change that. The bad thing is that neither can we change the century that is beginning. It is possible that the fatal trend towards the waste of scant goods will dominate us until we arrive at an environmental and economic disaster.

The electrified transport of merchandise will bring an improvement in this sense. Electricity can be generated from solar, wind or hydraulic power, besides the diverse forms of combustion. Transport directed by a network will provide abundant elements of saving. We have spoken previously about this. The aim of this chapter consists of observing the following statement: The transport of merchandise will generally be separated from that of passengers.

And this phenomenon will happen because of the following reasons:

Passengers and merchandise usually have different origins, destinations, paces and treatment. With the exception of the suitcase that travellers usually take with them, merchandise circulates separately in special lorries or trains. At the moment, lorries, due to their greater size and lower speed than cars, obstruct the traffic of passengers on roads and motorways. They are responsible for any constructed bridge having to be extremely solid and very wide. There are many reasons to surpass such a crude means of transport.

The transport of merchandise can be narrower. Merchandise generally fits into containers narrower than the ones used for the transport of passengers. Certainly, if we were to be exact we could say that a hefty man fits lying down in a box measuring 60

centimetres in width by 40 in height; but he would not want to travel thus, even very cheaply, while he is alive. Nevertheless, potatoes, jewels, wine bottles, bricks, coats, shoes, maize, pieces of furniture to assemble, pens, sand, paper, fish, iron beams, gas cylinders, balls, ham, microscopes, letters, coal and a lot of other things, probably over 90% of the merchandise that currently circulates in lorries, can be transported without difficulty in a box with those measurements. If we increased the width to one square metre in containers that reach ten metres in length, we can already include practically 95%.

What would become of us if it were not possible to transfer electrical power from the power station to consumers along a narrow cable? If we had to carry it in lorries! The electricity bill of a normal house would be exorbitant. The same with water, gas or petroleum conduits. The narrower a transport conduit is, the lower the price of its components and its installation, the lighter it is, the more easily it is possible to place it on any route in a valley or on a mountain, and the less the work costs to elevate or bury it.

What would happen if merchandise travelled within a conduit of 60 by 40 centimetres in cross section? We speak of 90% of merchandise; it is clear that a bed does not fit that way (except if we disassemble it). What would happen? To compare that conduit to an electrical cable seems somewhat crazy, but it is not. Just like the cable, it could hang between posts at a certain height without bothering anybody, it could reach all corners of a city, even the inside of buildings.

Another specific characteristic of merchandise transport consists of it being very manageable. Human passengers are not very manageable. They pay and control the route; they like travelling in comfort; if the trip is not public, they choose the hour to start off and the stops. A box with brushes, coconuts or office equipment lets itself be taken from here to there without saying a word. Anyone can handle it, because in addition:

Merchandise is less demanding. We can put it in very long tunnels without it getting tired; we can leave it stationary for a long time without it becoming impatient; curves nor sudden braking do not bother it; it does not feel sick on steep slopes. Some merchandise needs certain care: glass objects require cushioning so that they are not

broken; fish must go into cold chambers so that it does not rot; but generally it allows quite a robust treatment.

Merchandise can be put at more risk. If a load with several tons of peaches has an accident, it is possible that an insuring company, the transport company or even the transport network, is forced to compensate the client for damages, but this event will not bring about sensitive funerals. Risks with speed or with determined operations that would in no way tolerated with human beings can be taken with merchandise.

Merchandise is never in a hurry. It is possible that the person who sends or receives certain goods needs them to arrive soon, but merchandise itself is not in a hurry. Passengers live the trip, and usually it is an interval of their life with little utility or attraction for them. In contrast, merchandise does not live the trip. If a container filled with screws is needed in a factory in Milan at eight o'clock in the morning of the 15th, whoever sends it can do so many days in advance without the screws being annoyed at spending five, ten or thirty hours en route. Certainly, sometimes merchandise does live the trip; this is the case with some very perishable foods, such as fresh fish, or some living being, like diverse plants or animals; but their hurry will rarely be comparable to that of humans.

Merchandise is too voluminous, heavy and abundant for transporting it by plane to be feasible, even on very long trips. The airplane has not been able to compete with the lorry, train or ship in the traffic of merchandise, except for passengers' luggage and some type of light and urgent freight, like intercontinental mail.

We should bear in mind that the cumbersome lorries that nowadays disrupt circulation, like cholesterol in arteries, will be withdrawn from the landscape. Only voluminous merchandise that cannot be taken to pieces will travel outside the conduits in great containers.

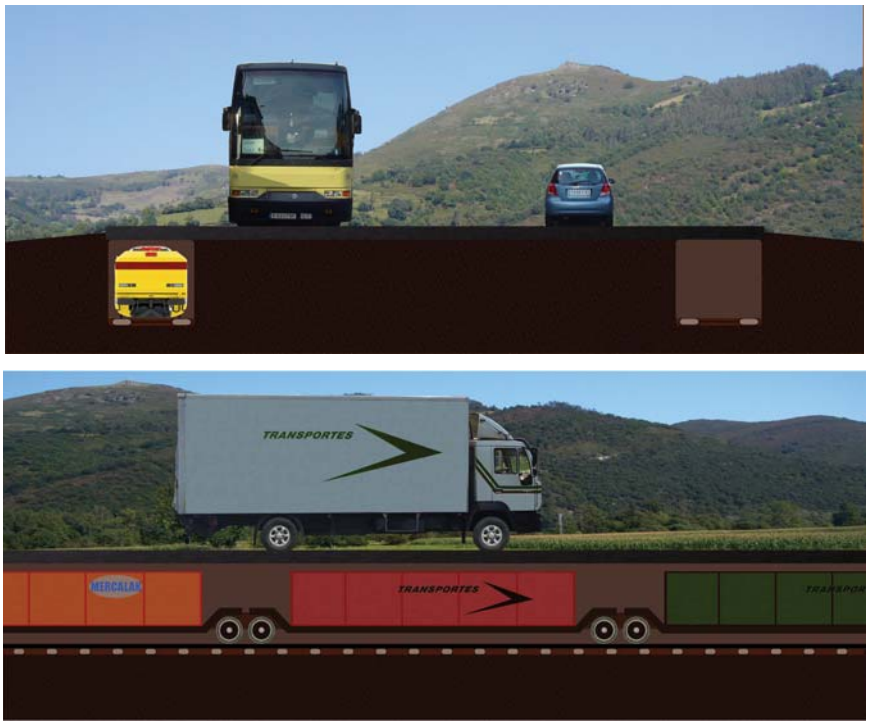
* * *

There will be diverse types of merchandise routes. We can imagine three sizes, not as a forecast, but to give an idea about the whole of the transport system: Long-haul routes that will occupy a two by two metre section between cities. Other more common routes will reach practically all the locations, with a square metre section. In many cases, there will be a single conduit for both directions, which will alternate according

to the network preferences. There will also be delivery conduits at home as we have described already: with a section of only 60 by 40 centimetres.

Probably, there will be many more kilometres of underground routes than aerial ones. The merchandise conduits can be placed just below the ground, so that the top surface is directly stepped on by pedestrians and driven on by vehicles. It will have opening covers every 100 or 200 metres for maintenance and inspection.

Minitrains driven by small locomotives will circulate inside conduits. The load that a heavy lorry carries currently will occupy perhaps forty or fifty metres of conduit in several narrow and long wagons. This is no more than it really occupies at present, since a moving lorry monopolizes sixty metres on average: the length of the lorry plus the essential safety distance from the vehicle that follows it. The space between an automatic merchandise train and another one can be very short. The conduit will absorb more intense traffic than the one of the biggest road without disturbing any other activity.



And, above all, it will be much more orderly. In the chapter dedicated to the network we have already compared the movement of merchandise to a post office

service. Every unit of load will travel from a point A to a point B, changing from one train to another, following its route between intersections. The network will be able to offer the users exact data above the time of arrival at any moment.

The relationship between order and traffic intensity is very important. Currently, on some sections thousands of vehicles crowd onto the road at one determined hour of the day until they form a traffic jam, because every driver arranges his/her trip independently, without the possibility of reaching an agreement with the others to distribute space and time. This will not happen with the network, as we have already demonstrated. It will have the means to regulate the traffic, even more so that of merchandise than the one of passengers. The network will uniformly distribute it throughout the day and night.

It is easy to understand the reasons that will cause the transport of merchandise by narrow conduit to be cheaper. The occupied ground will be very little, tunnels will also be narrow, bridges will be lighter and less abundant than the ones required for human travellers. When merchandise travels along its own conduits, routes will not demand infrastructures as expensive as those for passengers; often they will surround or climb mountains to avoid building tunnels. The huge bridges that support heavy lorries will stop being necessary. There will be many that are narrower and lighter than present bridges, on which the line of passengers and the merchandise conduit will be combined, one passing over another; but many other bridges will be still lighter because they will be constructed exclusively for human travellers, since merchandise, due to its specific characteristics, will make major detours. In cities like Saragossa or Vienna there will be perhaps a bridge for travellers over their river every one hundred metres, but one every 500 metres also designed for a merchandise conduit.

The great revolution in the traffic of merchandise will be caused by the super-narrow conduit of which we have already spoken. Just sixty centimetres in width, it will enter every street, it will penetrate buildings and, combined with elevators, it will take orders to every address. How can loads be carried in so small a conduit? With mini-locomotives, mini-rails and mini-wheels? With magnetic levitation or with compressed air? With pneumatic suction? With transporting tapes or traction cables like the ones of cablecars and ski lifts? It does not matter to us for the time being. It is sufficient to know that industrial engineering will be ready to offer diverse solutions as soon as the

demand arises. The domestic delivery lines do not need to be very fast. It is enough that they provide their strategic service punctually.

All types of food, clothes, office and study objects, cleaning products, tools and, in summary, almost everything that is bought daily in a house, fits into boxes of 40 centimetres in width by 30 in height and 90 in length. Commercial orders, requested by phone or from the multimedia screen found in every home, will arrive in a compartment designed for that use. There will be one in each residential building or in each flat, depending on the situation.

This means that carrying shopping bags or even walking to the shop will no longer be necessary. Such comfort, like every comfort, entails many contraindications; it will deprive humanity of a form of exercise and social life. It is a new step in the trend opened by the automobile and telephone. But, for better or for worse, it will prevail when people have this possibility available. As soon as one neighbour has the conduit in his/her home, all the neighbours will, unavoidably, imitate him/her. In the long run it is not impossible that humanity reacts against comfort as it formerly did against dirt.

This is an opportune moment to reflect on the freedom of societies to choose one path or another. Depending on how the 21st century matures, offering solutions different from those of the previous one, a different attitude will perhaps occur with regards to the services granted by machines, mechanical ones as well as those with artificial intelligence. Perhaps customs and laws will tend to protect the human condition with the premise that people must develop their body and their mind fully. Many people will opt for pleasant mental and manual work, while machines will be in charge of the unpleasant ones. In a near future with advanced technology it will be common to work with one's own hands in garden or an orchard, doing all types of craftwork or artistic tasks, taking long strolls, travelling by horse or bicycle… And all these activities will be accomplished for the same reason why the human being has always liked to dance. If a company offered a virtual dance service, where users would not really dance, but instead a holistically projected figure would do it, it would perhaps find some demand among people with disabilities or the aged; but generally we men and women dance for our own pleasure, and nobody wants to be replaced by a machine in the enjoyment of pleasure.

Computer science will produce devices that will do more and more things better than human beings, but we will continue doing many of these things for our own personal satisfaction. And perhaps the day will soon arrive when the first law that prevents the competition of artificial intelligence with that of humans in certain aspects that we decide to protect is passed. However, the person who chooses to carry out laborious physical tasks or tedious and repetitive mental workings will be very rare. Here we present one of the great challenges of 21st century humanity. Solutions, as we have already said, will not follow expired approaches. Many people from the near future will think in the following way: "I want to be the main protagonist in my life, where the fundamental technology is that of my thought, my hands, my legs, my senses and my heart". Perhaps they will not be wiser than their ancestors, they will continue seeking wealth and power, they will not even have abolished war from among their customs, but they will know how to survive in the time of hyper-technology.

CHAPTER 7
THE NEW SERVICE

A public postal service did not exist before the modern age. Kings and nobles could enjoy the luxury of having private messengers at their disposition that took their letters to wherever they wanted. A poor soldier recruited by force for a military campaign in a distant country lacked the means with which to communicate his situation to his relatives or to receive news from them. The story of the woman who awaits for years the husband who went to war, without knowing if he will return or not is a frequent issue in popular tales and romances. Only three centuries ago, many women suffered the same uncertainty that Penelope did, three millennia ago. The doubt was solved if the husband finally returned, or if a neighbour who could bring news of him did.

The order that nation states generated set about establishing a professional postal service that spread from the king and his bureaucracy to all the population. A service network was formed in this way. From any point covered by the network we can contact any other.

This process, considering the distance involved, can help us to illustrate the development of the service that the transport network will offer.

Currently carrying out a private trip is not possible if we don't have a car or the money to pay for a taxi. A private trip is already defined as the one in which the traveller decides the start time, the exact points of origin and destination, as well as the route and its stops. Starting off right now from my front door for the door of a friend's home, the journey can only be made in a private car or a taxi, not by bus or train. This situation is comparable to the prehistory of the mail service: Some people had a private messenger that carried their letter; but it was not possible to throw it into a post box at a price affordable to anyone, so that it arrived at the exact address. Public transport exists, but it does not achieve a tailored service, it does not take anybody from where they are to the door of their destination at any time.

The private trip in a public vehicle with a price comparable, in terms of transport, to that of a normal stamp in terms of the post office, will constitute the great achievement of the computerized transport network in combination with the computerized communications network. In fact, a trip in the middle of the 21st century will be nothing but the physical expression of a computerized communication between two distant points.

We must imagine the buildings of the near future, homes as well as hotels, administration offices, places of commerce, leisure, production, and even individual houses, equipped with a lobby that will have at least the following elements: Comfortable seats to await the arrival of the requested vehicle, a large window to see it and a multimedia device that will include a screen and a connection to the computer network. The telephone will form part of this connection.

All the trips offered by the transport network will be arranged in advance from one of these described lobbies or any other connection, frequently the mobile phone. The advance in booking can be of seconds or many days, according to the situation. The word arrange indicates that there will be a certain dialogue to harmonise the interests of supply and demand within the limits offered by the flexibility of both. Clients will be so used to such procedures that ordinary trips will be decided instantly.

The agreement will consist of the following phases:

1st. THE USERS WILL SET OUT THEIR TRIP REQUEST

This request will have some specifications like these:

- Type: A trip in a private vehicle, a private trip in a public vehicle (neotaxi), a shared trip on a flexible line (taxibus). In the cities there will also be shared trips on a fixed line for short journeys, like those of current buses, although never exceeding fifteen seats per unit. Their habitual use will not need advance agreement.

- The starting and destination points. Both will consist of the address of a specific door, with the street's name and the building number.

- The number of travellers. And perhaps other data relating to age, weight or other personal information that might be of interest to the network.

- The start time and margin of tolerance. This means that as a general rule the travellers will state something like that they wish to start off between ten and half past

ten in the morning, or that they wish to arrive before three o'clock in the afternoon. A margin is always necessary so that the network can combine the interests of many travellers. Emergencies will, logically, be dealt with as exceptions.

2nd. THE NETWORK WILL PRESENT ITS OFFERS

They will differ according to the type of trip. If it's only a question of using a private vehicle, the sole requirement is to state the route. If it is a question of a private trip in a public vehicle, diverse vehicles will be offered, according to their make and model, their space, their features and their price. More factors will need to be arranged when it is a shared trip on a flexible line. The immediate answer of the network will in general be limited to guaranteeing the trip, which means that, whatever happens, it will send a taxibus to the specified origin, within the established margin of time, without exceeding a maximum price specified with this guarantee. But the network will still not present its offers, because the network will need a while to learn and combine the requests of many travellers. We are going to imagine a proportion of times established by customs or perhaps by the law. This proportion is a third. According to the notice given when making the request, we will have the notice of the offer: For three days, for two; for six hours, for four; for one hour, forty minutes. Then, without more than a third of the notice of the request having passed, the network will send the traveller the details of its offers on a list where for each one it will include at least the following data:

- The time of collection and estimated time of arrival, within the tolerance limits presented by the traveller.
- The price.
- The number, model and features of the vehicle.

3rd. THE TRAVELLER CHOOSES ONE OF THE DIVERSE OFFERS AND COMMUNICATES IT TO THE NETWORK

An alert reader will realize that the network in this phase will encounter new problems, because everything depends on the definitive solution decided on by the travellers, so that some of its offers will be without demand and others will be overloaded. This is the moment for saying that we must leave the smaller difficulties of the system to be solved by the future designers of programs, but even now it is possible

to glimpse the possible solutions as well as the possible problems: The network will administer statistical data that will diminish the risk of agreement. In any case, the number of empty seats will be much smaller than that of current public vehicles. In addition, the network will be able to influence the client by means of the price. If it prefers that a certain traveller accepts a vehicle and not another one, it will offer him/her a lower price for the preferred one.

4th. THE NETWORK CONFIRMS THE AGREEMENT

We have already said that all this process will be dealt with right away in the majority of cases. We must consider that users will be very accustomed to it and that a lot of their trips will not be a novelty for them or for the network. In fact, there will be a high percentage of agreements made at the same time for several journeys, mainly the typical everyday trips at the same time, such as those from home to the work place, or vice versa. There will also be many cases in which the network, faced with the trip request, will present its offers immediately if they are for routes and times with a high intensity of traffic and the risk of vacant seats is very small. Often the network will recommend one of its offers and the user will accept it without a second thought. Furthermore, the clients will frequently order not a list of supplies, but only one trip suiting their request. For a short trip in the city they will not be concerned with the model of taxibus nor with a few minutes difference in the departure time; they will simply entrust the network to take them from their origin to their destination within the specified time frame.

* * *

We are going to study some concrete trip requests to reinforce the proposed scenario.

CASE STUDY 1:

A woman has asked for this trip from her home at five o'clock in the afternoon, one hour in advance, to go with her husband to the theatre. We have her concrete options underlined in bold. She does not need to specify the starting address with letters or numbers, since she has marked the option HERE, and the network knows from where

she is calling since it is a fixed located device. The user calculates that from her home to the Palladium theatre, situated in the same city, it takes about twenty minutes by taxi, which means about thirty minutes by a taxibus that is gathering and dropping off other travellers. For that reason she gives the network a margin of forty-five minutes, sufficient for the price not to be increased. The smaller the margin, the more it will be necessary to pay, within limits.

TRAVEL REQUEST

URGENT JOURNEY EMERGENCY

TIME MARGIN: Departure **18,10** Arrival **18,55**

Date __,__,__ **Today**

STARTING POINT: **Here** Number _____

Address_____

DESTINATION POINT: Number_____

Address_____**Palladium Theatre**_____

SEATS: **2**

VEHICLE:

Private number plate: _____ Taxi **Taxibus** Bus

COMBINED SEE MAP **ACCEPT**

As soon as she hits ACCEPT, the network confirms that it will guarantee the trip and that it will present its offers before 17.30. At the announced time a table with several taxibuses that meet her route, within the established time frame, is displayed on the screen. For example:

MODEL/SEATS	**START**	**ARRIVAL**	**PRICE**
OPEL.TX/12	18,13	18,37	3,25
FORD.HH/15	18,16	18,50	3,30
CITROEN.3P/9	18,22	18,55	3,10

The cheapest taxibus is the last one, without a doubt because it must make fewer detours than the others when collecting passengers en route; but the difference in price

is small, so she does not choose it since the function begins at seven o'clock and she would worry about some incident delaying the taxibus scheduled to arrive five minutes before. Nevertheless, she considers arriving ten minutes in advance sufficient, so she decides on the second option.

Our desire to focus this analysis on the essential aspects of the computerization of transport often cuts the wings of our imagination, which is ready to pursue even the smaller foreseeable details. Here we come across an example of it. Really, the matter of agreement will be more complex. This does not means that this complexity will be constantly used, but it will remain latent among the options that will be offered to the user. In this case, she can access a lot of data about those vehicles that we have called OPEL.TX, FORD.HH and CITROEN.3P in a bet on the evolutionary adaptation of old makes. A link will offer a lot of pages with the outer and inner images of the vehicles, their features and even a transport record. Maybe companies will offer up-to-date photography of their inside so that users can verify the state of its upholstery, for example. The more worn the upholstery, the lower the price, of course. But we must continue focusing on the essentials.

Both tables have been dealt with in about fifteen seconds. The woman has arranged thousands of trips in her life, and she does it as easily as handling a fork. The only thing to do is be present at 18.16 in her vestibule seated on a sofa waiting for the arrival, with a delay of rarely more than two or three minutes, of the promised taxibus.

CASE STUDY 2:

In this case, a family from Brussels want to spend one week's holiday in Rome. Some days in advance, they arrange the outward journey for 18th June. They do not have a private car, but they can afford an ample and comfortable vehicle exclusively for them. It has a small bathroom, which in 2052 will be compulsory for every trip of over two hours, an extensive boot, a small table in the middle, two multimedia screens, and the possibility of making several stops to have a rest. The journey between Brussels and Rome takes seven hours, but since they have a whole day to travel, they offer an abundant margin to the network. They are satisfied with starting off after eight in morning and arriving at the door of their hotel before ten at night.

TRAVEL REQUEST

URGENT JOURNEY EMERGENCY

TIME MARGIN: Departure **08,00** Arrival **22,00**

Date **18/06/52** Today

STARTING POINT: **Here** Number _____

Address _____

DESTINATION POINT: Number_____

Address **Pavese Street, 121, Rome**

SEATS: **4**

VEHICLE:

Private number plate: _____ **Taxi** Taxibus Bus

COMBINED SEE MAP **ACCEPT**

In the case of a private trip, the network will display immediately its list of vehicles on offer, complete with information about them. The exact starting time will not be set for several hours or days, until the network has combined sufficient data on the forming of a train of taxis from Brussels to Rome, or at least from Brussels to Italy, which would start off from a meeting point on the outskirts at ten o'clock in the morning, for example. Each taxi would gather its passengers at around 9.30 from their front door. Once this decision of interest to both parties has been taken, the network communicates it to the client, who simply has to confirm it.

CASE STUDY 3:

Here a man has requested a trip on an urban bus line half an hour in advance. It is a 15-seater vehicle that travels a fixed route with predetermined stops, like current buses. The bus stops of this hybrid between the light railway and the bus, which will circulate elevated on columns on many city streets, as a rule will be also elevated. The user has not put anything in the arrival margin because it doesn't worry him; this is a short and cheap trip. He could have gone to a bus-stop and waited there, but calling the network ahead of time he will know the schedule and the best line for him. He has called from his mobile telephone, which is not located since he has not wanted to do it; therefore, he must determine a starting address. He writes a number that knows by heart,

the one of his place of work. For the destination address he only needs to put **RTM Store**. The network knows where it is, like the rest of the city's public sites.

TRAVEL REQUEST

URGENT JOURNEY EMERGENCY

TIME MARGIN: Departure **17,30** Arrival __,__

Date __,__,__ **Today**

STARTING POINT: Here Number **28 33 630211**

Address _____

DESTINATION POINT: Number_____

Address_____**RTM Store**_____

SEATS: **1**

VEHICLE:

Private number plate: _____ Taxi Taxibus **Bus**

COMBINED SEE MAP **ACCEPT**

Once these options have been accepted, a table of buses on offer is displayed:

BUS NUMBER	SCHEDULE	COLL. / DEST. POINTS	DISTANCE FROM YOU / TO DESTINATION	PRICE
493	17,34	Mont Street C	150m	
	17,59	Mozart Street B	200m	1,75
208	17, 40	Mont Street C	150m	
	18,12	Iris Square	300m	1,60
741	17,48	Homero Street	500m	
	18,16	Picasso Street B	100m	1,75

They are buses that will pass on lines compatible with the client's trip in the minutes following the requested time. The table sets the estimated time when the buses will arrive at the bus stop and the estimated arrival time. It adds the distance from these two bus stops to the indicated starting and destination points.

In the three examples we have seen some options that nobody has used. URGENT JOURNEY and EMERGENCY do not need explanation; but COMBINED does. When this option is chosen, the network understands that there are several starting points or destinations, or both. For example, three friends want to go on trip to a beach. One of them is in charge of asking for a taxi or, if it is possible, a taxibus which will gather each of them at home. A taxibus is not always available in these cases, since perhaps there isn't one with a flexible route near the three houses. Taxibuses follows a line, like buses, but they can be diverted, hundreds of metres on urban routes and several kilometres on long routes, to provide their home service. When choosing COMBINED, a new table appears to specify every address.

We are going to suppose that in this case the friend who is in charge of arranging the trip does not remember the street name of the other two friends. The option SEE MAP is used for that task. When choosing it, a city map on which the user can indicate the exact points, appears on the screen. This is sufficient. Of course, the network computer will have maps of thousands of cities and countries all over the world for determining the route of any type of trip.

In none of the three case studies have we used the option *private vehicle number plate*… It seems annoying that someday it will be necessary to warn the network ahead of time even if we want to travel in our own car; but we must consider that it will drive our car integrated into a complex system of traffic. It needs to know every route to avoid problems. It might also be of use to form a train of several vehicles on a part of the journey, private ones as well as taxis or taxibuses.

* * *

We are speaking constantly of the network as a single person. Probably, it will not be like this. It will be, we hope, a single network, but many people, that is to say, many companies will interact with it. The vehicles offered to the user will be the property of companies in conjunction with a public authority that manages the whole of the network; there will even be determined route segments with private concessions, like those of current toll motorways; also there will be concessions for the maintenance of the routes; but we trust the general arrangement will be totally public.

The 20th century has consisted of, among other things, a still-unresolved, continuous struggle between that which is state-owned and that which is private. Generally, a country's great strategic companies, such as those of electricity, train, telephone, television, etc. belonged to the state. But the trends at the end of the century started towards liberalisation and competition, to avoid the defective operation of monstrous state monopolies. The problem that competition presents, as its name suggests, is the difficulty for collaboration. Imagining a computerized transport network in which, instead of working by general agreement, companies hinder the others in order to control the market, is like glimpsing chaos. When we spoke of the one hundred or two hundred daily 15-seater buses starting off on public trip from Paris to London, picking up and dropping off their passengers at the door of their origin and destination, thanks to the fact that each one is in charge of a limited zone in both cities, we were supposing that all those trips would be coordinated by the same regulation with the goal of maximizing the benefits of the service. But if they belong to different companies with different strategies, every one trying to gain customers from all of Paris and London, flexibility will be lost. We hope for a balanced solution, somewhere between public and private.

In the best case, every company will have its vehicles ready to be integrated into the order of the public transport network. Probably the private management of vehicles will offer a more effective maintenance service and more diverse benefits than the state one. When the network offers several options to our family from Brussels, among them is the one of choosing the management company of the taxi that it reserves, as well as the make and the model. We suppose every user will have his/her own criterion and certain information for deciding which one will offer better quality and fewer breakdowns. With this choice he/she will positively influence the competition.

* * *

The method of payment is a fundamental issue of the new service. We must consider that most of the time no representative from the network will appear during the trip, be it public or private, to receive it. With computerized driving will come computerized payment. Two possibilities exist: an anonymous payment by means of a previously bought travel card, and payment with the traveller's identification card that

will discount the amount from his/her bank account. We presume that both options will always be available.

Let's see how this aspect operates on a private trip in a public vehicle, which we have called a neotaxi. The client asks for it some time in advance and he/she reaches an agreement on time and price with the network. The vehicle appears punctually for the appointment at the front door; but, without a human driver, how does it knows that it opens its doors to the right traveller and not to an intruder? They will remain closed until the client introduces his/her travel card, that can be anonymous or not, in a suitable slot. Once the door is opened, it could be that a cunning client gets in with his wife, two children, two nephews and the grandparents cramped in a car with five legal seats. Who can control that, if there is no driver? Perhaps all the vehicles will have a camera with which the workers of the network can watch the interior at a distance? This threatens people's right to privacy. Two lovers will like to kiss without offering a show to the network's watchmen. An alternative is the one in which the camera exists, but obedient to an ethical code that limits its use to special situations, or that forces the network to warn travellers by means of a luminous or acoustic signal some seconds in advance when it is put into operation. It could also be that the camera works exclusively during the time in which the doors stay open. There is another way to exert passenger control by weight. By means of simple calculations of speed in relation to the power deployed by the engine (simple for a computer), the network can learn the weight of a vehicle. If this one has four legal seats, the maximum weight of the load will be around four hundred kilos. Anything that exceeds this amount will be in evidence. And for every trip with evidence or under suspicion of fraud, the network will have an old resource, that of inspectors. Human beings finally! Yes, many human beings in the service of the transport network will be necessary: Inspectors with an elegant uniform located at strategically important points of the city or circulating in little vehicles. They will be quickly informed so that they can have a look at the vehicles that the network considers suspicious because of their weight or any other circumstance.

We predict that on public trips such the one from Paris to London, a worker from the network or from the companies that work in collaboration, will be charged with remaining in the vehicle during the collection of passengers in the Paris zone, not only to inspect, but also to help with luggage, to inform and, in summary, to undertake

the job of welcoming and settling in that pleases the customer. This worker will not continue the trip to London, but when exiting the city he/she would leave the passengers on their own. Another worker in charge of a similar task on London streets will appear when arriving at the destination.

* * *

We have already spoken of the complexity of the communication between the traveller and the network focused on reaching a beneficial agreement for both. A fundamental part lies in the price. The enormous amount of data that a computerized network can combine in every case makes a great flexibility of price possible in relation to the following factors:

The distance to travel. This needs no commentary.

The type of vehicle: private, taxi, taxibus or bus. In each of these categories there will also be differences according to the number of occupied seats and the features offered in space, diverse luxuries, office or game accessories, the manufacturer and managing company's name, et cetera.

The type of track being driven on: Normal, fast or urgent.

The notice given when booking. The network will award the clients who ask for their trip ahead of time with a discount. For trips of more than one hundred kilometres, half an hour's advance booking could be considered minimum; two hours, sufficient; a day, good; more than two days, excellent. Each of these categories would entail changes in the price.

The availability of energy. In the same way that a cheaper nocturnal price of electricity exists, mainly applied so that heating can take advantage when the demand for electricity for industrial use falls, there will be a nocturnal transport price. And not only will the hour of the day influence the changes in price, but also the date. When the energy supply depends more on renewable sources than on diverse forms of combustion, the flexibility in demand obtained through price will be an important instrument. There will be expensive days with a shortage of wind, sun and water; and there will be cheap days with filled dams and wind turbines on maximum yield. Therefore, a non-urgent transport of merchandise will exist which will operate during

the hours and days with lower prices. Many people will look for offers when travelling as they do at present when looking for certain flights.

The line. Just as currently happens with toll motorways, there will be sections of route which have a different price per kilometre from that of other sections. Generally, this difference will depend on the cost of its construction and maintenance. There will be strategic lines on which it is possible to circulate at higher speed thanks to their well-finished surface, the form of their curves, et cetera, and the users will have to pay for such advantages.

The state of demand on a route. Thanks to its capacity for arrangement, the network will fight traffic jams at certain points generally seeking an agreement with travellers. It can offer options like this:

1. Entrance to Madrid in the North from Guadarrama, 30 minutes, 10 Euros
2. Entrance to Madrid in the West from Guadarrama, 50 minutes, 7 Euros.

Some clients with that route will choose the first option, and other will choose the second one. In this way, the network will ease traffic at the North entrance, which otherwise is in danger of gridlock.

Haste. We can see this with an example: A user wishes to arrange a daily trip at the same time from his home to his workplace. The network offers him a 30-minute journey at a price of 12 Euros, and also a 40-minute one at a price of 10 Euros. He may want save those two Euros daily, but it is also possible that he is not in a hurry. It seems incredible, seen from the point of view of today's traffic, that someday a lot of people will travel in cities without haste. We must put ourselves in the place of the users who travel quite happily without driving. It may happen that even in the smallest cars without a washroom there is a water tank with a practical and hygienic device for cleaning teeth. Thousands of 21st century citizens cleaning their teeth while they go to their workplace! It may also happen that on the screen of any vehicle they can connect to the film that they are following, a certain romantic or action series that altogether lasts fifteen hours, but that the travelling viewers see in episodes of about twenty minutes while they go and return every day from their home to their workplace.

These are trips without haste. Their secret consists of getting in the vehicle in sufficient time, and once inside letting the network worry about arriving at the predicted time. It is easy to understand that many users will choose between the fast option and the slow one according to their circumstances; but what does the network gain by that? It gains a certain percentage of travellers without haste who offer a margin with which to carry out certain operations, such as giving way to the travellers in a hurry at the crossroads or waiting for other vehicles to form a train with them. Also, it may happen that the network offers a guarantee: Every minute that the trip duration exceeds the established limit will mean a refund, to such an extent that in the previous example a ten-minute delay would make the trip free.

* * *

Another fundamental aspect of the new service will be the rule that nation states and the international community will apply in its regard. There will be laws on the matter of safety that regulate speed, the route of the lines, radars, crossroads, vehicles, et cetera. We assume that the network will take this aspect more seriously than human drivers. Somebody will perhaps allege the following: "Human drivers travel within their vehicle, they risk their own life, nobody can be more interested than they are in the safety of the trip". It is paradoxical, but that phrase does not reflect reality. Many cases demonstrate this statement. One of the major tasks of current traffic police is making sure that those travelling by car wear their seat belt. The fines for not wearing it are severe, with reason. Statistics demonstrate that the effect of an accident often goes from minor to very serious according to if the victim is or isn't wearing their seat belt. This is something evident for anyone who thinks about it carefully, and it is truly paradoxical that a policeman has to admonish a driver, as a father would his small son, for his own exclusive interest. We insist that: the network will apply the safety norms with more implacability than contemporary drivers.

There will also be a rule about business competition within the network to regulate, among other issues, the concession of operation licenses; other rules about the features of vehicles, which will take into account directives such as the one which states that all the long-trip vehicles must have a bathroom, and such as the one which states that the seats will be limited according to the inner space; and a rule on the passengers'

right to privacy; and an other on the secrecy of electronic information relating to journeys and payments with identification. After the rules, there will be a legal conglomeration dealing with claims, law suits, insuring companies, lawyers, plaintiffs and defendants.

With regards to the management of freight transport, we compared it to a post office service, that is to say, an omnipresent intermediary, available to all senders and apt for all addresses, which arranges the trip in a complex network. It is necessary to complete this image. There will be many companies carrying freight in the network. Online sales will be a wide-spread custom. We are going to put ourselves in the place of users by means of several case studies.

FIRST CASE STUDY

Order from Ana L. to the supermarket Netshopper: 2 kg of flour, 3 lettuces, 1 kg of tomato, 5 kg of rice, 1 kg of ham slices, 2 loaves of bread, 4 litres of milk, one pizza, an almond cake, a box of washing powder, 2 different bottles of shampoo, a packet of tissues. Time of arrival, between 13.00 and 15.00 hours.

The supermarket Netshopper gets the order ready in two boxes at 12.15 and puts it in its station of the narrow freight-delivery conduit. Netshopper works with the company Mercatrans, which deals with the transport of merchandise by narrow conduit within the network. At 12.30 several mini-trains that will head towards the east zone of the city, where Ana lives, have been arranged. At 40 kilometers per hour, the locomotive is following its route in the conduit. An automatic system leaves the order boxes in the stations of the various buildings. Most of them will belong to a block of flats and they will have a closed compartment for every neighbour. As soon as the order arrives, a luminous or acoustic signal, or both, are displayed on Ana's screen to warn her that she can already go down to collect it. But in the most modern residential buildings, the particular compartments will be in contact with a mini-elevator that will take up the orders to the flat.

SECOND CASE STUDY

A consignment of twenty tons of wheat from the agricultural company CCA, located in Benavente, to the industrial bakery IAGU, located in Santiago de

Compostela. It is not an urgent order. IAGU is happy for it to arrive within one week. CCA usually works with a certain transport company, Unitrans, which offers good prices, continuous information on the shipment, few disturbing incidents and numerous guarantees against delay or damaged merchandise. A convoy with five wagons, whose measurements in centimetres are: 100 x 100 x 400, arrives by an underground conduit. A small locomotive drives them. The CCA silos are placed in an industrial estate and they have direct access from the basement to the conduit. Several hoppers fill the wagons with the ordered cereal at six o'clock in the evening. It will travel taking advantage of the nocturnal tariff. A common terminal for the whole industrial estate exists. The convoy waits there. Late at night, the network uncouples it from the original locomotive and joins it to a train with units coming from the south towards Galicia. It will take three hours en route at an average speed of 200 kilometres per hour.

THIRD CASE STUDY

A married couple from Barcelona aged around seventy is going to return to home after spending fifteen days in a spa town in Salamanca. They are carrying three heavy suitcases filled with clothes, books, bottles, gifts for their family and many more things. They would include them with the luggage of their return vehicle if it were not for the fact that they first want go via Madrid to visit a relative. Since they don't want to have to walk around carrying that load during their visit, they decide to send two suitcases by conduit. They know the suitcases will arrive at their home in Barcelona before them. Something like this can already be done at present, but almost nobody does it since it is too expensive. What this couple will pay for the transport cannot be compared to what we would pay the post office service or any other mail company today.

The efficiency of the universal transport of freight organized in a network using specific conduits will make the small, but heavy, orders of this type (between distant places, in customized boxes that will share trains with other many boxes of very diverse merchandise) frequent.

There will in practice be feasible custom-made transactions without intermediaries such as the following:

- A consumer from Zurich requests ten kilos of organic oranges directly from a reliable producer in Pisa. With the same criterion he requests ten litres of olive oil from a producer from Salerno.

- A musician from Montpellier buys a handmade guitar from a craftsman in Granada from a catalogue.

- A restaurant in Madrid receives a fish and fresh seafood package on a daily basis from its habitual supplier in Asturias.

- A builder from Munich orders 250 tiles of certain old design to repair, with the fewest possible changes, the imperfections of an old villa, from a store clerk in Gante, the only person that has them, according to his catalogue on the Internet.

* * *

The computer screen will be the great protagonist in the transport of merchandise, even more so than in that of passengers. It will be used, in a single session, to decide upon both the purchase of items and their transport. We must imagine colorful catalogues, advertising reports, audio-visual instructions, chats between the salesperson and the buyer… It is possible that the changes introduced in this way cause important changes in consumption habits, which may or may not be positive. Perhaps the purchase of prepared food will become general, so that the task of cooking is put in charge of machines managed by professional cooks. It is a process that started a long time ago. Years before the same process happened with dressmaking: the family stopped making their own clothes. Maybe those three meals a day will not come full of preservatives, like current pre-cooked foods, since the conduit will distribute them from restaurant to consumer in a very short time.

Will all these facts influence the way we live together in family groups?

We must not demand a posteriori a high percentage of right answers from whoever studies possible future scenarios, but a high percentage of right questions.

CHAPTER 8
THE NEW VEHICLES

To present in great detail a vehicle which we think will circulate in 2050 is extremely risky. If, when the decades have passed, the prediction matches the reality in half of its fundamental aspects, we must consider it a great success in forecasting. However, it is worth the trouble of speculating. We will present several models using as a reference the features already studied:

- Small and light units.
- Computerized driving in a network.
- Speed separated by elevation.
- The electrification of engines.
- The transport of 90% of merchandise by independent conduit and the rest in special vehicles outside the conduit.
- The formation of trains in sections of the routes.
- The abundance of private trips in public vehicles.
- The slight persistence of the private vehicle.
- Vehicles for public trips with a maximum of 15 seats.
- A secondary system of transport at ground level at low speed with free tyres and guide-tracks.

To the main features we can add other secondary ones even more prone to mistake. However, they complete the scenario:

We suppose state and international rules will regulate traffic with at least as much dedication as they do nowadays. Not all vehicles will be qualified to undertake long trips. For reasons of sanitation and the traveller's comfort, routes of more than one hour in length will be carried out in vehicles with a bathroom, as well as reclining seats and a certain minimum space for each passenger. In this sense, it is foreseeable that

urban trips with standing passengers will be considered things from an underdeveloped past, as we currently judge long trips to be.

Safety rules will be even more stringent. Since there will be no human driver who needs to look ahead, and since in the case of collision passengers crash against the front part of the vehicle, we imagine that part to be fully padded, without glass, perhaps with some small transparency made of soft material through which travellers can see ahead. The main windows will be lateral. The computer screen, essential in every vehicle for entertainment, work and communication between the network and its users, will generally occupy a place in that part, but high enough for any person not to hit it in case of an accident.

In some link on the main screen there will always be data available about the exact point on the map where the vehicle is, the number of kilometres travelled and how many remain until the end of the trip, the anticipated arrival time, possible incidents, et cetera.

There will also be a system of acoustic signals for the traveller's service and comfort. Human voices or diverse characteristic prerecorded sounds will indicate, among others things: abrupt speed changes, mainly sudden braking; regular stops or those extraordinary ones due to traffic accidents; notice of arrival and alarm calls at a programmed time.

Considering that in the vehicles of the future passengers will be able to do some activity and will have at their disposition sophisticated computer equipment, we must foresee wide spaces for leisure, work or study. A central table with four or six seats around it will be frequent, as useful for playing cards as for spreading papers and office equipment on. There will be a screen that is different from the main one of the vehicle. The computer equipment will only consist of a screen, a camera, a microphone, a mouse and a keyboard. Passengers will not need to own a computer, but only to connect themselves to the computer network, which will have the computers to serve every user.

We can give the example of an employee of a company which works in the sale and distribution of clinical material. She directs the tele-sales section in the central offices in Barcelona, but she lives in Tarragona and she takes half an hour to travel from home to her work place, and vice versa. Nowadays, she would probably spend that time controlling the steering wheel of her car; in the future, she will be able to dedicate it to

screen leisure; she will also have the option to get on with work while she travels, inspecting the latest operations, so that half an hour on the way out and the same on the return are included in her day's work.

It may be that on public trips in small buses, some of the seats have an arm especially designed with a keyboard that can be place over the legs of the seated traveller in combination with a screen on the seat back of the traveller in front.

There is another reason to predict that vehicles of the future will generally be wider than current ones: They will not spend a long time parked, invading a space on city streets. Most urban public trips will be carried out by bus or taxibus, and almost all private trips will be by taxi, that is to say, public vehicles that will continue circulating in search of other passengers after each service, and they will rest, when demand drops, in an underground garage belonging to their proprietary company. Empty space has no weight. If a vehicle has four seats with four passengers, there will be little difference in the cost of energy and material used when it measures three or five metres. Only a little more body. What counts is the space occupied along routes, but the greater length of vehicles will be compensated with a smaller average distance between them, thanks to computerized driving and the formation of trains.

Since automatic driving is not guided by sight and since vehicles do not need to be seen at night on routes separated by elevation, they will not have external lights, or if they do they will be small, mainly to illuminate the side of the vehicle when collecting or dropping off passengers.

We can imagine that the vehicles designed to reach high speeds will have a sloping frontal part, such as usually happens with present-day cars. However, considering that in automatic driving on a track every vehicle can travel in two directions, a front and a back will not be established a priori. Both ends will be adapted for speed with aerodynamic shapes.

Engineering applicable to the formation of trains can bring different solutions ready to compete for the market. We will imagine as guidance two horizontal piston rods located in the lower front part of every vehicle. When receiving an order they project forward to enter, as does a male plug, two holes located for that purpose in the back part of the vehicle in front. All vehicles would be equipped with both devices. The piston rods would be held in place until a new order was given. A system of this type

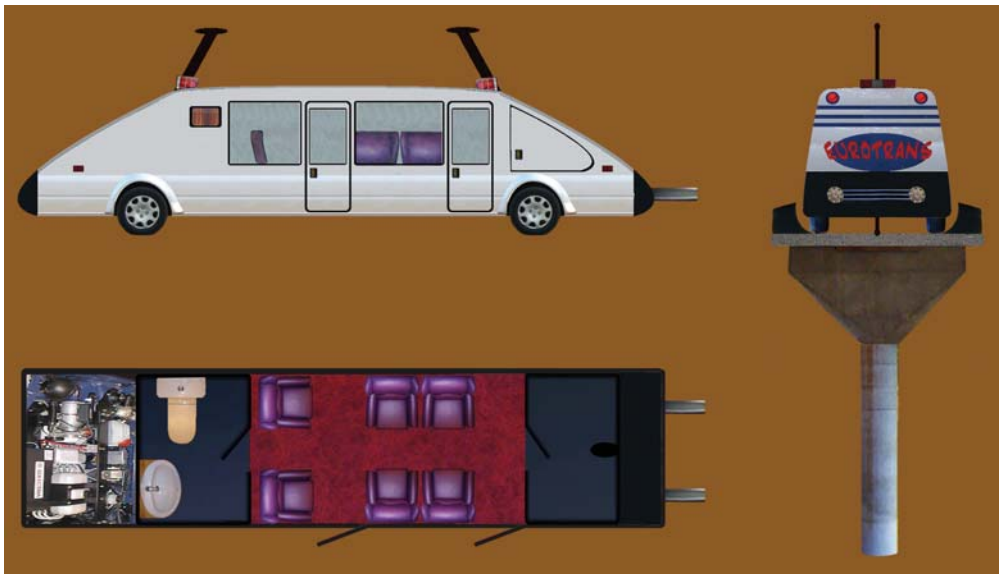
must be complemented with some mechanism for shock absorption between both vehicles.

Certainly, the formation of trains presents practical difficulties that could make it less usual than we have predicted. Perhaps the required front and back features for fast and safe connection will be too heavy and voluminous for it to be worth the trouble of carrying them on all vehicles. It is possible to imagine a technological resource of the network which will allow us to take advantage of the energy and space saved with the formation of trains without the nuisance of such accessories in each unit. Small units for connection could be available to the network at many points for where they can be placed between two vehicles. They could be placed vertically over the routes on turrets with an elevator able to quickly put them on the route between two stopped units, one ahead and another one behind. In addition, these devices could carry one engine, so that they are small locomotives ready to increase the power of the convoy formed with a few vehicles and several of them.

Another factor to consider when speaking of the vehicles of the 21st century is that not everything will be efficient and take rational advantage of resources. One of the most profound trends of the human being is aimed in the opposite direction: towards luxury, wastefulness, the satisfaction to own and to dominate. Many vehicles, either private like houses, or rental ones like hotels, will fulfill with refinements the assignment of differentiating rich people from the poor, and also from those of medium wealth. Long units with complete bathrooms, double vans like articulated buses, trains thirty metres in length for a single client or owner, with zones for servants, bedrooms, the kitchen, dining room, et cetera. How many people own two, three or more cars at present? Many. They do not use all of them simultaneously because drivers would be needed. But when the network can drive several units together, connected like trains so that it is even possible to pass from one to another en route, many tourist, business, political, commercial or other trips will be carried out in this way.

* * *

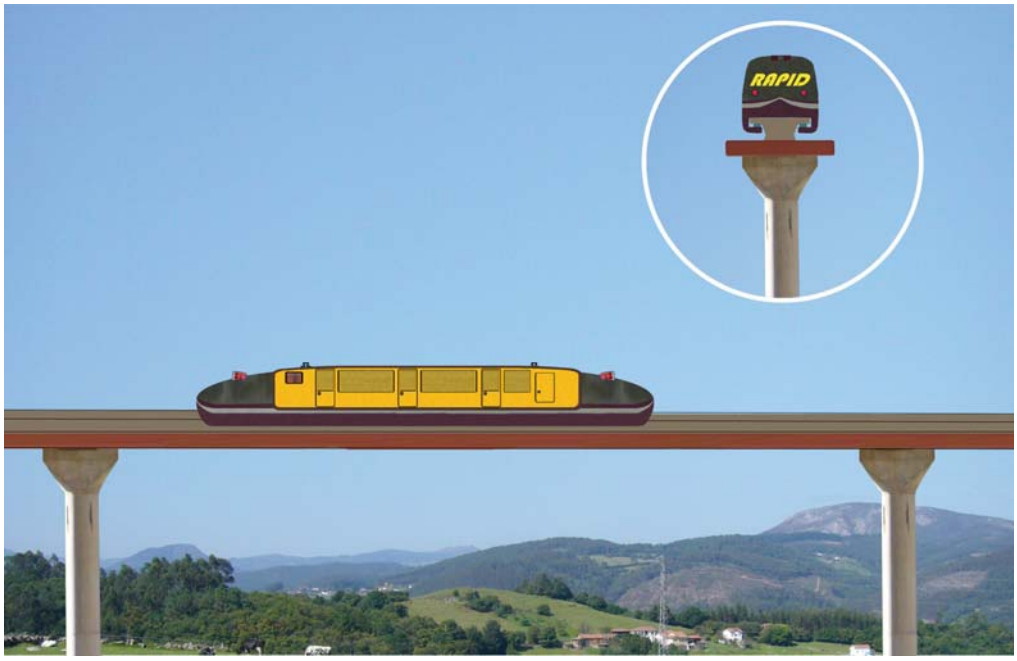
As a graphic sample of all that we have talked throughout the book, we present the following vehicle models:



- A six-seater car for use as a taxi or taxibus, able to reach 250 kilometres per hour. It circulates on a continuous bridge with a guide and a power supply on the floor. On slow routes at street level the guide and the power point are elevated. Their wheels are made with non-rigid material. From an aerial view, from left to right we see: The engine; the bathroom, which makes the vehicle fit for long journeys; the central room with six seats (which will include accessories for working and leisure, such as screens, keyboards, tables, etc., and also padded surfaces for safety); the boot with lateral and inner access; the guide-system and the retractable piston rods for forming a train.

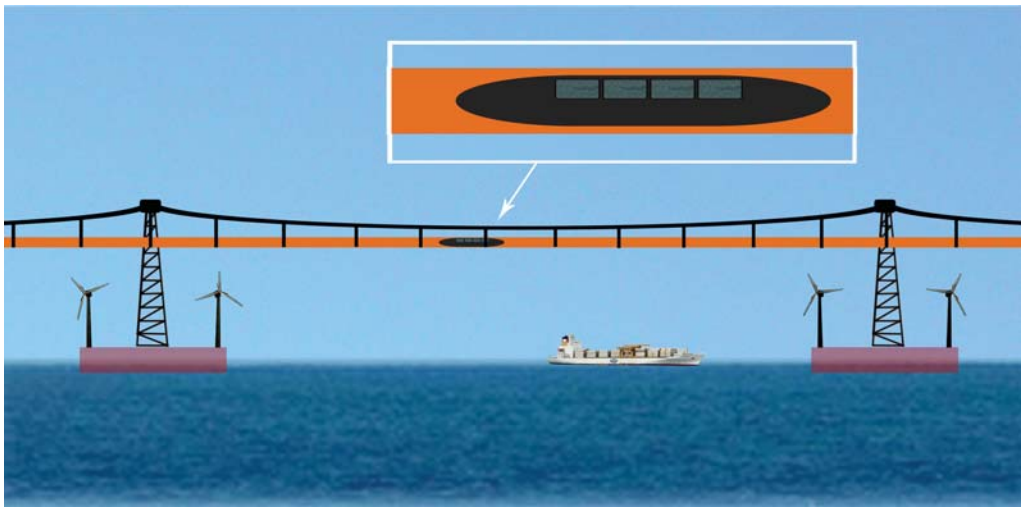
- A two-seater car for short journeys circulating on continuous bridge in an urban zone behind a six-seater car. It includes a screen and sound for leisure or work use in connection with the network. It has the features for making a train folded away.

- A very light elevated train with rails and a conventional power supply system based on automatic twelve-seater units. It can go down narrow streets without affecting ground-level traffic. A tunnel made with transparent plastic serves for acoustic isolating.



- A ten-seater unit for use as a long-haul taxibus on an elevated route, able to reach 400 kilometres per hour on a monorail. Its traction system lacks compatibility with the ground level routes, yet it consists of two parts: a carrier composed of the body and the engine, and the other which consists of a cab with the passengers' seats, their luggage, a bathroom and diverse other features. When arriving at the destination station,

a waiting crane will remove the cab from the unit and will put it on a conventional taxibus carrier with a compatible design to take the travellers to the door of their destination.



- A conduit over the sea supported by floating towers anchored to the bottom. A bullet-unit travels along the pipe at 400 kilometres per hour driven by a suction force.

- A private train made up of four units: 1, a car with a large boot and the engine; 2, a car with six seats; 3, a room with tables for playing and office work, and a dining room; 4, a car with a bedroom and a bathroom. They are four different sections joined by articulated parts accessible when in motion.

CHAPTER 9
THE TRANSITION

On fulfilling the forecasts and suggestions that this book contains, lorry drivers will see the gradual decline of their office. In this process there will perhaps be conflicts such as the one of several pickets destroying a merchandise conduit under construction with heavy blows before the journalists' cameras. Their fight will be useless, at least from the point of view of the changes in transport planning. Yet, to those who protest it will serve to obtain compensation from governments: subsidies for unemployment, early retirement or direct access to other jobs. Distributing equitably among the whole population such a fundamental economic resource that is employment is a huge political task.

Moreover, the country that puts off making the changes that other countries are developing, will have to pay a great deal for that delay further ahead, because in the West for several centuries technological advance has been fatal. And here the word *fatal* does not pass judgment, but, considered in its etymological sense, it means "dictated by destiny", inevitable. Nothing can be done against it. With all their benefits and disadvantages, the steam engine, the mechanical loom, train, assembly-line work, electricity, the car, the airplane, the television, the electric household appliances, the computer, etc prevailed, and everything which follows the same trend will prevail until a mysterious change in the mind, in social relations or even in science, brings about a variation in the course. It is a change that we cannot glimpse from here. Perhaps three or four hundred years will pass till it occurs. Perhaps one of the thousands of science-fiction stories written throughout the 20th century has the key, without anybody suspecting it. Also it may be that a cataclysm in history brings it forward.

Although the wronged lorry drivers do not remember it, two or three generations earlier lorries robbed the old transport professionals, muleteers, of their task. These had to retire their carts and mules from the scene with resignation. There is at least one piece of evidence which serves as consolation: With every technological change, while some

jobs become obsolete, other new ones appear. To this axiom we can add another one: In the long run the number of average daily work hours diminishes. This issue is not always positive since an entertaining job is better than an excess of leisure. A synonymous expression of *leisure* is *free time*, that is to say, that part of the day in which each person decides what he or she does or does not do, without being urged by the necessity to get economic resources. It is a full and pleasing time to a lot of people; it is an empty and boring one to others. Here we find one of the great challenges of future society.

In conclusion, the computerization of transport will face a certain resistance to change because of its huge influence on working life. What other resistance will it meet throughout the next few decades?

There are many vested interests in the current system of transport by road, so many that for some years they will have more power than the interest to create by innovation. For more than five decades, since the marginalization of trains, nothing has changed in essence. The automobile appropriated the world and extended its empire in space and time. A driver from New York who died in 1950 with all his faculties, would find very few difficulties in adapting if he had been revived in the year 2000. The cars from that time were already able to surpass 140 kilometres per hour, a greater speed than the one allowed after fifty years of obstinate motorway building.

It is natural that many vested interests exist after so much time with the same model. We have already considered the interests of professional drivers; let's mention now those of the great companies which extract and distribute petroleum and its derivatives. What will they do with their petrol stations when electrification becomes common? Will they react instinctively against the first applications of change? Will they embark on the race of technological competition? Will they try to get the concession for the first computerized routes?

Yet besides the vested economic interests there is a vested mentality, a way of understanding life that will react for some time against the signs of new things. We will examine these reactions one by one.

RESISTANCE TO AUTOMATIC DRIVING

THE COMPUTERIZATION OF TRANSPORT Julio Arbesú

A personal computer at the start of the 21st century, available to everybody, has more power than the computers used by the NASA in 1969 to carry a man to the moon for the first time. Its capacity for the storage and organization of data is fabulous; its applications in all scopes of life, from communications to product control, passing through industrial design and word processing, are so many that no branch of human activity exists that is able to evade its influence. However, paradoxes, contradictions and exceptions to the rule occur in all periods. At this time of the unstoppable advance of computer science an apparatus of great economic and social importance still uses primitive manual handling: the car. And for the time being an experimental route of road transport that offers a computerized service does not exist. There are trains, as is logical. Driving on a track can be easily computerized without any mental resistance. Train passengers have always been used to letting themselves be transported. Car owners will for some time refuse to let themselves be transported, because human beings, particularly men, like driving. The power offered by the steering wheel together with speed has been the source of much pleasure and many misfortunes, and it will bravely withstands, like the last defender of a castle, when everything around it crumbles under the attack of the enemy. Many private drivers will continue driving as long as laws allow it, when all the public and professional trips have already fallen under the computers' control due to the evidence of their effectiveness and safety.

RESISTANCE TO TRACKS

Roads of 10 or 12 metres in width, motorways of 30 or 40, plough through landscapes in all regions in developed countries. What will we do with those monsters and with the companies that build them when we advance towards small scale? Since the discovery of the transistor, this advance has constituted the most revolutionary trend of the 20th century. Who prefers a radio of eight kilos in weight to another of 200 grams which gives the same service? Who prefers an investment of ten million Euros per kilometre to another one which costs the quarter and supports the same intensity of traffic? Whoever benefits from the investment prefers it.

But this isn't the greatest resistance to tracks. It is rather the lack of imagination to conceive new types of track able to go anywhere without presenting a barrier on the ground.

RESISTANCE TO SMALL UNITS

We are going to repeat an axiom already formulated in the fourth chapter: "In the computer science era it does not make sense to make an effort to reunite more than fifteen people to undertake the same journey". For 21st century transport small things are practical, narrow things are effective, light things are profitable. We think that this has already been demonstrated by this point in the book. However, it is a very important change in mentality, because throughout the 20th century the transistor trend has not been applied to transport. Roads and bridges have become increasingly larger, tunnels have become increasingly wider, and buses and lorries more and more voluminous.

We must remember that the unquestionable victory of the road over the railway was due to the capacity of the former for moving small units. We must also remember that the main profit from railway lines is obtained in the surroundings of large cities, thanks to the services of suburban and underground trains, which circulate frequently with relatively short trains, compared with those long-haul ones. In spite of all the evidence, resistance in this sense, the inertia of old conceptions, will be an obstacle which will be difficult to overcome.

RESISTANCE TO ELECTRIFICATION

Although a great part of the railroad network has been successfully electrified, doing the same with traffic of small units presents a great difficulty. For a car with a combustion engine to be able to move on any surface it is only necessary that the ground not be too steep. Its engine gives it a huge independence. In contrast, a vehicle connected to the electrical current of a cable will have difficulties if it needs to move away from the network. A not very voluminous battery will suitably solve the problem of driving in car parks or private zones where there are no cables; nevertheless, we must not await long-haul independence with electrical engines. The drawback exists, and only a great stock of advantages will make us forget it. The first and main advantage is that automatic guidance will also need a mechanical connection for a long time.

RESISTANCE TO THE PRIVATE TRIP IN A PUBLIC VEHICLE

Perhaps this is the weakest resistance among those which we are presenting. It will be overcome when any user can travel in this way at the same or at a lower price than that of his/her private vehicle, with identical freedom of route and schedule and with the same privacy. For that moment to arrive time and investment are needed. Overcoming the eagerness for the possession and ostentation of one's own vehicle is not easy. Perhaps during a period it will be usual for users to keep luxurious vehicles in their garage which are only used for certain tourist trips, or to attend weddings and other social meetings in which the exhibition of one's own vehicle is as important as that of the suit. Meanwhile they will use vehicles offered by the network for routine trips, mainly short ones. It is possible that further ahead almost everybody renounces the troublesome possession of a vehicle, and that the longing for ostentation is directed towards the quality and the luxury of rented vehicles.

* * *

Having considered all foreseeable resistance against change, caused by so many decades with one sole dominant model; considering on the other hand that in different sectors to that of transport our society is accustomed to change; considering that the spread of the computer science empire is still at its time of splendour, we are going to study the phase of transition starting with a few pioneering projects that we will present as examples. Sooner or later they will take shape in countries from Europe, North America, the Far East or Australia with a strong technological initiative; but what companies will lead this race? Will it be manufacturers of cars, powerful computer companies, great railway corporations? In what exhibitions will the first animated scale models appear?

PIONEERING PROJECT 1. A RAILROAD LOSING WEIGHT

We are going to repeat, insisting as often as is required: "In the computer science era it does not make sense to make an effort to reunite more than fifteen people to undertake the same journey". This phrase will get all its authority when computerized vehicles move in a complex network; but we can advance in that direction starting from today.

A 400-kilometre line arriving in a large city like Berlin, Nagoya, Madrid, Sao Paulo or Atlanta, busy with hourly trains carrying 600 passengers, could increase its frequency to 15 minutes with units for 150 passengers.

Railway companies trying to increase frequency by means of reducing volume is a first great step. The technology for controlling dense traffic is already available. Frequency attracts customers. After frequency and customers the second great improvement will arrive: flexibility within the network, that is to say, the facility to reunite sufficient passengers with the same destination within a very varied choice of destination.

Let's give an example: Currently, several trains circulate every day between Malaga and Madrid; but none circulates between Malaga and Bilbao, Santander, Gijon or Corunna. The traveller who wishes to undertake one of these trips by train must travel to Madrid, and then, after waiting for perhaps several hours, must take a second train to the final destination. Yet, if the railway network could handle small units, trains made of three carriages with fifty passengers each, or even less, not only could offer a superior frequency Malaga - Madrid, but some of those trains could have cities from further north as a destination. This possibility would favour a part of customer demand, it would combine the Malaga - North trip with the Madrid – North one.

A third step in this sense is the possibility of advance agreement between clients and company thanks to a computerized service of communication and arrangement of trip requests. We will continue with the same example: Perhaps in the varied supply of small trains from Malaga a direct train between Malaga and San Sebastian still does not exist. However, if some days in the year at least fifty requests coincide on that route, the company can offer its clients this direct trip in a certain unit that will perhaps form a train with others between Malaga and Madrid, but will later separate to arrive alone or in a different train in San Sebastian.

All these possibilities would already be within reach of the bus companies if they were as large as the railway ones. However, the latter have a great advantage: it will be much easier to apply automatic guidance to them during the first stage, and so we foresee that they will take the lead in the development of public transport for passengers in the first decades of the 21st century.

PIONEERING PROJECT 2. A TAXIBUS WITH ADVANCE AGREEMENT

The possibilities presented by computerized communications for a new conception of taxi are far-reaching. The goal is to get, starting now, a much cheaper door-to-door trip than that supplied by current taxis. Starting now means with a human driver. We are going to imagine a city with a fleet of 12-seater taxis in permanent communication with a central computer control. The taxi drivers have at their disposition a small screen on which addresses and other data is displayed. The user calls central control by telephone, or communicates with it through the Internet, at least 15 minutes in advance. He/she requests, for example, the following:

STARTING POINT : 23 Manuel Falla Street	DESTINATION POINT: 55 Peace Street
TIME MARGIN: 14 – 15	SEATS: 2

The margin means that the traveller wants to start off after 14 o'clock and to arrive before 15 o'clock, accepting any possibility within this period, although the trip takes much less time.

Central control answers him/her in five minutes either through the voice of a worker by telephone or with a table on the screen. It presents the following offers:

OFFER 1	OFFER 2
EXPECTED DEPARTURE: 14.05	EXPECTED DEPARTURE: 14. 21
EXPECTED ARRIVAL: 14.30	EXPECTED ARRIVAL: 14.52
PRICE: 1.5 euros/seat	PRICE: 1.4 euros/seat
VEHICLE: 8223	VEHICLE: 7102

There may be some more offers, especially if the communication is written. The client only has to choose one of them and to arrive punctually in his/her vestibule at the agreed time.

How is a taxi control network able to do this at price far below the one of a conventional taxi? It is able simply by combining the data of many clients, which is simple task for a computer.

In those 12-seater vehicles, a taxi-bus hybrid, passengers that don't know each other get in and out. This is what lowers the price of the trip in relation to a conventional taxi. The driver follows the orders displayed on the table. Something like this:

1. 105 Cervantes Street.....	Collect 3
2. 23 M. Falla Street.....	Collect 2
3. 38 M. Falla Street.....	Drop off 2
4. 125 M. Falla Street.....	Collect 1
5. 18 Clarín Street.....	Drop off 3

The driver does not have to decide mentally about routes on the city map. It is the central computer software which knows this map profoundly: streets with no entry; streets closed by works, accidents, celebrations or demonstrations; zones jammed with intense traffic; short cuts between streets… The software also knows the expected times for each section, and it is able to draw up a complex route in the city's labyrinth.

It is reasonable to suppose that the implementation of the taxibus will cause important changes in urban transport. Many travellers will be dissuaded from using their private car. They will prefer to wait for a few minutes in the waiting room of their own vestibule rather than going to get their car from a garage. And even more helpful is being dropped off without worry at the door of their work place instead of looking for a place in streets saturated by vehicles or in a car park where you have to pay. Many cities favour buses and taxis with special lanes, banned to other vehicles. It is logical, they try to clear urban traffic by supporting public transport. In this way, we will see the hybrid taxibuses of the near future overtake private cars.

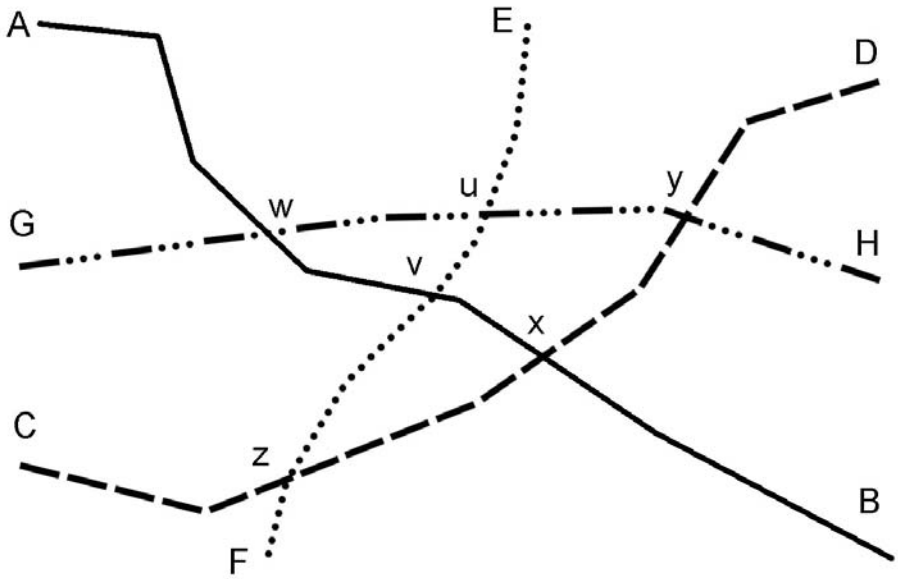
PIONEERING PROJECT 3. A VERY LIGHT URBAN TRAIN

A light urban train which has something of the conventional underground and a lot of the tram has been put into practice in many cities around the world. Nevertheless, full computerization aims rather towards a very light tram, with twelve-seater units.

A conventional subway can have tens of lines. In our drawing, a model with four lines is sufficiently illustrative. Every train comes and goes along each of them, from A

to B and vice versa; from C to D and vice versa; and so on. The same happens with bus lines. A traveller who wants to go from A to H will have to make a transfer at intersection w. Yet, a twelve-seater unit in a computerized network is able to travel by lines and intersections from A to B, C, D, or any other destination. When arriving at the station, users introduce their trip card in the control slot, then they indicate the point of their destination on a screen at their disposition. Immediately, precise information is displayed about the corresponding vehicle and how long it will take to arrive. In this way, travellers will be able to choose any point of the city without any transfers being required. Since they are small units, immediately grouping together at least eight people with the same destination zone to travel in each one will be easy.

MAP OF A CONVENTIONAL SUBWAY



Their commercial speed will be able to surpass by far the 25 or 30 kilometres per hour common on current subways, since a stop will not be necessary at every station, nor even at the majority of them. Considering that the network is reuniting passengers from a restricted zone of origin towards a restricted zone of destination in its vehicles, it is probable that they will only need to stop at one, two or three stations for

collecting and a similar number for dropping off. Quite often a unit will gather twelve passengers at station A with a common destination at H, for example, with no intermediate stop or transfer.

Having discerned the possibilities for efficiency that the very light urban train presents, we must consider that this system offers a very cheap solution to a city without a subway that needs to create the infrastructures of new underground routes. The first urban trains, like those of New York and Chicago, moved along the streets on high routes which had to support locomotives of twenty tons in weight. The lines of the very light transit would only support three tons, at the most. A continuous bridge of 140 centimetres in width for one direction, and under four metres for sections with both directions, can be placed on columns of about four metres in height, with about ten or twelve metres between each one, placed along the middle of a street of normal width. All this would disturb the traffic at ground level very little, since the line of columns would form a dividing line. As far as the users were concerned, not only would they have the advantage of travelling with sunlight, but they would not be forced to go down and then to go up long stairs to arrive at stations built at the necessary depth to obtain underground routes more level than the city's surface. An investment of this type could be several times lower than that necessary for opening the tunnels of a conventional subway for any city. Which city will be the first to adopt a system of public transport like the one described? Some tourist city which at the same time takes advantage of the innovative boldness as a tourist attraction? We will see it soon.

PIONEERING PROJECT 4. A GUIDE-BAR ON AN EXPERIMENTAL ROUTE

The guide-bar has been presented as a possible solution for computerizing traffic at ground level, considering it in combination with the separation of high speed carried out using light elevation.

The ideal scenario to test it is a network of a few kilometres within a great industrial and commercial exhibition. The novelty of the internal transport system can constitute one of the main attractions. The greater part of the investment will not be the installation of a simple bar held between pairs of columns, but the engineering of the vehicles. It is not essential that they are able to form trains in the first stage of

experimentation. What matters is the way of directing the wheels like a steering wheel does from the guide-bar, the control of the engine by central management and the system for the perception of obstacles on the route.

PIONEERING PROJECT 5. A NARROW CONDUIT FOR MERCHANDISE

Which will be the first company to build that species of squared *pipeline* in which all types of solid merchandise will be transported with great efficiency and very little environmental impact? It is a huge investment, since the narrow conduit will only be able to demonstrate its capacity at the outset over long distances. As soon it is put successfully into operation, everybody will wonder why it has not been applied many years before.

A line from the north to the south of France, Germany or Great Britain will be profitable. A trans-European line from the east to the west between Hamburg and Paris, then turning south via Lyon to Barcelona and Valencia, or to Turin, Milan, Florence and Rome, will also be lucrative. They will be the spines of a network which will spread everywhere. They would require very cheap infrastructures. Two one-metre squared conduits can be buried at little depth in both borders of any conventional road, or flanking a rail track. The road would soon be free from a great part of its heavy traffic.

The mini-trains, small locomotives followed by tens of wagons, will have the energy efficiency of electric trains. Yet, perhaps a species of funicular system, that is to say, an endless cable that serves as traction for units without an engine, will improve it. Pneumatic propulsion by the aspiration of the air ahead of a tubular train fitted in a cylindrical conduit has also been tested. The technological solutions are varied.

As happens with any other means of transport, the decrease of the cost per kilometre in merchandise transport by conduit will evolve as lines are extended. In order to entrust their products to the freight conduit, industrialists will have more reasons when it is able to carry these products to all their clients anywhere, than when only one line is available, however important it is. A fast system for the interchange of containers between conduit and lorries will replace these deficiencies in the development period.

PIONEERING PROJECT 6. AN INTERURBAN ELEVATED LIGHT ROUTE

We have already talked about the very-light elevated urban train. Elevation also is the best solution for long-haul journeys. Its advantages have been explained in detail in the fifth chapter, but it is worth remembering them briefly: The traffic elevated on a continuous bridge breaks away from ground level, so that it doesn't intrude and is not intruded upon; it does not interrupt the passage of people, animal or vehicles, nor even does it interrupt the vegetation; it does not run over anybody, it passes over snow and floods; therefore, it is able to advance more quickly even in populated zones. If we add to these qualities the lightness and narrowness offered by the computerized network, with passenger vehicles of no more than fifteen seats, we have practical and profitable infrastructures, very much cheaper than conventional motorways and railroads.

A highly-populated mountainous region in a country with technological initiative, such as Switzerland, would obtain the greatest advantages of an innovative project of this type, perhaps a line between Lucerne and Bern, perhaps one which crosses the country from the north to the south between Zurich and Milan. The units travelling along them would disdain the snow.

* * *

We will continue the study of the transition reviewing the role of governments and the companies involved in transport during the first stages.

THE ROLE OF TRANSPORT COMPANIES

Taxis

They are still many years to go until we reach the complete computerization of driving, during which the function of taxi drivers may revolutionise urban transport. As we have already explained, with pioneering project 2, the taxibus can immediately offer an attractive service for a high percentage of urban travellers, dissuading many of them from using their private car and dissuading others from supporting the inconvenience and the slowness of conventional mass transport. It is a question of enlarging the vehicles until they have twelve seats and of connecting all those in a city to a computerized system that arranges trips with clients in advance by telephone or the

Internet with the goal of taking travellers who do not know to each other (like in a bus) from the door of their origin to the door of their destination (like in a taxi).

Urban buses

The spending power of the cities' inhabitants in developed countries has been growing throughout the 20th century. This phenomenon has influenced urban public transport profoundly. It has multiplied to saturation point the use of the private car to the detriment of the use of buses and the underground. However, these latter also have an important percentage of users. But 21st century travellers can no longer be transported like lambs: jammed together, standing up or on the uncomfortable seats of dilapidated vehicles. Transport companies are investing more and more in the comfort of their clients. This is the correct trend. All the investments aimed to provide a more pleasant trip, within the characteristic sobriety of public transport, will be rewarded with success in the long run. We must reject, among the images of the future, the one of squeezed-together, standing-up travellers. As on long-distances it is unusual, even illegal, to sell a ticket without the right to a seat, the same will happen on short trips.

The second issue of evolution will be speed. In cities like Madrid, Barcelona, Saragossa or Seville it is habitual for passengers to put up with a half-hour bus trip to cover 10 kilometres. This situation happens not because the buses circulate at 20 kilometers per hour, but because they frequently stop to pick up or to drop off users. The greater the amount of seats, the more stops are needed and the longer they will be. Lessening the size of buses is equivalent to investing in speed.

And not only in speed, but also in frequency and flexibility of lines. It is probable that in the cities of 2020 we will see many more and smaller buses than we do now. This positive evolution will fully pay for the decrease in the number of passengers for each driver. The number of students for each teacher has decreased in modern schools and it is an irreversible phenomenon in developed societies. This drivers - passengers ratio, like the teachers- students ratio, offers more tailored attention, which with regards to trips is translated into less stopping, greater proximity to the door of origin and destination, and more frequency.

We also foresee interactive screens in vehicles and stations. Travellers will arrive at the station, they will indicate the destination address on a suitable device and

immediately they will obtain information about the most suitable line for them and the estimated time that the next bus will take to arrive.

Public urban transport companies have a great future in this phase of transition towards complete computerization. Their main competition will be the taxibus, which they will put an end to by fusing their services.

The underground train

All that has been said with regard to the correct trends in the investments of urban bus companies is valid for the underground urban railroad. The underground system must also diminish the amount of seats per unit and make lines flexible to avoid the majority of the transfers that nowadays are carried out along lengthy corridors. It must improve the technology applied so that units can travel with little distance between each other and with greater safety. Diverse 40-seater cars will stop one after another at a single platform to go to different parts of the city using a network of tracks with abundant junctions.

A customized travel card will be created to deal with communications between passengers and the network. At the entrance all the users will indicate their name, number or chosen nickname as well as their destination, and a network of screens will direct them in stations and in vehicles.

We insert here a small sample of an alphabetical list of the next few departures displayed in the station. It includes the identification of each traveller; the number of companions, if he/she has them; the number of his/her allocated car; the estimated time that the unit will arrive in front of the traveller and the destination address:

Eva Hidalgo	3241	13,20	1 Mayor St.
Michael Wolf and 2 others	3241	13,20	Vivaldi St. 10
Juan Puerto	2468	13,22	Sorolla St.
Chantal Arles and 1 other	2468	13,22	Lirios Sq.

Next we add a sample list of an upcoming arrival, displayed on the screens of the unit:

NEXT STOP:	15 Colón St.
TRAVELLERS FOR LEAVING THE VEHICLE:	Rachel Forest
	Carmen Soto and 3 others
	Paolo Conti and 2 others

Another factor in the development of urban transport is flexibility in prices. There will be several different prices throughout the day for the same trip, more expensive in rush hours to dissuade customers from crowding in short periods of time. The price will not be fixed every working day according to the time, but it will be in continuous fluctuation, within maximum and minimum limits, according to the level of demand for each line at each moment. The price per kilometre on the diverse lines at the current time will appear on the information panels.

The railway

The task of the large railway companies in computerization is decisive, although in 2050 the train, as we currently know it, will no longer exist. Its routes and ultra-fast transport, the successors of present high-speed trains will remain.

As we insist all through this book, reuniting many passengers in the same vehicle entails an effort unnecessary in the era of computer science. Travellers in 2050, who arrange their trip with the network in advance, will demand, even before speed, flexibility in lines to the point of starting off at the door of their origin and going to the door of their destination without stations or transfers. In order to travel from Versailles to Greenwich, the trip Versailles – Paris Central Station – London Central Station - Greenwich will not be suitable for them, but Versailles – Greenwich directly.

Such an approach is incompatible with the current operation of a company such as the Spanish RENFE, for example. The railway is not able to provide that service. It is too big. Consequently, the first challenge for railroad companies will be flexibility through decreasing the size of their trains. Trains with less than a minute's distance from each other will pass on the tracks of the future with total safety. In the next few years RENFE would have to be able to successfully offer non-profitable trips for the current long-distance train journeys such as: Valencia - Toledo, Gijón - Vigo, Granada - Badajoz, Seville - Burgos, et cetera.

By means of advance booking over the telephone and Internet agreement, flexibility will even bypass fixed schedules, which will be reduced to a minimum of guaranteed trips. Companies will combine the demand data of their clients to offer to a coincident group the most advantageous trip possible. For example, it could be that in the first few days of October one hundred requests for a trip between Bilbao and Salamanca concur, due to the start of the academic year at this city's university. Then, RENFE will offer these clients a train between both cities which does not circulate on other days of the year.

Once this evolution plan for railway companies is set out, based on the communication in advance between the network and the travellers and the decrease in train size and the flexibility of supply, the following step consists of the agreement of bus and taxi companies to offer complete trips. For example, the railway does not reach the city of Alcoy, but the travellers who want to go with RENFE from Madrid to Alcoy will obtain the complete service: A train from Madrid to Alicante and a previously scheduled bus between Alicante and Alcoy. Let's see another example: A family arrives at Atocha station, in Madrid, coming from Seville, in a high-speed train. The final destination of these four people is number 18 San Bernardo street. Then, RENFE will offer them not only the trip by train, but also the taxi which will take them from the station to that address, and at a reduced price. At the station they will receive information about the point where the booked taxi will wait for them. Clients can accept or reject this service, but we foresee that in many cases they will accept, and thus the railway will advance towards a time in which almost all trips will be from the door of origin to the door of destination.

Subsequently, railway companies will be called upon to invest in the high-speed trains of the future, which will travel on elevated light routes. Continuous bridges for trains of very quick small units, with the most modern propulsion, suspension, driving and safety technology will be built above current tracks.

The narrow conduits for merchandise, buried at little depth alongside the old tracks, will constitute another future use of railroad routes. The gentle slopes and the open curves of the railway lines make them much more apt than roads for the separated freight transport of the 21st century.

Interurban buses

The future of the companies of this sector entails the coordination of all of them in a network which manages the trips, in the same way that they have met in the same central station in all the cities in recent years. It is the only way for them to be able to offer flexibility of lines and schedules to their clients, thanks to an advance agreement. The travellers will book the ticket from home with a rewarded advance: the sooner they do it, the greater will be the discount, within limits. The combination of advance trip requests is the key to the process.

What has been said about other forms of public transport is valid here also: Interurban buses must become smaller and more frequent. From a given point, the supply of trips must be multiplied. The correct trend in investment consists of offering an increasingly complete trip to the user. The entire door of origin – station of origin – station of destination – door of destination trip must be integrated in the same ticket by means of combining services with urban buses and taxis.

Freight transport

The narrow conduits for wholesale use and the super-narrow domiciliary ones will be the protagonists within several decades. To progress from the prehistory of the computerization of transport, in which we are now, to that moment involves the long and complex process of the formation of a coherent network, a single network in which many companies will operate. This statement is applicable as much to courier companies as to the ones dedicated to the industrial and commercial transport of large volumes. The computerization of transport will be able to offer a highly customized service. For a shipment to be cheap a large volume of goods in a big lorry will not be required. The trend aims towards the development of the concept of a container automatically manageable at interchange stations.

Competition between many companies which work independently, each one trying to cover a whole country, is not effective. What is so is the combination of many companies within the same network where each one is in charge of a zone or a line, in the same way as the public transport of passengers has always been organized through concessions.

Travel agencies

The development of the task of travel agencies can become one of the key pieces during the evolution of transport towards complete computerization. The first agencies were born to solve the particular needs of extraordinary trips, generally in foreign countries, where the traveller does not know the language, the customs or the resources. Yet, gradually they have broken through into a widespread market to serve an increasing number of travellers for fewer and fewer extraordinary trips. Competition in this market will lead to the entire wishes of all travellers being satisfied at an acceptable price. We have already repeatedly stated throughout this book: What any user of public transport wants is to be collected at the door of his/her origin and to be taken to the door of his/her destination. Here it is the fundamental aim of the 21st century transport. Travel agencies are in the vanguard for advancing towards it.

We will make a short term forecast:

Madrid's central station. A train arrives from Corunna with three hundred passengers. Of them, fifty-one are clients of Indoor agency, which has arranged (in agreement with the railway company) a small train consisting of a small vehicle tractor with pneumatic wheels and several wagons on the platform. These small wagons have a level surface and railings around it. Helped by Indoor's employees, the recently-arrived travellers get on the wagons with their luggage. Once all the expected clients are collected, the small train makes its way slowly through the crowds on the platform to the place where three 20-seater buses, which also work for the agency, are waiting. Their task is to take the travellers to several hotels and homes in Madrid.

The service that Indoor agency offered to them consists of completing their arrival. The travellers have obtained a service far beyond the one of a bus or the underground which takes them from the station to their destination for a price far below that of a taxi, integrated in the ticket for the whole trip. The agency had the sense to combine the demands of many travellers.

We will go more deeply into this case. Maybe many of these passengers are clients of Indoor not only on this trip, but they have contracted a wide service which entails the agency solving the door-to-door concept on all their trips outside their home town. Continuing with the previous example, let's approach a traveller who comes from Corunna and does not live in this city, but in Ferrol. Indoor has been in charge of taking

her from her home to Corunna station. At what price? How? At a reasonable price, lower than that of a taxi, with a 20-seater bus which combines all types of demands in the province of Corunna. It has collected her from her home in Ferrol and from other parts of the city a traveller who is going to Madrid, and also others for the same train or other trains which will soon start off, or even travellers with routes not related to the railway station. The combination of demands produces the added value of this business.

We predict that within one decade a million people will have contracted services of this type with a great variety of agencies.

THE ROLE OF GOVERNMENTS

Administrations, be they local, regional, national or international, are under pressures from every sector of society. Within our subject, its task of very complex arbitration through means of legislation and the use of public funds must favor the evolution towards the transport demanded by the combination of social agents: fully-computerized transport. Yet, it must be done with discernment and care, without haste or delay. It is imperative to look ahead with a whole vision, to understand the keys of development from now on. They are the following:

- The separation of high speed.
- Pedestrian Urbanism.
- The separation of merchandise.
- The flexible combination of demand and supply, with advance agreement of trips, in a network.
- A very customized service, aimed to completely satisfy the travellers' needs from their door of origin to their door of destination.
- The reduction in the size of vehicles.
- Electrification.
- Circulation on tracks, eradicating the use of overtaking.
- Light Elevation, as the solution most in agreement with the set of new conditions for separating high speed.

The awareness of trends involves much in relation to present-day investments: Expensive and wide motorways will not be useful for a long time; they will become obsolete, although a part of their surface will be used for new lines. The first improvements that computerization will cause will see current infrastructures built upwards. The old roads at ground level will be employed for heavy or slow vehicles. Light, continuous bridges will be built above it for cars and other small and fast vehicles.

The right criteria for governments' action in the next few decades are the following:

Legislation must not interject as an obstacle to development. Useless norms which formerly were beneficial must not survive. They remain old-fashioned hindering as long as they are not definitively removed.

It is necessary to support every investment in future trends: vehicle integration in a public network of communication, electrification, continuous bridges, merchandise conduits, et cetera. And particularly, to favour new routes that give access to cities.

Safety requirements have to increase. We must understand, with an objective valuation, that the risk of travelling in a vehicle driven by a person at more than sixty kilometres per hour on a road at ground level is intolerable. We come to this objective valuation through the comparison with other risks in other areas, in which a lesser index of accidents is already considered intolerable.

Governments must proceed with an increasingly demanding environmental criterion. Nowadays nobody mistrusts the evidence that human activity on the planet, if it continues in the same way, will cause serious damage to the atmosphere, water, earth and the biosphere. Efficiency and power saving are increasing requirements for all branches of consumption.

A reality about which administrations have become concerned for more than two decades is occurring with the consent of society: Many streets have been reformed according to an urbanism designed for pedestrians. This is the appropriate action for the future. In 2050 all the routes for travel at more than 40 kilometres per hour will be elevated, the majority of merchandise transport will move in closed conduits, and at ground level vehicles will circulate slowly, giving preference to pedestrians.

Current traffic is regulated by a strict and detailed legal ordering. It is essential to reach an agreement between thousands of units in continuous danger of collision. A road network exists managed by public administration. A centralized organism controls the traffic in every country with increasing involvement. The network of transport routes must continue under public control. The work of private companies within it has to be regulated with regards to concessions to avoid chaotic competition.

EPILOGUE

Will the people who in the middle of the 21st century enjoy fully computerized-transport be happier than those of the 20th century or of previous times? Probably not. They will not be more or less happy. Old problems will be replaced by new ones and computer science, without a doubt, will constitute an inexhaustible source of them. In any case, humankind at present is not disposed to advance in any other direction.

In this book we have defended the following statement: Since 21st century transport will be like this, we must make that change as soon as possible, conscientiously, responsibly and with careful planning, because the transport model of the start of the new century is the worst one possible.

And it is the worst one possible in several aspects:

In the environmental aspect, due to the excessive combustion of petroleum derivatives, that affects climates around the whole planet and contaminates the life of most of its inhabitants. We can hope that fully-computerized transport with small units involves an almost total electrification, drastically diminishes the use of the private car thanks to its capacity for offering private trips in public vehicles, as well as public door-to-door trips, and improves the performance of all of them. It will also render the monstrous routes of the motorways old-fashioned.

In the social aspect, understood in a wide sense, since 20th century transport has severely influenced people's habits, mainly in the cities. Cars and cars everywhere have drowned street life and they have set us moving at an unbearably hurried rate. The latest trends in urbanism are reacting against the empire of the wheel in the city. Developed society is fed up with living in this way. 21st-century computerized transport offers a great advantage regarding this aspect because of light elevation (which also depends on the opportunities that the computer presents for doing without large vehicles) and also because of merchandise conduits. In addition, we hope the computerized network will drive vehicles less aggressively, with less risk and with less haste than the human driver.

In the economic aspect, since in the last decades of the 20th century the expenses of infrastructures and vehicles have created a bottomless pit for the state budget and for

that of individuals. They have redirected enormous resources necessary for other sectors towards transport.

* * *

This list of the horrors of the current system could be extended and detailed until it filled a book by itself; but numerous, very convincing ones already exist.

We reiterate our awareness that every forecast must recognize its limitations. Strong social upheavals (wars, plagues, subsistence crisis, etc.) can profoundly affect or interrupt scientific and technological progress. It is also possible that inventions appear that are so revolutionary as to create a new civilization unthinkable today. However, a student of the future has as many reasons for predicting that the order principle of technological advance, more than two centuries in age, steadier than nations, political regimes and ideologies, will continue its trend in the next hundred years, as a person has for booking a hotel room one week in advance (knowing that perhaps after that time he/she could be ill or even dead).

Doubt still remains as to whether the computerization of transport will be much more disorderly than what we have stated here. Maybe our good wishes for power saving, greater security, more human urbanism, less use of the private car, et cetera, have influenced the forecasts too much. Once at this point, it is honest to recognize an intention. As the predictions of pre-electoral surveys, when influencing the voters' opinion, also influence the results of elections, the futurists' work can never be absolutely neutral, since it tends to form opinion states that to a certain extent determine the behaviour of people. Nobody is bothered about influencing a little so that the future is better.

But the main influence of this book has to be awareness. From here we invite the reader to join those who are aware that the motorways and high-speed trains currently built are excesses of a time already surpassed.

It remains to say that all transport problems will not be solved with rational computerization. The key is to be found in one word: proximity. It is necessary to create proximity, or at least to avoid the formation of innumerable distances. A person who resides 100 kilometres away from his/her work-place is a *distance*. Millions of people in that situation are millions of distances that will indefinitely remain if they spend less

than one hour on the trip and it is not too expensive. An apple travelling three thousand kilometres for a consumer from a region where similar apples are cultivated, is a *distance* without sense, but inevitable in our economic model. Millions of products in that case are millions of distances that will involve a transport cost in economic, environmental and social areas. Will we gladly continue paying that cost or we will introduce some system for the control and dissuasion of distances into the transport model?

It is a question that we still do not dare to answer.

CONTACT OUR WEBSITE

www.futurtrans.info

IN ORDER TO MAKE SUGGESTIONS

Your opinion about the following is very important to us:

- The conditions of 21st century transport
- Automatic driving
- The transport network
- Future tracks
- The separation of merchandise
- The new service
- The new vehicles
- The transition

And any other aspect of your reading of *The computerization of transport*.

IN ORDER TO TAKE PART IN THE DEBATE

In 2050 will road vehicles driven by people at high speed still persist as the main form of transport? What important features will new technologies supply to human drivers to help them in their driving?

Is the following forecast right? In 2050 the most developed countries will have banned the circulation of any vehicle at more than 50 kilometres per hour if it does not travel separated by elevation, placement underground or fences.

Will large vehicles, such as the present trains or buses, adapt to the future conditions of public transport better than vehicles of less than 15 seats?

Will the use of guide-tracks become general? Can you contribute some concrete suggestion of design suitable for their operation and connection to vehicles?

Among the many forecasts contained in this book, which is the one most likely to be fulfilled? And the most improbable?

These questions and many others are included in the debate opened by *The computerization of transport* regarding land transport around the year 2050.

IN ORDER TO SPREAD THE IDEA

Has your reading convinced you that the scenario presented here is realistic, reasonable and opportune? If your answer is affirmative, without a doubt you would like to spread the idea. Do you have, through work or your relations, some way of collaborating?

* * *

To respond these questions, you should contact www.futurtrans.info

Our website offers, free of charge, the entire text of *The computerization of transport* and allows its diffusion by any means, as long as its author is mentioned.