NR2C New Road Construction Concept
Work Package 1 – Innovations for urban and suburban infrastructure

Deliverable D1.1

Expectations and needs for innovation in urban roadway systems

A vision for 2040

Modifications follow-up

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Preamble

This document establishes the synthesis of the work carried out within the framework of task 1.1 “Expectations and innovation needs” of Work Package 1 “Innovations for urban roads”. This task is strongly articulated with the contents of Work Package 0 “New concepts for the road of the future” since it constitutes, to some extent, a specific application to the urban environment.

Two days of interchanges and debates were thus organized on September 2004 the 14th and January 2005 the 25th. These sessions were entitled “The street of the future” and gathered together over 200 people to discuss and prospect the future, possible and desirable evolutions for the European cities and their street concepts.

The debates were introduced by a modified and adapted version of the presentation document used in Work Package 0, which exposes different scenarios of evolution of the whole society and a manner of questioning their implications in the world of roads and urban infrastructures. The points of interest were punctuated by presentations, in particular those dealing with the researches carried out within the Work Package 1, in order to stimulate new ideas and proposals.

The synthesis presented here is introduced by a definition of the general context to frame the discussion on current and future streets, based on particular historical key points. Then, in the second and third part, the ideas which arose from the debates are presented, as regards the probable evolutions, the needs and the expectations of the professionals and various stakeholders. In the fourth part, an overview of the communications which were produced for the workshop, is given. In this part examples of innovations are provided, which answer, directly or indirectly, the desires and wishes expressed during the debates. Finally, one will find in appendix the synthetic reports of the whole of the debates as well as a CD-Rom presenting the supports of the talks; the complete description of the debates is available on simple request.

1 - GENERAL CONTEXT

1.1 Roads and streets

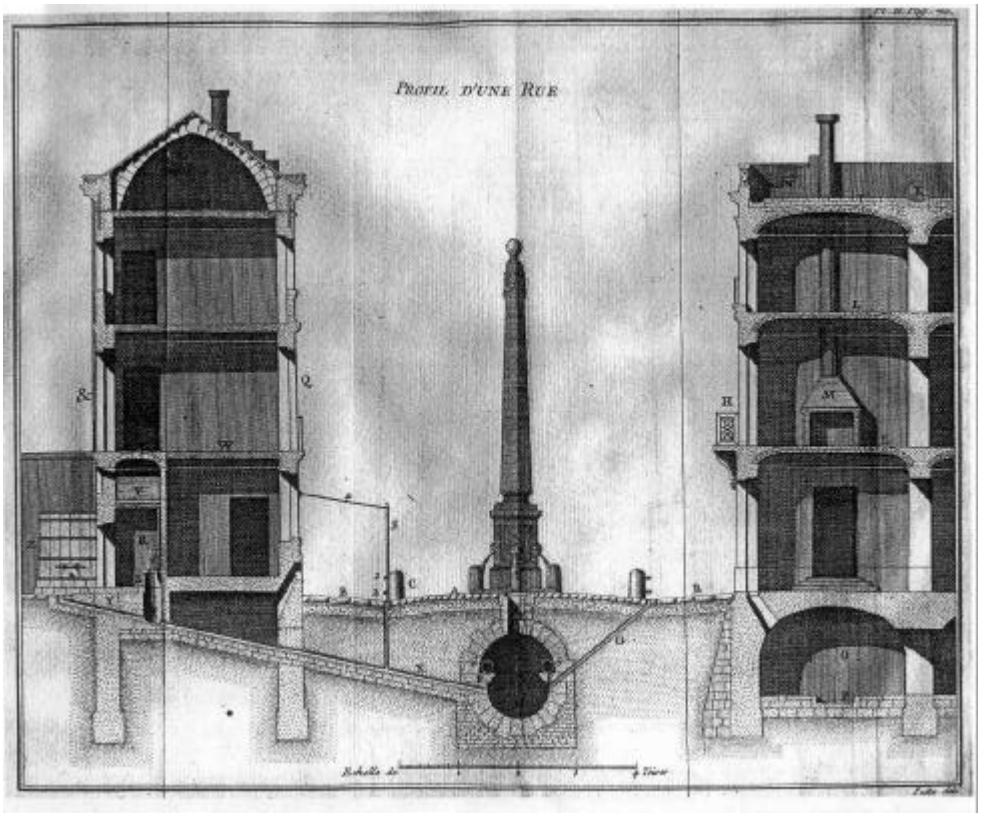
Is the "street" a "road which passes downtown"? Is it a "road adapted to the urban environment? " Is the street, in Latin *ruga*, "wrinkle", a special kind of road, *rupta*, "trench", or isn't it rather the reverse: the road which would be a kind of street?

At first glance, the parameter which distinguishes 'street' from 'road' seems to be the complexity of the former when one discovers the simplicity of the latter. The street supports innumerable uses; it is the place of coexistence of the underground and the aerial techniques, of public and private domain, of commercial and non-merchants exchanges, of predicted and unpredicted activities; it is sinuous, rough and it used to be muddy and smelly. Doesn't it contrasts with the rectilinear macadamization of the Roman roads getting right through the territory? Doesn't it contrast with the elegance of a form that is in perfect adequacy with the function of which it is the mould: to circulate?

"A circulated way whose edges are built", such could be a first definition of the street considered as a kind of road. Circulation rather than stillness, friction rather than slip, complexity rather than simplicity, delimited spaces rather than opened ones, uses rather than functions, alive rather than functional, such are the oppositions that one could be tempted to draw up between streets and roads. But where does the complexity of the street comes from ? Would it be enough for a road to go and "make a round" (circulate) "downtown" to inherit the urban qualities ? The experiences of the last four decades let us believe that it is not, that a road penetrating in the heart of a city is not transformed into a street. The observation of the growth of a burg which becomes a village, of a village which becomes a city, of the city which spreads out, could indicate that it goes rather differently: it is the city which, while extending, would adapt the road (which is often only a "way") and transform it into a street …

The street can be thought as a sample of the city, the basic pattern from which it is constituted and which gathers in itself the whole of the characteristics of the urban phenomenon. The street is at the same time the support of movement, of trips from one point of the city to another, from one activity to another, and the support of the establishment, of building constructions, of stability. It is the place of articulation between public and private spaces; it is both governed by the logic of the capital (to exploit, or to make short term profit) and by the economy of the inheritance (to preserve, or to make long term profit). The street, with the system of parcels and sectors, organizes at the same time the permanence and the renewal of the urban fabric: on the one hand, the layout remains, and with it the available space for networks, plantations and infrastructure. On the other, parcels are joined or cut out, one after the other, according to the nature of operations, while these parcels take value, while the buildings, which are the most transitory, are built and rebuilt, while their uses, their frontage or their occupants change. Thus the street, which is merely this one vacuum opened to the sky, is the most durable reinforcement of the urban system, since constantly, below it and on its sides, things are changing and fluctuating while the street itself remains, allowing the renewal of the city on itself.

The urban roadway system, contrary to the buildings, remains unthought until the 18th century, except as the receptacle of the daily urban garbage: the street is the residual and muddy space left over at the foot of the buildings. But the water run-off and the organization of an underground grid connected to the buildings will eventually push the roadway system – i.e. the urban ground in all its thickness – in the fields of architectural concerns.



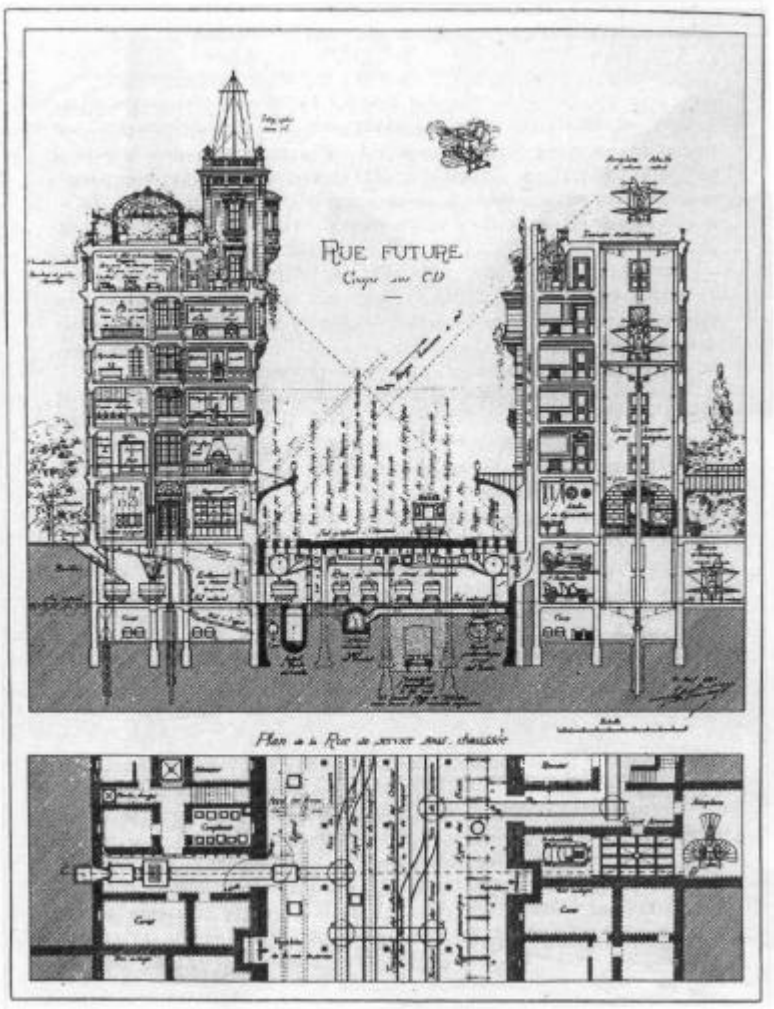
Pierre Patte, « Profil d'une rue », 1769.

The street considerated as a global system : the drainage system makes the buildings interdependent of the basements – rise and descent of water through the water conveyances – and of the sky – the conduits of the chimneys which let escape the smoke.

The appearance of the section drawing makes it possible to think the street as a global technical object, located between ground and sky, integrated in a topographic, geological and climatological context. In the longitudinal direction, this representation allows to consider the distribution of flows inside the available lateral space, starting with the surface road service, the distribution of water and the cleansing. Transversely, the relationships between these flows appear: their horizontal and vertical coexistence, their frictions and the organization of the exchanges from one edge to another. Curiously, it is at this time that the profile of the street undergoes an inversion of shape from the ground surface point of view: one passes from a concave profile, with the drainage by a central drain left under free air, to a convex profile, which becomes similar to that of the roads of close-cropped countryside.

During the 19th century, this way of thinking in terms of "flows" continues and leads to the concept of network, which will then apply independently to the distribution of water, to the streets as to the roads, the channels and the railroads. Thus, from the end of the 18th century, the profile of the street adopts side pavements and sometimes covered galleries which stimulate the commercial activities. This constitutes one of the first urban model aiming at separating the various flows, here pedestrians and horse-drawn. In parallel, the technical knowledge of the structure and of the coating of the roadways develops and

gradually contributes to give a scientific and an autonomous character to the field of the roadway system. With the increase of flows of all kinds, and thus of the importance of the technical systems in the urban organization, the streets will widen and impose their own constraints of connection to the buildings. Eugene Hénard's section drawing, which presents a "street of the future", illustrates this presentiment very well: at the beginning of the 20th century, this reality of flows and networks jump from one scale of magnitude to another, while at the same time the specialization and the division of the "available section" continues, being visualized out of the section drawing, and being consequently invaded and saturated by the multiplication of functions and their especially allocated spaces.



Eugène Hénard, « Rue future », 1910.

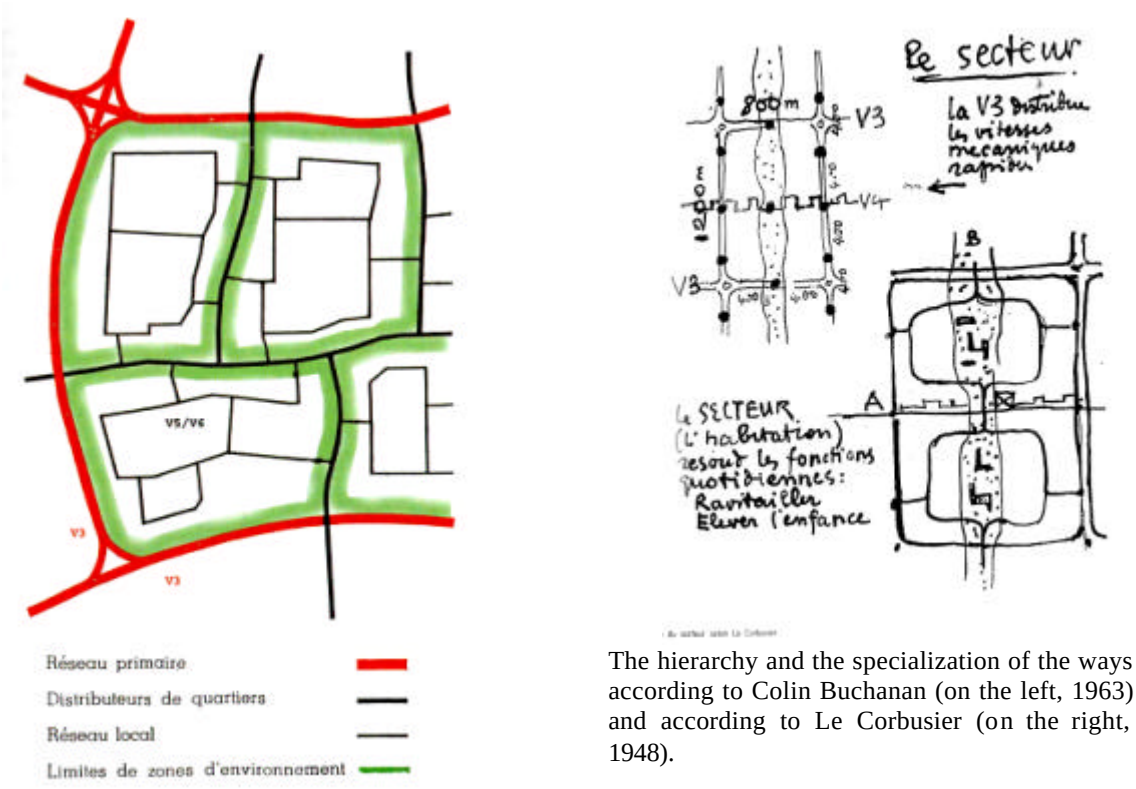
The profile of the street is exploited here until its last possibilities. But are these limits those of the street as such or that of the tool of its representation and design, the drawing section?

Would the "circulated way whose edges are built" reach its proper limits under the increasing pressure of the technical infrastructures? It is, consequently, the question of the relationships between architecture and infrastructure that is now raised with acuity.

Modern "urban design" was born at the moment of awakening of this jump of scale: not only that of the technical infrastructures, with the appearance of gas and electricity networks and especially that of cars in the city, but also that of the production of architecture which will be thought for the first time in a massive way. In fact, "whole pieces of the city" are designed and carried out thanks to the industrial methods of production, and more especially thanks to a "functionalist" way of thinking that reaches its maturation: to mitigate the difficulty of the

production of the city on a large scale, the 20th century urban way of thinking must simplify the problems arising by considering an univocal distribution of spaces according to a limited number of functions. “Functionalism” allots and adapts one space to one function.

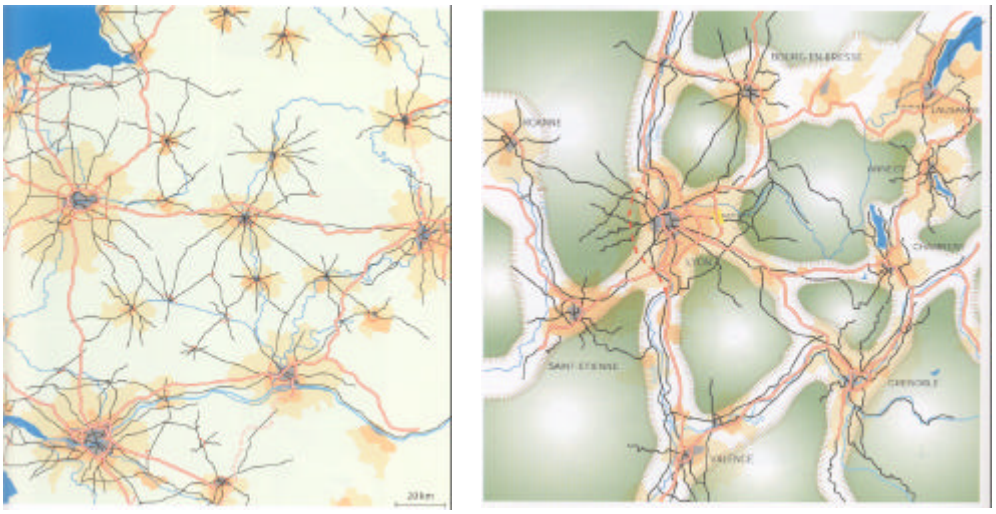
The “street”, if this word still has a meaning in this case, is now mostly considered in plan; it becomes part of a hierarchical network of service roads and only its longitudinal dimension is fully considered; all the questions of transversal relationships are eliminated: relationships from technical networks to technical networks – in the 60’s panned urbanisation which is made of housing bares and towers, the roadway system and the technical networks are independent and do not superimpose themselves, pedestrians paths and car ways are dissociated – or relationships from the buildings to the infrastructures – the configurations of the roadway system and that of the building arrangement are not interdependent any more. At the same time, the parcel, which traditionally defines the limits of each property, and thus the articulation of public space to private space, disappear, and the sector – i.e. a whole of parcels circumscribed by public ways – becomes isolated. Thus the modern “street” becomes almost mono-functional with the advent of the car.



The hierarchy and the specialization of the ways according to Colin Buchanan (on the left, 1963) and according to Le Corbusier (on the right, 1948).

The idea of the street disappears when the streets are reconfigured – e.g. by eliminating the tramway which was well established in France till the 50’s – to conform the urban space to an omnipotent function: motor vehicle traffic, a true “trench” (*rupta*, road) shearing the urban fabric. In France, from the middle of the 70’s, 64% of the households are motorized and nearly 20% of them have two vehicles. In twenty-five years, the vehicle ownership thus passed from 250 to more than 400 vehicles for 1000 inhabitants. In 2002, more than 80% of the households have a car and nearly a third of them are multi-motorized. The construction of the highway network, which enhances the French territory grid and sets the city-network, has started during the 60’s to reach nearly 9000 km in the year 2000. The cities, whose limits used to made firstly of ramparts, and secondly of faubourgs – which were true streets making both

the limit and the interface between the urban environment and the countryside – are now crossed and circumvented by huge infrastructures. At the same time, those infrastructures, by reducing the temporal distances, potentially open new spaces ready for urbanisation. Thus the shape of the road infrastructure becomes a major determining factor of the growth of cities, and it leads generally to star and linear configurations.



Concentric models in the French Atlantic plain (on the left) and linear models worked out by the valleys of the Rhone and the Saone (on the right), extracted from D. Mangin, *La ville franchisée*, 2004.

Despite the fact that since the 60's the roadway system is thought – by the engineers – independently of the buildings – designed by the architects –, its influence on the construction is far from being negligible: the road infrastructure delimits today tight zones inside which the urban installation is possible, surfaces that are now attractive and available, discontinuous portions of the territory that form today what one calls in Europe the "peri-" and the "suburban" city, "emergent city", "diffuse city" or "generic city", "in-between city", "spread out city", "franchised city", the "space of flows", etc. All these denominations reveal the floating of the current situation, our incapacity to recognize a "city" in the spatial forms that the urban phenomenon is taking, not only in Europe but nearly everywhere in the world.

Following the formidable increase of mobility and flows of all kinds, the "street", or at least the "way", as well as the whole of the networks, have been seen and thought primarily longitudinally, as one course from one point of the network to another, and not transversely, from a type of network to another, or from one side of the street to the other, so that sometimes they become inaccessible to each other. The points of connection to multiple networks gradually relegate the spatial continuity – the continuity of public space and its routes – with the old districts, and promulgated the "nodes" articulating the networks to the status of new "urban polarities".

As regards this "urban transition" that many of the European cities know today, the positions are contradictory but the street seems indeed to be a central issue of this debate. For some people, these new urban forms are the result of an inescapable evolution: the compact and dense cities that some regret today constitute only one stage among others in the evolution of city forms; however this stage would not be compatible any more with the technological discoveries, the evolution of the ways of life and the quantities of flow of any kind which the European society is currently experiencing. For other people, compactness and density are elements that are constitutive of the even idea of a city. They are essential

characteristics of any “good city form” that is concerned with the future; to consider a sustainable development can only be done if politically, decisions are taken to reduce trip-makings and flows requiring energy. And as it is observed, those trip-makings find their origin in the dispersion of residence, leisure and work places, a phenomenon that has reached a degree exceeding all what the compact cities of the past have known.

In all cases, and whatever the positions concerning the future of the European cities, the relation between the buildings and the way is today at the heart of the concerns, both on the scale of streets and that of cities, be they small, average or large. This relation passes by the bringing together of the professions, the development of common and concerted actions, and by the release of a common vision for the future.

Then, as yesterday certain streets saw themselves transformed into roadways, it is probable that tomorrow roads will be transformed into streets, according to the ways in which the cities will consider their development. Keeping in mind that “the road of today is perhaps the street of tomorrow”, shouldn’t one prefer “adaptive” designs, able to change of uses and functions in time, to designs that are “adapted” to quite specific functions that will perhaps disappear tomorrow?

To question the future of the street is thus to approach that of the city from a microscopic point of view: the street as the basic pattern of the urban fabric, likely to be repeated and repeated without ever being exactly the same, and carrying in itself the urban aspects of the territory. Conversely, to consider the road and its future is to consider the future of the city from a macroscopic point of view: the road as the basic pattern of the "territorial fabric", the "city-landscape" or the "diffuse city", whose condition seems to spread, already strongly on a European scale.

Thus roads and streets are complementary when one considers the problems of the contemporary city in a global way. So if yesterday roads used to penetrate the urban environment, sometimes brutally, often by successive transformations over the existing streets, perhaps tomorrow the roads and other infrastructures that are today at the city gates – i.e. at the end of our current streets – will be transformed into streets. What could resemble not a “street resulting from the path” but a “street resulting from a road”? And how will us be able to imagine and to conceive such transitions? Will the section drawing and the organization of the network in plan be sufficient tools to design the street of the future?

No matter what one can answer, the transformations of the street cannot be conceived without initially considering the men and the society who will be the actors of it. The past as the future of the street remain strongly related to individuals, trade associations and professional cultures that are complementary but also sometimes antagonistic. The street will undoubtedly remain under the influence of the evolution of technologies, but also of the political choices that will frame their development and of the design methods imagined for it. It is thus not useless, before prospecting for the streets of the future, to give some reference marks on the current situation and on recent evolutions, in order to better comprehend what will be the subject of the transformations to come.

1.2 Some statistical data on the current situation

1.2.1 *Some european data*

Some general data about the European Union, in order to consider the urban dimension of road transport :

- ✓ Population : 376 million habitants, 80% into the cities ;
- ✓ Surface : 3 million and 200 km2, 20% for the cities surface ;
- ✓ Urban traffic flow : 90% of the total ;
- ✓ Car trip-making : 79% of the total ;
- ✓ Displacement total costs by cars : 520 billion of euro.

1.2.2 The French vehicle park [1]

- ✓ The French park rises the level of 36 million vehicles on January the 1st 2004, including little less than 30 000 private cars, 5 430 000 industrial utilities and some 638 000 vehicles of more than 5 tons. On the scale of the planet, the total park exceeds 700 million vehicles.
- ✓ The average age of the vehicle is 7 to 8 years for a renewal rate which varies from 10 to 15 years. That is a way to see how long we should wait to see the technological innovations used by customers.
- ✓ The rate of equipment of the households is 80 % with at least one car and 20 % with more than 2 cars. It is the rate of multi-motorization which is today the principal source of increase in the French automobile equipment.

These French data give an outline, certainly a little deformed, of a situation that nevertheless concerns the whole of Europe. Thus, the parking downtown has become one of the major stakes of cities management, since it is at the same time a cause of dissatisfaction, a deciding factor in the modal choice for trip-making, a determining element of the street design, construction of buildings and general management of the urban space. The tendency concerning the architecture of the vehicles thus goes logically in the direction of small and specifically urban vehicles on one side, and towards general-purpose and multi-uses cars on the other. The vehicles using alternative energies are still very slightly represented today, in particular because of their cost which remains not very competitive and of the slowness of the renewal of the automobile park.

1.2.3 On the urban growth in France [2]

In economical terms, in France, “70% of the sales benefits are carried out in periphery, 10% in the districts and 20% in the downtown area (in Germany, those ratio are respectively 30%, 40% and 30%)”. Shops, even in the centre area, remain confined in some streets of exception. On the other hand, the large distribution centres, many of the mass leisure activities and even institutions are established in accessible surfaces that are visible and that have a great capacity of reception – i.e. outside the downtown areas.

[1] From D. Augello (Renault), « L’automobile 2020, une vision industrielle ».
[2] From D. Mangin, *La ville franchisée*, Editions de la Villette, 2004.

In terms of housing: “80% of the houses allotments are established in periphery, and 20% in central zone” whereas only 5% of the houses constructed each year are designed by architects. The other operations, drawn by geometricians, adopt mostly tree configurations, often because of the preoccupation of saving the cost of networks and the feeling of peace and safety it gives to the inhabitants. One can wonder: “will this specific suburban road be able to become a street?” at the same time as one wonders about the integration of infrastructures of great scale in places and local logics.

In territorial terms, the 80’s saw a reduction of French agricultural surfaces of “about 50 000 ha per year, and of the double in the 90’s. Each year, nearly 30 000 ha are yielded to accommodate great infrastructures like high speed trains, highways or industrial parks, or are sold to private individuals to be built.” Thus, it is 5% of the agricultural surface of the departments that disappear each year whereas the French territory is regarded as urbanized to a total value of only 8%. There is thus an “urban fringe”, that which one has so great difficulties to name and recognize as “city”, which relates today to the major part of the economical, ecological and social stakes of the next decades, whose fate is closely related to trip-makings of the individuals above all, and then, to the infrastructures and the vehicles they use for it.

The following study does not claim to predict the evolution of the whole society and the pieces of city that are going to be built during the forty years to come. The tendencies, even if they are shareable and allow to a certain extent to foresee certain aspects of future things, also depend for a large part on political decisions, on individual and collective choices, on private and institutional stakes that exceed the framework of technique. On the basis of the probable scenarios stated within the framework of Work Package 0, the point is not, here, to guess the future in order to adapt the technical solutions to a fixed image which one would have imagined more or less skilfully – in this case the most futuristic images are without contest those of the 60’s… – but rather to explore the various possibilities in order to direct the choices, the practices and the current policies of development.

2 - POSSIBILITY OF EVOLUTION AND PROSPECTIVE VISION

Directly linked to the question of the evolution of cities, the problematic place of the car must be put forward because of the existing debate on this subject and because of the significant effects cars had on the organization and growth of cities during the 20th century.

The postulate which consists in stating that cars will continue to be the major mode of trip-making at the horizon of 2040 is largely disputed. For some, it is necessary to imagine a breaking scenario, in which cars would not be used any more in the dense urban centres as cities of tomorrow have to offer more proximity and quality of life. But on the opposite, considering the current situation, the pragmatism of certain stakeholders lead them to think that even in the case of a rebalancing between the whole modes of trip-making, private cars will remain prevalent. Moreover, it is also possible to imagine and take into account a break in terms of technical innovation and vehicle equipment which would make possible to reduce the criticisms concerning cars.

Without seeking to decide on this polemical question, it is necessary to take note of this divergence of opinions, to see now which are the other probable evolutions as regards the urban infrastructures.

2.1 Scenarios for a prospective vision

The results of the consultation of the concerned stakeholders made it possible to release a certain number of evolutions that are to be considered if one wants to have solid prospective vision. To understand these issues, it is necessary to point out here the various tracks of reflection which were proposed to them at the time of these days of exchanges. The discussions and debates followed upon the presentation of four possible scenarios concerning the future social developments :

"A political revival": whose main idea is that the successive transfers of competences will increase the influence of the local decision makers ;

"An omnipotent market": whose main idea is that the limited budgets and the significant investments will lead to the application of the user/payer principle ;

"A sustainable development": whose main idea is that the awakening of the environmental impact encourages to privilege a sustainable development ;

"An exacerbated urban extension" : whose main idea is that the progressive thickening of the cities leads them to develop mainly around structuring axes.

If the application of these general principles to the urban environment can be an issue to debate, it nevertheless arises, from the general point of view, that the reality of 2040 will certainly correspond to a special combination of these scenarios, even if it is impossible, at the present time, to know the relative importance of each scenario regarding the future developments.

2.2 Possible evolutions

2.2.1 A « more human » city…

The will to reintroduce the "human aspect" in the quality of urban developments appears to be at the core of the stakeholders' concerns. If roads and streets were formerly thought by elected officials and technicians, local considerations and the participation of residents themselves to the transformation of their districts will play a significant role in the future projects. The appropriation of public space by the inhabitants, the increasingly large number of requirements expressed by the citizens in terms of accessibility and clarity, of flowered plantations and urban parks, of harmonious sounds, vibrations and lights, but also in terms of good forms and aesthetic thinking, must guide us towards one objective : to leave the exclusive and particular point of view of the one specialist to embrace the multiple points of view of the various specialists and users of these public spaces.

This desire to make the infrastructures more "human" can take several aspects:

- *True co-design:* the current steps in terms of participative democracy and citizens involvement into the design of infrastructures projects seek to convince users and residents of the good quality of projects already conceived: their mistrust or their opposition might be a barrier to innovation. This implies to integrate a pedagogical aspect of formation in these

exchanges. But in order to go further and to gain really from this involvement, that is to say in order to pass from consultations and dialogues to true "co-design" processes, it will undoubtedly be necessary to imagine new ways of designing and producing the city, based on shared designs at various degrees according to the nature and complexity of the various kind of operations.

- *"Hiding the technique":* to answer the will of the inhabitants to take part into the transformation of their district, the technique must be able to "disappear". It must be regarded as a tool that can be "translated" to the inhabitants. The choices should not be dictated by the technique, but technique should bring the light on the different opportunities; therefore it must be fully controlled.
- *Starting from the local point of view :* during a project, it is useful to think that each local action has some implications on the global evolutions: these evolutions are also a kind of emanation of the local level activities. That is why the clarification and the explanation of choices is significant, since it is this condition that allows to share or not the various points of view and then the construction of suitable answers adapted to each situation.

2.2.2 Better mobility in the city

In addition to this "more human city", one of the stakeholders' current concerns is the increase and diversification of the various forms of mobility. Once again, the consequences for the future are considered under various aspects :

- *Adaptability of the street:* the diversification of collective and individual modes of trip-making and their intensification for various reasons should lead to an integration of new services into roads and streets designs.
- *Inter-modality:* the modes of trip-making will be complementary before being concurrent. It is not possible to completely substitute some for others, and each of them will have a part of the trip-making market. The future of the minority means of trip-making also depends on the synergies they will succeed to create with the dominant mode – i.e. the car.
- *New forms of mobility:* it is probable that new means of trip-making will emerge during the years to come, in particular as organisational innovations supported by technical improvements. "Car-sharing" and "van-pooling" (which gathers a small number of passengers having similar destinations) may, for example, constitute new forms of mobility.
- *Time and infrastructure:* one of the fundamental aspects of roads and streets is the speed at which they are circulated ; can technical innovations help to control the speed? The significant being more the time spent by users in their trip-making than the real distance. This point of view is developed, for example, in the "chrono-aménagement" concept tested in the "Autoroute apaisée" project of the city of Grenoble, France.
- *The hierarchisation of uses:* as cities becomes more and more complex, it is necessary and desirable to carry out and to clarify the choices as regards the possible uses of public space. For this reason, it will be necessary to attempt to constitute clear criteria that are associated with certain concepts able to adapt to particular situations. The construction of these criteria is an opportunity to put the "human" at the core of the reflections.
- *Scarcity of space:* in the dense urban centres, the scarcity of space and the diversification of uses may require a separation of the distinct parts of the roadway system to improve the speed of public transport systems or to manage public spaces that are highly complex.

2.2.3 City without harmful effect

For the whole of the participants, the reduction of the harmful effects on the users is also one of the priorities for the future, both during the operating and during the construction phases:

- *"Furtive building sites":* non-perceptible building sites for users would support the limitation of the bothering of residents. These furtive building sites do not necessarily imply that they are fast, but rather than they do not disturb the users.
- *The use of ready-built elements:* for reasons of time and management of building sites, the use of ready-built units for the works, the networks and the urban roadways would make it possible to progress into the direction of the "furtivity" of building sites.
- *Attenuation of harmful effects:* this concern is reinforced in urban environment because of the pressure manifested by residents on various topics such as noise, pollution, vibrations, traffic jams, etc.

2.3 Break or transition ?

Concerning the possible scenarios of evolution by 2040, a significant point raised by the various speakers is this one : how will the society and its cities pass from the current situation to this distant horizon? To think of the intermediate stages would indirectly make it possible to forge an opinion on the possible final states.

A long-term vision does not necessarily pass by a break with what is currently done. Considering the heaviness of the modes of production and the importance of the car industry, the setting up of processes induced by the emergence of an hypothetical breaking technology is not easily conceivable. A technological break has thus little chance to be born by 2040. The years till 2040 may look like successive transitions without brutal break, and the final state may be an accumulation of all these day-to-day actions.

2.4 Exogene data

Concerning the possibilities of innovation and evolution, a certain number of exogene factors on which it is not possible to have an influence must be taken into account. Evolutions of these parameters can directly influence the choices made as regards transport:

- *Resources and cost of energies:* the future choices in term of transport will necessarily be guided by the cost of energy resources and by the evolution of the course of raw materials.
- *Technological break*: in terms of innovation, it is necessary to take into account the possibility of a technological discovery leading to a break in the modes of trip-making. The concept of technological break must be kept in mind without it being obviously foreseeable. The fuel cells or operation with hydrogen could, for example, support a new glance on cars and these new motorizations may take a certain part of the market.
- *Renewal rate of the automobile park:* the renewal rate of the park is 15 years. That implies that the cars of 2040 will have started to be built with the technological constraints of 2025. Moreover these cars are not built for the French market nor even for Europe, but for the world market.

- *Public health:* taking into account the "human" aspect of problems is a significant worry that is raised quite often. Such a top priority as the public health can make it possible to develop, or even to impose certain types of trip-making like walking or cycling that are strongly recommended.
- *Elimination of the pollutants at their source:* concerning the reduction of pollution, it is necessary to be conscious that, according to European directives, the car industry is to make disappear its pollutants by 2015. The vision of 2040 being more remote, it must take into account these intermediate goals.
- *Diversification of the concerned type of populations:* the lengthening of the lifespan and the ageing of the population force to consider designs that are adapted to this category of population. More generally, problems of trip-making of the whole of the people that show a reduced capacity of mobility (old people, handicapped people, accompanied people, partially-sighted or deaf persons, people with children in low-age or transporting cumbersome objects, etc.) must be taken into account from the beginning of the projects.

3 - EXPECTATIONS AND NEEDS

Concerning the expectations of the population, if the individual requests go in the direction of a greater use of cars, the collective answer cannot be the sum of the individual answers since this solution would lead to a dead end. It is thus necessary to wonder for which kind of people the innovations that we wish to bring are made. One way of thinking is to think in terms of assignment of means and of identification of the people concerned by the projects.

3.1 The economical aspect

According to the risks and to the costs generated by innovations, it is necessary to think of the financial aspect. Technical feasibility is a necessary condition but not a sufficient one. The following points show the various aspects to be taken into account :

- *To develop "businesses models":* in order not to see the projects fail at their stage of development, it is essential to think, while thinking of the innovations themselves, about the "deployment scenarios", that examine in particular the economical steps necessary to the viability of the concepts.
- *Optimised management of the exploitation:* it is possible to think about tools allowing to know in real time the state of tiredness of a built work in order to plan and to decide of possible repairs. This instrumentalisation of built works would allow both a better economical management and a better maintenance.
- *Partnership with the industrial world:* one condition of emergence of an innovation is that it could be profitable for the companies developing it. Possible innovations in terms of financial organization pass by the search for new solutions concerning the solvency of the operations and by the search for new partners likely to share the risks ; public/private partnership are an interesting example of evolution.
- *Innovation and risks:* in our society, the reinforcement of codes and administrative rules make the conditions of innovation quite difficult: those must respect the principle of precaution. It would be thus desirable to make evolve the administrative context in order to favour innovation by controlled and shared risks.

3.2 The organisational aspect

To succeed in dealing with the complexity of the urban areas and in building a territorial vision of it, it is significant not to limit the reflection to the simple influence of the street but to think in a more global way. The organisational innovations must make it possible to take into account the territorial approaches, the impacts on the existing city, the multiplicity of uses and functions, etc.. That is why it is useful to get out of the layout of the way and of its circulatory function to see, beyond this, the full site of which it forms one part. Within this framework, various tracks of reflection can be explored :

- *A local project leader:* the regrouping of the decision makers implies an impossibility of choosing a sectoral approach. With the multiplicity of stakeholders, it appears increasingly crucial today to be able to clearly identify one leader of the project at the local level that would be responsible of the juridical and financial stakes.
- *Organization of public transport:* to gain in effectiveness, the reflections related to public transport should be related to a more global urban reflection. Simultaneously, a very detailed attention must be kept as regards the service quality. To make public transport more attractive and more human, it is necessary to reinforce accessibility, comfort, safety, regularity, speed, multimodal information of travellers, etc..
- *Technical networks integration:* the networks management and maintenance has to be considered at the time of the global reflection on the streets of the future. These should be adapted to the nature of the networks (longitudinal and transverse networks) and according to their diameters (large diameters depend mainly on geographical conditions whereas small diameters are more related to the functions of the street itself).

3.3 The logistical aspect

The rapid evolution of needs encourages to think, upstream of the realization, of the sustainability of the new suggested concepts ; to know how long they can resist and how they can evolve. The notions of shelf life and of cycle lifespan could help to consider, in space and time, the infrastructure as well as its interface with streets and users. Hence several tracks of reflection can be explored in the field of streets management and exploitation.

- *Use evolutes in time:* considering the diversity of uses and functions which have to cohabit, it could be useful to think of their distribution in time. Public space can be shared according to the various hours of the days, to the various days of the week and to the various periods of the year. The same public space cannot accommodate with all the uses at the same time but several of them must be able to coexist. Thus, the question of flexibility is to put in relation to those of the diversity of uses. This differentiated use in time would perhaps facilitate exploitation and maintenance.
- *"Shared spaces":* in certain contexts, there is sometimes the possibility to arrange the streets without any delimitation between the pavements and the circulated ways, which is the reverse of what we usually see with the installation of "exclusive rights of way" for public transportation. There are examples of certain installations under development in London in particular (district of Kensingnton & Chelsea).
- *"Spatial pollution" of public area:* it is due in particular to an overflow of urban furniture and to the influence of cars. We can try to release public space by the means of urban furniture integrated into buildings or by the fusion of several furniture together.

Some examples are bins integrated into the buildings in Stockholm, or tree protections amalgamated with bicycle parks. The whole of urban furniture is a very large consumer of operational budget and those are to strongly decrease in the years to come. It is thus necessary to think about simple and economic modes of management.

- *Risk analysis:* if the evolutions of climate are not easily foreseeable, it is on the other hand possible to carry out a risk analysis. In the direction of a greater precaution we have, for example, the development of prevention plans for natural risks : floods, storms, risings, etc.
- *Spatial organization and carriage of goods:* to rationalize the deliveries, in particular with regard to the local trade, spatial and logistical means (service blocks, visible drain manholes, smaller trucks, etc.) should allow a better use and a better maintenance of public spaces.

4 - EXAMPLES OF CONCEPTUAL OR TECHNOLOGICAL INNOVATIONS

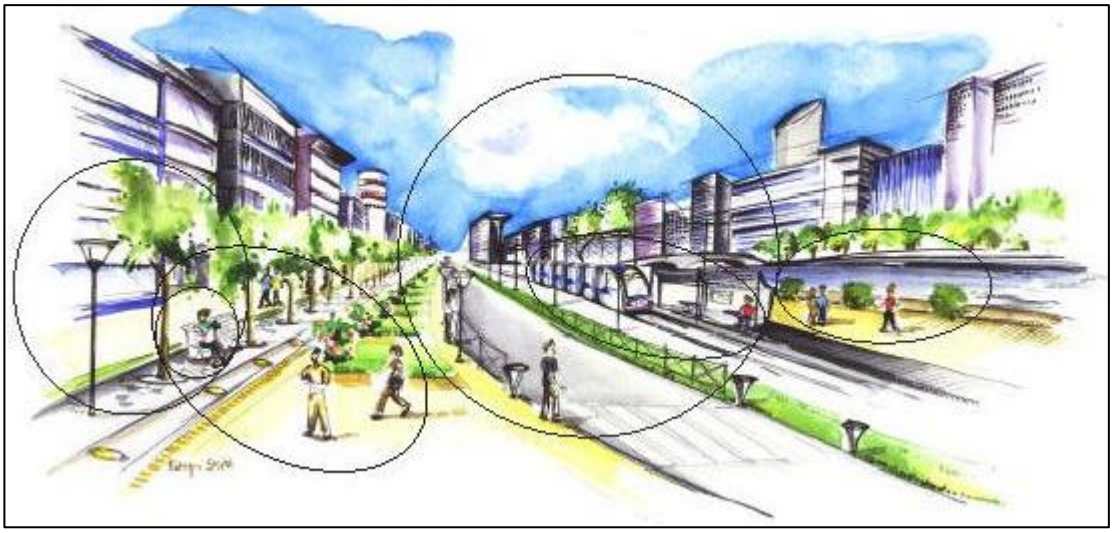
4.1 Design models

Could the uses, the environments, the architectural and the urban quality of the streets of the future be thought in relation to the technical fields without the latter imposing on the former their own particular way of thinking? This is the aim which the development of "design models" seeks to achieve.

In one same urban space, objects live together, each belonging to one or many urban systems: the system of cleansing, leisure, information, roadway, paths, shops and commerce, transportation… All these elements contribute as a whole to give a form to the spaces of everyday life in the city. What we experience everyday as inhabitants is the whole of these elements and their mutual overlaps, on which depends, for a great part, the quality of the spaces which are given to us. However the various specialists, technicians and experts took the practice to think these urban objects in terms of one single system to which they would belong to, that is to say in a functionalist way: the traffic lights to regulate circulation, low posts to prevent parking on the sidewalk, sculptures for the aesthetic of roundabouts, etc. Generally, architects and urban designers – when they are not themselves regarded as specialists – work on the interactions between all these systems, but one also finds multi-disciplinary teams, collaborations between various services. These people work through projects – architectural or urban projects. In fact, they are in charge of taking into account the whole of the urban systems in particular contexts in order to consider the spatial and technical transformation of the city.

But these professionals do not have a proper knowledge as each specialist has one. The co-operation between all these various systems is thus done "case by case", under the pressure of time, despite of the complexity of the task and according to the risks of the moment… and to the vogue: there are implicit models which are used and re-used nearly everywhere in Europe and in the world. Thus for example, the model of the mall is identical in Lima, Lyon, and Stockholm and in a number of other cities. One can also mention: "proper ways" for bus and tram exclusively – i.e. separated from the ways occupied by the automobile traffic – the alignment of benches, double alignments of trees, arcades, multiplex cinemas, glass-walls,

raised sidewalks, etc. All these are tools that designers implicitly implement in their projects of public spaces.



Many of these implicit models are still the result of a functionalist way of thinking on a more or less large scale. The “proper way” answers first the need for an effective public service of trip-making. The low posts deals with the problems of parking and the malls remain reserved for the use of pedestrians.

Research relating to the "urban design models" seeks to identify and develop the implicit models that are employed in a recurring way by designers in their projects of streets and public spaces in order to constitute a real knowledge of these models and good ways in which one can employ them. These models once clarified, corrected and enriched, become on the one hand a medium between the specialized knowledge of the scientific disciplines and the architects and urban designers projects, and on the other hand, an instrument of evaluation and capitalization of a growing knowledge on these projects.

Organized into a format composed of four elements [context - forces - intentions - configuration], this manner of formalizing urban design models allows the designer to adapt and share whole or part of the process which is presented by each model: the definition of the problem, an orientation towards a profitable conception, suggestions for solution to be transformed and adapted according to each particular project. One will then be able to distinguish three degrees of innovation in the design of multimodal infrastructures and urban spaces:

1. To identify, break up, enrich and transform the current urban models according to new specialized knowledge,
2. To invent new design models able to interact with current models and
3. To imagine models for a long-term future, independently of their compatibility with current modes of urban design, in particular independently of the standard technique possibilities.

In all the cases, these design models will be useful as tools of analysis and evaluation of existing and future sites, as design tools to pass from the program to the draft design of a

public space and its multimodal infrastructure, as a support of dialogue between designers, owners of the work, and inhabitants engaged in a true process of "co-creation".

If they succeed, these “design models” will constitute a shared knowledge of the ways of designing our cities, and as they will be refined and become increasingly consistent, as they will incorporate meaning for the various specialists and inhabitants, they will allow the community to aim at a certain life and subtlety in the design of streets and cities for the future.

4.2 The reduction of the harmful effects

4.2.1 General framework

Innovation in the automotive technology allows to react to the tendency to consider the limitation of the free flow road traffic as the solution for the problem of the concentration of the polluting vehicles. The environmental protection of cities, where the major part of the population lives, where the problems of mobility are stronger, where therefore it is necessary to focus the efforts, is faced with technically effective and socially acceptable measures – gradually introduced and for specific application – in order to avoid the constraints to the business and industrial.

Moreover, despite considering the technological improvements and the positive impact of the application of the data transmission by telematic for the bottleneck reduction and for the logistics, some studies consider that the emissions of the CO2 forecast from the 2010 car park in Italy, also with a contemporary increasing of the public/collective transports, will increase of 15%, and to year 2015 will be still advanced of 7% to those of 1990.

Within the next 10 years an ulterior reduction of the actual levels of emissions will be need needed , in order to assure the compatibility of the perspectives of mobility increase with the agreements of Kyoto. However, especially in the city, the problem of the reduction of not conventional pollutants, harmful above all for the health: benzene, fine particulates and hydrocarbons with high molecular weight, still remains opened. On the base of such forecast exercise, a development of motorizations to minimal environmental impact is expected (methane and hybrids) for city use and an increase in diesel propulsions (low emissions of CO2) in the rural areas.

The objective is to conjugate the development of mobility with the increase of safety and cleansing transports.

According to the European Environmental Agency Report, 20% (80 million people) of the European population is exposed to an A-weighted equivalent sound pressure level during 24 hours exceeding 65 dB(A) and more than 45 % (170 million people to levels between 55 and 65 dB(A). Small increases in noise level matched result in behavioural disturbance. Noise is in fact a major environmental problem that is still growing. It affects human health in several ways. Health can be impaired as the result of two main factors of exposure to excessive environmental noise: annoyance and sleep disturbance. In urban and suburban areas, road traffic is the predominant source of noise. Furthermore, as already indicated, passenger road traffic is expected to increase by 20% in the period 1998 to 2010. Road freight volumes are predicted to increase by almost 40% over the same period.

The reduction of noise should therefore be a high priority in order to improve the quality of life and health in urban areas. This means that a substantial reduction in tyre/road noise and engine noise must be achieved. At the same time the CEC short-term target (from EU Environmental Action Programme) for the year 2010 is a 19 dB reduction in road traffic noise with reference to the levels recorded in 2000. The World Health Organisation's medium-term target for the period 2000 to 2030 indicates a 29 dB noise reduction by road traffic.

In June 2002, the European Directive on the Assessment and Management of Environmental Noise (2002/49/EC, further indicated by its abbreviation END) was accepted and has come into force. Under this directive, member states will be obliged for the major roads, railways and airports as well as in large agglomerations to produce (by 30th June 2007) noise maps of noise exposure and (by July 2008) action plans to reduce exposure to be developed and reviewed every 5 years of a 10-year plan for noise annoyance.

Therefore the local authorities (regions and communities) of the European Union will play an important role insofar as they will define so-called Noise Action Plans, which should be based on noise reduction/abatement solutions such as new surfaces of and pavements as described below.

The resonant pavement is a development and improvement of the multi-functional composite pavement which consists of a surface single layer of porous asphalt of some 40-50 mm thick overlying a continuously-reinforced concrete slab. This new pavement type as composite multilayer, with resonant behaviour, is suitable not only to control the noise generation but also to control the propagation of tyre-noise emissions, by broadening the absorption spectra towards the medium and low frequency ranges. This will be obtained by taking into account not only texture optimisation and sound absorption of the top layer, but also acoustic resonance through the adoption of new materials and structural solutions so as to achieve a wide sound absorption range, resonant pavement behaviour and other types of pollution control.

"Eco-technical" type pavement solution consists of a double surface layer of porous asphalt of respectively 20 and 80 mm thickness, with different characteristics and performances, overlying a disconnection collaborating layer by metallic C shape as diffused resonators continuously distributed in the course.

"Euphonic" type pavement solution consists of a double surface layer of asphalt respectively of 20 and 40 mm thickness of different characteristics and performances, overlying a continuously-reinforced concrete slab including the resonant system continuously distributed in the course.

The resilient pavement is the first new type of pavement with the "dumping" behaviour, suitable to mainly control the generation of tyre-noise emissions while also influencing low frequency propagation. This could be obtained by dealing not only with the texture optimisation of the top layer, but also with its mechanical impedance, through the choice of raw materials, mixes and layers suitable to obtain a pavement with a vibration-absorbing behaviour in combination with acoustical durability.

The reduction of vibrations transmitted by road infrastructures, without increasing too much the construction cost, is going to be a very important issue to deal with in the urban area. The most effective construction techniques used up till now are based on very complex and expensive solutions (such as floating slabs) and on the use of special and once again expensive materials (such as elastomeric mats). One of the possible innovative techniques is based on the use of hot mix asphalt in which a share of the traditional aggregates is substituted with rubber granulate produced using waste tyres.

4.2.2 Nuisance-mitigating

The nuisance-mitigating infrastructure will be a prototype system of integrated innovative technologies to reduce noise, vibration and air, solid and liquid pollution. This system will be developed by means of innovative road pavement design solutions, new raw materials and composite and multi layers structures, active and passive equipments (i.e. forced air filtration, photocathalitic materials, phyto-control, and land soil-control) with the objective to achieve global nuisance mitigating infrastructures. The global nuisance mitigating prototype system shall give an answer to the strong need for a drastic reduction in traffic noise and air pollution abatement especially in suburban areas.

One of the most promising European noise abatement approach refers therefore not only to reduced tyre/road noise emissions relating to the top layer, including the absorption of vibrations by the "dumping" behaviour of a base layer, like in the "resilient" behaviour pavement, but also to tyre/road noise and engine noise absorption obtained from the "resonant" behaviour of the surface course and deep layers. A pavement with "resonant" behaviour would be suitable not only to control the noise generation but also to reduce the propagation of tyre-noise emissions, because it broadens the absorption spectra towards the medium and low frequencies range. Heightened noise abatement will be obtained by taking into account not only texture optimisation and sound absorption of the top layer, but also acoustic resonance through the adoption of new materials and structural solutions so as to achieve a wide sound absorption range, resonant pavement behaviour and other types of pollution control.

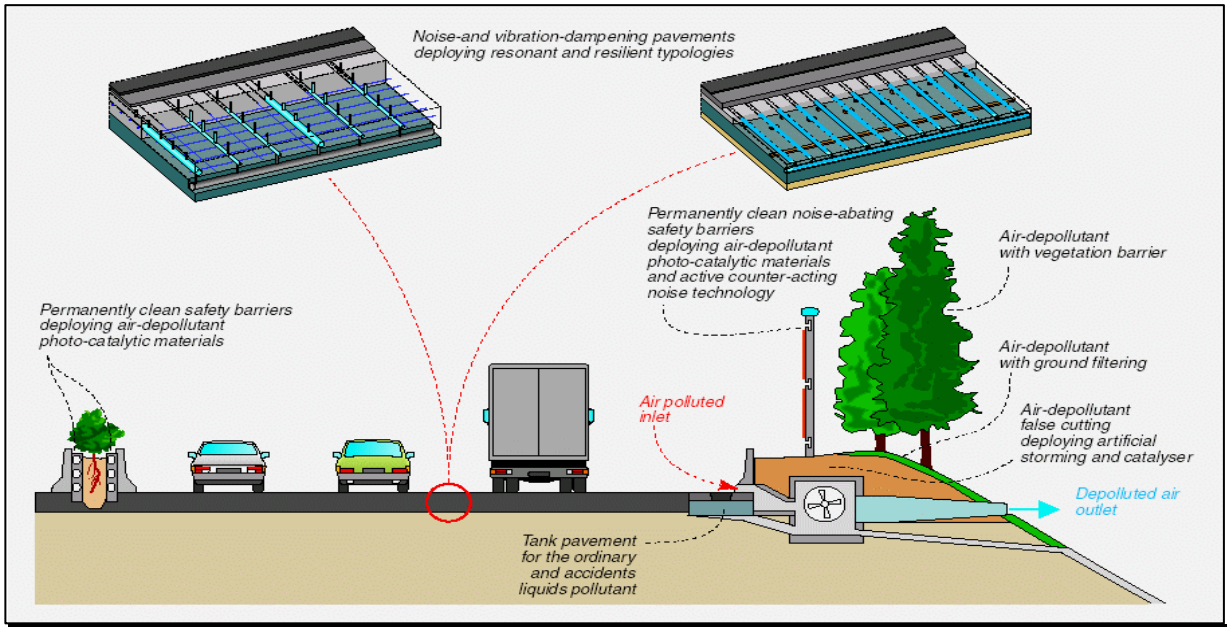
To further reduce noise, vibration and air, solid and liquid pollution from road traffic it is also necessary to take action on road infrastructure, with particular regard to road superstructures (pavements) and structures (tunnels or artificial cuttings). The innovative concept of the ecotechnic will permit the production of the integrated cleansed road obtained by innovative technologies.

The ecotechnic road section will be composed by

- ✓ permanently clean safety barriers deploying air-depollutant photo-catalytic materials;
- ✓ permanently clean noise-abating safety barriers deploying air-depollutant photo-catalytic materials and active counter-acting noise technology;
- ✓ air-depollutant with ground filtering;
- ✓ air-depollutant with vegetation barrier;

✓ air-depollutant false cutting deploying artificial storming and catalyser and installed in tunnels or U (including artificial type) sections;

✓ noise - and vibration - dampening pavements deploying resonant and resilient typologies.



4.3 Photocatalysis – a solution for the air pollution by traffic?

A variety of air pollutants have known or suspected harmful effects on human health and environment. In most areas of Europe, these pollutants are principally the products of combustion from space heating, power generation or from motor vehicle traffic.

Pollutants from these sources may not only prove a problem in the immediate vicinity of these sources but can travel long distances, chemically reacting in the atmosphere to produce secondary pollutants such as acid rain or ozone.

To achieve the European targets in 2010, the traffic has to concentrate on the reduction of the principle pollutants emitted by vehicles, which are carbon monoxide, oxides of nitrogen (NO_x), volatile organic compounds (VOC's) and small particulates. These pollutants have an increasing impact on the urban air quality.

In addition, photochemical reactions resulting from the action of sunlight on NO_2 and VOC's lead to the formation of ozone, a secondary long-range pollutant, which impacts in rural areas often far from the original emission site. Acid rain is another long-range pollutant influenced by vehicle NO_x emissions and resulting from the transport of NO_x, oxidation in the air into NO_3 and finally precipitation of nitrogen acid with harmful consequences for building materials (corrosion of the surface) and vegetation.

A solution for the air pollution by traffic can be found in the treatment of the pollutants as close to the source as possible. Therefore, besides the diminishing in exhaust by the car itself, photocatalytic materials can be added to the surface of pavement and building materials

[1;2]. In combination with light, the pollutants are oxidized, due to the presence of the photocatalyst and precipitated on the surface of the material. Consequently, they are removed from the surface by the rain.

Heterogeneous photocatalysis with TiO_2 as catalyst is a rapidly developing field in environmental engineering. It has a great potential to cope with the increasing pollution. The impulse of the use of TiO_2 as photocatalyst was given by Fujishima and Honda in 1972 [3]. They discovered the hydrolysis of water in oxygen and hydrogen in the presence of light, by means of a TiO_2-anode in a photochemical cell. In the eighties, organic pollution in water was decomposed by adding TiO_2 under influence of UV-light. The application of TiO_2 as air purifier originated in Japan in 1996. A broad spectrum of products appeared on the market for indoor use as well as for outdoor use.

Besides the air purifying action, TiO_2 is also used to obtain a self-cleaning material. Due to a very high hydrofilicity, a water layer is attracted between the dirt and the surface resulting in the washing off of the dirt particles. In addition, due to photocatalytic working, a decomposition of the dirt particles, especially of the organic particles takes place followed by the washing of the surface resulting in a cleaner surface.

Application of TiO_2 in building materials as photocatalyst

The increase in patents during the last decade indicates a huge interest, especially from Japan and Europe, in the application of TiO_2 as photocatalyst in building materials. Regarding the reduction of air pollution due to traffic in urban areas, the application on pavement surfaces or on the building surfaces in cementitious materials gives optimal solutions. To increase the efficiency of the photocatalyst, its presence at the surface of the material is crucial. It has to be accessible by sunlight to be activated. Consequently, the pollutant has to be absorbed on the surface and oxidized or reduced to a less harmful element.

The goal is to have as much TiO_2 as possible at the surface of the material, without the risk of loosing it by abrasion or weathering. Up till now, the most efficient way to apply the TiO_2 is in a thin layer cementitious material, which is placed on the surface. Application in concrete tiles is therefore very suitable: the TiO_2 can be added to the weathering layer. If the layer is slightly used, new TiO_2-particles will be present at the surface.

Photocatalytic pavement blocks, the TiO_2 is added in the upper layer

In Belgium, a test project is set up on the 'Leien' of Antwerp. On approximately 10.000 m², photocatalytic pavement blocks are installed in 2005. Measurements in laboratory as well as in situ have started to determine the efficiency in situ as well as the durability of the air purifying qualities.

TiO_2 and the photocatalytic process

TiO_2 is a metal, which is multiply present in nature. It is used as pure metal in high-tech applications, where it couples corrosion resistance and low density to high strength. It can also be used in powder form or as a colloidal solution. The oxygen TiO_2 has three different molecule structures: rutile, anatase and brookiet.[4]. In the case of rutile, two sides of the octahedron are in common. In this way, chains are formed. In the case of anatase, the four angular points are connected. In this way, a more porous morphology is formed, as can be seen in figure 1. The former is mostly applied as white pigment in paints, the second is preferable if used as photocatalytic cell. The latter has few application forms.

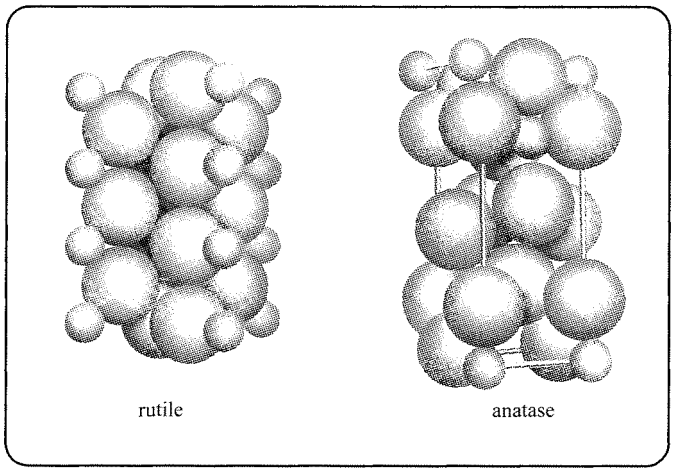


Figure 1. Anatase versus rutile [4]

To use anatase in heterogenic photocatalysis, UV-light with a wave length lower than 387 mm has to be present. Also the intensity of the light is important to optimise the photocatalytic activity. Normal daylight can be used for the photocatalytic reaction.

The photocatalytic reaction proceeds on the surface of semi-conductors via several steps: pairs of electron-hole are produced by irradiating the semiconductor. These electrons and holes can be recombined or can be separated due to adsorption of other products on the surface. Redox reactions between the trapped electrons and holes and the adsorbents present on the surface occur after which there is a desorption of formed products and reconstruction of the surface.

Heterogeneous photocatalysis with TiO_2 as catalyst results in a total mineralization of a broad gamma of organic compounds (alkanes, alkenes, alcohol, pesticides,…) Further it is possible to reduce NOx, bacteria and viruses.

4.4 Work PIARC : a catalogue of innovations and a step supporting the emergence and the development of the innovations

In order to identify and promote the best practices for the development of mobility in a sustainable development, the World Road Association is interested in innovation and regularly draws up panoramas on the requirements in innovation and concerning the best organizations allowing their blossoming, their development and their coding.

The probable evolution and the vision of the street of the future give a greater place to a scenario of transition instead of a braking scenario by 2040. It is thus relevant to observe the needs for innovation identified by the stakeholders' environment for today and tomorrow. In addition to that, concerning the technologies of roadway system one frequently needs around twenty years from the idea to emerge and, if it is relevant, the spread of its employment in the suitable field. A particular echo is thus to give in our field of urban infrastructures to the tracks of innovation engaged on the short term in order to imagine the future in the logic of "everything is technically possible".

Moreover, the federator subject of innovation is strategic, observing that we are condemned to innovate in the field of roads, streets and networks as in any other field, because the economical, social and environmental stakes are constantly evolving. For the technical and organisational subjects of innovation themselves, it is also necessary to revisit and innovate in our methods of initiating and praising innovations. Innovation needs organization and tools to deliver the concepts and the products, which the street of the future will have to integrate.

The PIARC knows the fact that the knowledge of needs, their consolidation by local committees, national and international representatives and their positioning concerning environment, security and social evolutions constitute the essential bases for innovation. To know the needs and the most efficient organizations, the international investigation related to four groups of questions:

1. innovating roadways to satisfy which need and to render service to which users ?
2. innovating roadways at which stage of development ?
3. can we identify the most relevant innovating roadways for the future ?
4. what is the origin of the innovations and which organizations can make emerge and promote these innovations ?

Concerning the needs, the framework of the answers made it possible to finalize a catalogue of technological innovation, which identifies twelve great families of concerns with precise examples of tracks of action as specified in table 1.

Table 1

CATALOGUE OF TECHNOLOGICAL INNOVATION		
Functionalities to improve		**Examples of tracks of innovation in urban environment**
1	To erase pathologies	Roadway system against crack and cart-track Integrated concept of interface
2	To optimize ergonomics	Composite roadway system, mixed roadway system Prefabricated roadway system
3	To preserve the environment	Roadway system tank, catalytic roadway system Euphonic roadway system or echotechnic porous, absorbing, antivibratory roadway system
4	To support multimode trip-making	Roadway with guided systems for public transport Roadway system with shared structure and coating
5	To integrate the networks	Roadway system with flexible emergence – dismountable Roadway system – roadway system for networks, micro trenches New global concept roadway system - networks - mobility - service
6	To contribute to the road safety by integration	Roadway system with qualitative coating, auto-cleansing roadway system, new technological bricks and new assemblies for coatings
7	Energy saving	Roadway system with low energy, tepid and cold coatings, renewable roadway system which can be recycled Evolutionary roadway system
8	To preserve the natural resources	Roadway system with controlled waste, Roadway system with recycled materials, Reprocessed roadway systems
9	To improve the road exploitation	Roadway system with no maintenance, prefabricated roadway system, enrollable roadway system, instrumentalized roadway system, intelligent roadway system
10	To resist the various constraints	Roadway system for static constraint, roadway system for cold and heat climate, easily flooded roadway system, self-draining roadway system, roadway system under cavities
11	To increase the economical performance	Temporary roadway system, progressive roadway system, transitory roadway system, multi-layer cast solid roadway system
12	To facilitate management	Self-repairable roadway system, self-evaluating roadway system, self-descriptive roadway system; adhesive roadway system

This tool allows to schedule the needs for innovation compared to the functionalities the roadway systems must ensure.

Expectations are strong and unanimous concerning the safeguarding of the natural resources and the sustainable development, the fight against recurring pathologies, the improvement of structures and materials ergonomics, with a particular mention for the public transport platforms, the roadways integrated into the sites they pass trough, predictive safety etc…

The urban area is identified as a particularly promising and petitioning area for the technological and organisational innovation, for in a complex spatial and temporal organization, it is necessary to innovate, not only to innovate in all the twelve mentioned functionalities, but also to answer to more targeted and specific problems of the following type :

- roadway systems at very long working life (> 100 years) ;
- transformable roadway systems by evolutionary functions ;
- multifunction roadway systems with space-time vocation ;
- auto energetic and furtive roadway systems for climates and seasons.

Elements of conclusion : context of the innovation

In answer to the question of "Which is the engine of the innovations", we observe that the user is more implied by the urban environment that in the case of the interurban roads, that the administrations are strategic levers concerning the innovations, that the universities and the research centres are the second force of promotion of the innovation and that industry and the companies are very active concerning the challenges of energy and the durable development, the natural resources, safety and integration.

Moreover, it releases a certain number of convergent ideas on the fact that the specifications based on the performances, the contracts of performance, the guarantees in the medium and long term, seem promising supports to instigate the innovation in the field of the infrastructures of roadway systems. The first contracts of performance operated on the whole of the network of urban roadway systems of the large cities abroad deserve in this respect being followed with all the desired attention.

Expextations of the townsmen as regards infrastructures ensuring a controlled mobility, alleviated, and furtive with respect to the embarrassments and harmful effects for all the period of first half of the 21st century will impose an activity of constant innovation. It will be necessary to take care during all this period so that the conditions necessary to a dynamics of the innovation for all the acts of planning, design, execution, exploitation and maintenance of the urban infrastructures are given, namely:

- to promote the idea that the innovation is vital for the company;
- to enforce the principle which the innovation implies the risk ; the controlled risk and risks it divided;
- to cultivate the reflex of the partnership for administrations and research centres which offer springboards to engineering and the companies to exert their ability;
- to take care of spontaneity, to guarantee creativity;
- to identify the barriers to the innovation regularly and to anticipate them for better treating them;
- to act so that the innovation can be financially constant;
- to privilege the concept of performance rather than that of means.

Observatories of the practices of innovation and periodic assessments of the policies of incentive and support for the innovation appear increasingly necessary in order to know the progress awaited for our future public.

The need for requirement of populations goes hand in hand with more marked impatience. Also let us guarantee that the professional world of the roads, streets and networks will be able to also innovate in the reactivity to satisfy the needs increasingly more evolutionary for the city.

Bibliographical Elements

General bibliography on the city and the urban one

D. MANGIN, *La ville franchisée*, éditions de La Villette, Paris, 2004.

Ch. ALEXANDER *et al.*, *A Pattern Language*, Oxford University Press, New York, 1977.

RESTITUTION DES TRAVAUX DU GROUPE DE REFLEXION « PARTAGE DE LA VOIRIE = UN ESPACE PUBLIC POUR TOUS », *Une voirie pour tous, Sécurité et cohabitation sur la voie publique au delà des conflits d'usage*, Décembre 2004

COLLECTIF, *La ville étalée en perspectives*, éditions Champ social, 2003.

D. AUGELLO (Renault), « L'automobile 2020, une vision industrielle ».

S. BARLES et A. GUILLERME, « Histoire, statuts et administration de la voirie urbaine », *in Guide Pratique de la Voirie Urbaine vol. 1*, éditions RGRA, 1998.

G. DUBOIS-TAINE, Y. CHALAS, (éds), *La ville émergente*, Paris, Editions de l'Aube, 1997.

J.-C. GALLETY, *Le concept de boulevard urbain*, CERTU, 1995.

J-L GOURDON, *La rue, essai sur l'économie de la forme urbaine*, éditions de l'Aube, 2001.

Eugène HÉNARD, « Rue future », *Les villes de l'avenir*, 1910.

K. LYNCH, *Good City Form*, MIT Press, Cambridge, 1981.

F. MIALET et V. FOUQUE, *Voirie rapide urbaine et espace public : quelles liaisons ?*, Collection du CERTU pour le Plan Construction et Architecture, 2001.

Ph. PANERAI, J-C. DEPAULE, M. DEMORGON, *Analyse Urbaine*, éditions Parenthèses, Marseilles, 1999.

Ph. PANERAI, J. CASTEX et J.-C. DEPAULE, 1997, *Formes urbaines, de l'îlot à la barre*, éditions parenthèses, Marseille, 1997.

P. PATTE, « Profil d'une rue », *Mémoires sur les objets les plus importants de l'architecture*, Paris, 1769.

A. PICON, « La voirie cherche sa voie », *in L'architecture d'Aujourd'hui n° 355*, nov-déc 2004.

T. SIEVERTS, *Entre-ville, une lecture de la Zwischenstadt*, éditions Parenthèses, Marseille, 2001.

Bibliography on photocatalysis

1. A. FUJISHIMA, K. HONDA, *Electrochemical Photolysis of water at a semiconductor electrode*, Nature, 238, 37-38 (1972)
2. A. FUJISHIMA, K.HASHIMOTIO, T.WATANABE; *'TiO_2, photocatalysis, fundamentals and applications'*, BKC, Inc., 1999, P. 176.
3. S. BERX, W. ROES, *Fotokatalyse in betonoppervlakken (in dutch)*, Thesis at the department of Civil Engineering, KULeuven, Belgium(2002).
4. I. SOPYAN, M. WATANABE, S. MURASAWA, K. HASHIMOTO, A. FUJISHIMA, *An efficient TiO_2 thin-film photocatalyst: photocatalytic properties in gas-phase acetaldehyde degradation*, Journal of Photochemistry and Photobiology A: Chemistry, 98, 79-86 (1996).