

Testing of the components

depending on the type of networks

The program is organized into a holistic approach. It deals with all the categories of road networks as well as their different phases, i.e. design, construction and operation. Each type of road has indeed its own particularities in terms of design, construction, maintenance and operation. Four different types of road networks are classically considered: urban, peri urban, interurban and local networks. The different themes related to the design, construction and operation of roads are organized into three interdependent elements, like in the FOR program ^[6-7-8].



The adaptable road element deals with the low carbon design, construction and maintenance of roads.



The resilient road element relates to the resilience of road networks regarding climate change and natural risks, as well as their energetic efficiency.



The automated road element deals with the automation of traffic and operations thanks to ICT.

A detailed description of these elements is provided in the three different roadmaps published by FEHRL in January 2013.

Since the beginning of the program, different demonstrators, which involved IFSTTAR and its industrial, academic and institutional partners, have been (or are being) implemented, in order to test and to label different innovative solutions.

The road as a vector of innovation

The long service life of road infrastructure, as well as their heritage character, makes innovative solutions a particularly sensitive topic in terms of public procurement. Over time, various policy tools have been designed to meet these challenges. Unfortunately, they are today disconnected from the recent tools related to research and innovation. Through IDRRIM, this action seeks to identify together with all stakeholders the weaknesses of current tools to support the innovation in road area and if necessary to revise or to propose new ones.

Among the proposals under consideration, three ideas deserve to be studied more closely:

- Federate the different competitiveness clusters, which use and provide innovative solutions for transport infrastructure, particularly road,
- Identify an operator capable of carrying a national road innovation program,
- Establish mechanisms for sharing collectively a risk taken by a single road owner.

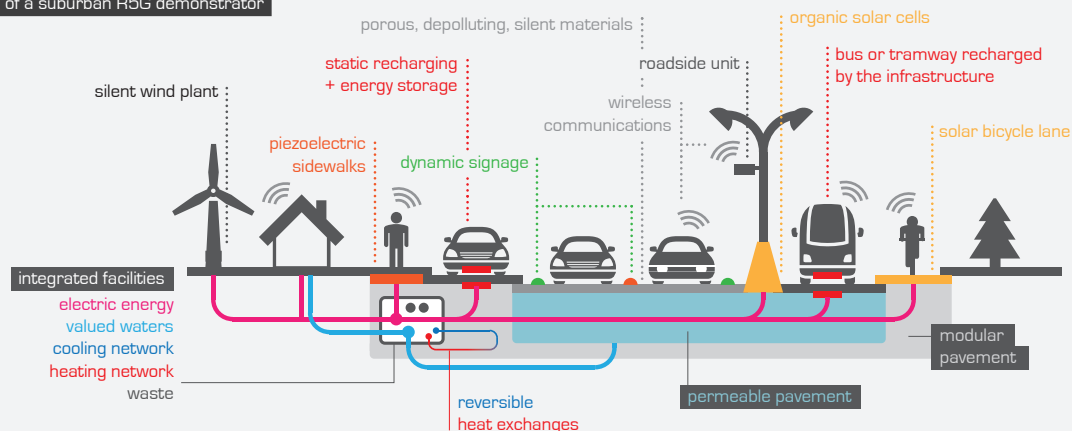
Testing of the acceptability

This action aims at integrating on a small number of demonstrators the most promising solutions based on performance achieved on the demonstrators related to the adaptable road, automated road and resilient road. The design of these innovative demonstrators aims at involving all stakeholders in terms of current and future functions of road infrastructures. This is the concept of "Function-Centered Design" (see the box). The evaluation of these demonstrators is intended to be as exhaustive as possible, in terms of analysis and life cycle cost, but also in terms of use by people who use innovative road sections and also by local residents.

Some innovative territories are already ready to welcome such an experiment. An overview of these territories mobilized by the R5G project is proposed in Figure 4. In the medium term, some of them could implement a suburban R5G demonstrator, like the one shown in Figure 5. It brings together on the same site different functions: energy collection, electric vehicle charging, vehicle-infrastructure dialogue and monitoring of environmental and weather conditions.



Illustration of a suburban R5G demonstrator



Today, users expect roads that are forever open. For road managers, this implies to propose infrastructures that are continuously tailored to the travelling needs, while offering a growing number of services; these infrastructures should also be stealthily maintained and resilient to weather events. However, the pressure of societal issues and budget constraints has made it more and more difficult for these managers to ensure an optimal operation of their networks. In synergy with the Forever Open Road program [1], IFSTTAR has launched the "5th Generation Road" program to tackle this huge challenge [2]. This program aims at designing full scale demonstrators integrating the numerous innovations that are already available within research centres, and demonstrating the synergy among them.



Need for R5G

Lots of technologies are already available in private and public research centres. A strong willingness to test and industrialize all the promising solutions and gather all together the existing innovations in all fields on the same site is today missing. These innovations may benefit from two recent technological trends. Firstly, energy, materials and information are converging fields, which means that in a close future, road infrastructures will be able to transport not only people and goods but also energy and information. Secondly, the development of smart vehicles can potentially be to the benefit of road infrastructures, in particular through the development of cooperative ITS solutions [3]. A global approach, which would cover the different aspects of road construction, operation and maintenance, road energy and environment, is then necessary. This is exactly what the 5th Generation Road implementation program presently envisions: a new road generation, built through a system approach, which gathers the best current ideas and demonstrates the synergism among them [4,5].

Technical Approach

Today, when a new technical solution is proposed to answer an open call for tenders, failure is not allowed, and this situation limits the possible risk taken by the company as the failure of the tested solution would be indeed very problematic for the image of the company. In the same way, companies are unlikely to propose complex systems, which gather the competencies of different industries, e.g. car manufacturers and road industry. Consequently, early stages innovative solutions are not likely to be implemented. Conversely, the design, the construction and the operation of full-scale research demonstrators, where risk is mainly (but not entirely) taken by the road authority, is likely to make a great difference. As a matter of fact, thanks to such demonstrators, the most innovative solutions, but also the more risky ones, and especially those proposed by research centres, are more likely to be tested and problems related to their implementation identified and further solved. However, these demonstrators must show a clear improvement with regard to the past and propose a technological breakthrough, so as to best meet societal objectives.

A three steps program

To deploy technological breakthroughs in road infrastructures, it was proposed to act on three levels. The first action is to identify, test and label innovative solutions. A second action, the acceptable road, is to integrate a subset of these innovations in some full-scale demonstrators, which are located on innovative territories. The objective is to evaluate the synergy between them, but also to identify potential problems for implementation in order to solve them. These demonstrators are not necessarily related to road engineering but are primarily intended to meet the challenges of society. A third action, the road as a vector of innovation, aims at designing the public policy tools that allow generalizing the different solutions on the entire country.



[1] FEHRL Strategic European Road Research Program, SERPP V, May 2011 [2] IFSTTAR, Stratégie scientifique de l'IFSTTAR - Les grandes orientations de la recherche à 10 ans, 2012 [3] Hautière, N. La route peut-elle capter plus que jusqu'à présent l'apport des nouvelles technologies ? In Transports, 480: 5-16, 2013. [4] Hautière, N., De-La-Roche, C. et Jacquot-Guimbal, H. La route de cinquième génération (R5G). Quelle infrastructure dans vingt ans et quels services en attendre ? Revue Générale des Routes et Autoroutes, 910: 28-35, 2013. [5] Hautière, N., De-La-Roche, C. et Op-De-Beek, F. Comment adapter les infrastructures routières aux enjeux de la mobilité de 2030. TEC : Transport Environnement Circulation, 217: 25-32, 2013 [6] FEHRL, The Automated Road - A roadmap for research, January 2013 [7] FEHRL, The Resilient Road - A roadmap for research, January 2013 [8] FEHRL, The Adaptable Road - A roadmap for research, January 2013



Function-Centered Design of Roads

In the field of technological innovation, a dominant trend is indeed to highlight technology, without always taking into account the users' needs; this is called a "Technology-Centered Design." Therefore, if this approach may seem legitimate on the purely technical level, the risk is to develop technologies that do not fulfil the needs and expectations of actual users. These technologies may be then badly accepted, which can lead to irrelevant or even dangerous human behaviors. Because of the growing complexity of systems and transport networks, this purely techno-centric view is not defensible anymore. To ensure a better success of technological innovations, the user must be put at the heart of the design process, which the ergonomists defined as a "Human-Centered Design". In the case of road infrastructure, a human-centered design approach is necessary because the road is, by definition, a place where different users interact (drivers, cyclists, pedestrians). However, the road also performs other functions that may have a very indirect link with the users travelling on it; for example, other types of networks (water, telecommunications, and energy) can pass through it. In addition, residents are not necessarily road users, but they are nonetheless affected by it (living environment, biodiversity, air quality, etc.). In this aim, the "human-centered design" method itself may appear as too restrictive with regard to these other indirect functions. So, it is necessary to develop a method that will be centered on the functions performed by the road: the so-called "Function-Centered Design". In this context, virtual conception and mockups play a central role, by helping the designers but also favoring the empowerment of users and residents.



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