Urban Roads in France: Overview and Recent Developments in Maintenance Management Aids

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Decentralization trends in France in recent years have made decision makers and engineers aware of the importance of having modern computer-based tools for the effective management of the major infrastructures represented by urban roads. Considerable developmental work was initiated and conducted jointly by the Association of Engineers of French Cities and the decentralized highway engineering network of the Ministry of Equipment. This has led to a range of computerized maintenance management programs designed with standard, user-friendly features for easy adaption to the everyday requirements of the highway departments of local communities. An observatory for general maintenance practices was set up, allowing the forecasting of requirements from the standpoint of the general approach and programming, as well as from the finer standpoint of diagnostics and expertise. These applications are examined and the two computer-aided tools most frequently used are described in greater detail along with the most promising technical and organizational potentialities for their distribution to engineers. What is involved is the Relational Tool for Maintenance Management (ORAGE) management aid system and the Expert System for Highway Diagnostics and Maintenance (SEVADER).

In France as in many other industrialized countries, over three-fourths of the population lives in cities, and a significant increase in this population has been observed in particular during the past three of four decades.

The importance of urban road facilities, their essential role in the life of the city, and their technical, economic, and social implications (Figure 1) lead to a growing demand for management aids. Recent decentralization measures have also brought about increased awareness of the need for better dialog between technicians and decision makers, thus calling into question some earlier practices that did not always optimize the respective roles of the technical expert, consultant, and decision maker.

These new conditions have made it possible to provide local communities with modern tools making extensive use of computer technology to monitor practices, to take better stock of existing facilities and their surroundings, and to allow better diagnostics and choices of action to be taken.

The Association of Engineers of French Cities (AIVF) and more particularly its working group on highway facilities, and the Techincal Network of the French Ministry of Equipment, through its central and regional organizations, have been working towards this objective and have pooled their efforts in the design, production, experimentation, and distribution of such computer aids. [The Technical Network of the Ministry of Equipment is headed in this area mainly by the Urban Transport Research Center (CETRA), the Road Research Laboratories (LCPC), and the Road and Freeway Engineering Research Office (SETRA).]

The AIVF, whose members include engineering technicians of regional communities, represents the profession

- Within public and semipublic organizations,
- Within private corporations, and
- Within the International Federation of Municipal Engineers, which participates actively in the various research and documentation actions relative to all the engineering tasks of regional communities.

Products are examined that are most attractive to local communities in the area of technical management of maintenance for highways and surroundings, on the basis of the criteria of the number of sites and the potential demand.

PRACTICES

The AIVF undertook a survey in 1985 to establish an overview of maintenance practices on urban roadway pavements.

Almost half of the 400 urban communities and cities in France with over 15,000 inhabitants responded to the survey, thus allowing the establishment of a computerized data base serving as an inventory and an observatory of maintenance practices on the national level. The data base contains valuable information, from which the following characteristic figures of urban road facilities were summarized:

Data Item	*Amount*
Total area of road facilities	430 million m^2
Average area per capita	20 m^2
Annual renewal of pavement	20 million m^2
Average renewal cycle	17 years
Average annual expenditure per capita for maintenance	72 francs (1985)

The following remarks can be made about these summary data:

- The total surface area of road facilities in cities with over 15,000 inhabitants represents the equivalent of 60,000 km of

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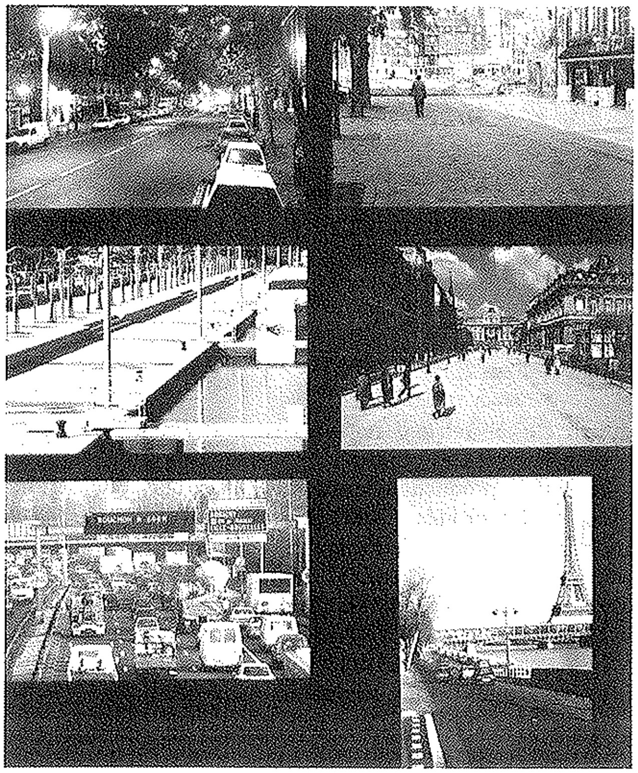


FIGURE 1 Urban roads: a broad variety of users, utilizations, and functions.

two-lane roads. This number is 10 times more than the motorway network and twice as much as the national highway network in France.

- There is an average of 20 m^2 of road per capita. This number can vary twofold from one city to another.
- The surface area contracted annually for the maintenance of urban roads in cities of over 15,000 inhabitants is approximately 20 million m^2 (which is the same order of magnitude as for the national roads).

On average, 5 to 6 percent of the surface area of existing road facilities is repaved annually as part of maintenance and improvements, with an average renewal rate of 17 years.

NEEDS

In addition to knowledge of field conditions encountered daily by the partners of the AIVF and the Technical Network of the Ministry of Equipment, joint studies were conducted further upstream on the subject of decision preparation tools. As in the case of the study of practices, these investigations were based on surveys aimed at political decision makers and their technical counterparts. All the diversity of local communities (towns) and territorial authorities (departments) was represented during interviews designed to allow better understanding of what is to be expected now and in the future from the dialog between decision maker and technician.

From this work, conducted within the broadcast framework of the National Committee on Technological Forecasting for Highway Engineering, two major points were brought out:

1. Among the major issues that highway professionals will be confronted with in the next 5 to 8 years is the *growth trends in management aid requirements*.
2. Decision makers wish to have three types of aids that are clearly differentiated and categorized with respect to time:

- Aids for determining the status and quality of service of highway networks,
- Aids for defining a policy and for scheduling of highway works, and
- Aids for checking job completion against job planning.

Two clearly distinguished expectations also appear as a common denominator to these aids.

1. Better coordination of highway works and underground works on networks. The interconnection of information systems and the programming aids of the different occupants of the public domain is a major expectation of officials from technicians within the next 5 to 10 years. This challenge is now achievable by technicians owing to progress already made or expected within the stated time frame in computer systems as regards hardware, software, and networking. Highway managers must take initiatives in order to gradually achieve consistency in the tools and methods used by different players of the public domain.
2. Excellent user-friendliness of products derived from these aids, and even of the aids themselves. Decision makers wish to have clear comprehensive documents allowing immediate perception by other officials and the general population of the messages involved. Topical maps constitute excellent media in this respect, the full importance and potentialities of which have not yet been understood by technicians.

POSSIBLE RESPONSES TO THESE EXPECTATIONS

Cooperation between the AIVF and the technical network of the Ministry of Equipment does not claim to be the only possible means of progressing with respect to the questions raised earlier. Many local or individual initiatives contribute to the improvement of knowledge. General and joint programs, nevertheless, make it possible to constantly have an overall view of the relation between needs and responses, and to apply more easily the consistency and complementarity required.

Thus, for highway network maintenance management, two approaches are considered separately, but from the standpoint of consistency (Figure 2).

1. To reply to the question as to where and when to intervene, the road network is considered as a whole. Use is made of the most sophisticated forms of management aids, optimized management models. The first-generation tool of this type most widely used in local communities is called ORAGE, the French acronym for "relational aid for highway management."
2. To reply to the question as to how to intervene, the network is no longer considered as a whole, but in terms of one or more pavements. Use is made of detailed diagnostic

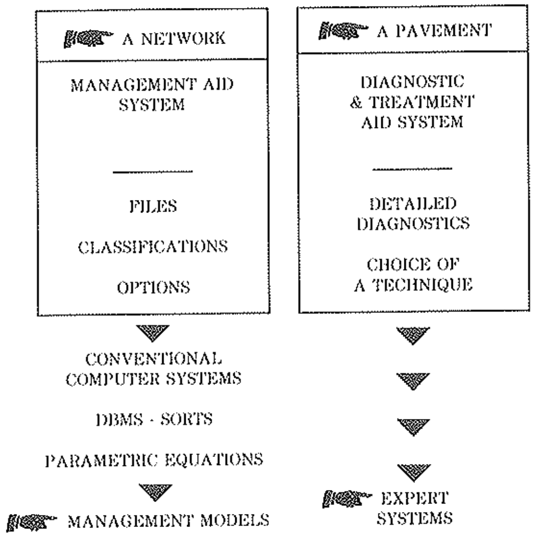


FIGURE 2 Management logic: pavement surveying diagnostics and choice of remedies.

methods, the most advanced examples of which are the expert systems. The tool of this type most widely used by local communities is called SEVADER, from the French for "expert system for highway engineering diagnosis and repair recommendations."

ORAGE and SEVADER may be used either independently of each other or together, because they are linked on compatible microcomputers. By mid-1990, ORAGE was set up at about 30 sites and SEVADER at 7 sites. The required equipment depends on the size of the town (number of highway segments to be managed). It is summarized in Table 1.

DESCRIPTION OF ORAGE SYSTEM

ORAGE and Products of Its Generation

In the family of management models, ORAGE is a first-generation tool. This designation means that it is intended primarily for setting up an order of priority for the sections to be maintained. This classification is obtained by combining,

TABLE 1 HARDWARE AND SOFTWARE RECOMMENDED FOR USE OF ORAGE MANAGEMENT MODEL AND SEVADER EXPERT SYSTEM CONSIDERED SEPARATELY OR TOGETHER

	ORAGE ALONE			SEVADER ALONE		ORAGE + SEVADER	
Application / *Equipment*	*Average city* *1200 seg*	*Large city* *3000 seg*	*Very large city* *20.000 seg.*			*Large or Very large city*	
Type of Micro	PC 386 > 16 MHz	PC 386 > 33 MHz	PC 386/33 SERVER + PC 386/16 Work Station	PC 386 20 MHz	PS 386	PC 386 > 33 MHz	PS 386 > 33 MHz
RAM	4 MB	4 MB	8 MB	5 MB	5 MB	4 MB	> 8 MB
Screen	Color	Color	Color	Color	Color	Color	Color
Additional board	Coprocessor 80387	Coprocessor 80387	Coprocessor 80387	no	no	no	no
Hard disk	> 100 MB speed < 28 ms	> 200 MB speed < 28 ms	> 320 MB speed < 28 ms	> 40 MB	> 40 MB	> 100 MB	> 100 MB
Printer	yes	yes	yes	yes	yes	yes	yes
RDBMS.	ORACLE Ver. 5.1.b.	ORACLE Ver. 5.1.b.	ORACLE Ver. 5.1.b.			ORACLE Ver. 5.1.b.	ORACLE Ver.5.1.b.
Other software	Drivers library and graphics	Drivers library and graphics	Drivers library and graphics	Windows ESCOP + le LISP	Windows ESCOP + le LISP	Windows ESCOP + le LISP	Windows ESCOP + le LISP
Image Bank Additional board	DVA 4000	DVA 4000	DVA 4000			DVA 4000	DVA 4000

with a certain weighting (specific to the objectives of each city and adaptable according to the type and function of road facilities), the different indicators characterizing the urban road and its surroundings. In the basic version, the basic criteria adopted are

- Deterioration of pavement surface,
- Bearing capacity of pavement structure,
- Loading,
- Condition of gutters and curbs, and
- Condition of sidewalks.

In addition to these basic criteria, multicriterion analysis sorts from descriptive files of road facilities make it possible to integrate large and diversified actions calling for an urban approach: functionality of streets, types of users, presence of underground networks, history, etc.

ORACLE, A Good Driver for ORAGE

ORAGE is designed around the ORACLE relational data base management system (DBMS). The DBMS, of American origin, has taken on a leading role worldwide in its category. This choice is based on the following considerations:

- ORACLE is a relational data base management system supported by many systems (UNIX, MS/DOS, VM, etc.);
- The MS/DOS system is identical in minicomputer and mainframe systems;
- A warm start is obtained on the microcomputer—in the event of power failure or any other trouble, the integrity of the data base is maintained;
- File and program access confidentialities are managed on the microcomputer.

Working Documents and Reproduction Associated with ORAGE

From the outset and throughout its development, the ORAGE system favored the quality of information reproduction, including that of intermediate data collection working documents. This feature was applied in the user-friendly design of screens for dialogs between user and machine as well as in computer graphics reproduction. A few examples of outputs from the data base generated on the site of the city of Montreuil sous Bois (of 120,000 inhabitants) in the Paris area follow:

- The dictionary of streets established in accordance with Standard AFNOR Z 20 008 of November 1976.
- Segmentation of the road network is prepared using a precise composition methodology based on rough preparation work on plan and field validation. A segment is the part of a street between two intersections. Intersections are integrated in a segment next to it.
- A preedited and personalized file for each segment contains general information on the makeup and the quantification functions for deterioration (Figure 3).
- Evaluation of road and classification of segments. The rating scale varies from 0 to 100 points, 100 being the most problematic case. The weighting is applied on the basic rating value for five adopted criteria: bearing capacity, deterioration, condition of curbs and gutters, condition of sidewalks, and traffic.
- Statistical reproduction. Two major applications are involved:
  —Multicriterion interrogations to determine the streets and the associated quantitative data meeting specific requirements, for example, a street in bad visual condition with bus lanes and local activities consisting of businesses.
  —The histograms of the overall or partial rating values for the segments that constitute service indicators and their evolution by comparing, year by year, the average rating values and the distribution of the ratings. In this regard, action strategies may be oriented and followed up by overall assessments.
- Topical maps (e.g., Figure 4). Operational for many years on minicomputers and color electrostatic plotters producing high-level documents, the ORAGE system is now implemented on the microcomputer in connection with intermediate working documents. The last reliability tests are under way, so that it will be possible in the near future to provide highly integrated services meeting the requirements of decision makers as well as technicians, namely the display of results, both as regards more specific issues resulting from multicriterion interrogations as well as overall assessments associated with the definition and with the follow-up of general maintenance strategies (Figure 5).

The completion of a topical map involves the following phases and options:

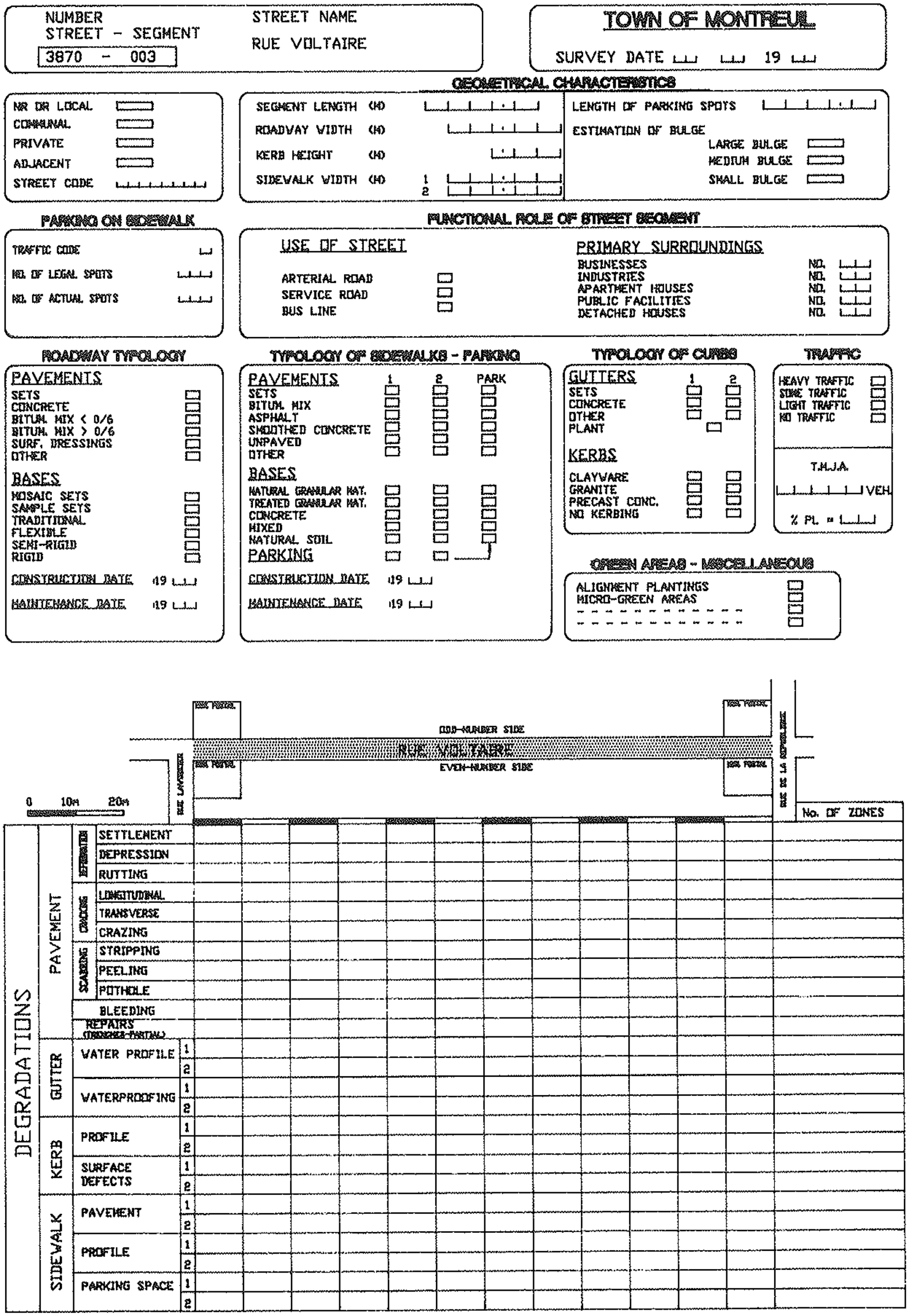
1. Choice of elements to be represented, such as corridors, roads, and networks;
2. Vectorizing of graphic elements to be represented (digitizing tablet and subsequent scanning);
3. Segmentation and structuring of pavements;
4. Choice of a referential (Lambert II);
5. Handling of representation tools such as color palette, lines, symbols, characters, and types of representation (centered symbol, lines, and bands);
6. Map items such as logo, legend, and title page; and
7. Graphic standards and software allowing fullest possible independence of software and hardware (e.g., DISSPLA) and graphic files.

Unlike computer-aided design (CAD), mapping does not create—it reproduces map bases and structured data that exist. The reproduction of any event occurring on these existing bases is immediate and its representation can be changed as desired.

DESCRIPTION OF SEVADER SYSTEM

Setup of SEVADER Operation

Following a documented survey by the Structures Working Group of the AIVF aimed at 400 French urban cities and communities of over 15,000 inhabitants, about 10 towns agreed to participate intellectually and financially in the building of



NUMBER STREET - SEGMENT: 3870 - 003

STREET NAME: RUE VOLTAIRE

TOWN OF MONTREUIL

SURVEY DATE ⎵⎵ ⎵⎵ 19 ⎵⎵

GEOMETRICAL CHARACTERISTICS

- NR OR LOCAL
- COMMUNAL
- PRIVATE
- ADJACENT
- STREET CODE

- SEGMENT LENGTH (M)
- ROADWAY WIDTH (M)
- KERB HEIGHT (M)
- SIDEWALK WIDTH (M) 1 / 2

- LENGTH OF PARKING SPOTS
- ESTIMATION OF BULGE: LARGE BULGE / MEDIUM BULGE / SMALL BULGE

PARKING ON SIDEWALK

- TRAFFIC CODE
- NO. OF LEGAL SPOTS
- NO. OF ACTUAL SPOTS

FUNCTIONAL ROLE OF STREET SEGMENT

USE OF STREET

- ARTERIAL ROAD
- SERVICE ROAD
- BUS LINE

PRIMARY SURROUNDINGS

- BUSINESSES NO.
- INDUSTRIES NO.
- APARTMENT HOUSES NO.
- PUBLIC FACILITIES NO.
- DETACHED HOUSES NO.

ROADWAY TYPOLOGY

PAVEMENTS: SETS, CONCRETE, BITUM. MIX < 0/6, BITUM. MIX > 0/6, SURF. DRESSINGS, OTHER

BASES: MOSAIC SETS, SAMPLE SETS, TRADITIONAL, FLEXIBLE, SEMI-RIGID, RIGID

CONSTRUCTION DATE 19 ⎵⎵

MAINTENANCE DATE 19 ⎵⎵

TYPOLOGY OF SIDEWALKS - PARKING (1, 2, PARK)

PAVEMENTS: SETS, BITUM. MIX, ASPHALT, SMOOTHED CONCRETE, UNPAVED, OTHER

BASES: NATURAL GRANULAR MAT., TREATED GRANULAR MAT., CONCRETE, MIXED, NATURAL SOIL

PARKING

CONSTRUCTION DATE 19 ⎵⎵

MAINTENANCE DATE 19 ⎵⎵

TYPOLOGY OF CURBS (1, 2)

GUTTERS: SETS, CONCRETE, OTHER, PLANT

KERBS: CLAYWARE, GRANITE, PRECAST CONC., NO KERBING

TRAFFIC

- HEAVY TRAFFIC
- SOME TRAFFIC
- LIGHT TRAFFIC
- NO TRAFFIC

T.M.J.A. ⎵⎵⎵⎵⎵ VEH.

% PL = ⎵⎵⎵

GREEN AREAS - MISCELLANEOUS

- ALIGNMENT PLANTINGS
- MICRO-GREEN AREAS
- - - - - - - - - - - - -
- - - - - - - - - - - - -

DEGRADATIONS				
PAVEMENT	DEFORMATION	SETTLEMENT		
		DEPRESSION		
		RUTTING		
	CRACKING	LONGITUDINAL		
		TRANSVERSE		
		CRAZING		
	SCABBING	STRIPPING		
		PEELING		
		POTHOLE		
		BLEEDING		
		REPAIRS (TRENCHES-PARTIAL)		
GUTTER		WATER PROFILE	1	
			2	
		WATERPROOFING	1	
			2	
KERB		PROFILE	1	
			2	
		SURFACE DEFECTS	1	
			2	
SIDEWALK		PAVEMENT	1	
			2	
		PROFILE	1	
			2	
		PARKING SPACE	1	
			2	

FIGURE 3 Segment file record containing typology and quantification functions for road deterioration.

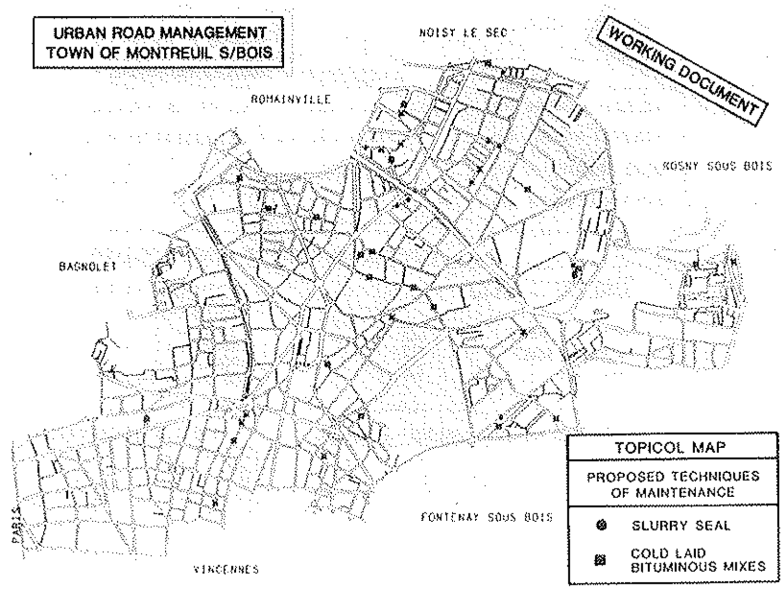


FIGURE 4 Example of topical map.

this expert system on the basis of a 50 percent cofinancing arrangement between the cities and the Ministry of Equipment.

The setup of the operation made it possible to distinguish

1. Pilot sites:

- Paris township—directorate of roads,
- Urban community of Lyons,
- Urban community of Lille,
- City of Nantes, and
- Laboratoire Régional de l'Ouest Parisien (LROP), Ministry of Equipment.

2. Associated sites:

- Urban community of Le Creusot-Montceau les Mines
- Urban district of Bayonne-Biarritz-Anglet
- City of Besançon
- City of Caen
- City of Reims

The latter city was the first community to be equipped with the complete system of computer aids for the technical management of highway maintenance with the SEVADER system combined with the ORAGE management system provided by the LROP.

Originality and Strong Points of SEVADER Expert System

One of the major concerns of the practicing engineers who designed SEVADER was to meet actual field requirements by remaining pragmatic and close to the material and human conditions of the technical departments. Thus, the following choices were made (Figure 6).

1. SEVADER had to handle all existing urban road pavements: bituminous materials, hydraulic concrete, sett pavements, and slabs.

2. SEVADER had to use current computer equipment, already available in main communities and costing less than 100,000 francs. Specifically, what was involved was an AT- or XT-compatible microcomputer in which dedicated cards (AMAIA cards) were added.

3. SEVADER had to incorporate the most characteristic features of the urban environment and its complexity. The analysis relative to the choice of surfacings for overlaying and for grinding-resurfacing incorporates—in addition to classical concepts of geometric feasibility, durability, costs, etc.—such important questions for the urban community as

- Environment, surrounding population, and noise constraints;

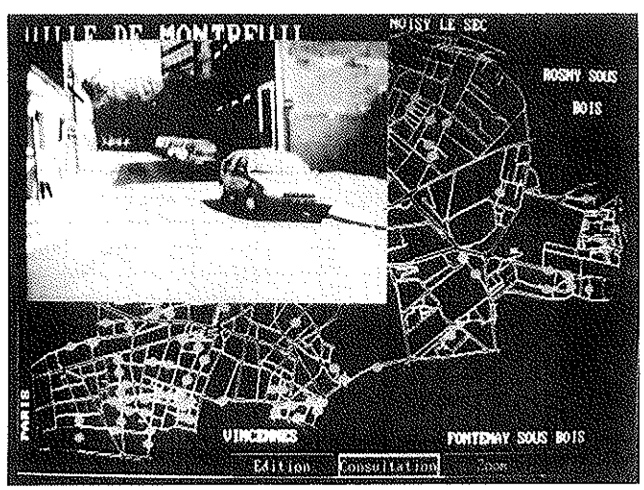


FIGURE 5 Example of display of results from multicriterion interrogations and overall assessments.

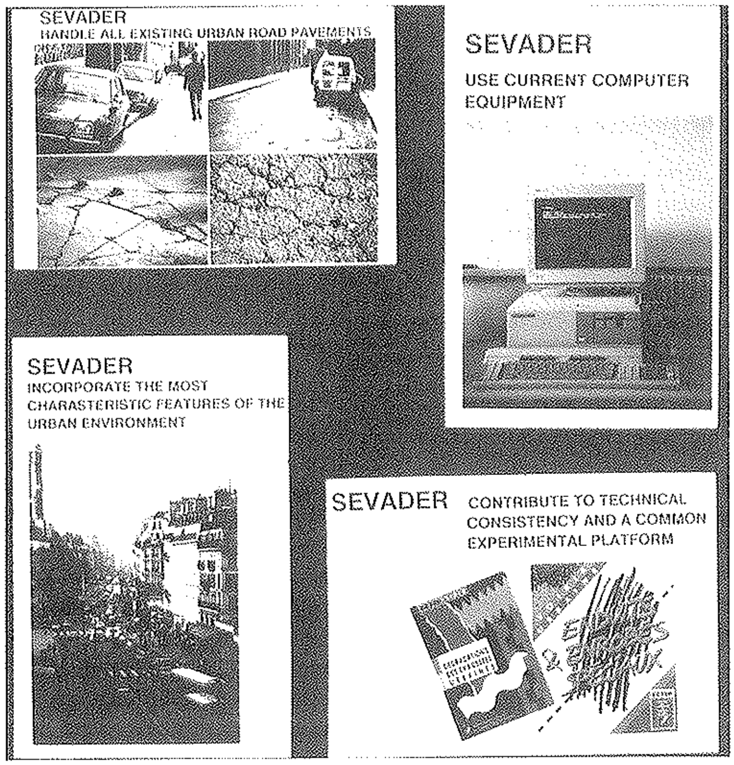


FIGURE 6 Main objectives set for the design of SEVADER expert system.

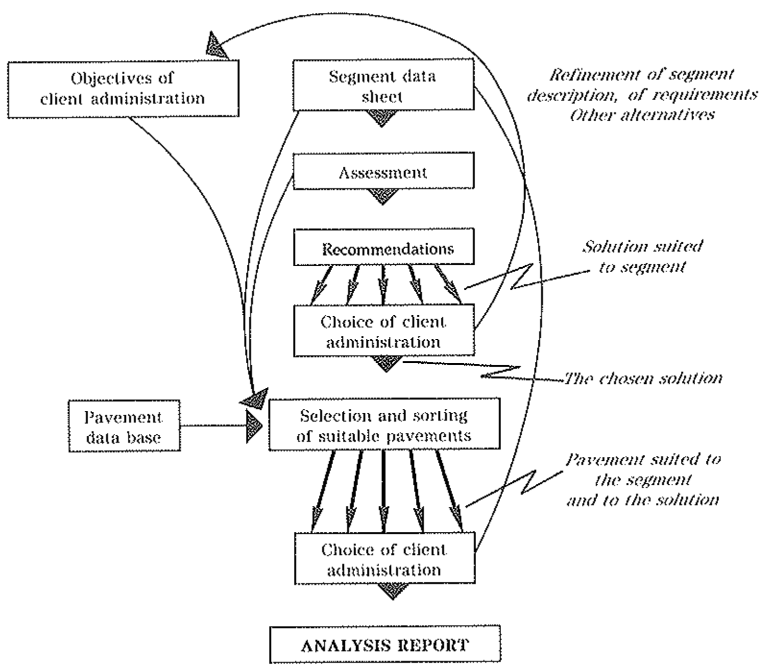


FIGURE 7 SEVADER—a phase in the analysis of a road facility.

- Repairability within the more general question of maintenance;
- Aesthetics and cleaning ease;
- Time required for restoral of service; and
- Workability in relation to the emergency of networks.

4. SEVADER had to contribute to a certain technical consistency and to a common experimental platform between the different players in the area concerned. For example, the knowledge base for special contractor surfacings was integrated into the SEVADER 01 version (with core common to cities) along with processes that formed technical recommendations according to the procedures set up jointly by the trade and by public authorities. This option is the foundation for an efficient maintenance procedure because of the situations that are constantly changing, sometimes within a short period.

Description of SEVADER Expert System

As in any expert system, SEVADER distinguishes between knowledge, on the one hand, and computer logic that implements this knowledge. Thus, SEVADER is made up of

- A commercially available inference engine, ESCOP, Version 5, written in LISP programming language (specializing in the field of artificial intelligence). ESCOP was designed and developed by the ITMI Company and is in fact an expert system development generator that also delivers the knowledge expression language, the data processing system, screen multiwindowing, etc., making the application as user friendly as possible under the environmental computer constraints set.
- Three main knowledge bases implemented within the framework of a logical development of analysis and reasoning (Figure 7).
  - —Diagnostic knowledge base, which generates the assessment of the examined road facility;
  - —Action recommendation knowledge base, which feeds the search for possible solution typologies, for example, joint sealing, ultrathin surfacing, grinding-resurfacing, etc.
  - —Pavement knowledge base, which aids in determining the best choice of products within the solution family chosen after the preceding phase. This base allows a finer presentation of several choices to the user.

The implementation of these different modules and the service functions associated with them represent about 15,000 lines of program and over 600 reasoning rules. These results are included in the SEVADER documentation delivered to users. These developments indicate the logic used within each module of the SEVADER architecture.

Description of Road Segment

Three screens, predocumented partially in the case of the SEVADER–ORAGE combination, characterize this description (Figure 8):

1. Structural and geometrical description;
2. Degradation and surveying (specific schedule by typology of pavement, bituminous pavements, concrete pavements, sett pavements, and slabs); and
3. Environment and loading of road facility.

The road segment investigated is thus characterized by 65 indications, 60 percent of which are mandatorily documented but, in most cases, this task is facilitated because what is involved is simply locating the information on the segment within a prior classification. In addition, an effective on-line aid is constantly offered to the user.

MANAGEMENT OBJECTIVES

The concerns of the highway manager may be summarized by six main themes: safety, durability, environment, comfort, maintenance, and economy. For each project, the goals set may place greater or lesser emphasis on each of these themes. The SEVADER user can hierarchize choices and choose certain qualitative options, such as the colors for the pavement.

RECOMMENDATIONS FOR ACTION

The logic implemented consists of the following:

- Leaving the segments within problems, i.e., having a satisfactory evaluation with regard to the objectives indicated;

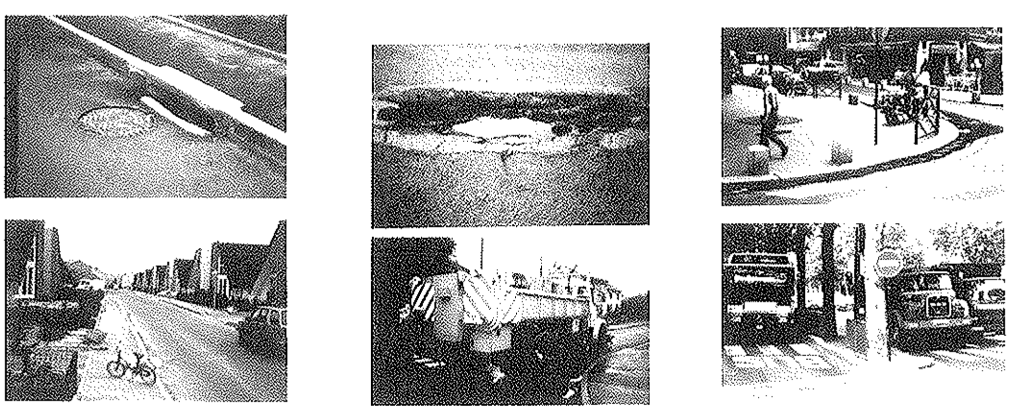


FIGURE 8 Three families of data characterizing the urban streets and roads examined by SEVADER: (*left*) structural and geometrical description, (*center*) degradation and surveying, (*right*) environment and loading of road facility.

- Determining what can be physically set up considering the technical and geometrical constraints;
- Determining what would be the minimum required to meet average durability objectives (life of 7 to 8 years) on the basis of condition evaluations and traffic evaluations; and
- Using the terms of the comparison between what is physically possible and the required minimum to establish several proposals able to satisfy as well as possible the hierarchy of desired objectives.

Two types of solutions are derived from this analysis: overlays covering the entire range of thicknesses, from 1 to 10 cm, and grinding-resurfacing.

SELECTION AND SORTING OF SUITABLE SURFACINGS

The surfacings knowledge base documents the available surfacings within each solution typology in the sense defined earlier. By mid-1990, this base included about 70 products.

Each product is described quite completely. A certain number of properties are qualified by a notation system from 1 to 6 according to a hierarchy established within each solution family typology. The costs indicated in FY 1988 of course call for readjustment on the local level for each location site.

At the end of the phases, and after having interrogated the user several times on crucial points of the analysis of his choices and his options so that SEVADER may remain within its function of aid to proposals, the tool delivers the analysis report on request, summarizing the main points of the reasoning.

SOME ASPECTS OF OTHER SOFTWARE OPERATIONAL IN CITIES

In relation with or as a complement to the two products described earlier, two systems are intended for areas oriented more towards predictive models with an overall aid in the choice of conventional solutions applied to the entire highway network, or towards detailed knowledge of the allocation of expenditures for maintenance and improvements on the road.

In the first case, what is involved is Follow-up and Maintenance of Urban Pavements (SECUR), which presently includes three main modules:

- A data base with four information levels,
- An information system, and
- A management aid system, including the calculation of quality of road from viewpoint of user (QCU) and visual quality of structure (QVS) grades and the search for conventional solutions for maintenance works.

In the second case, what is involved is Software Aid for Follow-up of Street Improvement Costs (LASCAR), which has four objectives:

- Understanding the formation of costs for the road,
- Understanding the condition of the road capital,
- Characterizing the improvements and expenditures to evaluate the implemented policy, and
- Predicting future expenses by annual follow-up.

SUBSEQUENT ACTION TO BE CONSIDERED

The awareness of the capital and stakes represented by urban road facilities by an increasing number of officials of territorial communities has led to a growing demand for tools aiding in the management of road facilities, oriented initially toward the crucial aspect of their maintenance.

The structuring of the French highway effort and the efforts to concentrate and pool the complementary know-how between the practicing engineers of cities and the representatives of a technical network of the government, which is highly decentralized and present in the field, has made it possible to better determine the issues involved and especially the expectations of decision makers and managers.

In particular, it was possible to separate the requirements of today and of the near future on the one hand, and those of the medium term on the other. A large majority of decision makers wished to start with the setup of simple and pragmatic (first-generation) tools, structured so that they could be gradually upgraded toward more optimized systems once the community acquires the basic knowledge (for initialization and updating of the tools). The dissemination of products of this type has been initiated and is taking place satisfactorily in the urban cities and communities of France.

It is now necessary to organize a general follow-up and assessment of the adoption of these tools by local highway managers. This has already been under consideration by user clubs created in connection with partnership arrangements between AIVF engineers and the Technical Network of the French Ministry of Equipment, as in the case of the effective organization adopted for the initialization and maintenance of these software tools and the methods associated with them.

For the longer-term requirements, it is necessary to pursue and intensify research and experimentation to check the possible degrees of suitability between normal evolution in the urban area caused by increased functions (network improvement, etc.) and the maintenance laws in the more classical sense of road wear. Similarly, the cost aspect must be a permanent and major factor in the tools.

The interconnection between the different tools developed by the occupants of the public domain is still felt to be a strong requirement. Computer links between data collection systems, management models, and expert systems designed for detailed diagnostics and technical and economic choices of maintenance and rehabilitation alternatives constitute an initial phase of this chain of homogeneous production of information on highway facilities. It is up to highway managers to take the initiatives for, to initiate, and to extend this process. Engineers in France must meet many challenges in the coming decade to fulfil the expectations of the decision makers.

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