New Approach for Improvement of Highway Maintenance in France

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Highway maintenance policy in France has been completely revised as part of modernization efforts affecting central and local administrations of the Ministry of Civil Engineering. The new policy is based on expanded training for maintenance managers and workers, improved management strategies and organizational structure to provide new levels of service to road users, integration of new tools and techniques to improve efficiency, motivation of workers through participative management, and improved communications among all organizations involved in highway maintenance. Since 1986, 50,000 people have been involved in this effort to improve the maintenance level of service. In the decade to come a new phase will be initiated requiring contractual agreements between all agencies involved in the maintenance of France's roadway system. The contractual agreements were prescribed by the French government in 1989 for all state administrations.

The DDEs—Directions Départementales de l'Equipement—can be likened to local departments of transportation. They belong to the Ministry of Civil Engineering, Housing, Transportation, and the Sea, hereafter referred to as the Ministry of Civil Engineering. As state agencies in all 100 departments (counties), the DDEs are in charge of maintenance for national and local highways. In each DDE, the highway management section has a maintenance equipment department—a logistics and works departmental unit—that provides all the maintenance vehicles necessary. All maintenance actions are carried out by the territorial subdivisions, which are similar to maintenance (or district) centers or local agencies, and by private contractors.

INTRODUCTION

France is the largest country in Western Europe. It has about a fourth as many people as the United States, even though it is only about twice as large as the state of Colorado. France has a diversity of terrain, including the snow-capped Alps on the border with Italy; sunny beaches and steep cliffs stretching along the coast on the Mediterranean Sea; fishing villages along the northwestern Atlantic coast; and colorful apple orchards, dairy farms, vineyards, and many historic castles throughout much of the countryside. Weather conditions are a mixture of oceanic and continental climates.

France is also an industrialized nation with great automobile, chemical, and steel industries. It is a leader in growing wheat, vegetables, and many other crops. France is fifth among the countries of the world in international trade.

To support its economy, France maintains about 3,600 mi (6000 km) of expressways, 17,000 mi (28 000 km) of national highways, and 200,000 mi (340 000 km) of local highways, in addition to city and town (commune-level) roads and streets. The basic unit of local government is the commune. France has about 38,000 communes, which vary in size from small villages to large cities. Each commune is governed by an elected council, which selects one of its members as mayor. Mainland France and the island of Corsica are divided into 100 departments (counties). Each department is also governed by an elected council, called the general council, which selects one of its members as president. Since 1982, the presidents of the general councils have been in charge of the 200,000 mi of local highways.

At the departmental (county) level, the national government is represented by the prefect, who is appointed by the national government and is in charge of the expressways and national highways.

The different road systems are maintained and operated by the 100 DDEs. Each DDE contains a highway management section, which has maintenance equipment at its disposal and relies on territorial subdivisions (local agencies) and private contractors to accomplish roadway maintenance.

The DDEs employ close to 50,000 persons in highway maintenance. Whereas highway maintenance work is accomplished under the supervision of the highway management department head, maintenance procedures are issued by the Ministry of Civil Engineering's (a) Department of Roads and (b) Department of Personnel Management. The maintenance cost for national and departmental highways stands at more than $2 billion, of which more than half is for personnel.

At the departmental (county) level, the DDEs are for the national government, represented by the prefect, and for the department (county), represented by the president of the department's general council. Working for two distinct authorities has led the DDEs to change gradually to improve highway performance and efficiency. French highway maintenance policy has been modified as part of these modernization efforts affecting national and local administrations as a whole, and especially the Ministry of Civil Engineering.

THE NEW HIGHWAY MAINTENANCE POLICY

The new policy, drawn up and gradually implemented since 1986, has five main elements: better training, improved management, better equipment, increased worker involvement, and improved communication.
Better Training

Since 1985, significant efforts have been expended to train new and existing staff. Previously, maintenance activities were accomplished using only road construction equipment and techniques. However, users and elected officials have demanded higher standards for road maintenance, reinforcing the need for better training of personnel to meet changing road maintenance requirements.

For example, since 1987 highway management heads have been able to attend three 2-week management training programs developed by the National School of Roads and Bridges (ENPC—Ecole Nationale des Ponts et Chaussées). These programs had been limited to the heads of the DDEs. New personnel entering the subdivisions will be provided with training starting in 1990. The training will consist of solving problems in maintenance task requirements and crew organization. In a similar fashion, subdivision heads are now provided with training. This was already the case with managers of logistics and works departmental units.

During the last 4 years, all personnel in highway maintenance and related departments have been provided with basic training that makes it possible for them to be fully in charge of their activities. This comprehensive training program could not have been implemented without the help provided by the technical schools, the ENPC and the ENTPE (Ecole Nationale des Travaux Publics de l’Etat), which train engineers, and the 10 professional training centers.

The next step will be to assess the impact of this ambitious training policy.

Improved Management

Plan, perform, assess, and correct: these are guiding principles for achieving better results. This new way of conducting highway maintenance not only incorporates the technical aspect of performing highway maintenance but also accounts for new maintenance techniques, better-trained personnel, and the end results as perceived by users. Improving management techniques is a long-term (5- to 10-year) effort, involving planning as well as programming and follow-up on actions carried out within the constraints of human and financial resources.

The new approach, initiated in 1987, emphasizes the following:

- At the departmental level, comprehensive evaluations of all aspects of highway maintenance policy;
- At the subdivision (local) level, evaluation of the cost of highway maintenance tasks using the CORAIL software; and
- At the user service level, evaluation of the level of service provided to road users.

Better Equipment

Previously, construction equipment management was carried out by the logistics and works departmental units that purchased, maintained, and rented equipment to subdivisions. This approach has changed because of pressures from private contractors, equipment manufacturers, and subdivision personnel.

Each logistics and works departmental unit is now more aware of the fact that to become better equipped means accepting technological advancements through

- Experimentation with and understanding of new road construction techniques;
- Use of new data processing applications, such as expert systems (ERASMUS) and data bases (VISAGE);
- Introduction of new equipment units requiring cooperation with private contractors and equipment manufacturers; and
- Promotion of innovations originating with department personnel.

There are two difficulties to this approach to improving daily work productivity: it requires a constant search for new technologies and sensitivity to the impact of the new technologies on personnel. Only if this is realized will each worker become aware of the need to improve efficiency and be a positive agent in the actions to be carried out.

Increased Worker Involvement

Equipment division and subdivision personnel are at the heart of the highway maintenance modernization effort. They must cope with various difficulties stemming from users’ demands, increased scrutiny from elected officials and the media, work force reductions, and increased work loads. The maintenance employees represent an important potential. Highly dedicated to the public service, they are capable of improving in their job. To increase maintenance worker involvement, every effort must be made to make it easier for the employees to express their opinions and make proposals. It should also be realized that workers may be directed to accomplish tasks or use methods that may not be to their liking—for example, performing needed maintenance work over a long distance on a given route rather than working in a limited geographic area.

Many experiments aimed at involving the personnel in this process have taken place during the last few years. To help with this effort, engineers must enter into a dialogue with the maintenance workers. The training received by engineers in previous years did not always prepare them for this activity. Therefore, some engineers must be trained in the necessary communication skills before entering into dialogue with the maintenance workers.

Improved Communication

The efficient implementation of the new highway maintenance policy, though impelled by the Department of Roads and by the Department of Personnel Management, depends heavily on the DDEs’ efforts. Therefore, it is essential that as much information as possible flow between the different organizations involved.

The Ministry of Civil Engineering has long been encouraging communication between the organizations involved in roadway maintenance, as indicated in the following examples:

- Technical discussions between the Department of Technical Research and Development on Highways and Express-
ways and the Central Laboratory of Roads and Bridges of the Ministry of Civil Engineering,

- Professional discussions between managers of logistics and works departmental units and the highway management heads (since 1987), and
- Interdepartmental discussions between the Club for Exchanges of Experiments on Departmental Highways and the Task Force on Highway Maintenance (Groupe Permanent de l'Entretien Routier—GPER).

The objective of the third set of discussions, which started in 1986, is to facilitate the horizontal dialogue among the various Ministry of Civil Engineering units and the vertical dialogue among the Ministry of Civil Engineering units, the Department of Roads, and the Department of Personnel Management. To accomplish this, the GPER is organized into four subcommittees that meet three to four times a year. Each subcommittee is made up of 15 to 20 members, who represent different departments. The subcommittees address the following areas: techniques and equipment, human resources, relations with Ministry of Civil Engineering employers, and relations with road users.

The GPER provides a forum for information exchange and makes the results known through a video magazine and a newsletter describing all aspects of the highway maintenance effort.

The approaches described above have made it possible to make outstanding progress in the modernization of highway maintenance during the last 5 years.

CONCLUSIONS

A new policy on highway maintenance has been formulated through dialogue between 1985 and 1990. In the decade to come, a concentrated effort will be made to expand the policy through contractual agreements that will identify results to be achieved. The agreements will assume a variety of forms:

- A 3-year contract between the DDEs and the Ministry's departments for all activities (not just maintenance activities);
- A special 3-year contract with the Department of Roads regarding maintenance of the national highway system, with provision for yearly progress reports; and
- Contracts of two types with department (county) officials in charge of departmental highways: a 5-year contract for maintenance of the departmental road system and a 5-year contract regarding equipment activity within an equipment procurement and renewal policy.

The implementation of these contracts, which is of concern to the 100 DDEs, will require additional progress on two levels: definition of service levels wanted on routes and adjustment of service levels to meet the needs expressed by the road users.

Implementation of road maintenance could then be assessed according to methods prescribed by the government in 1989 for all state administrations. These methods describe the distribution of responsibilities to DDEs through the contractual agreements, the setting up of target objectives and the measurement of results, the satisfaction of citizen and user needs, and the assessment of public policies.

There is no reason to doubt that the results will meet with favorable public response.

APPENDIX

TRAINING

Training problems are important in road maintenance. The Ministry of Civil Engineering must train 50,000 civil servants, consisting of 35,000 employees in the subdivisions, 8,500 employees in the logistics and works departmental units, and 6,000 works surveyors ensuring personnel supervision.

Many of the 8,500 employees in the logistics and works departmental units have highly specialized jobs. Their training is less of a problem because they can be trained in centers existing in the industry.

Until recently, the 35,000 civil servants employed in subdivisions were provided with no training. Two actions have been taken to correct this. The first consists of a 14-day training for new employees. During the training, technical as well as more administrative and organizational topics are developed. The aim is to provide employees with a minimum knowledge of the environment they are entering. The second consists of providing each employee with 5 days/year of professional training. The training must deal with all facets of the trade.

The training is conducted locally by the DDEs. To this end, local training staff have been trained by interregional professional centers relying on teaching materials drawn up at the national level.

It is difficult to assess the results of the training. However, it is believed that it has brought about (a) better involvement of employees in their work thanks to the decompartmentalizing that training sessions provide through practical information exchanges between fellow workers and (b) a better grasp by employees of their role within the administration as well as their responsibilities to users and elected officials.

The training of nonsupervisory employees must be rapidly implemented in order to modernize road maintenance.

MOTIVATION OF MAINTENANCE WORKERS

Whereas in the past, few experiments were conducted on motivation of nonsupervisory employees, during the last few years such experiments have become more numerous. However, so far no policy has been decided at the central level, except for encouraging this type of incentive.

Actions can be classified into five categories: training actions, quality circle-type actions, study groups, user-oriented actions, and maintenance forums.

Training actions were described in the preceding section. Quality circle-type actions have been launched in several departments. Results of quality circles are often limited (for instance, change in support for temporary road signs to prevent them from falling down). On the other hand, results are often directly useful. Their modes of operation challenge to a large extent the practices of the personnel hierarchy, as this hierarchy must let initiatives develop, consider proposals, and give effect to selected solutions.
Maintenance study groups have been recently established (less than 2 years ago). They bring together, within every DDE, all the intervening parties (employees working as assistant civil engineers of the State Public Works, subdivision staff, and district engineers). Almost all study groups are centered on technical fields (maintenance of pavements, roadsides, road signs, winter season activities, constructive works, and operation). They are intended to provide further knowledge of the relevant field, to make proposals to be applied in the whole DDE, and to bring about better understanding between all parties.

An example of user-oriented actions is to provide information to the public. Although the primary aim of user-oriented actions is not to motivate employees, they often bring about positive effects thanks to the acknowledgment they grant to nonsupervisory employees.

Maintenance forums have been organized by various departments (departmental bureaus, professional training centers, and the Department of Personnel Management). These events provide employees with opportunities for meeting. They do not all have the same purpose. Thus, the purpose of forums organized by the departmental bureaus is often to make the bureau’s activities known at the local level. The purpose of forums organized by training centers and the ministry’s Technical Research and Development Centers is to get related departments to know each other better and to make new techniques known. The purpose of forums organized by the Department of Personnel Management is partly to give greater value to innovative approaches.

Whereas these actions are different in character, they all lead to better consideration of the employees’ aspirations and contribute to an increase in their motivation.

NEW MAINTENANCE EQUIPMENT

Maintenance spending over the national system and over the departmental systems is divided into three main areas: 40 percent is allocated to general-purpose work that is already highly mechanized (repairs of surface layers, repairs of markings, etc.), 40 percent to standard maintenance work in the production field (pavement reprofiling, mowing, vegetation clearing, localized pavement waterproofing, and winter season activities), and 20 percent to emergency work (pavement palliative maintenance, repositioning of road signs, road survey, etc.).

Efforts during the last few years have been essentially directed toward standard maintenance tasks in the production field because the greatest possibility for gain lies there. As for equipment, the emphasis has been put on two fields: standard pavement maintenance and roadside maintenance.

In the field of pavements, it appeared that major savings could be achieved in surface waterproofing techniques. A new machine called a chips-and-asphalt spreader (see Figure 1) has been designed and distributed nationwide. Compared with previous practices, this equipment provides a saving ranging from 40 to 65 percent depending on the type of repairs. However, this machinery is primarily for use on moderate traffic road systems (2,000 vehicles/day).

For roadside maintenance, several mowing vehicles are in the development stage. Here again costs have sharply decreased. It is difficult to assess gains in productivity because local conditions are highly diverse. Nevertheless, it is believed that, on the average, productivity has more than doubled.

Until 1985 mowing and clearing of shoulders were performed with farming tractors. A new vehicle has recently been developed in cooperation with a manufacturer. The new vehicle, the PMS Nicolas (see Figure 2), is several times the price of the tractor. Despite its high cost, innovations (hydrostatic transmission, heavy-duty engine, general design, etc.) have made it possible to reduce maintenance costs per square meter by approximately 30 percent. About 20 units of this type are in operation.

Several manufacturers have built prototypes along the same lines—vehicles specifically designed for road maintenance. Four new trucks are currently on trial. Figure 3 shows a vehicle derived from lift trucks. It is provided with hydrostatic transmission and can drive rotor tools. Figure 4 shows a four-wheel drive vehicle, specially built by a small firm, that emphasizes ergonomics. Figure 5 shows a vehicle fitted for mowing and clearing vegetation. The manufacturer is considering using it to perform ditching and verge-leveling work. Figure 6 shows a truck derived from a mountain farming vehicle that is on trial in two departments.

COMMUNICATION

The DDEs must adapt to (a) decentralization, which transfers decision-making processes from the national level to the
departments (counties), and (b) rapid changes in technology. Communication can assist in the adaptation.

Efforts are being made to (a) provide access to basic information for each of the various media and (b) use the multimedia concept (newsletters, communication actions, videos, and technical files) to the maximum. Two examples of communication illustrate these efforts:

- The Department of Personnel Management organizes forums at which employees themselves present improvements they have made. The events are organized at the regional level and group together from five to seven departments (counties). They provide opportunities for employees to exchange their experiences and increase their expertise.

  Three or four forums of this type are organized every year in different regions. Innovations presented during these meetings are disseminated through the various information vehicles (newsletters and videos).

- Within the framework of the GPER a video magazine has been created. Its production relies on units belonging to different departments; each unit contributes reports or stories. This tool has made it possible to collect information in two different ways: through the video units that identify and publicize local experiments and through the personnel involved in maintenance, who are beginning to use light video equipment to make their achievements known.

**ERASMUS—AN EXPERT SYSTEM FOR ROAD MAINTENANCE**

Design work and decision making pertaining to the pavement maintenance of the French road system are spread over about 100 operational sites. At the national level, specialized technical establishments, oriented to testing and research, complete the system of decentralized expertise. These activities involve a few hundred engineers in charge of the decision-making process and a few dozen experts who specialize in one or several facets of pavement techniques. On the whole, this amounts to an annual work expenditure on the order of 5 billion francs. Experience indicates that a share of this spending corresponds to maintenance work, the efficiency of which could be improved by solutions better adapted to technical and economic constraints.

ERASMUS is based on the technology of expert systems. The prime quality of ERASMUS lies in its being a vehicle for propagation of knowledge on road maintenance techniques and economy within the community of users. It contains the whole range of expertise to be found within the professional community and presents it in an easy-to-operate didactic form. Provided with a user-friendly graphic interface, ERASMUS is operated by users with no knowledge of data
processing. It is intended to equip every operational decision-making site and is installed on SUN 3/60-type workstations.

ERASMUS assists the user in further specifying the descriptive data of the case to be dealt with: pavement structure, visual condition, results of tests concerning its present state, weather conditions, and traffic conditions. The graphic interface guides the user through the case specification process and allows incomplete definitions.

ERASMUS then draws up one or several diagnoses describing the problems the pavement is experiencing. The diagnosis system performs a nonstraightforward reasoning. It has a feature that enables it to conduct the reasoning further on the basis of "suspicions" (generation of multiple hypotheses), which lead to the possible conclusions "hypothesis proved right" or "hypothesis not matching up with visual condition data." It can issue queries to pavement engineering calculation programs and interpret their results. From elements in the reasoning conducted by ERASMUS, the user can infer the nature of complementary tests that are likely to further specify diagnoses.

The expert system reasons on the basis of the diagnosis or diagnoses derived from the previous stage, considers them simultaneously, and concurrently works out solutions for the diagnosed defects. The reasoning takes into account technical and economic constraints on acceptable solutions presented by the user. Finally, ERASMUS draws up a report on the work and costs involved in the solutions.

ERASMUS has been installed for development and validation at more than 14 sites. Moreover, nine pilot sites have been testing ERASMUS since June 1989 and have handled more than 300 cases. ERASMUS version 1.0 is ready for distribution and the first orders have already been registered. Further developments and improvements are in the design stage.

THE CONTRACTUAL PROCESS IN THE FIELD OF HIGHWAY MAINTENANCE

In the early 1970s the Department of Roads launched an ambitious program for coordinated reinforcement of pavements on national highways. This was accompanied by a preventive maintenance policy whose purpose was to preserve the structural property of pavements. The process for allocating funds was based on centralized procedures. The DDEs appropriated the preventive maintenance concept, and it now appears necessary to give greater autonomy in decision making to local services. Thus the current trend is to implement a policy of contracts regarding financial relations between the headquarters at the Ministry of Civil Engineering and the DDEs.

The new arrangements require putting at the disposal of prime contractors tools ensuring (a) a proper technical knowledge of the condition of the property to be maintained, (b) a proper financial knowledge of means to be used, and (c) a homogeneous approach to service level assessment over the whole territory. At present the tools exist to accomplish the first two functions. As for service levels, documents have been drawn up and issued that make their quantification possible.

A contractual process, however, the main element of which is the quantification of service levels, is difficult to implement quickly. This is why the procedure will first be tried during 1991 in a few departments (counties) before being extended to the whole territory.

The contractual process as applied to relations between the Department of Roads and the DDEs will stand as a methodological basis for negotiations between clients in the departments (counties) and local-level central government agencies as these are put at the disposal of territorial authorities.