Summary of Road Maintenance in France

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In European terms, France's road network is very dense. It consists of 1700 km of state-run motorways and 4500 km of motorways privately run, as well as 28 000 km of Class A roads and 350 000 km of Class B roads. Since 1980 traffic has increased by at least 4 percent per year nationwide, which has led to increased maintenance and improvement needs. During the same period the budget has stagnated and maintenance personnel have been reduced by from 1 to 1.6 percent per year. The administration has therefore had to rethink its maintenance methods in terms of technology, staffing, and organization. In this paper the present organization and role of the Public Works Administration are traced, the main evolution of road maintenance in France is outlined, and technical reports of other French experts are summarized.

The French road network is one of the densest in Europe with

- 1700 km of state-run motorways,
- 4500 km of privately run motorways,
- 28 000 km of Class A roads,
- 350 000 km of Class B roads, and
- 600 000 km of minor and byroads.

Each network has a main contractor that finances its maintenance and development:

- The state for state-run motorways and Class A roads,
- Motorway companies for privately run motorways,
- 100 County general councils for Class B roads, and
- 36 000 Towns (communes) for minor roads.

OVERALL MAINTENANCE BUDGET

Maintenance of the national network of state-run motorways and Class A roads alone represents an annual cost of around 10 billion francs (about $1.660 billion).

To this figure should be added the salaries of the 50,000 state employees working on network maintenance. This is half of the total personnel, and the annual cost is on the order of 5 billion francs (about $830 million).

Finally, some 60,000 machines and vehicles are involved, and renewal costs are 500 million francs (MF) per year (about $85 million).

The foregoing figures highlight the financial burden that road maintenance represents for France. However, in spite of economic problems, road maintenance cannot be neglected because traffic volumes are on the increase and users are becoming more demanding. The present challenge is therefore important and must inevitably lead to better money management, improved productivity, and modified methods.

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ORGANIZATION OF SERVICES

Central Organization

Two committees are in charge of road maintenance:

- The Directorate of Roads and
- The Directorate for Road Safety and Traffic.

Both of these belong to the French Ministry for Public Works, Housing, Country Planning and Transport.

The Directorate of Roads also manages policy, new engineering structure budgets, and maintenance for the following undertakings:

- Coordinated road strengthening works;
- Maintenance of carriageways already strengthened (routes that undergo preventative maintenance);
- Regular maintenance of carriageways and Class A road ancillaries such as roadsides, plantings, and rest and service areas but excluding traffic signing; and
- Supplying equipment to county depots.

In 1986 the budget for this was on the order of 1.1 billion francs (about $185 million) for coordinated road strengthening, 1.1 billion francs (about $185 million) for the maintenance of strengthened routes, 770 MF (about $130 million) for regular maintenance, and 120 MF (about $20 million) for depots.

The Directorate for Road Safety and Traffic is responsible for

- Maintaining road signs;
- Winter road service; and
- Road equipment management (control systems, variable message signs, traffic diversion signs, etc.).

In 1986 the budget for these activities was

- 50 MF (about $8.4 million) for signing,
- 85 MF (about $14.2 million) for winter road service, and

- 60 MF (about $10 million) for maintenance and management.

To define their policies and improve techniques, these two ministry departments rely on the "technical network" made up of the Service d'Etudes Techniques des Routes et Autoroutes (SETRA) (Roads and Highways Engineering Department) and the Laboratoire Central des Ponts et Chaussées (LCPC) (Public Works Central Research Laboratory). This network is extended to an interregional level by the Public Works Regional Engineering Centers (CETE).

Until the 1960s maintenance was neglected in favor of new works. In 1968 a policy of coordinated road strengthening was instigated to reinforce carriageways of main Class A roads to make them "frostproof." In 1972 a preventative maintenance policy was instituted for new and strengthened roads; resurfacing was to be done according to a defined cycle to prevent degradation and avoid repairs.

Only in 1983 did the Road Maintenance Study Group highlight the need to radically rethink regular road maintenance practices (in order to better understand the costs) and to train personnel in modern maintenance methods. Since then technicians' interest in, and enthusiasm for, maintenance methods has reawakened.

Local Level

Public Works District Direction

At the county level maintenance is coordinated by the department of transportation of the district (DDE), which is responsible to the following main contractors:

- The state for the national network (state-run motorways and Class A roads) and
- The county, represented by the general council, for the county network of minor roads.

Each DDE defines its annual maintenance program within the budgetary limits set by one or the other of the main contractors.

Subdivisions

The DDEs are kept aware of the situation at specific sites by 10 to 20 subdivisions per county. Subdivisions are responsible for supervision of maintenance work for the state and the counties. In addition, they are concerned with communes (10 to 20) and their minor roads in rural areas. Maintenance in towns is normally the responsibility of the town's technical services. Some subdivisions have wider responsibilities and take care of canal and waterway structures.

On average one subdivision manages

- 20 to 50 km of Class A roads,
- 200 to 400 km of Class B roads, and
- 500 to 1000 km of minor roads.

Around large built-up areas, state-run motorways are managed by one or more specialized subdivisions.

A subdivision is usually run by a Public Works Civil Engineer seconded by a Public Works Technical Assistant. About a dozen secretaries, designers, and accountants complete the office staff. Personnel more directly concerned with road maintenance at work sites are

- Two to four site supervisors,
- About a score of skilled workers, and
- A score of works officers.

Almost all of these people used to be paid by the state, but for the past 2 years county general councils have been able to hire staff.

In certain rural areas, subdivisions also manage a number of "commune" officers.

County Depots

There is an equipment depot in the majority of counties. The depot supplies specialized equipment to subdivisions and supervises

- Painting of road markings and
- Surface dressing repairs in some counties.

It also takes care of machinery and vehicle maintenance. County depots are jointly managed by the state and the county.

In accounting terms, a depot is an independent unit in the DDE's budget in the sense that it invoices the services it renders to the subdivision and must balance its books between income from services invoiced and expenses such as equipment amortization and maintenance. The annual budget of a depot is on the order of 40 MF (about $7 million).

Depots are usually run by a Public Works Civil Engineer under the authority of the DDE. Personnel have a special status known as Depot Workers (OPA). A single depot can employ from 50 to 180 workers.

REGULAR MAINTENANCE JOBS

Types of Tasks

Regular road maintenance depends on the kind of area served and the general context (town or country). This makes analysis of the problem difficult. Tasks can, however, be grouped under five main headings:

- Regular carriageway maintenance,
- Maintenance of ancillaries and rest areas,
- Road signing and machinery and vehicle maintenance,
- Winter road service, and
- Regular maintenance of engineering structures.

In 1986 a working group on External Services' Road Maintenance Equipment analyzed the work involved in the first three of these headings and broke it down into 28 different tasks. Specified for each task were

- The type of road in question,
- The DDE department concerned (subdivision or depot),
- Personnel needed,
- Present degree of mechanization of the job,
- Average unit cost,
- Equipment necessary to carry out the task,
- Suitability of equipment allocated to the various tasks and types of present or future improvement, and
- Personnel health and safety problems specific to a given task.

Winter road service also came under special study as did engineering structure maintenance cycles.

Principal Maintenance Techniques in Use

Carriageway Maintenance

Surface Sealing This technique is used to repair road surfaces, mainly with surface dressings that are an emulsion of bitumen and chippings applied by a spreader; this is known as "patching." This method is often used by subdivisions, but it is costly in emulsion and the repaired surface is not compacted. This can lead to "bleeding" or "fatting up" in hot weather.

Reshaping Reshaping is done before surfacing, most frequently using hot or cold macadam spread with a finisher.

Filling Potholes This is usually done by obsolete methods using noncompacted cold macadam, which often leads to repeated visits as the repair deteriorates. There is a lot of room for improvement in this technique.

Dealing with Bleeding The technique used in hot weather is chipping with 4- to 6-mm chippings. Rolling with a smooth-surfaced roller is essential. Sandwiching macadam with chippings also produces good results.

Repairing Trenches Electricity and telephone companies use carriageways as an easy place to dig trenches. This has disastrous results for road surface conditions and leads to tracking or rutting and patch works. Cement-bound granular materials should be used to limit settling. Trenches dug with specialized equipment have clean straight edges and are easier to fill and resurface. A surface sealer applied along the edges of trenches is recommended.

Carriageway Cleaning Cleaning is carried out to remove superfluous chippings after resurfacing or, on fast roads, when snow has melted, to remove the spread gravel. Either a towed or a self-propelled suction sweeper is used.

Replacement of Failed Areas This is not very common, and replacement requires the body of the road to be rebuilt. Because only small areas are involved, compaction is not done thoroughly.

Ancillaries

Mechanical Mowing and Scything of Road Verges This is one of the commonest tasks in spring and summer. The equipment normally used is a rotary mower that cuts the grass and leaves it on the roadside, which sometimes leads to the disadvantage that summer fires spread faster. Average speed is 2 km/hr. This type of machinery is dangerous for the personnel working with it.

Mechanical Brush Clearing The most suitable machine is a rotary cutter attached to a farm tractor. Speed is around 1.5 km/hr.

Pruning and Lopping French roadsides are often planted with plane trees. Low branches are lopped with mechanical saws from telescoping elevator platforms. This work is expensive and sometimes dangerous, especially in heavy traffic.

Maintenance of Grassy Areas Grass on rest areas and grade-separated interchanges is mown with low-speed mowers.

Cleaning Aqueducts In most cases this is done manually so it is very slow and requires intensive manpower.

Ditch Cleaning This is usually done by dredging with a mechanical shovel at a speed of 1 to 1.2 km/day. Chopping systems are also used, but only where the chopped material can be left on neighboring properties; these systems are not suitable where vineyards border the road.

Road Signing

Aside from repairing or replacing damaged road signs, the main job is to clean signs and roadside marker posts. Cleaning is normally done by hand. If signs are movable, the simplest solution is to replace them with clean ones and then clean the dirty ones in the workshop.

Winter Road Service

Preventive Salting This is done to prevent ice formation, or before or after snowfalls. Salting is done from automatic salt spreaders working from lorries.

Salting and Gritting Packed Snow Salting is done as described previously. A technique known as "salt mush," which consists of saturation salting, is being developed. This is efficient at temperatures below −6°C when the salt cannot hydrate fast enough on frozen snow. Gritting is only done locally on secondary roads.

Snow Clearing In mountainous areas special machines (snow cutters and blowers) are used to clear snow. In other areas snow is cleared by lorries with adjustable V-blades in front. These vehicles are often four wheel drive and have strengthened chassis.

Regular Maintenance of Small Structures

Maintenance of small structures is essentially a question of supervision with attention paid to water drainage because proper drainage contributes to long life.

If a structure is made of bricks, plants and bushes whose roots break up the brickwork should be systematically removed.

Carriageway joints should be cleaned to allow them to expand freely.

Personnel and Equipment

Personnel

Road maintenance personnel are organized into three or four brigades per subdivision. Each brigade is responsible for a specific road sector or, sometimes, for greater efficiency, a particular route. A brigade is led by a supervisor or a very skilled worker and consists of five to ten skilled workers and office staff. A brigade's area of operation is a canton.

Equipment

Subdivisions have their own equipment for regular use, and they rent specialized equipment from county depots. Typical equipment owned by a brigade includes

- One tipper lorry, with a payload of 3.5 tons, per 100 km of road,
- One tractor (45 to 75 hp) per 100 km of road,
- One van, and
- One transportable or nontransportable vibrating roller.

Subdivisions in mountainous areas also have

- One lorry with a payload of 9 or 15 tons,
- One loader, and
- One or two transportable salt spreaders.

The county depots rent more specialized equipment to subdivisions. Examples are patching equipment for surface sealing with emulsion and highly productive mowing and brush cutting equipment. Specialized depot teams also carry out most sign painting using painting machinery that automatically doses the paint.

Maintenance Budgets

An average budget can be broken down as follows for both national and county networks:

Unit	*Amount*
Depot	21 MF (about $3.5 million) including amortization of equipment
Subdivisions	52 MF (about $8.7 million) for the national and county networks
DDE	2 MF (about $350,000)
Total:	75 MF (about $12.5 million) per year.

This is 4 million to 7 million francs per subdivision, or 70,000 francs (about $12,000) per kilometer for Class A roads and 15,000 francs (about $2,500) per kilometer for Class B roads.

The budget devoted to roads in communes is quite variable. In rual areas it is on the order of 10 MF (about $1.7 million). The DDEs are not very active in urban areas because maintenance work there is undertaken by the technical services of the communes.

The budget is used as follows:

Use	*Percentage*
Carriageway maintenance	30
Maintenance of ancillaries	20
Winter road service	20
Miscellaneous	30
Total	100

Regular maintenance work is usually carried out under the supervision of subdivisions with the assistance of county depots.

Help from outside firms is used only in special cases, for example equipment rental or specialized jobs such as marking of long stretches of road. However, outside firms are engaged in the majority of cases in which new macadam surfacing is required. Macadam surface renewing is shared equally by outside firms and the county depots. About two-thirds of the budget is devoted to new surfaces.

EVOLUTION OF REGULAR MAINTENANCE

General Evolution

Since 1980 the DDE working environment has been rapidly modified by both institutional and socioeconomic factors.

The institutional evolution is the result of decentralization. The law of March 2, 1982, delegated the state's authority to "Territorial Communities." This law stipulates that "Communes, Counties, and Regions shall be administered by Elected Councils." This law also removed all state administrative supervision of communities as well as specific grants (especially for roads).

Grants have been grouped in the form of one general allocation from the state to the community. This law also excludes all supervision of communes by counties. Administration had previously been very centralized in France, so this law represents a real administrative and cultural revolution.

In each county there are three administrative types of road network—national (Class A), county (Class B), and communal (minor or byroads). The main contractors for these three types of roads are totally independent, but road users have no idea that these "frontiers" exist.

The DDEs that manage the national and county, and sometimes the communal, networks have had to adapt to this situation. In particular, they have now to take into account the more demanding financial management requirements of main contractors. Funds are jealously kept for exclusive use on the networks for which main contractors are responsible.

The socioeconomic evolution can be observed in all developed countries and leads on the one hand to a reduction of economic and resource activities and on the other to public demand for less administration.

The result is a reduction of funds and public investment; major motorway works are contracted to private or mixed companies. Regular maintenance work, however, is not very profitable for business and remains largely a DDE responsibility. DDEs therefore have to meet maintenance needs with less money and fewer personnel.

Existing staff are worried about this evolution taking place around them that they cannot easily understand or follow. Road maintenance officers tend to be unmotivated, which is bad for work quality.

This evolution can also be viewed in terms of the need to invent and develop new techniques and equipment, as well as the need to better organize and train manpower.

Evolution of Techniques and Equipment

The evolution of regular maintenance techniques is closely allied with the development of machines, particularly for maintenance of ancillaries and road signs.

Regular maintenance techniques have not evolved much because they represent only a small, scattered market for manufacturers, unlike the market for new, big investment works. They have been developed mainly in response to administrative encouragement of resurfacing product and machinery manufacturers.

Hot, noncompacted materials of the rolled sulfur asphalt type have been experimented with for surface sealing. This technique is usable for shallow surface repairs, but it is difficult to use and has not yet lived up to its promises. Black binders can also be improved by the addition of polymers of the rubber type, but they are used mainly for large areas of top resurfacing.

It should be noted that hydrocarbon binder emulsions, the breaking point of which can be controlled, have recently been introduced. These emulsions are an improvement on conventional emulsions the breaking point of which depends on ambient hydrometry and the mineralogical characteristics of the aggregate. In time this advantage should encourage the use of emulsions for maintenance.

Many mastics for sealing surface cracks have been developed since 1980. The firms that have developed these products usually also apply them because this is a delicate job that requires surface preparation with heat guns to strip the overburden of bituminous concrete and the use of pretreated industrial microchippings.

For surface sealing, a decisive step forward has been taken with the improvement of spreaders for patching (see paper on Two Major Innovations in this Record by G. Point) and the SECMAIR Company's automatic chip spreader that allows binder quantities to be better dosed (2 kg/m^2 of emulsion instead of 2 to 3 kg/m^2 with traditional spreaders), but, above all, it gives far better returns, multiplying productivity by five. The cost per square meter of surface treated is reduced by 40 to 60 percent. Experience has shown that this machine, which has so far been bought by 40 road enterprises, will bring with it a new maintenance concept that can be called "regular planned maintenance."

The use of aggregate-bitumen combinations appears to be promising for reshaping carriageways. These combinations are made in a central mixing plant by cold mixing graded aggregate 14 mm in diameter with a bitumen emulsion. Such combinations need to be vigorously compacted and the surface needs to be sealed, but this can be done a few months later.

Treatment of bleeding, or fatting up, can be improved by the application of hot chips plus dust, after drying at 160°C.

Trench repairs are made easier by special excavating machines that produce clean-cut edges that are easier to reseal. Certain companies have perfected automatic resealing machines. An example is the J. Lefebvre Company.

Evolution of Maintenance Equipment for Ancillaries

This evolution is characterized by multipurpose equipment. The first such piece of equipment was the multiuse vehicle (MUV) designed by the Société Nicolas. This machine was originally developed for mowing and palletization but has been progressively extended to deal with brushwood clearing, ditch cleaning using cutters, sweeping, and more recently snow clearing with cutters and blades.

Other machines, though less multipurpose, are being developed by a variety of manufacturers. These machines are usually pneumatic extensions to tractors for loading and other tasks.

Evolution of Road Sign Maintenance

Research has been concerned mainly with roadside marker post cleaning. One company has developed an automatic cleaning machine that is still in the experimental prototype stage.

It might be profitable to improve the sticking power of adhesive sign faces so they would resist high-power hose washing, but it appears that nothing has yet been done in this field.

Evolution of Winter Road Service

The only new salting technique that should be developed appears to be "salt mush." A saturated salt solution, prepared just before it is applied, is spread on the road. Salt mush is effective at −6°C because the salt cannot hydrate fast enough in contact with the snow.

For snow clearing, a V-blade attached to the front of a self-propelled vehicle continues to be used. The shape and coating of the blade can be perfected to clear snow faster without its sticking to the blade. Smooth plastic coatings have been developed by a number of manufacturers.

Evolution of Public Works Organization and Management

Since 1986 the whole Public Works Administration has recognized the need for reorganization to meet maintenance requirements, taking into account budgetary restrictions.

Centrally, the partitioning triggered by decentralization has led to funds being directed to the DDEs. The central Roads Management Committee is only concerned with overall budget programming and coordinating innovation by working with the technical network and with businesses.

Locally, the DDEs are making efforts to use good management practices.

Finally, a coordinating body called the Permanent Roads Maintenance Group (GPER) has been set up.

Evolution of Central Organization

At the central level, maintenance funds have thus far been distributed in a very specialized way. Funds destined for national roads and motorways come from three central administration committees, the Roads Committee, the Road Personnel and Safety Committee, and the Traffic Committee. These committees are divided into subcommittees and bureaus. The specializations of these bureaus and the suggestions of the technical services have led to a regrouping of maintenance problems. This maintenance regrouping can be found at the county level. The organization of the DDEs has been strongly influenced by that of the ministry.

There are three necessary elements of network maintenance: manpower, equipment, and funds. The balance among these three is difficult to attain in the present administrative situation. Moreover, this balance also depends on geographic criteria and local priorities that are difficult to appreciate at the central level. It has thus become essential that responsibilities be very seriously accepted at the local level.

Centralized funding is used to achieve this objective. Such centralization cannot, however, be complete and immediate because of the problems involved in rapidly modifying existing structures. However, the Roads Committee is going to regroup funds that have hitherto been allocated to road markings, maintenance of ancillaries, maintenance of main road machinery and equipment, vehicle and fuel purchasing, regular maintenance of engineering structures, and winter road service. It is therefore to be hoped that this measure will encourage managing bodies to make small savings everywhere so that larger local works can be carried out with the resulting savings.

However, the maintenance of roads already strengthened is specialized and must therefore remain centralized to ensure conservation of the national heritage.

At present the DDEs rely on state and county funding. Twenty percent of purchases are made by the state and 80 percent by county general councils. There are therefore as many equipment buyers as there are counties. In this context central committees cannot to any great extent influence the market, nor can they dictate the purchase of any particular type of equipment.

Purchases have, until now, very often been made on the recommendation of depot heads. However, purchasing decisions are strongly influenced by internal organizational considerations that have developed through systems dating back to the 1960s. This reasoning should be dropped in favor of purchases determined by the type and size of the tasks to be accomplished.

The Roads Committee will supply funds to the DDEs for the purchase of modern maintenance equipment. This step should give a shot in the arm to the whole system and help to modernize services.

Relationships with manufacturers take the form of dialogues in which the central administration's primary role is to quantify the tasks to be done and to determine what needs to be done to accomplish each task. The report that is given to manufacturers is only a first stage that must be furthered in all areas in cooperation with the industrialists concerned.

It is necessary to inform external providers as much as possible about specifications and the use of new machinery. Several organizations including the Permanent Roads Maintenance Group (GPER), the Technical Road Study Planning Department (SETRA), and the Central Bridges and Highways Laboratory (LCPC) carry out this information distribution, which is a prerequisite for new maintenance ideas.

Evolution of DDEs

Regular road maintenance has always been left to the initiative of divisional engineers, so maintenance quality depends to a large extent on their conscientiousness. Recently the DDEs have been reorganized to set up maintenance–road management services in charge of coordinating, programming, and ensuring more rational management of road maintenance funds in each county.

Technical and management tools are being developed:

Technical Tools Fast, efficient, road data collecting techniques followed by automatic data processing are being developed. Data banks are also being set up, and the prototype is known as the Roads Data Bank (BDR).

The Roads Data Bank allows each DDE access to data on the national road network that are collected automatically by specialized devices designed to observe the condition of road surfaces and road signing. The INFOROUTE interrogation system allows the BDR to be asked questions such as

- What signing equipment is there on this road section?
- What is the road surface condition at this point?
- What maintenance work has been done on this section since 1983?

At the present time research is being carried out on the use of video disks to image routes. There is an existing prototype designed for engineering structure maintenance.

Management Tools These are bookkeeping tools assembled under the name "CLAIRE." They are designed to

- Increase understanding of the use of funds received from the state and territorial community in order to better control management and maintenance costs and
- Detect differences between targets and results, which should make forecasting easier.

They are intended for subdivisions and should be computerized soon.

The county depots already have computerized state-of-the-art analytical bookkeeping systems for determining prices of equipment and machinery. The most recent version is M R 4 G.

As is the case in other fields, expert systems are springing up. The Technical Road Planning Study Center (CETE) in Aix-en-Provence has developed a system of road maintenance aided by a multiexpert system called ERASME, which is designed for flexible pavements.

Expert systems are of interest not so much because of the results they give, but because they encourage engineers to take into logical account all maintenance parameters.

Permanent Roads Maintenance Group (GPER)

The GPER was set up in October 1986 by the head of the Roads Committee to form a permanent information center to collect information about local experience and advise the various central management directorates: the roads directorates, the road safety and traffic directorates, and the personnel directorates.

This organization completes the road maintenance cycle studies of civil engineers in the field. The recommendations made by this group are sound because they come not only from engineers but also from depot heads, works supervisors, and welfare and safety inspectors. These people are divided into four "workshops" that make up the GPER with its Roads Directorate national secretariat.

- Workshop 1: Techniques and Equipment,
- Workshop 2: Human Resources,
- Workshop 3: Contacts with Main Contractors, and
- Workshop 4: User Relationships.

Each workshop is headed by a county manager.

Evolution of Jobs and Training

Evolution of Jobs

Until the 1950s road maintenance in France was undermechanized and the responsibility of road menders and district (canton) road surveyors. Each road mender was in charge of 3 to 7 km of road known as a "canton road." He was his own boss and did maintenance work himself, or sometimes with temporary help; he cleaned ditches and gutters, trimmed shoulders, and the like. He was well known in his village and his main strength was his muscles.

Between 1954 and 1959 it became clear that increasing mechanization of maintenance machinery such as sweepers, rollers, and patchers made it logical to group road menders into teams. Thus individual responsibility for canton roads gradually disappeared.

The county depots were created in 1967 and have become more and more mechanized as they have acquired tractors, mechanical shovels, self-propelled sweepers, painting machines, and automatic mowers.

Maintenance crafts are diversified and specialized, especially at the depot level; there are vehicle and machinery drivers, radio specialists, and road marker painting teams.

At the subdivision level, on the other hand, skills have not evolved at the same speed and do not really meet today's requirements. Most of the personnel are trained on the job and are still attached to the values that built the reputation of the old-time road menders. What is more, staff numbers continue to fall, and the whole notion of brigades becomes senseless near big agglomerations.

Finally, engineers and senior management have taken note of the need to better coordinate and program maintenance work at the county level. This means that the DDEs need to have real road management policies.

The present changeover period requires up-to-date training in:

- The latest techniques and management methods and
- The use of new techniques and equipment.

Training

Training Senior Managers Since 1987 each engineer responsible for the road maintenance service of a DDE has undergone a road management training course of two 6-month periods:

- The first is at a university and includes four 1- to 2-week modules devoted to road techniques and modern methods of management and organization.
- The second consists of drawing up and putting into practice a "road maintenance methods and organization modernization" project in each DDE and involving all of the personnel in the working groups.

Training Managerial Staff At the regional level there are Permanent Interprofessional Training Centers where specific maintenance training for managers and site supervisors is given. The ministry is also trying to provide more training information. Thus, in February 1987, SETRA published a Practical Guide to Regular Road Maintenance.

Training Workers and Officers The evolution of techniques during an officer's working life leads to the need for retraining during his career, especially as recruiting is reduced and average age increases. The average officer is 40 years old, and it is not easy to change his thinking habits quickly.

A lot remains to be done in the training of road officers. Audiovisual methods are preferred because they diffuse information rapidly. It is also absolutely necessary to modify recruitment methods to take into account the qualifications required.

Infrastructure and Maintenance Concepts

In general, roads used to be simple carriageways bordered by two raised edges and by ditches. Modern roads include

- Central reserves,
- Roadside landscaping,
- Crossroads with planted islands,
- Grade-separated interchanges that are planted, and
- Rest areas.

Traffic and safety management needs have led to the gradual cluttering of roadsides with safety fences, signposts, and lampposts.

Recently equipment such as traffic sensors has been embedded in the roads themselves. All of these objects meet various needs, but they represent obstacles to logical maintenance management and complicate road works.

Rural Roads

Roadsides

The presence of roadside marker posts at the distances presently prescribed leads to new cleaning and maintenance jobs that are difficult to mechanize and slows down the mechanization of verge mowing and ditch cleaning to such an extent that it now appears to be desirable to entirely rethink specifications to take these problems into account.

A comparative study could solve the problem, but certain parameters, such as operators' safety, road users' comfort, and the effect of new ideas, are difficult to estimate.

Safety fences also slow down mechanization of regular maintenance jobs, such as mowing behind, in front of, and under these barriers; ditch cleaning; tree pruning; and maintenance of slopes and banks, not to mention winter road service.

Measures can be taken to alleviate problems before projects are carried out; obstacles can be moved or weakened, ditches and drainpipe openings can be better designed, banks can slope more gently, GS2SO-type safety fences can be used where barriers are necessary, and the ground can be treated to minimize vegetable growth under barriers (noneroding gravel to be cleared yearly by chemical or other means) to avoid manual mowing and cutting with inefficient garden-type mowers and scythes.

Signposts are often positioned for maximum visibility, but road maintenance and safety consequences are rarely taken into account although recent studies have allowed ideal posts to be defined, particularly from the safety standpoint. Overhead and gantry sign installation is even more important because it dictates barrier installations and the use of roadside mowing and ditch-cleaning equipment. Lightposts create the same types of problems as signposts.

Efficient, easy-to-maintain drainage should be studied: roadsides should be leveled to a 2 in 1 nonstabilized slope; water should be directed to avoid gullying; ditches should be designed to be crossable and thus maintainable with present equipment; drain clearance should be limited by suitable installations.

Cuttings and embankment slopes should be designed to take into account the following considerations: soil stability; safety (slope, height, and appearance); and environment (landscaping and its maintenance, depending on the availability of materials, the slope, and the type of vegetation chosen). Mechanical equipment cannot operate on slopes of more than 3 in 1, and available mechanical arms are limited in length. Thus banks near abutments of engineering structures are often difficult to reach and maintain.

Landscaping can lead to serious constraints. For aesthetic reasons and reasons of safety (visibility and fire risk), mowing needs to be done two or three times a year, watering needs to be done regularly, and trees must be treated yearly. Trees must be carefully chosen to have the same growth rate and the same frost and pollution resistance; they must present minimum danger for vehicles. Special maintenance considerations for plantings that present safety problems on Class A roads were specified in Circular No. 80.41 of November 28, 1984.

Central Reserves

A majority of problems with roadsides are also present on central reserves; in some cases they are magnified because of

the difficulty of accessing central reserves. It should be noted that

- The original profile of stepped slopes cannot be maintained.
- Mechanical mowing of central reserves is essential for reasons of operator safety. If widths are insufficient for the passage of mechanical mowers, it is better not to sow grass.
- Well-chosen tree plantings can require minimal maintenance, which can be mechanized by using a cutting and pulverizing machine.
- A surfaced central reserve requires at least annual sweeping.
- Maintenance of safety fences on central reserves under urban and suburban heavy-traffic conditions is such that one or two concrete lane separators may be preferable, provided drainage and vegetation problems, including watering and maintenance, are studied at the same time if two lane separators are to be installed.
- The choice of lampposts may be governed by maintenance considerations, provided they meet safety requirements for width and positioning vis-à-vis the barriers; curved channels or even open rectangular gutters can be used on central reserves to direct water.

Highways That Cross Built-Up Areas

Where a rural road crosses villages or small built-up areas, the work done is usually to strengthen or improve existing roads.

Road verges are replaced by pavements that must be surfaced to prevent growth of vegetation. They must also be designed to meet drainage requirements.

When roads cross large built-up areas, consideration must be given to lampposts, restraining devices, dynamic operating equipment, and noise screens.

Grade-Separated Interchanges and Rest and Reception Areas

Design of these features must take short- and medium-term maintenance into account. In certain cases maintenance considerations may influence the design itself. Requirements include

- Limited earth movement.
- Earthworks designed to be planted and maintained mechanically. This means accessible slopes, grouping like beds (grass, trees, etc.), and automatic watering in some regions.
- A minimum of surfaces to be maintained; in some cases the land can revert to agricultural use.

CONCLUSION

In the world of road maintenance, in-depth cooperation is essential, but this is only possible when the institutional, budgetary, organizational, and technical situations are well understood.

The French road maintenance "framework," which is special from several viewpoints, has been described. The special nature of this framework may be responsible for some recent innovations.

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