industrial countries. These sensual assessments are then quantified in terms of the various costs of the maintenance operations and the benefits that they should bring in the form of reduced operating costs for rising traffic, substitution or postponement of heavier rehabilitation and reconstruction work, and preservation of all-weather accessibility. The difference between cost and benefit streams can be expressed as a rate of return on the initial investment in maintenance equipment, workshops, technical assistance, and so forth.

The resultant rates of return have tended typically to be very high for maintenance projects that have been considered for financing by the Bank in recent years. That this is so seems to provide a further indication that, in many countries, a marginal shift of additional resources into maintenance from new construction or from other sectors could indeed be advisable. Of the twenty-one highway loans and credits totaling more than $650 million that the Bank and IDA approved in the fiscal year ended June 30, 1978, thirteen included substantial maintenance components. An economic rate of return was calculated for twelve of the maintenance components and for all new construction components. The rate of return for the maintenance components was estimated to be more than 100 percent in four cases and averaged more than 40 percent for the other cases, while the estimated rate of return for new construction averaged 24 percent, within a range between 11 percent and 56 percent. The flow of benefits from the physical investment in maintenance is, of course, much shorter than from new construction; in the former case, it is six to eight years, corresponding to the estimated average life of the equipment involved, compared with twenty years for most new construction. There is no reason, however, to suppose that benefits cannot be reinvested over a period of time at equally high returns in the maintenance field.

For the reasons discussed earlier, estimates of rates of return for maintenance programs may be subject to more variance than those for construction programs. The difference in the expected values cited is substantial, however. Most of the Bank-assisted maintenance projects that have already been completed, despite substantial shortfalls in their physical achievement, have been judged, nonetheless, to show estimated actual rates of return far higher than the opportunity cost of capital. This fact tends further to confirm that efficient maintenance operations have the potential for very high returns.

Chapter 2: The Experience of the World Bank

The World Bank has been concerned with the development of maintenance capabilities from the beginning of its lending for highways in developing countries in 1949. Many of the earliest loans to the highway sector were for the purchase of maintenance equipment, a need that was identified by the borrowing countries as their most pressing one. The Bank soon made it a standard practice to attach to loan agreements covering road construction general covenants requiring that the roads be built, or that the highway network as a whole be adequately maintained, "in accordance with appropriate engineering and economic standards." It was often more difficult to fulfill the covenant, requiring as it did for its effective accomplishment a complex and widely spread organizational infrastructure that was both properly motivated and financed, than it was to construct efficiently the particular roads to be financed. Experience persuaded the Bank that more active assistance was necessary to help borrowers develop adequate systems of maintenance.

The involvement of the Bank in maintenance, therefore, has steadily deepened and broadened. It has deepened in response to evidence that earlier prescriptions had proved to be only partially effective or that there was still much more to accomplish. No maintenance development effort was foreseen, for instance, as being of more than ten years' duration at most; none has turned out, in reality, to be that short. The Bank's involvement has broadened as the combined result of the continuing need for maintenance of most long-time borrowers and the widening range of countries that wish to borrow for highway development. Even within the last two or three years, Bank lending for highways has begun for the first time—or has recommenced after a gap of fifteen or more years—in Bolivia, the Dominican Republic, Oman, Panama, and Portugal—in each instance with a project in which maintenance was a major component. Further new borrowers are expected.

In its support of maintenance, the Bank has maintained a constant objective—to help countries develop efficient systems for carrying out, on a continuing basis, economically and technically appropriate operations. But the scope of its objective has widened, especially beginning in the 1970s, to include rural roads as well as national networks. The relative importance given the objective itself has increased. There have also been several significant changes in the techniques the Bank has employed to support maintenance efforts. In the earliest years, assistance was largely confined to the provision of finance for the purchase of equipment and, occasionally, for the construction of workshops. Later, the Bank helped to finance the employment of general consultants to highway departments. In neither case, however, did the Bank become deeply involved in specific objectives or targets of operational performance. The next approach taken by the Bank was to focus lending more specifically on pilot districts in which improved maintenance would take place. The long-term results of these various efforts were generally limited.

By 1968, the Bank began to exert its first major effort on maintenance in many African or Asian countries and a second—or, in some instances, a third—effort in many Latin American countries. A more comprehensive approach to lending was applied, of which the main elements were typically:

- As a basis for support, a consultant-formulated, four-year program setting kilometric targets for the carrying out of periodic and routine maintenance;
- Reform of organizational structure, generally stressing the need for separate units, each with a specific responsibility for the maintenance of the national network and for maintenance equipment, stressing the need for some rationalization of regional structures, and emphasizing modern management information and costing systems for the efficient control of maintenance works;
- Inclusion of more intensive specialized technical assistance or consultant services with a general brief for training as well as responsibility—executive or advisory—for the operation of the total maintenance program;
- Agreement with borrowers on the specific amounts that would need to be provided out of recurrent government budgets for maintenance throughout the years of operation of a program and, sometimes, agreement on mechanisms for channeling appropriate resources, such as road funds, into maintenance;
- Enforcement of vehicle weight limits, selected on the basis of economic analysis for the country in question, plus emphasis on the formulation of appropriate laws, establishment of weighing stations, and clarification of enforcement responsibilities.

The financial support of the Bank for these programs typically covered the foreign-exchange costs of the traditional items—workshops, new equipment (with an initial inventory of spare parts), spare parts needed for the rehabilitation of existing equipment, and technical assistance. Support also began, however, to include more readily the foreign costs of periodic maintenance operations, whether by contract or by force account, and occasionally, in the poorest countries, small sums to meet local currency expenditures.

Many operations of this type were financed between 1968 and 1972. The general pattern of results, however, was disappointing. Broadly consistent with the wider pattern, of twelve projects that were devoted almost exclusively to maintenance, two were moderately successful, four largely failed, and the remainder were in between (about 50 percent to 70 percent achievement of physical targets, within a project period typically extended for one to three years). The projects

were overambitious, not in the sense that they were not needed—even in the "failures," the Bank-assisted facilities generally accounted for most of what maintenance was actually done—but in the sense that hindsight suggests that the various resources that were available were not put together in a way that would permit project objectives to be met. While the new organizational structures were, in fact, largely created, while equipment was procured normally in the quantity planned, and while new data and accounting systems were indeed designed, effective operation of these various components was much more difficult. Even so, the overall economic returns estimated to have been realized from these twelve projects were generally high.

Two main problems were found: a shortage of qualified and motivated personnel and a shortage of operating funds. Training programs were too small, too partial, or too discontinuous. In some instances, the organizational structures and operating systems that were created were too elaborate, considering the great scarcity of trainable personnel. Loss of qualified staff or of potential recruits to the higher-paying private sector was an important additional constraint. While agreement on annual targets for maintenance allocations does seem to have helped, budgetary appropriations have often proved to be inadequate, either because inflation rendered the agreed-upon targets too low or because budgetary stringency prevented their being met despite, in some cases, quite serious efforts. Actual maintenance operations suffered additionally from the rising share of appropriated funds that had to be devoted to wages, from pressing requests on the maintenance organization to undertake other work, and from particular difficulties in procuring foreign exchange to pay for imported items such as spare parts and fuel.

Another important problem was that of delay in starting up the projects. This problem was characteristic of almost all the projects. Out of twelve projects specifically devoted to maintenance, in only one did the first main delivery of equipment take place within about a year of the signing of the loan; in all others, delivery took at least a year and a half, and in four, more than three years. Weight control, other than that imposed by road conditions and gradients, was seldom effective, because of opposition by truckers and a shortage of enforcement staff.

In response to this experience, the Bank and its borrowers have further developed their approach to maintenance efforts, and recent projects show an important evolution from earlier operations. Some of the main characteristics of recent projects are:

- Increased emphasis on staff training. Consultants, hired for their expertise in training, initially make a comprehensive inventory of staff, on the basis of which they formulate a training program; training is established as a permanent function in the borrower's organization, which will have its own training facilities and established staffing positions for trainers and which will issue a formal policy statement regarding training.
- Further precision in budgetary forecasts of requirements, with distribution between the main categories of expenditure shown and in which special mechanisms for problem areas, such as the procure-

ment of spare parts and renewal of equipment, will be established and in which provision for annual reviews will be made. (The Bank is showing a greater readiness to finance more fully periodic maintenance and the restoration of an inventory of spare parts, but it only rarely finances any part of recurrent operating costs for maintenance.)

- Agreement on specific, annual operational targets, particularly with regard to the availability, use, and scrapping of equipment and on programs of action through which these targets might be attained; and more critical analysis of requirements for equipment, in the light of the high costs implied by past low availabilities with a view to using more labor-intensive techniques, where they would be appropriate, or more private contractors.
- More professional preparation of those parts of the project that call for mechanical-engineering skills, carefully integrating phased programs of procurement of spare parts for the overhaul (corrective maintenance) of existing units and future preventive maintenance, fleet replacement, development of workshops, and related training and technical assistance.
- More intensive economic analysis by the Bank, in conjunction with borrowers, to evaluate alternative levels and patterns of maintenance expenditure more precisely and more convincingly.
- Introduction of automatic weighing scales, to reduce the human frictions involved in the control of vehicle weights, and consideration of this issue within the wider framework of regulation of the trucking industry.

In several instances, by starting the project preparation early enough and providing extra, though limited, Bank consultants and staff assistance, it has proved possible for programs with these characteristics to be prepared largely by staff of the public works agency in the borrowing country itself. Local preparation, of course, helps to increase local understanding of, and commitment to, the eventual project. Early involvement of officials from the finance ministry has also been important in securing necessary financial support and a program of appropriate size. The principal financial contribution of the Bank continues to be for the purchase of equipment (including workshops and weigh stations); in the period fiscal 1975-77, Bank loans for road maintenance averaged $60 million in commitments, whereas the amount in the period fiscal 1969-1971 was only half as much. In real terms, therefore, lending has not greatly increased in amount.

Several borrowers have taken promising initiatives along these lines, and recent maintenance projects, by the stage of their approval by the Bank, have been far better prepared than any in earlier years. At the same time, the Bank has increased the emphasis that it puts on the adequacy of borrowers' maintenance efforts to the extent that it makes as one criterion of eligibility for further highway loans a positive assessment of adequacy; approval of several new loans was delayed in the last year or two pending the taking of appropriate steps. The effectiveness of such stands has unfortunately been reduced

occasionally in the past by the readiness of other institutions and bilateral export credit agencies to proceed with new lending irrespective of a borrower's adequacy in maintenance efforts. The evidence is clear, however, that borrowers often attach high value to firm actions by the Bank on matters of principle that are as important as is the integrity of a maintenance organization and maintenance funding.

Chapter 3: The Attitudinal Dimension

Most people, like most organizations, readily perceive the importance, in principle, of properly maintaining those assets for which they are responsible. The difficulty comes in sustaining that conviction steadily over a period of time, particularly when practical pressures to act in a contrary way arise. Not very different from the householder pressed by his family to postpone a roof repair so as to take advantage of a furniture bargain, the highway department official often faces strong pressure to skimp on maintenance so as to meet the needs of at least a few of the groups constantly at his door asking for access improvement. He has, working against him, common popular assumptions, such as that roads once paved take care of themselves, or that there is no reason to bother, since the effects of maintenance are washed away by the next rains. He is often faced with an environment, moreover, in which irregularities are not uncommon in the award of construction contracts and in supervision of construction, control of vehicle loads, use of maintenance equipment, and maintenance operations themselves. Maintenance is unglamorous and never-ending, and it is noticed only after it has been absent a while. It lacks the professional and political prestige of new works.

Creating and sustaining a positive attitude toward maintenance, both in the public at large and among highway department employees, is more than fundamental; it is often a need that is more critical than the provision of additional budget funds. But the development of a positive attitude can also help solve funding problems in two ways: greater public understanding makes it easier for governments to increase allocations and a serious attitude in the highway department provides more assurance that the funds will be wisely spent.

Within the highway department, a positive attitude on the part of top officials is crucial in establishing maintenance as a task of real importance, in generating an *espirit de corps* and a sense of responsibility, in enabling firm action to be taken so that proper audits and inspections are made and that corruption is rooted out, in inculcating a disciplined approach to preventive servicing and maintenance, and in setting high standards of performance. The degree of dedication and leadership shown by a few key executives has been a critical factor in the success or failure of Bank-supported maintenance projects. Seemingly simple aspects, such as whether a minister and other senior officials show an interest in maintenance in their visits to the regions, whether they take time while there to inspect the facilities they pass

and commend or criticize those responsible, and how much of their best staff they put into maintenance are vital factors. Such considerations are much more important than such gimmicks as "performance competitions" between maintenance districts, although these, too, can sometimes be useful. In some countries, broad, national movements of indoctrination that stress discipline and responsibility, such as the Saemaul Undong in the Republic of Korea, have also helped considerably.

For the broader public, special publicity campaigns are often needed to generate understanding and cooperation. For instance, again in Korea, an increase of nearly 100 percent in the maintenance budget was finally won in 1979 after an intensive public-relations campaign to explain the importance of highway maintenance, through the press, radio, and television and by letter to other ministries and to provincial governments, by the government highway department. Most of the few successful efforts to control overloading of vehicles have depended critically on intensive public education and advertising campaigns, such as the one undertaken four years ago in Honduras, prior to the introduction of clearer regulations. Automobile clubs, road-transport associations, transport-user groups, and broader public-interest groupings, such as chambers of commerce, can often play a vital intermediary role in disseminating information, generating support, and representing public demands.

The emphasis of the Bank on good highway maintenance has been of recognized value to many ministers of public works in discussions within their own governments and in efforts to strengthen their own organizations. But more might be done, possibly in association with groups such as the International Road Federation or the various international highway safety bodies, to build up the infrastructure of public-interest institutions that will sustain efforts at maintenance and make it easier for governments to provide the necessary support. The formation of road-user associations could be more widely encouraged and public education campaigns could be assisted with material illustrating, in a straightforward way, the importance of maintenance and showing how countries compare with one another in effort and results. The Bank will also actively seek to impress on other lenders and donors of aid the importance of maintenance and the need for a unified approach in dealing with maintenance issues.

Chapter 4: The Financial Dimension

A perennial problem in highway maintenance is to ensure that sufficient funds are actually spent, steadily and effectively, on the maintenance of highways. Experience has shown that obstacles exist at every level. They may come, for example, from political concern that public opinion will be more impressed with new works; from the reluctance of planners to cut budgets for capital development and preference for schemes with a sharp developmental effect; from the eagerness of foreign-assistance representatives to ensure that the principle is upheld that such programs make a durable contribution to development and that these involve local financial participation; from over-budgeting and unexpected shortfalls of revenues that cause only a partial release of authorized funds from the ministry or treasury; from the difficulties of stopping or slowing new construction contracts once they have been started; and from failures to budget adequately for debts due local suppliers. Detailed country assessments that have been carried out in the last few years generally recommended increases of between 25 percent and 200 percent in spending for maintenance.

In most countries total revenues from road users—in the form of gasoline and diesel taxes, license and registration fees, import and excise taxes on vehicles and components, and tolls and fines—are now a multiple of existing maintenance budgets and adequately cover all desirable expenditures on routine and periodic maintenance, at least for the main national network. In many instances such revenues total more than the sum of *all* public highway expenditures, construction included. But because they are so important, they are also a critical part of general government revenue, for use in all fields. Although the Bank has sometimes acted quite effectively to encourage countries to make appropriate increases in fuel taxes, the problem of maintenance funding, nonetheless, has remained unresolved. Thus the difficulty of solving the funding problem is one that is found more on the expenditure side of the national budget.

Some countries have sought to resolve the dilemma by specifically earmarking certain taxes for use on the highways, and the Bank, on several occasions, has strongly supported the creation or re-creation of such road funds in the expectation that they would fully cover the costs of routine and periodic maintenance and the maintenance and renewal of equipment. However, almost no earmarking solutions appear to have produced these results in full, and several countries have moved away from the system. There have been many problems: in some instances, governments, under severe budgetary pressures, have not paid in all the taxes their laws would allow; when the road funds were set up to cover the costs of both maintenance and construction, moneys were often preempted by ongoing construction contracts; because the earmarked taxes were collected at fixed rates—so many cents per liter of fuel, for example—revenues soon became insufficient to cover the costs of inflation-plagued maintenance operations; in some countries, fuel consumption fell as fuel prices rose, and revenues fell as well; and maintenance-department operations that were financed by the funds were sometimes diverted to purposes other than highway maintenance.

One country in which the system of earmarked taxes does appear to be working on the whole effectively is Paraguay. There, maintenance work is now largely financed by 10 percent of the revenues collected from the fuel tax and through a special surcharge on imports. The revenues from these taxes are paid in equal monthly installments and are usable until the end of the fiscal year. To improve the earmarking system, the Bank has recently helped several African countries set up, outside the national treasury, separate accounts that are specifically to receive all or part of fuel tax revenues, usable only by the public works department and only for maintenance operations.

The establishment of such separate accounts may be a step toward the creation of an independent highway authority. Indeed, in one country, a legal precondition of a Bank loan was that the maintenance department be declared a road maintenance authority. Although imaginatively put forward by some transport economists as an appropriate way of managing a country's highway network generally, the concept of a financially self-sufficient, semipublic, national highway authority has not yet been applied anywhere. But toll-road authorities, such as exist in several countries, are approximations of it, albeit on a limited scale. One highly successful authority is the Korea Highways Corporation. Responsible for the maintenance of some 1,200 kilometers of expressways and main highways and run along commercial lines, it offers its employees much higher salaries than the national roads organization and provides strong incentives for efficient work. The corporation sustains a generous level of maintenance, which is fully financed out of toll revenues. Annual maintenance costs average about $12,000 per kilometer of high-standard highway.

Even if an independent authority is not created, the commercial notion that a country's highways are fixed assets, for whose maintenance it is reasonable to pay about 2 percent of replacement value annually, is helpful in promoting the cause of maintenance. Preservation of the national patrimony, the notion that the benefit of works contributed by outsiders are spread to all, national pride in having better roads than other countries, and the recognition that transport systems are of supreme importance in a landlocked country have all been telling points in debates on transportation policy in Niger and have helped that country win popular acceptance for its efforts in highway maintenance. One of the largest and poorest landlocked countries in Africa and severely affected by the Sahelian drought of

1972-74, Niger nevertheless raised maintenance allocations from about 4.5 percent of total revenues of the central government in 1965 to a rate of 7 percent that was sustained throughout the first half of the 1970s. In most other African countries, the existing range of such allocations is about 1.5 percent to 2.5 percent. A generally felt conviction of the Niger government that the adequate maintenance of roads was important to the economy of the country was far more important than the creation of any automatic mechanism in bringing this policy to fruition; indeed, Niger's road fund was abolished as a separate account in 1970.

Yet the case of Niger is also instructive in illustrating the difficulties that developing countries have in sustaining adequate levels of maintenance funding. In the period 1970-72, an IDA credit was financing half the costs of periodic maintenance in the country; in addition, the routine maintenance service had new equipment that was fully paid for from the proceeds of the credit. During that same period, some 8.5 percent of Niger's national budget would have been required solely for the maintenance of the country's main national network had IDA assistance not been available; and in the economically difficult years of 1973-75, about 10 percent of the national budget would have been required for Niger to sustain, on its own, routine and periodic maintenance and repair and renewal of equipment at adequate levels for the main national network.[1]

The government economized principally by cutting back on periodic maintenance (only about 100 kilometers of roads a year were regravelled, while to regravel 250-350 kilometers would probably have been worthwhile), by omitting any accumulation of reserves for the replacement of equipment, by strictly limiting purchases of new equipment, and by allowing inventories of spare parts to decline below the most efficient level. Routine maintenance of the main national network was kept at constant levels that were close to adequate. This prescription was probably the best one to follow under the circumstances. But some roads have deteriorated because of the postponement of periodic maintenance and now they require more extensive, deferred, periodic maintenance. There are also indications that the cumulative financial restrictions on the equipment division, together with virtual cessation of staff training on the departure of the IDA project consultants in 1973/74 and subsequent further sharp reductions in foreign technical assistance, may have affected the adequacy of routine maintenance even more recently as the availability of equipment lessened. In 1979, however, as the result of increases in recent years of revenues from the exploitation of uranium, Niger began a substantial replacement of equipment out of its own funds, and a larger periodic maintenance program, aided by the provision of new equipment and technical assistance from IDA funds, has been inaugurated.

[1]A rough assessment, on the basis of standard costs for different types of road, suggests a figure of about 15 percent in this period for the adequate maintenance of the country's total network.

While the magnitude of Niger's maintenance requirements and the intensity of its effort to meet them are somewhat exceptional, it is clear that highway maintenance is, generally, a much more serious burden in Africa south of the Sahara than in most other parts of the world. Rough calculations for a broad range of developing countries, half of them in that region and half distributed over all continents, show that barely adequate maintenance of national road networks would require more than twice as high a proportion of government revenues in African countries as elsewhere: a median of some 3.3 percent (range: 2.5 percent to 5 percent) of the total in Africa, while only 1.6 percent (range: 0.5 percent to 3.0 percent) is required elsewhere. If the burden is measured as a proportion of gross domestic product (GDP), the difference is even greater: a median of 0.7 percent (range: 0.3 percent to 1.4 percent) for the African countries, while the proportion is only 0.22 percent (range: 0.1 percent to 0.5 percent) for the others.

Analysis of current expenditures for the same sample of countries shows that funds equivalent to twice as high a proportion of GDP in the African countries as in the others are already being devoted to maintenance; nonetheless, the shortfalls in expenditures needed to maintain roads at "bare minimum desirable levels" are generally between 20 percent and 70 percent in the African countries. They are small or nonexistent in the others. Comparisons among countries in Africa, and among poorer developing nations elsewhere, suggest that the large differences in the share of GDP that needs to be devoted to maintenance are due less to the poverty of the African countries than to their large size and sparse populations.

The heavy dependence of African economies on foreign financial assistance has presented an additional problem. Foreign assistance agencies have typically been prepared to finance as much as 70 percent to 90 percent, or even more, of the costs of construction contracts in Africa, but only for the purchase of new equipment for maintenance, which represents about a quarter to a third of total maintenance costs. They have been particularly reluctant to finance the buying of spare parts for existing equipment. Although maintenance seldom accounts for more than a third of total public expenditure on highways in developing countries, and sometimes much less, the amounts of local funds devoted to it in the poorer countries are often nearly as large as those devoted to highway construction. In the poorest countries, funds spent on maintenance are sometimes considerably more than those spent for construction.

In these circumstances the possibility of generating three times as much foreign aid inflows for any given volume of incremental local budgetary expenditure in the highways field must weigh in the mind of finance ministry executives. There is no doubt that in many African countries this awareness has given rise to a bias in favor of new construction over maintenance projects, especially since neglect of maintenance means that rehabilitation is eventually required. Rehabilitation, of course, is capital investment that normally qualifies for a high proportion of foreign financing.

The World Bank has had two policies that affect its participation and objectives in maintenance operations. One, stated in the Bank's normal maintenance covenant, requires a country to maintain its roads adequately; the emphasis is clearly on the need of a country to develop maintenance capacity and to channel sufficient effort into this function, no matter what sources of financing might be tapped. The second policy normally limits the Bank to financing capital expenditures. The application of this policy to highway maintenance and similar operations has meant that the Bank has lent only in exceptional circumstances for any purchases of goods and services that promise to yield benefits over less than, say, a five-year period. The two policies are linked in that a goal of the first-named policy is to develop local financing mechanisms that can provide a sufficiently regular and assured flow of funds into maintenance—especially for expenditures yielding only short-run benefits but eventually for those with longer economic life, too.

Difficulties arise in those instances in which the first policy, essentially an institution-building aim, conflicts with the second, which is a financial policy. Further complicating the picture is the fact that failure in achieving the first aim with regard to routine maintenance can mean that the financial burden imposed on future generations (or on donors, in the event of grant aid) by eventual borrowing for expensive rehabilitation would actually be greater than if funds had been borrowed to help finance regular routine maintenance. Routine maintenance costs less than rehabilitation in terms of discounted present worth; in addition, the financial gap preventing the execution of routine maintenance is often only that part of its total cost that corresponds to expenditures on fuel, spare parts, and imported materials.

In many countries, the development of a smooth-running system of routine maintenance is a need of the highest order if the goal of institution building is to be met. Yet the reluctance of the Bank to finance recurrent expenditures largely limits its financial contribution to payment for initial inventories of equipment and spare parts, plus any related technical assistance. In theory this limitation should present no insuperable problem, and in fact many countries have succeeded in increasing sharply their own budgetary contributions to maintenance; for example, such contributions have been sustained at a level 100 percent or more higher than before in Chad, Indonesia, Liberia, Nepal, the Philippines, and Tanzania within the last few years. In some cases, however, even these increases are not sufficient; in others, such rapid increases are not feasible. The lack of foreign exchange can be a particular problem; although initial inventories of spare parts and their replenishment, purchased through savings on other components in Bank-assisted projects, have helped in a few instances, expensive equipment has sometimes been left idle for long periods for lack of funds for fuel, spare parts, and materials.

Where these problems reflect not merely a lack of fiscal and administrative effort but a real lack of room for maneuvering—as can happen in African countries in particular, with their comparatively high maintenance burdens—it would seem appropriate to take a more liberal attitude toward the financing of recurrent costs. Considerable government participation, in the form of wages of laborers, the payment of which has seldom been a major problem in routine maintenance operations, would still be necessary; providers of assistance, such as the World Bank, could then cover part of the costs of purchased inputs, particularly items such as fuel, spare parts, and bitumen that must be paid for in foreign exchange. World Bank participation, on a declining basis, in helping to finance the incremental recurrent costs of routine maintenance, could help concentrate the institution's effort, as well as that of the borrower, on whatever the greatest need might be and assist a country through a transition period to a higher regular level of performance in recurrent maintenance. Justification for such financing would thus be based on a combination of institution-building and budgetary considerations, which would be explicitly stated, along with a plan for developing local financial mechanisms and increasing local participation in maintenance financing more generally, as will be discussed later.

In some respects equipment presents an opposite case, one in which Bank financing is readily available but in which special provisions may also be required to ensure that the purchase is fully supportive of the institution-building objectives. The purchase of equipment clearly qualifies as capital expenditure because the usable life of the equipment extends through a period of years. Borrowing for the purchase of equipment can be eminently desirable as part of the general borrowing policy of a country. But the efficiency with which fleets of equipment are run at present often leaves much to be desired. Rates of availability, use, and productivity are extremely low. Provision of new equipment, therefore, must often be accompanied by intensive efforts to improve performance in these respects, in order to keep the numbers of units required to a reasonable minimum, to secure the best results from the investment made, and to increase the self-sufficiency of a country.

Recognizing the difficulties of running fleets of equipment efficiently within normal government administrative systems, many countries have tried to establish autonomous budgets or revolving funds for maintenance equipment, fed by hire charges from users of equipment. Appraisal reports of the World Bank have often supported this objective. Such funds have a multiple potential purpose: first, to make operations more flexible—in facilitating expeditious purchase of spare parts, for instance, and removing cumbersome pre-audit requirements of regular government procedures; second, to discourage diversion of equipment to uses other than on the road, a major problem in some countries; third, to enable assessment and monitoring of trends in the efficiency of maintenance and operation of equipment, so that management can act expeditiously to reduce costs; fourth, to promote awareness within the highway department of the high cost of equipment—most simply by an hourly use charge—and thereby to encourage economic use; fifth, to offset any possible distortional effects on decisionmaking—against labor-intensive operations, for example, or against contracting work out to the private sector—that might appear as a result of lending on Bank terms to the public sector for procurement of equipment; and sixth, for those countries, quite numerous, that should reach the stage of being able to finance replacement of equipment out of their own resources, to facilitate such purchases, and to encourage decreasing reliance on foreign borrowing.

Effective operation of such hire-funding schemes has also faced difficulties in many countries, however, and seems to need more serious attention from the Bank. These schemes require a special initial effort to develop the necessary accounting and management skills—principally in a few key staff—and supporting technical programs for improving the availability and maintenance of equipment so as to reduce costs. The divisions responsible for road works have to be given sufficient funds, supplied regularly, to pay the hire-charge rates. A problem in many instances has been that the rates have been set too low in the past, essentially because large initial purchases of equipment, financed out of assistance from the World Bank, have postponed the need for regular renewals, and it has been difficult for financially constrained ministries of public works to undertake the accumulation of reserves for later replacement purchases when they knew that replacement of equipment could always be covered by further foreign borrowing.

The way to help strengthen the financial framework may be to place the accounting operations on a more clearly commercial basis, including the payment of interest on capital and depreciation in the hire charges, and to lend those portions of Bank loans that are for the purchase of equipment to such revolving funds on the shorter, harder terms (with exchange risk transferred) now sometimes used for loans that are destined for credit institutions. In this way the real costs of operating equipment would become clear to all concerned. Also, setting up equipment procurement plans—as in the recent Highway Maintenance Project in Oman—and even procurement contracts, in such a way that deliveries take place over a series of years, would help. Such a system would avoid the problems of absorption connected with large one-time arrivals of new equipment—sudden needs for greatly increased numbers of operators and mechanics that some countries have been unable to meet properly. It would ensure a smoother pattern of aging of equipment, thus helping to make the availability of equipment more nearly constant and the need for mechanics more regular. And it would lead to an eventual pattern of needs for renewal that could more easily be met by those countries that should be moving toward financing renewals themselves. The same principle of phased procurement applied to spare parts, with only an annual review of the price structure for approved dealers and contractors, would help ensure a smoother flow of parts and reduce the burden of procurement work.

Even while encouraging the adoption of a more fully commercial accounting system—because of the contribution that commercial accounting can make to solving the equipment-management problem—the Bank should also make it clear from the start that in the poorer countries it would normally be prepared to lend for replacement of equipment. Greater clarity on this subject could enable the Bank to be more insistent that countries provide out of their own foreign-exchange resources—with transitional assistance from loans as it is needed—regular funds to maintain inventories of spare parts at the 15 percent of aggregate value of equipment that is generally essential for efficient maintenance of equipment in countries that are far from the main supply routes. A few years ago, Honduras set up a small but useful emergency revolving fund, under the control of the maintenance department, to expedite the import of spare parts. It may be possible to develop advance operating funds provided under some recent IDA credits to African countries into permanent funds of this nature.

Financing of periodic maintenance, with an expected life to the benefits of the work of at least five years, is an area in which the Bank has already shown great flexibility. In some instances, in which local funding might be expected to cover the costs of materials and operation of equipment, the Bank has simply lent for the purchase of equipment. But in others, in which adequate funding could not be provided from domestic sources, the Bank has financed a share—normally foreign-exchange costs, but sometimes more—of total costs, as it would in connection with any capital project. The emphasis on institution building would guard against a problem that has sometimes arisen—that of expanding force account operations to a level that the borrowing country cannot sustain through the medium term—and would encourage systematic consideration of private contractors, thereby helping as well to develop the local contracting industry.

The long-run, institution-building aim that all maintenance expenditures—for periodic works and renewal of equipment as well as for routine operations—be recognized as the borrower's responsibility, to be financed internally or on commercial terms, probably needs clearer emphasis in Bank policy. The importance attached by the Bank to increasing financial self-reliance should be expressed by close analysis of the long-term trends—before, during, and after a particular proposed project—in the proportion of *total* maintenance expenditure that is covered by local budget funds. Clearly, the size and growth of the maintenance burden in relation to the size of the country's economy should be taken into account, as should extensions of maintenance coverage, exogenous shocks to the government's financial performance such as declines in the market prices of major export commodities or natural disasters, and the weight of economically justified requirements for new building in the highways sector.

Treatment of all road-maintenance obligations together would clarify the real burden on the country and avoid the difficulties of definition that sometimes arise in distinguishing recurrent from periodic expenditures. Among countries that now receive the greatest external assistance for maintenance, these internal-financing shares of total maintenance costs now appear to stand at about 50 percent for the poorest countries and 80 percent for the richer countries; with development they should clearly rise to reach 100 percent in the most advanced countries that borrow from the Bank at any particular moment. Linking Bank assistance directly to a rising local financial effort may sometimes be a useful short-run technique for encouraging this trend.

The specific agreements on domestic appropriations for maintenance in each of the coming four or five years that have been sought in recent years in connection with loans and credits, while they have not always been fulfilled, have nonetheless undoubtedly been useful in assisting government planning, reducing misunderstanding between governments and the Bank, and helping ministries of public works to get adequate attention from ministries of planning and finance. It is obviously essential that these agreements be prepared in proper recognition of the prevailing local context and the time that may be required to overcome existing deficiencies—of information, capacities to spend effectively, realistic government financing ability, and so forth—and that they be thoroughly understood between borrower and Bank. Sometimes they may need to be yet more specific—more clearly covering routine and periodic road maintenance and equipment maintenance and identifying separately the foreign-exchange operating funds required and total expenditures other than for labor—and to include simple index formulas, such as local prices of fuel, labor, and spare parts, appropriately weighted, for updating the estimates. Proper planning and sizing of projects would also be helped by including in such agreements some indication of the expected magnitude of the maintenance burden after completion of the project and a rough projection to show how its financial requirements might be covered.

In practical Bank policy, giving greater emphasis to the institution-building objective defined in the maintenance covenants of the loan agreement means that Bank-assisted maintenance programs should turn out to be better balanced than they now are. Also, more attention would be given to the development of local financing mechanisms according to the order of their institutional priority; arrangements for spare parts, whether for routine or periodic operations, or indeed for road improvement, would be the first essential. Equipment funds, with their multiple advantages for efficiency of operation, would have a better chance of success. Finally, the cumulative amount of foreign lending required could, in some cases, eventually be less, both because institution building should be a bit more rapid and because roads should be less often allowed to deteriorate to the point of becoming major rehabilitation cases.

Chapter 5: The Staffing Dimension

In many regions, especially in parts of Africa, the most serious constraint on highway maintenance is the lack of adequately trained or experienced staff. In other parts of the world, generally better supplied with skilled manpower, severe shortages still often characterize the maintenance field. This is especially true of government departments concerned because interest in maintenance is low and salaries are poor. Apart from some countries in which the matter was neglected until quite recently, the Bank has given considerable attention to training in maintenance, supporting it with financing for the foreign exchange costs of construction of physical facilities, purchase of training equipment, technical assistance, and overseas fellowships. But the results have so far been generally rather disappointing. As shown in Chapter 2, this effort has been receiving somewhat more attention in recent projects, but those results cannot yet be known.

Some maintenance training programs have suffered in the past from the overoptimism of governments or their consultants as to the numbers of people that could be made available for training or to the educational backgrounds that trainees or counterparts would have. But the more worrisome problem is that in retrospect it often seems as if more could have been accomplished within the program period, even given the scarcity of human resources that prevailed. Programs have sometimes been envisaged only for mechanics and operators, for example, although field supervisors and inspectors were equally in need of training and would have been available. In other instances training has been directed exclusively toward the particular needs of two or three new mechanized units, to the neglect of the consequences for the remainder of the maintenance operation from skimming off the best personnel for such units. Internal imbalance among the various complementary elements—equipment arriving late in the stay of the technical assistance team, delays in beginning workshops and the availability of classrooms, and so on—and unfortunate discontinuity in training through failure to sustain programs once started are problems frequently encountered.

A serious training program for a maintenance organization should be based on a careful, forward-looking analysis of the prospective balance between the skills expected to be required, at different levels and in different specialties, and those that are already available. Allowance should be made for considerations such as the learning capacities of existing staff, their availability for training, the need to replace expatriate employees, and the losses of staff that come about because government agencies in most countries, particularly in developing countries, are training grounds for the private sector. The program should be comprehensive in the personnel that it covers, from senior engineers and managers to patrolmen and drivers (of the highway department and any other entities responsible for maintenance, such as local councils), and in the modes of training that are considered, including overseas schools and visits, counterpart arrangements, equipment supplier courses, classroom training, and on-the-job training. Such planning can seldom be done in sufficient detail without periodic, thorough inventories of staff and their educational attainments.

But thorough program preparation and planning are only half the story, for experience has shown that to foresee the need for trained staff and the availability of trainable people, in all the relevant dimensions of specialty and capacity, is difficult if not impossible. Continuity in the training effort and flexibility in adjusting it to changing needs are therefore essential. Too many programs have ceased with the departure of consultants after four or five years and have then taken another three years to reinstall.

One exception to this pattern is to be found in Rwanda, where a continuous, in fact a growing, effort in highway maintenance training has been sustained since 1972. In 1970 consultants were instructed to prepare an eight-to-ten-year maintenance program—an unusually long program. Perhaps in part because of the long perspective taken from the outset, considerable effort was made to ensure continuation of the technical-assistance services: the principal group, financed for the first four years by the United Nations Development Programme (UNDP), was extended for eighteen months under a supplementary IDA credit, mainly to cover a construction cost overrun, and was then financed for an additional four years under a new IDA maintenance credit.

Together with bilateral technical assistance, particularly for the workshops, this group has provided a reasonably comprehensive range of counterpart and practical field training for inspectors, supervisors, foremen, mechanics, fitters and electricians, operators and drivers, administrative staff, surveyors, and laboratory technicians. With their efforts and the earnest support for training provided by the government, the country was able to absorb a fivefold increase in its maintenance equipment park in one year. Thanks to simultaneous efforts by the government to increase the number of nationals graduating from local and foreign engineering schools, the number of Rwandan engineers and technicians in the Roads Department increased from three in 1971 to twenty-six in 1977. But the technical assistance consultants also saw early that a more thorough, complementary classroom training effort would be worthwhile. A program was prepared, and, while it could not begin in 1975 as originally intended, mainly because not enough appropriate staff could be released, it is beginning now.

As a result of these changing needs and perceptions, the foreign staff in the Roads Department, concerned primarily with advice and

training of one sort and another, increased from nine in 1971 to twenty in 1973 and further to twenty-two in 1978. In its first four years, the new formal training program will cover almost all departmental staff above the grade of laborer, but continuation of training is envisaged, with some continued foreign assistance for at least an additional five years and probably longer.

Thus training needs to be recognized as a continuing function and to be institutionalized, so that training considerations are given sufficient weight in the formulation of policy for the department and so that training staff receive adequate recognition and career prospects. Training is needed not only for new recruits—who may be numerous if losses of staff to the private sector are high; 10 percent a year is not unusual—but also for recycling present staff. Some governments, such as those of Romania and Korea, have already introduced broad standard requirements that all government staff undergo at least minimum amounts of training every three to five years. Modern training programs in maintenance supported by the Bank usually provide capacity for at least brief training of between a tenth and a fifth of total staff above the grade of laborer each year.

Training of local staff to facilitate the communication process and to carry on the training program is essential. One particularly successful, lasting, training center for mechanics and operators was established by the International Labour Organisation (ILO) in Syria in 1972-73. After initial delays in obtaining counterparts and classrooms, equipment was installed, 500 trainees were put through the course, and the center was then handed over to nine Syrian instructors who had meanwhile been trained abroad. A supplementary ILO project in 1975 provided a short-term specialist to assist with organization.

In countries in which training within the highway department is likely to continue to be important, it may warrant the creation, not only of a special unit or section such as the large majority of departments now have, but also of a division or other unit of higher administrative standing. This is mainly because of the need to attract professionals of high quality and to allow them to participate in decisions on such a wide range of matters as recruitment policy, placement and promotions, the training aspect of field operations, and standardization of equipment. The division chief would be responsible for planning, promoting, and coordinating all forms and levels of training, in accordance with a departmental policy statement on staff training, and he would be expected to coordinate these activities with the development of relevant training outside the highway department.

Among training techniques, there is evidence that short classroom courses followed by actual practice in a working brigade, under observation at arm's length by the teacher, has considerable potential. This is the essence of the training production unit concept, successfully applied in the past in Tanzania and at present in Oman and Zaire, among many other countries; it offers trainees more responsibility and the opportunity to learn from their own mistakes. One of the most successful features of the Rwanda experience was the use of the equipment when it first arrived in 1975, not for the maintenance operations envisaged under the project, which would necessarily be dispersed, but for building a short road close to the capital where staff could be carefully screened and trained under full supervision before being sent to the field. For the difficult task of training illiterate mechanics and operators, important advances in audiovisual techniques have been made in recent years and have been applied successfully—in Sierra Leone, for example.

Motivation of trainees is a key factor in successful training. It is partly a question of attitude and thus heavily dependent on appropriate leadership and an *espirit de corps* in the highway department. But salary and status both during and after the training period are crucial. One problem is paying participants during training; this means recognizing, when budgeting for departmental personnel, that a certain percentage of staff should at any given time be undergoing training. A small degree of overstaffing is therefore warranted. In a few countries potential recruits can be attracted to training even without salary during the training period; an interesting experiment being made in Rwanda is to offer trainees free food provided by the World Food Programme. But the budgetary implications of absence of staff members on training, travel to the training center, and the like must be recognized.

From the long-term point of view, staff members need to feel that good performance during and after training will be appropriately rewarded in salary and status. This is often a major problem because of the rigidities of salary structures under civil service systems. In some countries, good training opportunities are seen as a partial substitute for good salaries, but it follows that a high rate of turnover is inevitable. In some highway departments the argument has even been reversed: a minimal training effort has been justified on grounds that trained staff will quickly be picked up by the private sector. That seems a negation of a critical development function that highway departments should be fulfilling. In practice, moreover, provided there is reasonable flexibility on the part of the civil service authorities, it is often possible to provide, at relatively low total cost, the small individual adjustments in salaries, functions, and status that make it possible to retain a reasonable minimum of trained staff for the maintenance department.

In its support of training, the World Bank may need to give even more attention to adequate preparation of programs and to the crucial importance of continuity of effort. Although preparation of training components has improved, their readiness for execution at the stage of loan approval generally is still considerably less than that of engineering works, for which detailed engineering must normally have been largely completed by the time of loan negotiations. In particular, the inventory of personnel, which corresponds to the collection of basic data on soils and hydrology for engineering works, may need to be done more often before loan approval, so that an effective training program can swing rapidly into motion, in close coordination with the physical components of a project.

Once the importance of the continuity of programs has been recognized, the Bank may be able to provide adequate support through new loans, as it did in the case of Rwanda cited earlier. But there are situations in which new projects are unfortunately delayed. In such a circumstance, much might be said for sustaining such a vital, yet relatively inexpensive organism as a training center through the interim period until a new project loan is made, by lending for the relatively small foreign-exchange costs of continuing operation—mostly for technical assistance, though minor amounts of equipment or other supplies might be needed. This would have been of great value in several African countries during the last decade and could now be done relatively easily by a small extension of items eligible for financing under the Project Preparation Facility of the Bank or by separate arrangements of similar administrative simplicity.

Chapter 6: The Management Dimension

Improvement of the efficiency of maintenance operations is the key issue in a few countries, in the sense that existing budgetary allocations would probably be adequate if they were efficiently spent. But it is an issue of some importance in most countries, both because of the scope that does exist for accomplishing more with the available funds and because of the tendency of finance ministries to cut requested budgets on the grounds that the funds would not be well spent. Typical problems are excessive numbers of staff, inadequate supervision of staff, limited availability and use of equipment, low productivity compared with that of organizations that perform similar functions in the private sector, diversion of equipment and effort to works other than maintenance, and periodic depletion of funds.

Most of these problems have a heavily structural side to them, which can only be solved in time—by attrition of staff, by the introduction of greater flexibility in personnel policies, by the training of middle management, by setting up better arrangements for ensuring a regular flow of spare parts, by limiting interference from politicians and local dignitaries, and by finding alternative ways of meeting the need of local authorities for modern equipment for their own works. Some of the suggestions in other chapters on the organizational framework for maintenance, accounting for equipment and training of staff, are relevant here.

But besides the promotion of appropriate structural change, both internally and with other branches of government, the main responsibility of management is to make the best of the prevailing situation to run its own program as effectively as possible. A great deal of emphasis has been placed in many Bank-assisted projects on the application of modern management systems for planning, programming, budgeting, scheduling, control, and data collection, and it is difficult to avoid the conclusion that it has often been overdone. In some instances, the management information systems introduced by consultants have simply proved too complex to function or to be used beyond headquarters. In others, they were excessively dependent on computers that were unavailable or functioned poorly. More often, elaborate reports have continued to be produced at lower levels of the hierarchy, but there has been no effective system for checking them, and they have been little used, for lack of qualified headquarters personnel to handle them or for lack of interest. The effort seems to have been spread over too many systems, with too much detail, and with insufficient attention to the structural constraints on the ability of management to act.

The experience suggests that management may in fact help itself most by phasing in new systems rather cautiously and slowly, except when it is responding directly to its own felt needs. At the earliest stages it may be best not to attempt much regular collection of detailed data for planning purposes—such as quantities and costs, traffic counts, and deflection measurements—or even for detailed comparison of actual against plan, leaving this to periodic special efforts. Instead, attention should be focused on two systems—one largely a matter of training and attitudes, the other a full-scale management information system, but limited to the operation and maintenance of equipment.

The first might be entitled "an intensive field inspection and supervision system," but its main purpose would be to develop a strong sense of discipline and responsibility throughout the maintenance organization. For written reports it would rely on traditional budgeting and accounting systems at the level of the field division or subdivision and the simplest (normally pre-existing) work-order and daily-activity reporting at the crew level. In sum, it would concentrate on developing and inculcating in supervisors down the line a responsibility to make both regular visits and ad hoc, unexpected visits to the units of which they are in charge, to commend or criticize as appropriate the quality of work done, and thereby to impress upon the staff the standards to be attained and ways of attaining them.

Compilation of reports, other than accounts of essential expenditures for forwarding to higher levels, would be specifically discouraged in order to free as much of the time of managers and supervisors as possible for inspection and education visits. The only new regular report that might be considered would be a simple semiannual or annual report by field supervisors on the state of the roads (surfaces, shoulders, drainage, and so forth) under their responsibility. This report could strengthen the effort to focus supervision on basic purposes and the adequacy of final output and could be used for control and planning. It was pointed out in Chapter 1 that assessment of the quality of maintenance is still in good part a matter of vision and feeling, even when the most complex systems of measurement are available. By the same token, the most important need is to develop such faculties in all the staff; each staff member should have a concept of appropriate standards and a sense of responsibility for keeping the roads under his charge up to those standards, whatever the effort that might be required.

In the operation, service, and maintenance of equipment, the sense of responsibility for proper use and regular checks is of course also essential. But here it is also both easier and more important to maintain full written records, especially if, as suggested elsewhere in this report, equipment is made the responsibility of a separate division that hires it out to the field division. And the records for each piece of equipment—on servicing, use of spare parts, availability, use, and productivity—should be compiled, verified, and analyzed regularly.

Such data are essential for decisions on the reallocation of equipment among field operations, decisions on policies concerning stocking and ordering of spare parts, identification of pieces that should be scrapped, pros and cons of standardization in each type of equipment, and revision of hire charges. Records of the use and productivity of equipment, moreover, compiled in the right way, can often yield the best information on quantities and costs of any major maintenance works done; management of highway maintenance needs accurate records of periodic maintenance work accomplished, and these can be obtained largely from the log books of the responsible mechanized units.

Many countries have nonetheless encountered difficulties in introducing accurate and reliable systems of recording and accounting for equipment, largely because of the high degree of precision continuously required of everyone involved—operators, mechanics, store clerks, and their supervisors. One of the advantages of the hire-charge system is that it places more of the transactions and operations on a monetary basis, with two parties to each transaction, so that precision—in such matters as downtime caused by the lack of spare parts—automatically takes on more importance. But the main point is probably to recognize that good management information systems for equipment are both very important—if the large amount of capital tied up in fleets of equipment is to be used efficiently—and quite difficult to achieve, so they should be brought to smooth operation before other systems are taken up.

An appropriate third step in the development of management systems, highly useful but not to be attempted before effective field inspection and equipment-information systems are well started, might be the establishment of a small organization and methods unit in headquarters. This unit would not normally gather large amounts of data from the field divisions, but would do spot studies in highly concentrated problem areas at the request of top management. Questions might arise about performance in a particular subdivision, for example, on which management needed a more thorough assessment than line management would have time to produce; or a small-scale time study might be worthwhile to explore a suggestion for reduction of the cost of some regular maintenance procedure; or a detailed comparison between different makes of equipment and their performance records might be needed before a new order was placed. The function is one of trouble-shooting studies: avoiding the twin dangers of becoming so involved in day-to-day management that no time is left for small-scale but serious studies or so swamped with regular reports from the field as to be little more than a repository of history.

With good leadership, the need will, of course, gradually be felt, and the means will become available—mainly in highly educated, middle-level manpower—for compilation of basic crew-level reports into regularly written subdivisional, divisional, and regional reports on maintenance operations. New types of reporting may also be needed. There are many alternative dimensions and emphases in such reporting systems; the possible scope ranges from broad, average quantities and costs of various classes of road to full detail for each individual

stretch of road. Rather than design a total system at the outset, even for phased introduction, it may be best simply to let the system grow by following the priorities that emerge from the interaction of field managers, headquarters managers, and an organization-and-methods unit, taking care only to replace and combine rather than to duplicate whenever a new need for information is posed.

Well before the stage of full sophistication is reached in cost-information systems for maintenance operations on the road network, it is likely that the need will be felt for collection of planning data more regularly than on the "periodic basis" suggested earlier. Traffic counts on roads that carry in excess of, say, 100-200 vehicles a day, will have high priority; initially they might be taken every two years, but soon they would be needed annually, in different seasons. Equally important in those countries in which light pavement has been extensively used will be deflection surveys, which should really be made annually if sufficient information on the rate of deterioration is to be available. With the development of scientific measurement and interpretation of road roughness, regular roughness surveys are likely to be seen increasingly as a useful aid in defining the type and nature of maintenance that should be undertaken each year. Eventually, these surveys might be combined with any broader, pavement-rating system to make a permanent road inventory as a tool for setting maintenance priorities and strategies.

The rather slow development of information systems for planning and estimating costs suggested here means that overall planning and economic analysis of maintenance projects such as those financed by the World Bank must continue to be heavily based on the kind of judgment that now guides maintenance planning. But the most important implication is that projects should directly support and reflect the highway department's management systems in the sense of including targets for key objectives highlighted in those systems. This is what is called in recent Bank maintenance projects an "action plan," in contrast to the maintenance project or program itself. While the latter would define the basic standards for road maintenance and the quantities to be accomplished, the action plan would identify, for the same period, key instrumental variables and the measures needed to raise them to higher levels of performance. The action plan is focused directly on operational efficiency and short-term measures to improve it. Sometimes these might be matters of institutional or personnel-policy reform or they might have to do with the training of inspectors.

But the wide evidence of difficulties in efficient management of equipment suggests that, for many countries, action plans should now be aimed at equipment-related targets—such as rates of availability and utilization and productivity, by type of equipment, and the adequacy of inventories of parts. Developed with the aid of experienced mechanical engineers, the action plan would detail and phase the specific measures—corrective or preventive equipment-maintenance programs, improvements in organization and management, procedures for ordering spare parts, and so on—required if the targets are