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MEMORANDUM

TO : See Distribution DATE: 16 September 1968

FROM : Judith Tendler, DPEC

SUBJECT: Northeast Highway Maintenance Evaluation

1. Attached is the preliminary version of an evaluation of the highway maintenance loans in the nine Northeast states. The purpose of the evaluation was to provide an understanding of the various aspects of the maintenance question, so that the Mission could benefit from its experience in the Northeast projects in the design of future projects and in the implementation of current ones. The evaluation is being circulated in preliminary form so as to benefit from the comments and suggestions of those who have at one time or another been involved with the highway maintenance projects. The study is comprised of an analysis of the highway maintenance problem, drawing on examples from the Northeast experience, and a set of recommendations based on the analysis. The analysis and recommendations are presented in summary form below.

2. AID has invested in highway maintenance in Brazil because of the tremendous need for improvement in this sector, and because of the damaging effects that neglect of the sector has had on the productivity of the country's transport system. The neglect of maintenance is the result of a constellation of circumstances that normally appears in developing countries: (a) highway maintenance doesn't have the powerful interest groups behind it that highway construction does—the road contractors and the politicians—and therefore is not able to defend its claim on the scarce appropriations of the public sector; (b) equipment is generally scarce in the public sector, so there are likely to be great pressures from other sectors for use of the maintenance equipment; and (c) several prerequisites of a routine maintenance program are difficult to encounter or create in a developing country—an even flow of budgeted revenues, sufficient supervisory and mechanical skills to keep the equipment maintained and running, an adequate supply of parts distributors in the region—to mention the most important.

3. The difficult going that maintenance has is also related to a certain economic rationality underlying its neglect, (a) because of poor road construction techniques, maintenance is more costly and roads have to be renewed more frequently than in a developed country; and (b) a major part of the roads under a state maintenance department's responsibility are unpaved. Such roads are more costly to maintain than surfaced roads, require a more rigorous scheduling of maintenance activities than do paved roads, and are often looked upon as temporary phenomena to be upgraded eventually to paved roads.

4. Lastly, maintenance department budgets are burdened with the cost of an unproductive large labor force, resulting from the fact that highway departments are often the makeshift solutions to unemployment problems in labor-abundant economies.

5. All these factors participate in a vicious cycle that excludes acceptance of and financial commitment to the concept of ongoing road maintenance. The purpose of a highway maintenance loan, then, is to provide equipment and technical assistance in a way that will help break into the vicious cycle, and that will partially overcome or bypass the institutional and economic obstacles to maintenance. When the technical assistants leave and the equipment starts wearing out, it is hoped, the program will be implanted firmly enough to be able to continue on its own.

6. The most difficult aspect of highway maintenance implantation is the assuring of a continuing flow of budgeted funds to this activity. If the maintenance department is more able than is usual to influence this flow of funds, or to resist diversion of these funds to other activities, a good part of the highway maintenance battle will be won. Hence much of the strategy of this paper is based on strengthening the maintenance department as an institution within the highway department and the public sector in general—taking as a model of success the strength of the road contractors, their ability to attract public revenues toward road construction and to be less cut off than other activities during moments of budget shortfalls. This strengthening of the maintenance department implies a sufficiently long period of insulation from certain types of problems—most important, the lack of adequate equipment maintenance, and the difficulty of obtaining spare parts. This strategy also implies protecting the department against its own weaknesses—the tendency to favor betterment over routine maintenance, and to ask for more equipment than it can absorb. The following recommendations are meant to be techniques for implementing the strategy summarized above.

a) <u>Spare Parts</u> (Section II.1.)

1) A spare parts allowance should be provided in year 2, year 3, year 4 and year 5 after the arrival of the equipment—above and beyond the 10% spare parts that come with the first delivery;

2) this allocation for spare parts should be made in the form of an account, rather than the parts themselves;

3) the local maintenance engineers should be the major decision-makers about what spare parts should be ordered, because of their experience with the rate at which parts wear out, with the ability of their mechanics to repair certain parts, and their knowledge of the varying facility with which the parts can be obtained in the local economy;

4) if the spare parts allowance should increase the size of the financing considerably, the amount of equipment to be purchased should be reduced correspondingly;

5) the technical assistance part of the project should provide for an initial intensive program of techniques to prevent pilferage from spare parts warehouses, or diversion of parts to other uses.

b) The idleness of the existing labor force of state highway departments should be considered, as much as is possible, the result of a missing factor of production--equipment. The overriding criterion of equipment selection, therefore, should be a program that will complement rather than substitute much of the existing unproductive manual labor force. (Section II.2.)

c) Equipment maintenance should be given priority attention over highway maintenance. Technical assistance should be concentrated in this area, and funds should be unconditionally guaranteed for the construction and the provisioning of central maintenance shops that will be necessary to implement this priority. (Section II.3.)

d) The amount of equipment that has the widest range of uses in other sectors should be reduced to a minimum--namely, jeeps and pickup trucks. (Section II.4.)

e) Betterment equipment should be reduced or completely eliminated from maintenance projects. AID financing of this activity should be for the contracting of betterment projects rather than for the acquisition by maintenance departments of betterment equipment. (Section II.5.)

f) The equipment list should be designed according to equipment/kilometer ratios only as a first approximation. Final decisions should be made according to "absorbability" ratios: the increase in the size of the equipment fleet as a result of the project, the required increase in the size of budgetary expenditures on maintenance, and the required increase in the number of supervisors, engineers, mechanics and operators. (Section II.6.)

g) <u>Imported Equipment</u> (Section II.7.)

1) Imported equipment should be kept down to a minimum, and equipment specifications should be changed, where possible, to achieve this purpose;

2) imported equipment should be procured through program loan financing, if the only other alternative is biddings in which any manufacturer who meets the specifications is eligible, and in which the local engineers' preference for certain brands of equipment cannot be deferred to. This should be done to avoid uneconomic diversity of brands, and to avoid equipment that does not have good service and

representation in the state concerned.

h) The major burden of drawing up and justifying equipment lists should rest on the engineers who will be using the equipment. (Section II.8.)

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NORTHEAST HIGHWAY MAINTENANCE EVALUATION

The following is a series of observations and recommendations on the AID highway maintenance program in the nine Northeast states. On June 30, 1964, AID authorized Loan No. 512-L-019 to SUDENE, in the amount of US$20 million and US$3.2 million of cruzeiro equivalent (PL 480) for highway maintenance equipment and BPR technical assistance for the Northeast state highway departments (DERs). Sixty five percent of the equipment purchases were to be made in Brazil (US$11.2 million equivalent), and thirty five percent in the United States (US$6.3 million). An allocation of US$2.5 million was made for Bureau of Public Roads (BPR) technical assistance.

This report is based on a reading of the project files and engineers' monthly progress reports, and a two-week trip to the Northeast. Most of my time was spent in Pernambuco—visiting maintenance residencies, state roads on which maintenance was being carried out, construction projects, and talking with maintenance mechanics and engineers, private engineering consultants, highway department officials, SUDENE engineers and officials, other public sector officials, and USAID/BPR maintenance engineers and mechanics. Two days were spent in Fortaleza, in discussions with engineers, mechanics and other functionaries of the state highway department. My selection of Pernambuco and Fortaleza, given the limited amount of time, was based on the relative success of the former, and the problems that occurred in the case of the latter. Section I of the report is a description of some of the problems that a maintenance program will confront. Section II presents a series of recommendations and their justifications.

I

The lack of adequate highway maintenance practices in an underdeveloped region like the Northeast is closely related to highway construction techniques, institutional and financial weaknesses, and soil and climatic conditions. When highway maintenance is seen as part of this larger whole, the lack of it takes on a certain economic rationality—or, at least, such a view makes clearer the specific difficulties involved in implanting a

highway maintenance program in a region like the Northeast.

The most obvious and oft-cited reason for the lack of highway maintenance is that politicians and state highway departments find it more attractive to build roads than to maintain them, and that therefore road-building eats up the maintenance share of the highway department's receipts. Although this explanation is quite important, it nevertheless neglects other important difficulties involved in highway maintenance, which are unrelated to the political unattractiveness of the activity. Moreover, the political-unattractiveness explanation of bad highway maintenance tends to overshadow the fact that the type of highway construction techniques that are used in a developing region cause the lack of maintenance to have a certain rationality. And lastly, the political-unattractiveness explanation of poor highway maintenance implies a strong inverse correlation between road-building and road maintenance: the more highway construction that is undertaken beyond this sector's fair share of the highway department's budget, the less resources will be left over for maintenance, and the worse highway maintenance will be. Yet the two Northeast states which have the most successful highway maintenance programs —Bahia and Pernambuco—are precisely those states which spectacularly exceeded their budgetary limits in the undertaking of ambitious highway construction programs, and are now desperately seeking outside financial help to pay off their road contractors. Instead of saying that roads are badly maintained because resources are eaten up in construction, it might be more accurate to say that road maintenance does not have the resource-mobilizing attraction of power plant, bridge, subway, or highway construction. The latter, of course, has an important causal effect on the flow of funds to maintenance, since both rely to some extent on the same revenues. But the Pernambuco and Bahia cases show that good highway maintenance can coexist with deficitary highway construction, and that there are other factors involved in the maintenance problem—factors that are obscured by the glaringly obvious political pull of highway construction on scarce highway department resources. These other factors not only show a more complex and problematical picture of why highways aren't maintained, but they also suggest that good highway maintenance is not dependent on a previous curbing of the politician's voracious appetite for highway

construction—a precondition that would make highway maintenance prospects quite dim.

I. 1. The Earth Road Maintenance Cycle

Most of the Northeast roads under the maintenance responsibilities of the state highway department are earth or gravel, with the exception of Pernambuco and Bahia, where paved roads represent 20% of the DERs maintenance responsibilities. The existance of a marked rainy season imposes a rigorous cycle on even the simplest highway maintenance programs: the earth road must be bladed immediately before the rains, and drainage facilities thoroughly cleared. This preparation makes the road less vulnerable to impassability during the rainy months, and makes recuperation possible after the rainy season. As soon as the rains end, the road must be scraped and graded, but not too soon after the rains, for the equipment will simply bog down in the mud; if too much time lapses before this work is done, however, the road will have become so dry that scraping it will cause the wind to carry away the roadbed in a fine dust. A week or so lost before or after the rains can mean that the earth road loses out on its annual and essential dosage of maintenance. The rainy season itself, according to this cycle, should be spent on intensive repair and preventive maintenance of the equipment, to prepare it for the large amount of work to be done in the weeks after the rains. During the dry season, routine maintenance can be carried out at a much more leisurely pace-keeping drainage facilities in order, and grading of the roads preceded by wetting of the dry surface.

There are various reasons why this finely timed cycle of earth road maintenance is difficult to achieve in an underdeveloped region like the Northeast. First of all, it requires that the maintenance department receive its operating expenses with punctuality during the pre- and post-rainy-season months, and during the rainy season itself—when there will be a concentrated spending of fuel, lubricating oils, and spare parts. If a few months delay in the receipt of such expenses make it impossible to buy fuel, lubricating oils and spare parts, then a whole year's maintenance can be lost. Delay in state and federal distribution of budgetary

resources, however, is quite common in developing countries. Moreover, the monthly tax collections of a predominantly agricultural region like the Northeast vary strongly with the agricultural cycle, and may be at a low precisely during the time when the needs for earth road maintenance are greatest. Since state governments are often pressed for funds during these months of low tax receipts, and since maintenance departments usually do not have strong bargaining power at moments of appropriations scarcity, maintenance bears more than its share of these momentary reductions in operating revenues. Such dips in state receipts add to the probability of uneven flows of operating funds to maintenance departments, and to the difficulty of assuring receipt of these funds during the months that are crucial for earth road maintenance.

The immediate availability of spare parts during the period of intensive equipment use is essential to the execution of earth road maintenance. Nevertheless, a guaranteed flow of budgetary resources is not the only determining factor. In an underdeveloped region in the process of building up a highway maintenance department, the inventory of the residency or central shop is often not adequate to cover all needs. This happens not only because of financial stringencies, but also because the relatively small size of such a state's equipment fleet, and the scarcity of capital, makes it quite costly to tie up capital in an adequate inventory of spare parts. This smallness of scale, as well as the thinness of the industrial market in an underdeveloped region, means that spare parts are not always readily available, even when finances are. All these factors contribute to the delays that occur in the acquisition of spare parts for down equipment—delays that can have a major deleterious effect on maintenance of earth roads, if they occur during the period of intensive road and equipment maintenance. (It takes Mesbla, the major Recife distributor of road equipment and parts, four to ten days to order a part not in stock from the Huber-Warco, Clark-Michigan or Caterpillar factories in São Paulo, even though ordering is done by telegram, and freight by air. Securing a part from abroad—as in the case of the International Harvester equipment, whose Brazilian representation is weak, often takes several weeks, if not months.)

There is one more difficulty imposed by the rainy-season cycle on a struggling highway maintenance department in a region with earth roads. The period of intensive equipment maintenance during the rainy season is an essential complement to the two periods of intensive earth road maintenance, which means that a considerable amount of equipment should be stationary at the residency and central repair shops during the rainy season. Road maintenance equipment at rest in the shop is much more prey to diversion by other sectors of the economy than when it is out on the road. A shopful of road equipment is a sitting duck for mayors, state deputies, public housing construction managers, and emergency relief officials. It is more politically difficult for a maintenance engineer, maintenance department director, or highway department director to refuse a mayor's request for use of equipment that is at work and out of sight. This vulnerability to diversion means that the equipment may not receive the proper care necessary for it to perform intensive maintenance after the rains; moreover, the equipment is sometimes returned only after considerable delay, and usually in bad condition. In sum, the intensive-equipment-maintenance phase of the earth-road maintenance cycle is subject to as many hazards as the intensive-road-maintenance phase of the cycle. (The diversion problem is discussed in a later section.)

The above description shows the difficulty of building up a highway maintenance capacity when the seasons and type of road dictate such rigid scheduling. When maintenance can be carried on in a more flexible way throughout the course of the year, the above-outlined problems are more easily overcome for they relate to the inability of the activity to tolerate delay, and to the impossibility of spreading the work load more evenly throughout the year. A more permissive, ongoing type of maintenance is characteristic of areas where rain is spread more evenly throughout the year; more important, it is also characteristic of <u>paved</u> roads. That is, the amount of maintenance required on paved roads before and after the rainy season does not at all approach the intensity of that required on earth roads. Although it is essential that drains be cleared and potholes and cracks be filled, this work does not require the mobilization of

equipment that earth road maintenance does, is not as costly, and parts of it can be done in a labor-intensive way. In short, paved road maintenance before the rainy season is not so dependent on the fueling, lubricating and immediate repair of equipment, as is the case for earth roads. Moreover, the maintenance of shoulders on paved roads, the cleaning of drains and repairing of holes and faults in the road are activities that can be carried out at an unhurried pace throughout the dry season; on earth roads, the drying of the surface precludes the possibility of doing certain kinds of work.

If a maintenance department's budget suffers a few lean months, or if equipment is down or diverted for several weeks, the result for paved roads will be the postponing for the same period of routine maintenance on these roads; on earth roads the delay can mean the loss of a year in time, and the serious deterioration of the road. For an underdeveloped region with a marked rainy and dry season, therefore, it may be easier for a maintenance organization to be built up around a system of paved roads, given the institutional setting in which that organization will have to exist. By the same token, it may be that only in the more developed countries will it be possible to encounter adequate maintenance programs on earth roads--because of the institutional ability to comply with the timing rigidities of the earth-road maintenance cycle. The underdeveloped country will find it less difficult to maintain the more sophisticated kind of road, and only in the developed country will the institutional atmosphere be more conducive to maintaining adequately the most primitive type of road. More specifically, one could say that a maintenance organization in Brazil has a higher chance of success if its roads contain a high enough proportion of paved roads to make its demands for operating expenses fairly even throughout the year--that is, if there are enough roads to allow for some evening out of the peaks and valleys of earth road maintenance expenditures. This may provide some explanation as to why Bahia and Pernambuco have the best maintenance organizations: they are the only two Northeast states with a significant percentage of paved roads (20%).

The foregoing discussion shows that a mechanized maintenance program for a system of predominantly earth roads may be highly costly because of the vulnerability of the fleet of equipment to the institutional atmosphere in which it must operate. This may explain to some extent the lack of interest in highway maintenance, and the often-expressed attitude that highway maintenance is a luxury that a developing country cannot afford. There are other factors that taken together reveal a certain logic to the lack of interest in maintenance in developing regions. An understanding of these factors can contribute toward the formulation of a judgment as to whether a maintenance program makes sense at a certain stage of development, and whether it has any chance of "taking."

I - 2. The Approach to the Earth Road

The lack of interest in maintenance becomes more understandable as one looks at techniques of an attitudes toward construction of paved roads. In a region where development is anticipated and believed to be the answer to a region's social and political ills, politicians promote themselves on the promise of bringing about large economic changes, and the atmosphere is pervaded with a sense of temporariness about things. In this context of ever-expected change, an earth road is looked upon as a temporary phenomenon, and is treated as a kind of "development laboratory," in which changes are registered and reacted to: if an earth road generates enough traffic, then it will be promoted to a paved road. The political pressures of the users, when the earth road becomes impassable, will be both the signal for promotion to a paved road and the source of political support for raising the revenues for paving. Earth roads, in short, are to some extent transitional phases in the evolution of paved roads.

The road system of an area in which there is still a lot of road-building to be done is consequently not looked upon or treated as a fixed patrimony. The question is, which earth roads are evolving and pointing to development potential—that is, becoming impassable and causing public outcries (the degree of deterioration of a road, and the period in which it occurs, is very much a function of traffic density). Because of this

evolutionary conception of earth roads, there is not much chance that their maintenance will be considered important. Of course, the majority of these earth roads may never need paving, nor will they ever get paved—and therefore, routine maintenance is fully justified and badly needed. Even the most ambitious of paving politicians does not look upon the whole earth road system as potentially paveable. What is important, however, is that there is no long-run certainty about which roads will prove paveable, and hence the earth road system as a whole is considered as being in a state of flux. When earth roads are looked upon in this way, as unfinished investments that await first the demonstration of potential, then the concept of maintenance is rather alien, based as it is on the idea of conserving a fixed investment, a completed project, a valuable patrimony.

From the point of view of building paved roads, this approach to earth roads can also represent a roughly economic way of undertaking a road construction project, by dividing up an investment which is "indivisible" into two divisible parts: the building of the road, and its future betterment and paving. The deteriorated dirt road and the complaints of users about its conditions are ways of getting at a kind of post hoc traffic count in conditions of extreme uncertainty. This two-stage process of building a paved road also means that considerable support can be garnered for the second stage, the paving of the road, from those users who have come to depend on the road and cannot tolerate its rundown condition. The lack of maintenance may thus be an inadvertent way (in some cases, of verifying the need for a paved road. Given the conditions of uncertainty surrounding many highway investments, the consequent fragility of traffic forecasts, and the high cost of indivisible capital investments, this method of roadbuilding without maintenance (including the loss of roads that are built, unmaintained and demonstrate themselves not important enough to get paved) may be less costly than the building of roads that are paved from the start.

Even roads that are planned to be paved from the start are frequently constructed in this two-stage manner in Brazil. There is often a considerable lapse of time between the opening and grading of a road, and the time when

it is paved—usually because of a shortfall on funds. During the interim period, traffic usually rides on the subgrade, before the drainage work has been done, and the road receives no or little maintenance. (Maintenance is better on the already paved stretches of the road.) This earth or gravel half-constructed road suffers considerable deterioration before paving, due to the lack of drainage and maintenance. In such cases, the neglected earth or gravel subgrade is not so much an example of deterioration to the local populace and state highway engineers, as it is a sign of development to come. This, in turn, reinforces the "temporary" image of earth roads.

The evolutionary view of earth roads is related to another common phenomenon in developing countries—the tendency to pave where traffic densities require it. Although the evolutionary view of earth roads makes some sense for the small percentage of roads which should or will get paved, the consequent neglect of maintenance on roads that will be forever earth contributes to the tendency in developing countries to pave where traffic densities don't require it. Since earth roads fall into such bad condition, they come to be considered as an inadequate type of road, even for the level of traffic that a well-maintained earth road could support. In such cases, the lack of maintenance, instead of teaching a lesson about the importance of maintenance, simply convinces people that earth roads are something to be gotten rid of as soon as possible and exchanged for more "serviceable" paved roads.

The evolutionary view of earth roads is only one of many factors which are responsible for the enthusiasm for paving rather than maintaining earth roads—namely, the pressures of road contractors, cement suppliers, potential users, and of politicians looking for public works projects. But leaving aside for the moment those pro-paving forces who are serving their own interests, the evolutionary view of earth roads helps to explain the lack of great concern for maintenance that is prevalent even among responsible highway department officials and maintenance engineers. (One maintenance resident engineer in Pernambuco told me that the greatest contribution of the AID maintenance loan was that it gave more financial

rope to the highway department for undertaking road construction that was urgently needed.)

I. 3. Road-building Techniques

It was pointed out in Section I.1. that a road maintenance organization might be less difficult to build up in a system with a significant percentage of paved roads, because of the more flexible schedule of maintenance on paved roads as opposed to earth roads. This does not mean that paved roads in developing countries will necessarily engender good maintenance organizations--to the contrary, the neglect of maintenance is very much related to the way paved roads are constructed in such countries. A common observation by foreign technicians is that paved roads in developing countries are not built to the standards that they are in the more developed countries; this was frequently remarked upon by technicians working in all parts of Brazil, as well as in the Northeast. The defects that result from this type of construction--potholes, faults, sagging, etc.--are quite costly to repair, in comparison to the costs of routine maintenance on well-constructed roads. Moreover, the necessity to reconstruct, recap, or redo the fills on poorly-constructed paved roads arises much sooner than it does on well-constructed paved roads, and therefore the frequency of such investments will be greater than in a country like the United States. Hence, given the investment and maintenance cost profile on a poorly-constructed paved road, routine maintenance is to a certain extent superfluous: the road will soon show its construction defects, these defects will appear regardless of the adequacy of routine maintenance, and the repair of such defects will often compete in costliness with a major reconstruction job. Competent state highway engineers are usually cognizant of the difference between defects that have to do with poor construction, and those that have to do with poor maintenance. When a resident engineer has a poorly constructed asphalt road under his responsibility, he finds that all his scarce resources and equipment are being poured in that road, and to no avail: hence he himself starts to pressure for re-paving, or partial reconstruction, in order to make his maintenance operations more efficient. In short, construction standards prevalent in a region like the Northeast make maintenance

on paved roads quite costly. More important, such standards lessen considerably the costs of neglecting maintenance—for the road will have to be resurfaced or reconstructed much sooner than would be the case if construction were according to U.S. standards. Once again, one sees a certain economic rationality in the neglect of maintenance.

I. 4. The Preference for Concrete

There is another aspect of road construction techniques and attitudes in the Northeast which bears directly on maintenance practices. One is impressed, when driving through a state like Pernambuco, with the existence of earth roads at one extreme, and concrete roads at the other—in combination with the relative lack of intermediate-type roads (gravel, surface treatment, or even asphalt). Given the fact that a concrete pavement can cost twice as much as an asphalt pavement, and that asphalt will cost considerably more than a surface treatment, it is surprising to see concrete and asphalt being laid on roads that have somewhat low traffic densities. Although this coincides with the common observation that developing countries have a tendency to overpave because of the political and economic pressures mentioned above, there is another explanation of this phenomenon, which is related to the type of construction techniques used.

There is a mythology about concrete roads that gives a key to the explanation. One often hears from Pernambuco state officials, entrepreneurs, and engineers that Pernambuco builds good roads that last a long time and don't need any attention, in contrast to the other Northeast states, and that's because Pernambuco builds concrete roads and doesn't waste time with asphalt. One has only to cross the border into Paraíba to the north or Alagôas to the south, it is said, to move from a fine concrete road to an asphalt surface full of holes and falling into pieces. What's the use of saving money by building asphalt instead of concrete, it is said, and then having the road fall apart after the first rainfall? Better to spend the money now, the mythology says, and not have to pay any attention to the road for several years, than to save now in order to have headaches in the near future. Moreover, concrete roads are the most economic solution, it is said, because they don't require any maintenance.

The partial truth that the concrete myth expresses is the following: the technology of concrete mixing and spreading is considerably simpler than that of asphalt. If one puts a little too much cement into the concrete mixer, then the result will be simply a road that is little more durable and expensive than planned; if there's too little cement, less durable than planned. Asphalt is a sophisticated technology, even though the results are considerably cheaper than concrete. A mistake in proportions or temperature in making asphalt can mean that the road will break up after a very short period of time, or after the first rainfall. Concrete is often a more widespread technology than asphalt in developing regions; in the Northeast, asphalt was completely unknown and untried some years ago, and the legendary miserable roads of Paraíba and Alagôas were the first asphalt experiments in the region. Concrete, in addition to its greater simplicity, has been known and used in the Northeast for years. (The influence of local cement manufacturers was also a factor in the preference for concrete roads.) Asphalt, though cheaper than concrete, requires the skilled handling of a complex technique and is not tolerant of variations in quality.

More important, asphalt is considerably more sensitive to the quality of the construction of the road base than is concrete; or, at the least, a poorly constructed base will have effects on an asphalt pavement sooner than it will on a concrete pavement. It is the construction techniques on road bases and sub-bases in developing countries that come under most criticism from developed country road technicians, for they are crucial in determining the life of the pavement. Adequate preparation of the base is essential for drainage, and for enabling the pavement to stand up under the weight of the traffic. All this involves the proper selection of the base material, the proper quantity of that material, and most important, the proper application of it. The most common characteristic of Northeast road construction techniques is the lack of sufficient compaction; the rollers go over the material to be compacted only a fraction of the number of times that they would on a U.S.-built road. The result is that the pavement soon breaks up, and gives way particularly on fills, which have to be redone or frequently repaired. Because a concrete pavement will take longer to reveal the defects of its base, it is naturally considered more desirable and economic than asphalt in a region with poor construction

techniques. If asphalt is constructed on a poor base, its economy over concrete (in a case where it is justified by predicted traffic and the availability of local materials) is to a certain extent a fiction.

One other factor explains the concrete preference: although the reinvestment in replacing the concrete road is much greater than that of replacing the asphalt pavement (which amounts to resurfacing), this reinvestment must occur with greater frequency on the asphalt as against the concrete road--even in the case where both are well-constructed (about 10 vs. 25 years). The concrete preference, in cases where asphalt would be justified, is obviously not based on an economizing of capital, but on a desire to economise on resource-mobilising activities (resources for maintenance and resurfacing of asphalt). Needless to say, the rationality of this approach serves to reinforce the poor-construction|poor-maintenance cycle. That is, the concrete preference is based to some extent on the knowledge that adequate maintenance will not be forthcoming. Here is another case where the proper lesson is not learned: when asphalt roads break up, planners blame it on the technology (asphalt) and not the construction standards, and they build concrete the next time around. (Another reflection of the neglect of the base problem is that the DNER, in its attempts to improve road construction methods, long concentrated attention on paving techniques, and only recently started to give equal attention to the base and sub-base--i.e., the compaction problem, among other things.)

The poor-construction|poor-maintenance cycle may not be as uneconomic as it seems. Proper compaction--the area where developing country standards seem to fall the furthest behind U.S. standards and have the most damaging effects--means that a roller may have to spend one day instead of one hour on a stretch of road, which increases considerably the cost of the project. This may explain why AID/BPR engineers considered the bids of Brazilian contractors for the AID-financed Northeast road construction projects considerably lower than was expected. The fact that AID persisted in imposing the construction standards specified in the bids on these contractors may explain why they later ran into financial difficulties, and

resorted to various devices to try to escape from their original budget estimates. (There is another explanation for these low bids: they were made in 1964 and 1965, a time of slack demand in the road construction industry, and of general stagnation in the economy. Consequently, there was severe competition for the AID-financed projects--not only because the contractors needed business, but because an AID-financed project was considered more secure as to the probability of payment than the state-financed projects. Hence contractors may have bid knowingly below their costs.)

Compaction is also quite costly in terms of time--a cost that is quite real in the atmosphere of economic development, where a project frequently gets finished only because of the pressures of the politician who is banking his career on it. If time is lost through proper compaction, then the roadbuilding project may extend beyond the politician's term of office, and may never get finished. Poor construction standards may thus represent a choice, not between poorly- or well-built roads, but between having or not having a road.

Poor-construction|poor-maintenance standards may be the "right" standards for a region in which the institutional demands made by more advanced standards are impossible to meet, and are in themselves attributes of development rather than preconditions of it. Moreover, in that the road requirements of a developing region will vary considerable with time and will be difficult to predict, it may not make that much economic sense to invest in "longlastingness"-- in contrast to smaller, more frequent investments in poor quality roads. Actually, the criticism by developed country technicians of Northeast and underdeveloped-country road construction techniques are in general reminiscant of 19th century English criticism of the "flimsy" techniques used by the Americans in railway and other transport construction. The English noted that the cost of American lines had been brought down by the necessity of making a little capital go a long way, and by the sacrifice of many of the elements of permanent endurance which were part of English railways. The English constructed

their railways "to last for ever," made their rails strong enough for any possible weight of engine, their drainage system capable of removing any conceivable flood, their bridges firm enough for many times the weight they would ever have to bear. The Americans, on the other hand, believed the English desire for permanence "a bar to future improvement," and planned for putting up with "what will do." The most important considerations in railway construction, the Americans said, were economy and speedy completion. "It is better to extend the system of railways as far as possible at once," said an American engineer, "and be satisfied in the first instance with that quality of construction which present circumstances admit of, rather than to postpone the execution of work so immediately beneficial to the country." 1/

These explanations have a familiar ring, for one hears them constantly from Brasilians as justifications for the way they construct and maintain roads. They show that "poor" Northeast road construction standards and their justification find an analogue in the history of American transport development. The economist who quotes these 19th century observers suggests that the difference between American and English railway construction methods has an explanation independent of the desire to economise on capital, and his explanation is also reminiscent of the arguments that have been made in this paper. The American railway was likely to be less intensively used than the English railway, he points out, and therefore did not need to be so well built. In America, moreover, a system big enough to carry the load expected when the new region was fully opened up would be much too big for traffic in the years immediately after building; whereas in England, it could be expected that the load would reach near its maximum soon after building, and therefore there was every reason to build a railroad to last "forever." American railway building, in sum, was based on characteristics of low initial traffic densities and unpredictable changes that are in some ways similar to the underdeveloped

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1/ H.J. Habakkuk, AMERICAN AND BRITISH TECHNOLOGY IN THE NINETEENTH CENTURY: THE SEARCH FOR LABOR-SAVING INVENTIONS (Cambridge University Press, 1967), pp 88-89.

country setting, and probably explain to a certain extent the type of construction and maintenance standards prevalent in such countries.

II

The previous discussion sheds some light on why maintenance is neglected in developing regions. It suggests that highway maintenance may not be of great priority at certain stages of a region's development, and that various institutional factors that are both cause and effect of this low priority will make the implantation of ongoing maintenance practices difficult. The following discussion sets forth some recommendations on the designing of any highway maintenance projects in which AID may be involved.

First, some comments of a general order. The maintenance projects in the Northeast became fully operational at the beginning of 1967, by which time almost all the equipment was delivered. Hence it is still too early to make a definite judgment on the success of the program—a judgment that can be made only when the BPR technicians leave in early 1969, and when equipment starts wearing out and needing replacement. Although some of the equipment with shorter life is starting to approach replacement time, there are as yet no plans on the part of the state highway departments or SUDENE for financing such replacement. This is not necessarily a cause for pronouncement of doom, for intensive equipment maintenance can stretch out the life of such equipment—as usually happens in developing countries—and because this type of financing could conceivably be arranged at the last minute.

Another factor making an evaluation difficult at this time is a change that occurred in the tax appropriations to state highway departments, along with a lag in the commencement of the new tax collections which were to compensate this reduction. The lag caused considerable decreases in predicted highway department revenues since mid-1967 to the present time. On March 15, 1967, the 40-60% allocation of the National Highway Fund (NHF) to the federal government (DNER) and the states, respectively, was switched to 30-40% (of the states' 40% share, eight percent goes to the municipalities). This reduction meant about a 30% reduction in anticipated DER revenues. In compensation, the states were authorized to

impose and collect for their DERs a special sales tax on all petroleum products, but the effective date of this tax was postponed to the beginning of 1968. Hence the DERs of all the Northeast states have been financially squeezed during the last year, and maintenance budgets and operations have suffered in varying degrees in all states. The accompanying tables of equipment utilization rates in the various states gives an idea of the relative success of the program.1/

The state DER's financial problems are apparent in all states. In Pernambuco, Mesbla refused two months ago to supply any more equipment or parts to the state highway department, because of a six-month backlog of unpaid accounts, amounting to NCr$34,000. (Mesbla is the major distributor of road equipment and parts in Pernambuco.) An accommodation was worked out between Mesbla and the DER in late August. In Ceará, the Highway Department Director recently ordered all maintenance residencies to reduce their operations to the basic minimum, because of the shortfall of projected revenues; the purchase of spare parts and materials was stopped several months ago, and the department is NCr$2 million in debt to its suppliers. Road contractors in both states are clamoring for payment, and the state banks are desperately trying to work out short-term solutions.

Hence despite the great difference in quality between the Pernambuco and Ceará DERs, there was no question that all maintenance programs were vulnerable to the changing of gears in the allotment of federal highway

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1/ It is difficult to get an idea of standards of performance from the SUDENE table because of the amount of equipment and the high variance in rates of utilization between the various types. The table does give an idea of the relative rates of utilization as between the nine states, which seem to divide into three categories: (1) the highest are Bahia, Sergipe and Pernambuco, (2) a middle group is formed by Ceará and Piauí, and (3) the lowest group is Paraíba, Rio Grande do Norte and Maranhão. July was the middle of the rainy season, which explains to some extent the generally low level of all the utilization rates.

The AID/DPR table provides a better general picture, the nine states falling more or less into two categories: (1) the higher states of Bahia, Sergipe, Pernambuco and Alagoas, and (2) the lower states of Maranhão, Ceara, Rio Grande do Norte, Paraíba and Piauí (in descending order).

taxes to the states. Because of this generalized cutoff of funds, it would have been quite difficult to make an independent judgment of the various state programs without the engineers' progress reports, which dated back to the beginning of the program. I have checked my current impressions against reports of the pre-1968 situation, so as not to be unduly impressed by problems that emerged solely as a result of the change in National Highway Fund allocations. Nevertheless, the durrent financial crisis should be looked upon as a test case for the new maintenance programs, because all government departments in developing regions can be expected to be subjected to unevenness and shortfalls in the flow of their revenues. Moreover, many Brazilian officials told me the highway budget problems were a result of ambitious construction programs as well as the tax law changes. They felt that the shortfalls, therefore, would have occurred at any rate.

One final factor has obscured somewhat the degree of success of the Northeast maintenance programs. There were almost insuperable bureaucratic problems, and consequent lengthy delays in equipment delivery, due to the presence of various administering agencies, each with its own set of administrative procedures and political objectives: AID, BPR, nine individual DERs, and SUDENE. Both AID/BPR and SUDENE were involved in the implementation of the loan, and inspection of the states' programs. This was a cumbersome arrangment, as everyone admits, and the AID-SUDENE relationship was never clearly defined.

It is assumed that in other cases, where a SUDENE would not be present, and where some experience has already been gained, that such delays could be diminished. The maintenance loans are to a considerable extent institutional loans, and thus are based on AID judgments of institutional capability, political will to carry through a given program, and interest on the part of a given group of engineers. In the Northeast case, four years lapsed between the drawing up of the program and the time at which the loan became operational (1963-1967). As could be expected, major political and personnel changes occurred during that period, and thus AID's original institutional judgments and contacts, as well as the Brazilian political commitment and the interest and involvement of a given set of Brazilian

Page 19, after 1st line:

A project such as highway maintenance is quite difficult to evaluate because of the lack of measurable standards of progress, and because of the far-flung nature of the physical results, in addition to the fact that an evaluator from outside cannot make his own visual before-and-after judgment. There was general agreement among BPR technicians that Pernambuco and Bahia were the best states, and that at the same time, they had had competent DERs and maintenance programs before the project. The problem states, it was agreed, had usually been Piauí, Ceará and Maranhão—in terms of budget shortfalls, equipment diversion, and will will about not being able to divert idle maintenance equipment to construction projects. BPR technicians felt considerable progress had been made in Sergipe and Alagôas. Paraíba and Rio Grande do Norte were not as problematical as the northern states, but hadn't shown the progress of Sergipe and Alagôas (Paraíba seemed to have more than its share of diversion problems).

Most of the Brazilian maintenance engineers, mechanics and DER officials with whom I talked were in favor of the program because "it gave us more equipment." The comments about technical assistance were equally divided so as to make it difficult to arrive at more than a neutral judgment. SUDENE and other officials not involved in the operating aspects of maintenance were very disturbed about its implementation problems—mainly, the problems of not being able to put idle equipment to other uses. They considered the project a headache, although they thought highway maintenance a good cause. Some said that there was no question but that the highway maintenance "mentality" was much further advanced than it was before the loan.

I often heard from the Brazilians that the BPR engineers were more appreciated than were the BPR mechanics. There were cases of behavior problems with some of the latter; moreover, there was some resentment by the Brazilian engineers, who considered a mechanic below them professionally and socially. I had the impression, however, that a good BPR mechanic was more able to get something done than a BPR engineer. A central shop full of unrepaired equipment was the mechanic's métier. It was a challenge

for him to see what he could do with it, and every piede of ingeniously salvaged equipment was a measurable sign of progress. The BPR engineers, on the other hand, had often worked previously in road construction. Like the Brazilians, they found maintenance somewhat tedious. The underdevelopment of the sector seemed to appall them more than challenge them.

Both mechanics and engineers seemed to have felt more successful about the states where they had gone in and created something from the start, in contrast to states with more developed institutions, where they had to work with the existing ways of doing things. The engineer assigned to Bahia was told by the DER when he arrived that they appreciated and needed the equipment very much, but that his presence would be considered that of a "watchdog." The engineer believed that Bahia had a well-developed maintenance organization that could run on its own; he was much more pleased with his work in Sergipe, where their experience with maintenance and equipment had been next to nothing. Likewise, the mechanic who worked in Pernambuco and Alagôas felt he had been much more effective in Alagôas because he had built up a central repair shop almost from nothing; although Pernambuco was also in need of improvement, it was already an ongoing institution when he had arrived, with its own ways of doing things. The problem quality of the Ceará, Piauí and Maranhão programs seems to have been reflected in the BPR technicians sent there. In many cases they were surprised and depressed by the physical discomforts of the region, and there was a high rate of turnover.

Many of the BPR technicians with experience in maintenance projects in other countries felt that the Northeast program was poorly conceived, to the extent that the loan did not provide local financing for the construction of repair shops and residencies, and that the period of technical assistance was too short: the BPR people are to be phased out by March 1969, two years after the arrival of most of the equipment. These BPR technicians cited examples of maintenance projects in Turkey, where they stayed eight years before they felt that the program could stand on its own feet. The general consensus, then seemed to be that

the BPR people had not been there long enough to be able to leave and let things run well by themselves.

BPR people also felt that their relations with the Brazilians were prejudiced by the fact that they were made to run constant interference for AID with SUDENE and the DERs on unpleasant and unreasonable administrative demands. They felt this prejudiced the possibility of their building up good working relationships with the Brazilians; needless to say, this problem made AID-BPR relationships difficult. Another point of disagreement with AID and BPR was the training courses in the U.S. BPR wanted the Brazilian engineers to spend a considerable amount of time at one or two maintenance departments; AID people, however, wanted to arrange visits to several states within the same period of time, and the AID approach prevailed. (An ex-director of the Pernambuco DER characterized the approach as "turismo todoviário," and contrasted it to a highly-praised program of French technical assistance in highway maintenance, which has been in existence since 1958. Every year one or two engineers from the Pernambuco DER go to France on this program, spend first a month in intensive language training, and then four or five months in the maintenance section of one state highway department.)

The problems of such a project are much more identifiable than the progress, and hence have probably received undue emphasis in this paper, in relation to the progress that has been achieved. In lieu of direct measures of progress, I think that indirect guides such as the major problems in spare parts and equipment maintenance give a good idea of whether the highways are being maintained—i.e., whether the equipment is running and whether the necessary revenues are being channelled into the highway maintenance sector. As an overall judgment, I would say that the project has probably left a positive balance that varies considerably between the states - but that the cost to Brazil and to AID was considerably greater than the benefit.

Page 41, after paragraph that continues from previous page:

There are other reasons that a mechanized maintenance program is vulnerable to equipment diversion in a developing region. In such an area, the political and economic elite is so small that the lines between a state governor, his highway department's maintenance equipment, on the one hand, and the mayors, fazendeiros, state deputies and other influential friends on the other hand, are so direct that the equipment is bound to become a vehicle of political favor-granting. To give the highway department a fleet of brand new and conspicuous equipment with a "no trespassing" sign is to put the state governor in the position of saying "no" to those to whom he owes political favors—saying "no," that is, if he complies with the loan agreement. The possession of a fleet of maintenance equipment, in short, gives the state governor a new instrument for granting favors—whether he wants it or not. If, for example, he refuses the request of an influential fazendeiro for equipment to work on his access road, then he may lose the allegiance of that fazendeiro. In short, if the state governor complies with the provision of the loan agreement, the equipment can become a political hazard to him. (The state governor, moreover, will not want to pass up the opportunity to use the equipment for his own political projects—build airstrips, grade land for a housing project in order to meet its inauguration date, etc.)

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Page 43, after paragraph that continues from last page:

One of the major Pernambuco residencies has two crawler tractors, one was not working because a bushing had worn out in the pump, there was a shortage of this part in the state, and the mechanics of the residency were trying to make the piece themselves. The residency's other crawler tractor had been borrowed by the main residency three weeks before "for an urgent service." As a result, five dump trucks in perfect condition were idle, awaiting the replacement of the part for the tractor.

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Page 48, after "the amount of equipment."

One of the most frequent comments I heard from Brazilian officials in and outside the highway departments, and by some BPR technicians, was that there was "just too much equipment," especially in the poorer states. This was to some extent a result of the atmosphere of pressure in which the loan was negotiated, where there was not sufficient time available to make detailed checks and re-checks of existing fleets and needs. In Maranhão, for example, the DER reported that it had 7,000 km of roads under its responsibility. An equipment list was designed to equipment/kilometer criteria, based on this figure. It turned out that only about 500 of the 7,000 kms of road were under the responsibility of the state; the rest were country roads and city streets. It was not surprising, then, that between August 1966 and March 1967, ninety percent of the project equipment was used on city streets and country roads.

Another frequent, and related comment was that the program had been too big to swallow institutionally and financially—in terms of the supervisory capabilities, mechanical skills, and construction of new facilities that was necessary to absorb the project equipment. The project equipment fleets, for example, represented a manyfold increase in the existing fleets of most states.

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technicians, did not necessarily have any validity or strength.

II.1. Spare Parts

One of the major problems of these programs was the difficulty of obtaining spare parts. I suggest, based on the justification outlined below, that a considerable part of any maintenance loan be set aside for the phased acquisition and replacement of spare parts—throughout a three- or four-year disbursement period after the equipment has arrived. The spare part allowance should be in the form of an account, rather than the parts themselves, against which the maintenance department can draw to buy the parts it needs. A ready supply of spare parts for several years is one of the crucial aspects of a maintenance program, for the following reasons.

It is generally recognized that politicians and policy-makers do not consider road maintenance of very much importance; those highway department officials and engineers who do attribute importance to maintenance usually do not have the political strength to assure a flow of revenues to the maintenance sector. Unless a maintenance loan somehow succeeds in elevating the public sector's evaluation of maintenance, then highway maintenance will not continue after the equipment wears out and the AID technicians leave, if it lasts even that long.

One way to bring about such a change is to turn maintenance departments into a "pressure group" within the state government, with a fixed patrimony of working equipment to defend, and with a network of well-maintained roads to be able to point to as being in jeopardy if operational revenues fall off. The maintenance loan should be designed to make this pressure group strong enough so that it becomes politically uncomfortable for the highway department director, or the governor, to deprive that sector of its share of the transport budget. The loan should amount to a kind of "subversion from within:" to be successful, the maintenance department will have to put pressure on the state governor and highway department director in order to defend its activities, and it will have to have the economic and political strength to win. A maintenance loan, in short, should create a source of budgetary discomfort under the state government's wing, a "lobby" which will be able to extract money

from the state budget, just as road contractors are able to mobilize public resources for road construction. Of course the maintenance engineers will never approach the revenue-mobilizing strength of the road contractors; in compensation, the stakes for which the former will be fighting are considerably lower.

Although this approach may seem to represent the implicit philosophy behind the present AID maintenance projects, it nevertheless implies a strategy somewhat different than that being followed under these projects. The current maintenance programs have relied on promises of financial backing from the state governments several years into the future, and concomitant affirmations from the state governors and highway department directors of the economic importance of highway maintenance. If state governments failed to come through with the necessary resources some time after the program had begun, AID policy was to tend to demand new financial commitments from these governments, and to punish their non-compliance by threatening withdrawal of funds from financing in other areas.

Although such demands are necessary on AID's part from a purely creditor point of view, the major burden of the program's institutional success should not rest on these high-level political commitments. For according to the institutional characterization of the maintenance problem outlined above, the Agency should not expect to work with the governor, but rather that he will not come up with the resources promised. The whole diagnosis of the maintenance "disease" is based on the lack of esteem in which maintenance is held by policy-makers and politicians, and the existence of strong political and economic interests (contractors and politicians) which succeed in directing highway department revenues into construction channels. It cannot be expected that a lump-sum financing dangled before the eyes of the state governor will change this set of attitudes about highway maintenance, or the powerful constellation of interest groups that reinforce the attitude, or that it will guarantee a flow of operating revenues for several years into the future for this sector.

The state government, in other words, should not be looked upon as a protector of the incipient maintenance program, but as its potential destroyer. For this reason, the program should be given some kind of insulation against its government during several years, instead of being made dependent on it. The ultimate goal of the program is not that the state government will appreciate the value of maintenance and direct an ongoing flow of resources toward the sector, but that the maintenance sector will emerge strong and independent enough from its period of AID tutelage to defend itself against the inevitable incursions of opposing interests. It is for this reason that AID demands on, or measures taken against, the state governors are not likely to guarantee the ongoing success of the maintenance projects.

What precisely does it mean that the maintenance department becomes a "pressure group." It is very interesting to watch the defensive vigor and political strength that a maintenance department gains by its acquisition of a fleet of equipment. The organization of road maintenance operations contributes considerably to this: the equipment is distributed among various maintenance residencies throughout the state, and each engineer then possesses a small fleet of equipment that he comes to look after and defend as if it were his own. He worries if one of his few tractors breaks down, thus immobilizing several other pieces of complementary equipment; if he

can't get a spare part, he sends urgent messages to the highway director, and in the meantime may have his mechanics drop everything and work desperately on improvising the needed spare part; he argues with the maintenance director that it is an outrage to have his equipment not working, or he may personally go to the spare parts distributor and plead on the basis of their personal friendship to supply the part on credit.

The AID maintenance projects, in short, give a sense of personal possession to the resident engineers, and to the chief of the highway maintenance department--as well as a concomitant strong sense of violation of personal property if that equipment is not properly serviced or used. For example, one of the state deputies of Pernambuco once asked a resident engineer to borrow an AID-SUDENE motorgrader and its operator, to work on the access road of the fazenda of a personal friend. The resident engineer refused, saying that the equipment could only be used for maintenance of state roads, and an exception could be made only with the written authorization of the highway department director. The deputy said he had the personal verbal authorization of the governor, left, and returned a few hours later with the local sheriff, who arrested the grader operator and ordered him at gunpoint to drive the grader to the fazenda. When the highway department director heard of the incident, he went enraged to the governor's office, asked if it were true that he had given verbal authorization, and upon the governor's nod of the head, he resigned--and is now director of the maintenance department.

It is not simply the possession of equipment that gives the maintenance engineers some institutional leverage, but it is also the fact that they are engineers, among the most respected of professions in developing countries. They are not only "owners" of equipment, when it comes to their defense of their interests within the state government, but they are a recognized technical and social elite and therefore already have access in government circles. Moreover, in some of the less developed or more agricultural states, the state highway department is the major employer of engineering talent in the region, and often builds up a fine professional reputation--as in the case of Pernambuco. This also contributes to the fact that even the group defending the maintenance equipment cannot be summarily brushed aside.

This new mechanism of defending maintenance has nothing to do with defending highway maintenance, but rather is a group's defense of its equipment. The engineer's patrimony is not his highways, but rather, his equipment. This may be one of the benefits of a mechanized, as opposed to a labor-intensive highway maintenance program. In the latter case, the deterioration of highways is not nearly as specific, graphic and personalized as the stilling of a huge expensive piece of road equipment. Moreover, if there are social welfare pressures favoring the employment of manual labor for highway maintenance, these pressures do not necessarily fortify the highway maintenance department, because they are imposed from without, according to timing that is related to

the unemployment cycle, rather than the highway maintenance cycle. To the extent that the unemployment pressures to hire maintenance labor impose strict non-engineering constraints on the way the maintenance engineer does his work, they make highway maintenance uninteresting to the engineer. Conscientious highway department managers, for example, are often against hand-construction in roadbuilding not necessarily because they think it inefficient, but because of the possible debilitating effects it will have on their administration. In a region afflicted with chronic unemployment, state deputies will often pass laws requiring that all currently contracted temporary laborers must be taken on as permanent employees of the public organ that is contracting them. Hence highway department administrators sometimes have reason to consider labor-intensive techniques an undermining of their administrative control, and a source of vulnerability in their striving to build a competent, independent state institution. (Actually, this labor-intensive/capital-intensive distinction is made here for illustrative purposes; the distinction is somewhat artificial in this case, for a labor-intensive maintenance program can still require a large fleet of complementary equipment--as is discussed in the next section.

The forming of a maintenance pressure group through the acquisition of equipment is analagous to the road contractors as a pressure group in their promotion and defense of highway construction. One often hears it said in the Northeast today that the one thing there isn't a shortage of is highway construction equipment. The last few years have seen a spate of

road-promoting Northeast governors, who started ambitious road-building programs and soon ran into financial difficulties because of, among other things, the reduction in the states' share of the National Highway Fund, and expected outside international financing that did not materialize. Meanwhile, many road contractors had built up their equipment fleets in anticipation of the announced road-building programs, or had already won contracts and were mobilized for the job. The clamor of the contractors--not only to receive their payments, but to prevent the slowing down of the proposed construction programs--was apparent throughout the region. Special emergency financial arrangements were sought by the state governors with the state banks to meet short-range payments problems, and more longeterm financing for proposed road projects was desperately sought from private foreign banks. (A short-term arrangement with BANDEPE, the state bank of Pernambuco, took care of NCr$6 million of a NCr$13 million state debt to the contractors. To continue the road construction program, the state bank was seeking a US$10 million loan from a private foreign bank.)

The justification of the Northeast states' intensified search for road construction financing focussed more on the possibility of idle capacity in the private sector, than it did on the argument that it was important for the roads to be built. The effective political pressure, in short, was the specter of the road contractors' idle equipment, rather than that of unbuilt roads. Analagous pressures can be generated by a mechanized maintenance program--a group defending its idle equipment is a

more effective force in the cause of highway maintenance than is the threat of unmaintained roads.

The clamor of the road contractors is more crucial at the moment when budgeted programs face revenue shortfalls, than in the planning and budgeting for construction. The pressures of the maintenance equipment "owners" are also quite crucial for that sector, for it is more in the shortfall than in the budgeting that maintenance gets the axe. It is not the budgetary commitment to maintenance that guarantees the carrying on of that activity (indeed, the budget requests of district offices of the DNER for extra maintenance allocations are believed to be made often as a means to secure additional funds for new construction.) What is important is the ability of the maintenance sector to defend itself when the almost inevitable budgetary squeeze starts to occur. And it is during this post-budget phase that the "owners" of idle maintenance equipment can be most effective.

For this reason, the commitment of a highway department director or state governor to dedicate a certain amount of future receipts to highway maintenance is not as relevant for the growth of a successful maintenance institution as is the strengthening of that institution to the point that it can defend itself from inevitable attempted cuts. This strategy is the logical outcome of the observation that highway maintenance doesn't have behind it any of the powerful pressure groups that highway construction does. By creating a strong group of equipment owners within the highway department, a

highway maintenance project can simulate to a certain extent one of the major elements of success of the highway construction sector.

Based on this institutional strategy of the maintenance problem, it becomes clear that a one-shot dose of equipment, spare parts and technical assistance does not provide a long enough strengthening period for even the most promising of maintenance departments--and relies too heavily on the commitments of those who are uncommitted to maintenance, the present and future state governors. Hence my suggestion that there should be staggered doses of spare parts replacement allowances, to be drawn upon in Year 2, 3, 4 and perhaps 5 of the execution of the program. This allowance, of course, still leaves the maintenance department dependent on the state government for expenditures for personnel and fuel. Of the three categories--spare parts, personnel and fuel--personnel is the least likely, or the last, to be cut (although the situation was so bad in Piauí and Maranhão in early 1968 that the DERs were two months behind in meeting their payrolls). Fuel purchases are more likely to be cut than personnel, as occurred in Piauí in early 1967; but state highway departments can often resort to buying directly from PETROBRÁS if they are in a pinch. This has been done in Ceará, where the shortfall in revenues had a considerable effect on the maintenance department. Maintenance residencies had been buying fuel from private distributors in the interior, but because payments to the distributors were so delayed, they began to refuse to supply further orders from the residencies. The highway department then stepped in and

centralized the purchase of fuel, buying directly from PETROBRÁS, which, as a kindred government-owned institution, could be convinced into accepting delayed payment. The deparment distributed the fuel itself to the interior residencies in its own tank trucks.

Spare parts is the item most vulnerable to revenue shortages, and at the same time is the only one of these three items which undergoes considerable cost increases as a result of delays in payments. Spare parts distributors, although not selling on credit to the state highway departments, must nevertheless build the cost of credit into their prices, if they are accustomed to receiving payment with several weeks delay. Moreover, when major distributors refuse to supply more parts because of unpaid accounts (as in the case of Mesbla with Pernambuco), the highway department is likely to seek out the parts at smaller, or unauthorized dealers, who often buy their stock at retail prices from São Paulo distributors, and who at any rate charge considerably higher prices. The necessity of maintenance departments to cope with spare parts financial problems, in addition to those of personnel and fuel, is particularly burdensome and injurious during the early years of the program.

Another reason for insuring a flow of spare parts to a maintenance fleet is to prevent maintenance departments from destroying their own capital in order to create a supply of spare parts - that is, to avoid the probability of equipment cannibalization, a phenomenon that sometimes occurred in the Northeast programs during periods when the state did not provide funds to purchase parts or to maintain an adequate inventory. In Maranhão, for example, a project dump truck was delivered with a windshield that had been broken during transport. Before very long, the truck was missing its battery radiator, generator, horn and shock absorbers. The truck, needles to say, was never used. These striking cases of de-capitalization are not necessarily irrational, given the impossibility of obtaining spare parts and the powerlessness of the maintenance engineer over the state's budget. The destroyed new truck was traded for several pieces of older equipment, restored to running condition with the cannibalized parts. It should be noted that the absence of funds for personnel or fuel cannot lead to the same destructive effect on the maintenance department's fixed capital. Hence the even greater importance of insuring a maintenance program against a shortage of funds for spare parts.

The Northeast maintenance projects included a 15 % allowance for spare parts, which were delivered at the same time as the equipment. This percentage takes care of roughly a year's need for spare parts.

If three or four more years of spare parts allowance were to increase considerably the size of the financing, I would strongly recommend the reduction of the equipment program by a corresponding amount, in order to facilitate including the parts allowance. My impression is that one dose of spare parts is not nearly enough to build the requisite strength into the maintenance organization, or to accustom the maintenance engineers to having a permanent fleet or operating equipment, or to accustom the politicans and road-users to seeing that fleet of equipment in continous operation. The clamor over a lack of resources for spare parts will be much greater and more effective after four years without such problems, than it will be after the first round of spare parts is exhausted.

One more suggestion about the spare parts; after a first limited dose of spare parts that comes along with the equipment, the parts should be provided in the form of an allowance, rather than the parts themselves. The allowance should be divided into annual portions, which will be made available only at the beginning of the fiscal or calendar year. First, the maintenance engineers are the most knowledgable about what parts in their particular region wear out rapidly, what parts can be easily found in the region in comparison to those that can be purchased only with considerable delay, what parts are more easily repairable by the maintenance department mechanics, which equipment is most crucial to their maintenance operations and therefore should have a more secure parts backing, etc. Several complaints were made by the Pernambuco

and Ceará maintenance people about the "mix" of parts that were received - some small, inexpensive parts that wear out rapidly were not received in sufficient quantity, some that require infrequent replacement were received in greater quantity, and some large, very expensive parts that require infrequent replacement were also received, which represented an excessive immobilization of capital for a small maintenance organization. The problem cited above are likely to arise with the best-planned inventory of spare parts. It is important, therefore, that those most familiar with the rate at which parts are used up and the ability to replace them rapidly, are the ones who are choosing the parts.

Another reason for supplying parts funds, rather than the parts themselves, is to give the maintenance engineers a sense of rationing a limited amount of resources for spare parts. Notwithstanding the general difficulties of obtaining spare parts, there is a tendency for maintenance mechanics in the project states to throw away broken-down but repairable equipment pieces, when there is a seemingly endless stock of new parts on hand. This lavishness with parts is also a result of the lack of sufficient mechanical skills for recognizing the repairability of a part and knowing how to do it. If the maintenance engineers are supplied with a limited fund for the acquisition of parts, then each parts purchase reduces the total amount of resources available for all

parts during one year - in contrast to receiving the parts themselves, where the using up of a part diminishes only the stock of that particular type of part. The need to ration a total fund might help to curb somewhat the tendency to be lavish with parts.

It might be argued that the spare parts allowance is too extravagant a concession - although it need not be if, as I am suggesting, the original equipment list be reduced in compensation. But it should be remembered that, in the case of the Northeast projects, significant contributions were required from the state highway departments for the construction of new residencies and repair shops. Many of the BPR and Brazilian technicians felt that this was an inordinate strain on the budgets of the state highway departments. The proposed spare parts allowance, therefore, does not mean a complete lifting of the burden offthe state highway departments - and it comes at a time when the initial commitment to and enthusiasm for the project may have worn off considerably. (BPR experience with successful maintenance assistance programs in other countries had been that counterpart funds had been used to finance these necessary structures, as well as allowances having been provided for future spare parts needs.)

One last point about spare parts. In any developing country, there is a considerable amount of pilferage of warehoused inventory, especially in poorer regions where public employees receive very low wages. When one sector of the economy is equipped with shiny new equipment and parts, there is no question that a given proportion

of these parts will be drained off by employees, particularly the less specific parts, like tires. In the central maintenance shop of a Northeast state, for example, the BPR mechanic inaugurated a system of keeping track of the tire number of maintenance vehicles. He soon found that this did not work, since tire pilferers would run the vehicle against the side of a curb and thereby rub off the number. The BPR mechanic therefore devised a branding iron with the highway department's initials, and proceeded to have every official tire branded. The AID maintenance projects should concentrate considerable assistance on this problem at the beginning of project implementation, if not, the AID-financed supply of spare parts will simply feed other sectors of the economy.

2. Excess labor

One of the assumption of the Northeast maintenance loans was a reduction of the excess labor burden on the maintenance departments' payrolls. Such a reduction would not only diminish their operating costs, but also would be the necessary concomitant of a project whose aim was to mechanize the production technique. The projections of highway department expenditures on which the Northeast projects were justified assumed the reduction of this excess labor force - or, at least, its stabilization. These intentions were not realized (as also happened in the south-central states maintenance projects), and the continuing burden of these expenses was one of the contributing factors to the current shortfall of projected revenues and operating problems of the Northeast projects.

State highway departments are traditionally the employers of last resort in an excess-labor economy - just as in the United States the road sector was the focus of much employment-creating effort during the depression. This makeshift alleviation of a region's employment problems represents the implicit, or even inadvertent, "employment policy" of the state and federal governments. To that extent, the state highway department is not very much in control of its own destinies as far as the employment question is concerned. Even though it may wish to reduce its manual labor force, attempts to do so will be met with resistance. Hence the failure of highway departments to carry out their commitments to AID about excess labor was not really a matter of bad faith, but rather a lack of realism.

It is no accident that the burden of employment-creation has fallen to such an extent on highway departments, for construction and maintenance do absorb large absolute amounts of unskilled labor, and, in contrast to most technologies, they allow a wide range of possible combinations of labor and capital. Hence the large labor force of maintenance departments represents not only social welfare considerations, but, given a certain combination of factors, has the possibility of being productive. This excess labor can be looked upon not as an unproductive factor with which efficient maintenance can never be performed - but rather, as a factor that is unproductive, because of the lack of an essential complementary factor of production, capital (i.e. equipment).

Viewing equipment as labor's complement rather than substitute means that an equipment-purchasing program for highway maintenance should be designed to put as much of that excess labor to work as possible. (Here is an area where the Brazilian engineers can make an important contribution, based on their experience with equipment shortage and excess labor, and of how to bring the two together.) Such an approach makes sense in that, as our experience has shown, the highway department will not be able to shed its excess labor, nor is this a desirable policy for AID to promote - given the existence of labor - employing maintenance techniques. More important, an equipment program whose primary aim is to make that labor productive will bestow more control over the administration of maintenance to the department itself, in contrast to the present situation where the employment of an unproductive factor is imposed from without.

A maintenance project designed according to the above considerations will provide a fleet of equipment that will be large in relation to the existing stock, and small in relation to the labor with which it will work. This will help build the strong equipment-possessing group of engineers discussed in the previous sector and at the same time add another source of pressure in favor of the course of highway maintenance - the continued absorption of otherwise unemployed labor (or a least, will relieve the maintenance program of the political stigma of being employment-reducing). The strength of political pressures in favor of labor-employing highway maintenance is illustrated by the case of state deputies cited in the last

section, who often get laws passed making highway departments change the status of all their contracted labor from temporary to permanent during periods of unemployment.

Note that I am making the labor-intensive argument on productivity and not social welfare grounds. That is, maintenance departments have excess labor and highways don't get maintained because, among other things, one of the crucial factors of production, fixed capital, is missing. I do not claim that all the excess labor of maintenance departments will be able to be absorbed by an effective maintenance program. I propose, rather, that Brazilian economic and institutional circumstances will be able to accomodate only a maintenance program whose primary criterion of equipment selection is to bring together new equipment with the previously idle factor, labor.

This labor-using approach is not as impossible or unproductive as has been sometimes claimed. For example, when it became clear to AID quite recently that the revenue shortfalls and the CACEX importation problems of the southern states maintenance loan limited considerably the amount of equipment that we could finance, it was also recognized that the personnel-reducing assumptions of the loan were not realistic, corresponding adjustments were then made by our engineers in the design of the program, in order to incorporate some labor-intensive techniques. I suggest that we can obtain a more productive result by using such an approach from the start.

3. Equipment maintenance.

I suggest that the major emphasis of highway maintenance projects be shifted from highway to equipment maintenance. BPR technicians gave first priority to equipment maintenance in the Northeast projects in early 1966, and began to treat equipment utilization as a secondary goal. In many cases, equipment maintenance in the project states was minimal, often because the DERs didn't have sufficient funds to improve their maintenance shop facilities.

The implantation of a highway maintenance program assumes the coexistence or creation of several other important factors - the most important of which is equipment maintenance. One of the BPR mechanics spent most of his time at the central shop teaching the shop mechanics to repair parts that they would normally throw away - parts that, in the United States, would be repaired mechanically or replaced because it was relatively cheaper than repair. This mechanic pointed out the beaten-up cab of a tractor, which would have cost several thousand dollars to replace; the DER maintenance engineers had given it up for scrap, but the mechanic insisted that it be repaired in the shop. He believed that it was imperative that intensive equipment maintenance techniques be learned, given the fact that spare parts cost two or three times in the local Brazilian market what they would cost in the United States, and given the fact that the shop was filled with unoccupied labor.

One is impressed, in walking around a Brazilian highway maintenance shop, with the amount of unrepaired idle equipment along with untutuored idle Labor. What is required in this situation is not more equipment, but a bringing together of the idle labor and unrepaired equipment, through the provision of mechanical skills. (The same BPR mechanic spent the first several months of his assignment repairing and clearing the central shop of major pieces of down equipment, owned by the DER before the AID loan.)

There is no doubt that the major struggle of maintenance engineers is not to keep the highways maintained, but to keep their equipment in running condition - for highway maintenance cannot exist without equipment maintenance. A reliable equipment maintenance organization is an essential ingredient in the strengthening of the maintenance engineers, because it increases their ability to "make do" on their own when funds for spare parts run short. Moreover, in an underdeveloped region without an adequate supply of parts suppliers and without adequate service by equipment manufacturers, a considerable burden of the service normally supplied by the manufacturer must be supplied by the maintenance shop itself. For example, all eighty of the Clark-Michigan front-end loaders arrived with a steel plate that was defective because of poor casting, and which broke sooner or later. The maintenance shops found it less troublesome to re-cast the part in their own foundry, a service that normally would have been furnished free of charge by the manufacturer.

4. Equipment diversion.

Running through much of the above argument is an emphasis on the necessity of keeping the equipment running, and the difficulties that must be overcome to do so. My emphasis on this factor is not so much based on the cost of idle equipment, but refers to the precious ground that is lost when equipment lies idle in the building of a strong maintenance organization. One of the costs of idle equipment is its diversion to other uses. The diversion problem was significant enough in the Northeast program to merit some attention here.

According to the loan agreement, use of the project equipment was prohibited for any activity other than state highway maintenance. The equipment technically belongs to SUDENE and not AID or the DERs; according to the loan agreement, SUDENE had the right to withdraw from a state any equipment that was diverted. Because the diversion problem proved to be considerable, and because there were some truly emergency cases justifying diversion, a later implementation letter (no. 12 of September 1966) required that any such diversion be requested of SUDENE in advance, and would be granted in agreement with AID. Diversion in general is very difficult to prevent by legal, inspection, or punitive measures.

In an underdeveloped region, where state-owned equipment fleets are scarce, the enriching of one sector with equipment in comparison to the rest is bound to result in the draining off of some of that equipment by other sectors. In Pernambuco and Ceará, the Army, which

has the right to commandeer public equipment, took several dump trucks for some weeks, in order to carry out anti-guerrilha maneuvers. In Ceará, the SUDENE-AID equipment was used to grade land for building an earth satellite station. In Paraíba, AID allowed the equipment to be used to reconstruct a washed-out airstrip and it was then used to build an adjacent parking lot. In Fortaleza, the equipment was diverted for construction of city streets. In Teresina, the project equipment was used to level an area for a housing project. I saw some SUDENE-AID pickup trucks at a road-construction site.

Equipment diversion is almost a foregone conclusion in regions like the Northeast, subject to repeated natural catastrophes of flood and/or drought, and chronic crises of unemployment. For a year or so in Ceará, the dump and pickup trucks were in constant use for emergency relief because of the drought, then because of the subsequent floods, and then because of the drought again. In Paraíba, when the new equipment was arriving in 1966, most of it was sent to an area of intense unemployment to be used for employment-creating municipal road-building projects. Even in a richer state like Pernambuco, with a stronger maintenance department, thirty newly arrived Chevrolet trucks were commandeered by the state government for emergency flood relief. In general, a considerable portion of the maintenance equipment was diverted to unemployment relief in mid-1966, by the order of SUDENE and the state government. In sum, the maintenance fleets helped the Northeast governors relieve the crises that afflicted their states - crises whose catastrophic proportions were in themselves a function of the underdevelopment of the region. This kind of equipment diversion

was bound to occur, and is impossible to forbid. To the extent that an equipment fleet will naturally be drawn into such service in an equipment-scarce crisis-ridden region, it may be fruitless to think of mechanized maintenance, because of the "divertibility" of the factor of production used.

Although an undue amount of time and haggling has been spent by AID and SUDENE over individual cases of diversion, and though these cases have created political antipathies against AID on the part of SUDENE and the states, it seems that the no-diversion provision in the loan agreement is a help to the maintenance engineers. It is a crutch for them to lean on when they are approached by local politicians for the use of their equipment. One of the DER directors said he wished that AID hadn't authorized the use of the equipment for a road betterment project, because this had given rise to several requests from other mayors who also hoped to qualify for the same kind of exception.

One of the advantages of the otherwise cumbersome arrangement in which SUDENE owns the maintenance equipment and "lends" it to the DERs is that when maintenance engineers are approached by mayors and other pretenders to the equipment, the engineers defend themselves by saying that the equipment doesn't belong to them, that it belongs to somebody else (SUDENE), and that they will have to get permission from the owner.[1/] This in itself may represent too much bother to the

1/ In reality, the equipment belongs to the DERs, although SUDENE has the right to take it away or transfer it to other states. SUDENE, however, considers such action politically impossible.

requester, and the word that gets around that SUDENE-AID equipment is a nuisance to get one's hands on. The SUDENE-is-the-owner excuse is apparently effective enough so that one state's highway department traded equipment among its residencies so that the residency that was most victim to pressures for diversion had only SUDENE-AID equipment in its fleet, and no equipment owned by the DER. Most of the DER equipment got shifted to the residencies faraway in the sertão, where pressures for diversion were not as great.

It would be desirable if an executable threat could be worked into the loan agreement concerning diversion - as a way of protecting the maintenance departments. One maintenance engineer in Ceará said he wished that AID or SUDENE would comply with the threat of removing the equipment, so as to make equipment diverters in his state more timorous. But this would probably be much more time-consuming and politically abrasive than would be worth the effort; and, at any rate, most of the unjustified diversion probably goes on undetected. Finally, taking back the maintenance equipment would be counterproductive to the extent that it would punish the maintenance department, as well as the diverter.

The only significant protection against equipment diversion is a strong maintenance department, which has the ability to resist such incursions. It is for this reason that it is crucial for a maintenance residency to not have its equipment lying idle for an unduly long period of time. Of course, down equipment isn't that easily diverted; but to the extent that such equipment works jointly with other types of equipment, these other perfectly functioning pieces of machinery

may have time on their hands because of the lack of their complement. This is a more likely occurrence that one would think, because of the small size of the fleet of each residency.

Another common occurrence with idle, down equipment is that a requester of the equipment, such as a neighboring mayor who wants to repair some city streets, will offer to supply the missing spare part immediately. Although this may be a practical way of getting spare parts to the equipment during periods of financial stringency, the maintenance engineer usually finds that the mayor now thinks he owns the piece of equipment, because of his investment in it, does not give it back, or feels he has a permanent claim to borrow it. Even down equipment, in sum, is not protected from diversion.

There is one more way of building some protection against diversion into the maintenance program. First of all, the amount of equipment that is non-specific to maintenance and has many general uses - such as jeeps, "rurals", and pickup trucks - should be kept down to a bare minimum. (The Northeast projects included in total 5 jeeps, 14 "rurals", and 72 pickup trucks.) Second, betterment equipment is more vulnerable to diversion than purely maintenance equipment - more specifically, the 235-hp crawler tractors (HD21). The 115-hp (TD-15) and the 65-hp (D-4) crawler tractors are less vulnerable than the heavier 235-hp equipment, which can be used in construction, as well as betterment. The 115-hp (TD-15) tractor is on the edge between maintenance and betterment, and the 65-hp (D-4) is strictly for maintenance. Of course, the case for reducing

considerably the amount of betterment equipment cannot be made solely on the basis of protection against diversion. There are, however, other more important considerations that may make it wise to reduce or eliminate completely this type of equipment.

5. Betterment.

One of the recurring problems of the Northeast programs was the neglect of routine maintenance in favor of betterment work. The two most developed Northeast states with the best DERs, Pernambuco and Bahia, let out their betterment work, instead of doing it themselves. (In the United States, highway departments generally contract out their betterment projects.) Pernambuco, in fact, did not want the 235-hp crawler tractor that is dimensioned for construction, preferring the smaller 160-hp equipment. One of the suggestions made by the Pernambuco maintenance director about the equipment mix was that while 11 160-hp tractors were acquired, there was still a complementary need for the smaller 65-hp tractors, which are strictly for maintenance. This director also said that the Pernambuco DER preferred to contract out betterment because it was a "headache" - it ment more funcionários públicos and a larger equipment fleet. Hence one of the most developed states in the Northeast, with a DER long known for its competence, had equipment less powerful, by its own preference, than that of some of the poorer states. (Sergipe had 2 HD21, 235-hp crawler tractors, Alagôas 10, Rio Grande do Norte 2, Ceará 2, Piauí 5, and Bahia 13.)

The justification given by BPR technicians and non-state DER officials for the performance of betterment work by the states ("force account") instead of by private contractors is that (1) there is a lot of betterment work to be done, and much of it occurs in bits and pieces, not conducive to the letting out of contracts, and (2) the states are too poor to contract out their betterment. When given the choice, the poorer states in the Northeast wanted the betterment equipment. In 1963, when BPR technicians discussed an 80-km construction project (MA-15) with the state of Maranhão, they gave the state the option of receiving financing for the contracting out of this betterment project (1-A type loan), or financing for equipment purchase by the state to carry out the betterment project itself (2-A type loan). The state opted for the force account, so that after the project was completed, they would have the equipment on hand for any other project they might want to undertake.

I recommend that betterment equipment not be included, or be reduced considerably, in AID maintenance loans. It is clear from the Northeast experience that if a state highway department in a developing region is at all equipped to do betterment work, routine maintenance is likely to fall by the wayside. The primary aim of the AID loans, however, is to build a maintenance organization that will institutionalize the habit of routine highway maintenance. If the responsibility for betterment within the state highway department threatens the evolution of routine maintenance, then it should not be added to the maintenance department's responsibilities. Moreover, generally accepted practice is to contract out betterments and repairs of a major or emergency nature, as well as re-sealing, surfacing

and aggregate production. If AID believes that betterment work in a certain area merits financing then we should finance the contracting out of these projects, instead of the acquisition of a fleet of betterment equipment.

Betterment is somewhat analagous to construction, in terms of its difference from maintenance. Betterment and construction usually involve a series of discretely defined projects, in comparison to the ongoing quality of maintenance. A fleet of betterment equipment in the hands of a maintenance department is like a fleet of construction equipment in the road contractor's hands: as soon as one project is finished, strong pressures will be exerted to initiate another project - because the equipment is available and potentially idle, and because betterment, like construction, is more "interesting" than maintenance. Since the bent of highway departments is toward construction and betterment, as against routine maintenance, it is not surprising that in the Northeast projects the equipment that could be used for either activity was often used for betterment.

Betterment projects require a broader dominance of engineering technique than does maintenance; moreover, like road construction, they should be subjected to some kind of independent supervision and control, which, of course, does not happen when the highway department itself executes the project. BPR officials told me that the force account method has never been very successful in developing countries because their highway departments do not have the technical capacity to carry out such projects. In sum, the inclusion of betterment

within a highway maintenance loan seems unwise from the point of view of the institutional objectives of the loan, in terms of the technical problems involved, and in view of the fact that the more developed and successful maintenance organizations do not exercise that function, and prefer not to.

It was pointed out in the last section that betterment equipment is more vulnerable to diversion than equipment that is appropriate only for maintenance. If a maintenance department should go through financial difficulties, moreover, the existence of betterment equipment is likely to give rise to administrative and political headaches for AID. When there is a temporary drying up of funds for maintenance and the equipment is left idle, this often provokes a general clamor, not to find revenues to put the equipment back working at maintenance, but to use the equipment in highway construction where funds are already, or more readily, available (as is happening in the case of Piauí). BPR technicians themselves proposed a farm-to-market road program for the idle project equipment in the Northeast, one of the principal justifications being that such a program would be funded with outside budgetary support.

When betterment equipment suitable for construction lies idle, AID is put in the position of refusing the diversion of this equipment because of the conditions of the loan agreement and the objectives of the loan, and at the same time is blamed for the fact that the equipment is standing idle (as in the Piauí case). If the maintenance department's fleet were strictly maintenance equipment, it would be more "locked in"

to the maintenance sector. A shortfall in funds would mean that the only solution, within the highway department, would be to find funds for maintenance. Although the revenues might still not be forthcoming, the possibility of a non-maintenance way out of the problem is considerably less than when the fleet includes betterment equipment. In sum, when a DER's maintenance fleet does not include betterment equipment, AID to a certain extent protects itself and the maintenance department, in the case of a shortfall of funds, against the inevitable pressures to divert that idle equipment to highway or other construction. If betterment is considered as urgent a priority as routine maintenance, then AID should consider financing such projects separately - that is, in the institutional form in which such work is most efficiently done.

6. The amount of equipment.

The criteria determining the amount of equipment to be purchased should be related to the objectives of absorbability, rather than to that of maintaining the region's highway network (assuming that the former criterion will give a lower amount of equipment than the latter). That is, instead of making up an equipment list according to equipment/kilometer ratios, I would make final decisions based on rations such as (1) the fleet of project equipment: the fleet of existing equipment, (2) the percent of projected budget to be spent (including the construction of new facilities) on maintenance; the percent of past <u>actual</u> expenditures on maintenance, (3) number of mechanics, operators, engineer and other supervisory personnel necessary to successfully administer the program: present number of mechanics, operators, engineers and supervisory personnel. The last three ratios are to a considerable extent a function of the first, which is the most important.

I suggest, as a first approximation, that the new equipment fleet should not increase the existing fleet by more than 75%. The program should be deliberately designed, moreover, to provide an equipment fleet that is <u>inadequate</u> (in amount, not mix) to meet the highway maintenance needs in the state. First, the sign of success of a maintenance program will be that the department itself, after some years, will be able to mobilize the funds for any more equipment it may want, or need to replace. Secondly, the successful implementation of the loan, as shown earlier, is highly dependent on a concentrated effort in the area of equipment maintenance and provision of spare parts - an effort which will have to give just as much, if not more, attention to the DER's existing fleets (as the case of the BPR mechanic in Fortaleza demonstrates), as it will to the project equipment. This effort, along with concentrated attention on the spare parts problem, may be feasible, and successful only if the amount of total equipment is considerably less than it would be to adequately maintain the state's highways. And finally, the Northeast experience shows that an equipment program that meets the equipment/kilometer requirements for mechanized highway maintenance may end up undermining its own chances for survival, by overwhelming existing institutions and resource mobilization patterns.

6. Imported equipment.

Every engineer and official I spoke with started the conversation with complaints about the difficulty of getting spare parts from abroad for the International Harvester equipment (30 TD-15 crawler tractors).

Each complaint was followed by a story of an International Harvester tractor that was down for several weeks, or even months, because of the delay in obtaining a part from abroad. Although the case of International Harvester was most severe, there was a generalized difficulty, according to the engineers, in obtaining spare parts for the imported equipment. It is not only the delay in obtaining an imported spare part that creates difficulties for a maintenance program. Any major equipment delivery such as that of the Northeast projects involves a certain amount of defective equipment and other mistakes. The resolution of such problems in the case of imported equipment is prolonged and costly. For example, the parts catalogues shipped by International Harvester with the original equipment were out of date. As a result, when the spare parts ordered by the DER finally arrived, they did not fit the equipment. The International Harvester Brazil representative went to Recife in September 1968 to confer with BPR engineers about the problem, took the list of incorrect parts shipped to Brazil for study, and promised to come to some kind of accommodation. Meanwhile, months had been lost in the attempt to obtain spare parts. Regardless of the final outcome of this particular problem, the usual delay in obtaining spare parts from abroad was multiplied several times by the problems, mistakes and defects revealed after equipment delivery - the type of error that was bound to occur in a big shipment.

This problem was foreseen during the time of loan negotiations; SUDENE asked that the American bidding be limited to those companies that SUDENE knew had sufficient representation in the Northeast - most

particularly Caterpillar. BPR bidding regulations did not allow this type of preference, and instead a clause was written into the instructions to bidders stating that no bid would be considered "from a firm that does not certify in writing that it has a service organization capable of furnishing spare parts and service to each of the Project States." After International Harvester won the bid for the crawler-tractors, they closed down their fabricating facilities in Brazil, so that the level of their Brazilian representation diminished; experience with other imported equipment also demonstrated that adequate spare parts and service did not exist in the project states. Hence the bidding instructions did not seem to have any more than a pro forma significance.

Another aspect of the imported equipment question was the increase in variety of equipment brands. Maintenance engineers complained of the lack of standardization, and how this exacerbated the spare parts and equipment maintenance problem. During the loan negotiations, some of the DERs expressed a preference for certain equipment brands - based on their desire to maintain a certain degree of standardization in their fleets, as well as their experience with spare parts acquisition. These preferences could not be met, because BPR procures on the basis of bids from any qualified manufacturer who meets fixed specifications. When service and spare parts are scarce and costly, buying equipment solely according to competitive bids and lowest price is uneconomic if it entails, as it did in this case, a diversity of brands.

Because of the small size of each state's equipment fleet, which increases the indispensability of individual pieces, and because of the complementarity of the imported equipment to other pieces, the imported equipment usually being the largest, most expensive, and fewest in number, the spare part problem was frequently the major determinant of whether or not a residency's fleet was working.

Any future maintenance program should diminish considerably this problem, or else a strong probability of failure is built into the project. The central importance of this matter has to do with the fact that the success of such a program is based not on the beginning and completion of a project, but on the creation of an organization that can keep its equipment running constantly. The continuous running, wearing out and replacement of equipment and parts is the heart of the project; hence the obtaining of parts should be just as routine a matter as the running of equipment.

There are two ways in which this problem can be brought under control. One is to severely limit the amount of equipment that is required from abroad, even if it involves changing equipment specifications. Highway maintenance is a flexible enough technology to afford considerable latitude in the drawing up of equipment specifications. Any efficiencies that might be reduced as a result of using an [illegible] cubic-yard front-end loader, instead of an [illegible] cubic-yard front-end loader, are certainly minor in comparison to the phenomenon of equipment lying idle for several weeks because of the delay in

obtaining spare parts from abroad. Moreover, because the Brazilian market of an international equipment manufacturer represents a minimal percentage of his sales, it is not crucial to his business, nor even necessarily economic, to supply adequate service. To a Brazilian equipment manufacturer, however, the highway maintenance equipment fleet of any particular region will represent a more significant portion of his sales market, and it will be much more to his interest to supply service and parts along with his equipment. The scale of his market makes it more worthwhile economically, and his reputation will be more at stake than that of a foreign supplier.

The second approach to the problem of imported spare parts is to limit the bidding to those manufacturers in whom the Brazilians have confidence. There already exist strong sentiments among road engineers about the brand of equipment they like, the preferences almost always being based on the facility with which spare parts can be obtained and the quality of service. Caterpillar is the favorite imported brand, for these reasons. (This preference was also expressed by BPR technicians, who said that the problem of International Harvester was not peculiar to the Brazilian case, but that the difficulty of obtaining parts and service from that company was common throughout the world.) If BPR bidding regulations would not allow the limitation of eligible manufacturers, then a possible alternative might be purchase of the equipment through program loan financing. This would avoid the necessity to bid, and would facilitate buying in accordance with the maintenance engineers' preferences.

8. Selection of equipment.

It is generally good idea to accede to Brazilian engineers' equipment preferences and prejudices in the planning of maintenance projects, for several reasons. Engineers often do not use equipment they don't like. For example, there was a mobile lubricating unit sitting idle in one of the major Pernambuco residencies. The resident engineer told me that most of his roads (78%) are earth roads, and that this machine, with its sensitive gauges and fine tubings attached to individual lubricating tanks, rattles interminably when it bumps along earth roads, often causing damage to the tubes and gauges. Moreover, the fine dust that follows in the wake of vehicles travelling on earth roads rapidly clogs up the meters, which hence require constant cleaning. Finally, the area spanned by the residency was small enough so that it was not inconvenient for the equipment to be lubricated at the residency itself. When it was necessary to lubricate in the field, the engineer said he found it more practical to use hand oil cans.

Another case of disliked idle equipment were the mower tractors. In the agreste of Pernambuco, a region with rocky outcrops and low scrub vegetation, the blades often break on the rocks. (The BPR engineer suggested to me that the operators probaly do not lift up the blade, as they should, when they come to a rock.) The blades of this piece of equipment, constantly in need of replacement, had to be ordered from abroad, and involved several weeks of delay. The idle mowers were therefore a common fixture of the Pernambuco

residencies. Whatever the specific difficulties that were involved in this piece of equipment, the fact is that it was disliked. Great effort was not made, therefore, to keep it in working order.

The mower example points to another reason for following the Brazilian engineers' equipment preferences. The engineer knows that his operators are not well-trained or well-disciplined enough to lift up the blade when they come to a rock. Thus, even though he may think the equipment sensible, he won't order it because he knows it will not be run properly. A complaint was made, along these lines, by a Ceará maintenance engineer, about the Chevrolet trucks. The truck was too light, he said, given the way his drivers treat equipment. Although they had been told not to "race" and abuse the equipment in other ways, this was their natural pattern of driving, and there was no way to control it. A heavier truck, he said, would wear less rapidly from such punishment. It is this kind of implicit calculation that is important in the selection of equipment, and that will be made only by the engineer who knows the region and the work.

It may be that the Brazilian engineers' preferences are not the best alternatives, or represent pure idiosyncracies. Many resident engineers are recent college graduates who lack knowledge or experience of highway maintenance operations, or may know little about equipment repair and maintenance. But whether they are right or wrong, the point being made here is that the ultimate technical success of the project is dependant on the consent and enthusiasm of those who work

on it. It will be the maintenance engineers' treatment of the equipment, their knack at getting it fixed, and their "jeito" in getting funds out of the highway department, that will determine whether or not routine maintenance will become an accepted practice. If they don't like the equipment, they will be less interested in keeping it running.

This "democratic" characteristic of the designing of a maintenance project is in direct contrast to projects like road construction or power plants. If the local engineers involved in a road construction project financed by an international institution disagree with the engineering standards imposed by that institution, this will have no effect on the termination of the project. Moreover, the factors that determine whether the finished road will be adequately maintained will be completely unrelated to the local engineer's preference for or prejudice against the construction technique used. A foreign lender can impose techniques disliked by the project managers in a road, power or sewerage project - or persuade them to use equipment they are not accustomed to - without adversely affecting the quality of that project (unless the technique selected actually proves to be inferior). The case of maintenance, however, is quite the opposite: the less the equipment reflects the managing engineers' preferences, the less successful the project. To the extent that the technology of maintenance allows considerable latitude, an intelligent deference to the local managing engineers' likes and dislikes is not a costly luxury.

This suggestion of increased participation does not imply that the AID Northeast projects went against local preferences. To the contrary, I had the impression that except for a few cases, the DER directors accepted the equipment lists proposed by the BPR engineers. This may simply mean, however, that the political prospects of acquiring a large fleet of maintenance equipment quite cheaply overshadowed any possible objection on specific items. In other words, AID receptivity to DER participation in the drawing up of the lists is not enough; the democratic approach will have to be forced. Participation is more likely to be forthcoming if one goes below the director level in the highway department engineers' ranks. The most crucial aspect of an equipment loan for the DER directors and for state governors is obtaining it; to them dissension over the type of equipment will mean delay in the winning of this political gain, or even the possible loss of it. The resident engineers, on the other hand, have no political or career stakes in the loan; it is not costly for them to express and explain their preferences in equipment selection. This is the kind of expression we want to encourage, and to defer to as much as possible - for the more the resident engineers agree with the equipment, the more they will work to keep it running.

One more reason for bending over backward to the engineers' preferences. The engineering profession has had a prestige in Brazilian society, and its education have had a reputation of technical competence, almost unequalled by any other professional group in the country. Road engineering moreover, is considered a sector long

mastered by this profession. Regardless of the competence of Brazilian road engineering relative to American standards, the fact remains that we are dealing with a group that considers itself, and is considered by society, a technical and social elite. Because the engineers' ongoing enthusiasm for the program is basic to its success, because they are running the equipment, and because they possess highly valuable access to government sources of revenue, it is quite important to draw out their opinions and defer to them as much as possible.

For the above reasons, I would suggest that equipment lists be put together during group discussions with maintenance engineers, and that the DER director's opinions be sought at a secondary stage. I would also suggest that the major burden of preparing the equipment list and justifying it rest on the Brazilian maintenance engineers, and not AID engineers. Moreover, if there are significant changes in the engineers or directors with whom the list has been discussed during the time that the loan is being negotiated, I would strongly suggest that the list be presented to the new group or the new director, not with the idea of justifying it, but in order to get these persons' opinions, reactions, additions or deletions. This forced participation of and concession to the maintenance engineers - within certain technical limits - will build considerable strength into the program as it gets into its more demanding operating phases.

JDT/sbm:bdo:djw

Utilization Rates of SUDENE-AID Equipment, July 1968[a/]

TABLE I

Amount		Bahia		Sergipe		Pernambuco	
		Amount	%[b/]	Amount	%	Amount	%
466	Dump Truck	39	65.0	2	77.0	92	67.0
59	Flat-bed Truck	-	-	5	82.0	10	75.0
72	Pick-up Truck	13	115.0	6	103.0	14	111.0
20	Fuel Truck	3	289.0	2	6.0	-	-
72	Water Truck	13	42.0	4	33.0	9	33.0
14	Jeep Rural	-	-	4	104.0	-	-
5	Jeep	-	-	-	-	-	-
34	Crawler Tractor HD21	13	93.0	2	10500	-	-
30	Crawler Tractor TD15	-	-	4	67.0	11	94.0
68	Crawler Tractor D-4	26	82.0	-	-	-	-
61	Motorgrader 9D	16	78.0	6	80.0	11	71.0
107	Motorgrader 10D	21	68.0	2	84.0	14	56.0
80	Front-end Loader (Mich)	8	83.0	5	120.0	14	62.0
18	Front-end Loader (Cat.)	18	64.0	-	-	-	-
73	Industrial Tractors	13	67.0	3	10.0	14	21.0

Footnotes:

a/ This is a selected list of the more important project equipment.

b/ These figures are the percentage of average normal use (in kilometers or hours per month), as calculated by SUDENE.

Source: SUDENE, Dept of Transport

USAID/B DPEC:JDT:djw
September 1968

Utilization Rates of SUDENE-AID Equipment, July 1968 (cont'd)

Paraiba		R.G. Norte		Ceara		Piaui		Maranhão		Alagoas	
Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amt.	%
58	32.0	43	29.0	82	43.0	54	44.0	48	26.0	50	N.A
4	36.0	9	52.0	5	46.0	7	51.0	9	57.0	10	N.A
6	82.0	13	86.0	3	73.0	7	72.0	-	-	10	N.A
1	-	-	-	7	120.0	3	133.0	4	52.0	-	N.A
12	25.0	6	8.0	5	36.0	6	37.0	7	8.0	10	N.A
-	-	-		3	-	3	63.0	4	68.0	-	-
-	-	-	-	-	-	-	-	5	63.0	-	-
-	-	2	15.0	2	63.0	5	75.0	-	-	10	N.A
5	36.0	-		6	53.0	4	72.0	-	-	-	-
1	26.0	6	63.0	11	68.0	3	33.0	6	33.0	5	N.A
8	79.0	-	-	10	38.0	-	-	-	-	1	N.A
5	33.0	7	35.0	12	26.0	11	59.0	2	4.0	10	N.A
9	59.0	7	47.0	12	75.0	10	56.0	7	-	8	N.A
-	-	-	-	-		-	-	-	-	-	-
6	21.0	5	8.0	10	13.0	5	30.0	7	15.0	10	N.A

TABLE II

Utilization of SUDENE-AID Equipment, Jan-Aug, 1968[1/]

	%
Bahia	75.0
Sergipe	70.0
Pernambuco	75.0
Paraíba	45.0
Rio Grande do Norte	50.0
Ceará	50.0-55.0
Piauí	40.0
Maranhão	55.0
Alagôas	70.0

1/ USBPR estimates of percent of maximum operating capacity. Eighty percent is considered a good rate of utilization.

Source: USAID/BPR-NEO

USAID/B-DPEC:JDTendler:djw
September 1968