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9. ABSTRACT

Experimental programs were undertaken in Columbia, the Philippines, and Ghana, from 1971 to 1974, to explore methods of cutting costs of public construction. Efforts centered either on road and highway construction or on the building of multifamily housing. The objective was to develop a set of guidelines for identifying and implementing opportunities to reduce construction costs based on actual experience. The current state of construction material technology was assessed and alternative construction materials were sought to cut cost, including the use of domestic materials over imported ones. It was found that the opportunity to reduce costs by more intensive use of indigenous materials are limited. On the other hand, significant cost reduction opportunities arise in the area of construction technologies themselves, especially in the evaluation of the mix of labor and capital entailed in a particular technology. Methodological guidelines resulted as followed: 1) work within the administrative structure; 2) concentrate on that relevant to the project and its goals; 3) use existing technology and try to improve it; 4) aid similar projects; 5) remain flexible.

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THE EXPERIMENTAL DERIVATION OF A METHODOLOGY FOR THE REDUCTION OF THE COSTS OF PUBLIC CONSTRUCTION IN DEVELOPING COUNTRIES

Report to

THE OFFICE OF SCIENCE AND TECHNOLOGY
of the
UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C.

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Arthur D. Little, Inc.

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E. H. Geoffrey Gowen, David I. Hellstrom, and James J. Staikos participated in the field work in Colombia. Oliverio Phillips contributed as a consultant concerned with the design of the action plans.

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John H. Reedy participated in the field work in Ghana.

Marjorie Maws and Anita Lord organized and administered the Washington conference.

Charles Bliss served as project manager and participated in the three field programs. Bruce S. Old served as overall project consultant.

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GUIDELINES FOR IDENTIFYING AND IMPLEMENTING OPPORTUNITIES TO REDUCE COSTS IN PUBLIC CONSTRUCTION IN DEVELOPING COUNTRIES

APPENDIX B - COLOMBIA - SUMMARY SECTION HOST-COUNTRY REPORT (ENGLISH AND SPANISH VERSIONS)

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APPENDIX D - GHANA - MINUTES OF THE MEETINGS HELD TO PLAN THE FINAL REPORT FOR THE CONSTRUCTION-COST REDUCTION STUDY

APPENDIX E - PROGRAM OF WASHINGTON CONFERENCE ON COST REDUCTION IN PUBLIC CONSTRUCTION FOR DEVELOPING COUNTRIES, NOVEMBER 1974

I. SUMMARY

A. PURPOSE

This report covers the activities and results of a project which Arthur D. Little, Inc. (ADL) undertook for the Office of Science and Technology of the Agency for International Development (AID) on the subject of establishing a methodology for reducing costs in the construction of public works in developing countries. The work, which began in July 1971 and was completed in November 1974, incorporated four major activities. Three activities were experiments in selected host countries - Colombia, the Philippines, and Ghana in that order; and the fourth activity was joining with AID in sponsoring a major conference in Washington in November 1974 to consider critically the methodological findings from the experiments.

AID is interested in assisting organizations in developing countries, who are concerned with government-financed civil engineering projects, to reduce construction costs. This interest extends not only to the identification of opportunities for cost reductions in the construction sector, but also ultimately to the accomplishment of the reductions. Specifically, AID is interested in taking a first step of assistance by making available to participants in the public construction sector of developing countries a set of guidelines for identifying and implementing opportunities to reduce construction costs that reflect actual experiences. The intent is that the guidelines would provide an impetus for government, private organizations in developing countries, and lending agencies to institute programs of cost reduction in public works construction, with or without the further participation of external assistance agencies.

AID accordingly requested ADL to undertake a specific project with the following goals:

- the design of a methodology suitable for developing countries, aimed first at identifying and then at

implementing cost-reduction opportunities in the construction of public works;

- the establishment of the practicability of the methodology by identifying and testing prospective elements in the course of three experiments to be carried out consecutively in Colombia, in the Philippines, and in Ghana; and, ultimately, by presenting a draft version of the methodology for review and discussion at a conference of interested participants in Washington, D.C.; and

- the presentation of the final version of the methodology in a format suitable for AID publication and distribution as a set of guidelines for identifying and implementing opportunities to reduce costs in public construction in developing countries.

B. SCOPE AND APPROACH

Three experiment projects were to be undertaken, one experiment in each of three countries to be selected by AID, and the results of each experiment were to be incorporated in a host-country report prepared by the host-country participants of the project with ADL assistance. The methodology was to be inferred from the specific results in the host-country reports and the generalized experiences of ADL as a participant in the three experiments. Selected members of the host-country team in each country were to participate actively in the program of the Washington conference.

While accomplishing the project goals, ADL was to emphasize not only the technical aspects of identifying cost-reduction opportunities, but also the identification of the institutional and social barriers to the implementation of the results which may exist within a developing country. Moreover, it was expected that a particularly promising area for finding

cost-cutting opportunities would be the substitution of indigenous for imported materials. Accordingly, the original scope specified the following:

- Identify, formulate, and carry out materials research and adaptation projects which will reduce short-term costs and long-term drains on national budgets.

- Focus on locally-available materials, or those which are the least expensive to import, yet yield a high efficiency in performance.

- Make an assessment of the current state of construction materials technology and research opportunities.

- Develop a technical basis and provide an impetus for:

  -- undertaking the most appropriate materials projects;

  -- improving the capabilities of local engineers and institutions in the analysis, testing, research, and innovation aspects of materials technology; and

  -- encouraging both government and private industry to adopt the concepts of cost reduction and value engineering.

- Clarify the types of adaptive research and other action programs offering the most promise of making a significant impact in the field of materials technology.

- Upgrade the ability of counterparts to analyze not only the technical problems but also the institutional and social barriers to the utilization of improved materials.

C. RESULTS

1. Guideline Principles

A set of principles evolved from our original planning that guided our participation in each host-country effort, and which ultimately helped in identifying significant elements for incorporation in the guidelines. These principles are the following:

- work within the organizational structure for the administration of the cost-reduction project, which we found had already been set up for us by each host-country government;

- concentrate on the topics or projects in the public construction sector that are relevant to formal or informal national goals or aspirations as these become evident;

- avoid topics or efforts that deal with the selection of the construction project, rather deal with topics or efforts that concern cost reduction in the implementation of given construction projects;

- focus attention on those areas of construction activities that promise the largest reductions in costs, and the largest potential to overcome institutional impediments to accepting and accommodating change;

- include efforts not only to identify technological opportunities, but also to identify techniques to penetrate the industrial sector with improved technology in the manufacture of construction materials;

- assist the counterpart organizations in the host countries, with respect to their cost-cutting capabilities, to clarify

gaps and weaknesses in their operations, to identify priorities for attention, and to formulate action plans; and

- retain flexibility as to the nature and extent of our participation with the counterpart organizations in the project work.

2. Procedural Principles

We were able to retain almost intact the procedures for participation originally planned. Thus, our participation involved the following activities:

- Reconnaissance. A reconnaissance before detailed work began by travelling to the host-country for the purpose of understanding the administrative base for the project, identifying sources of information, helping to select counterpart personnel, and helping to establish the general project schedule.

- Information Gathering and Evaluation. Helping in the concerted work effort to collect the information and data that would enable the counterpart personnel to assess the current state of materials and construction technologies for public works and the identification of alternatives that promised reductions in construction cost.

- Conference Planning. Participation with the counterpart personnel in the planning and conducting of a conference/seminar intended to present the action plans for achieving cost-reductions and to assess the practicality of implementing the plans by providing a forum for the organizations affected to state their views and reactions.

- Host-Country Report. Rendering assistance to the counterpart organization to prepare the final report of the work in which the recommendations contain the action plans to achieve the reductions in cost identified during the work.

- Follow-Up. A visit to the host-country at a sufficient interval after completion of the work in that country to determine the implementation that has occurred.

3. The Host-Country Results

Construction-cost reduction opportunities were identified in each experiment and host-country reports were prepared in Colombia and in the Philippines. Copies have been submitted to AID. These reports describe the activities in each country and present specific action plans for implementing the opportunities for cost reduction that were identified. ADL participated in these two country-projects over a continuous period up through the end of the project work. This participation covered the activities of reconnaissance, information gathering and evaluation, conference planning and attendance (Philippines only), the preparation of the host-country report, and the follow-up. The summary sections of the host-country reports are reproduced for convenient reference as Appendix B (Colombia) and as Appendix C (the Philippines). The Colombian counterpart organization decided to eliminate the public conference because of their views on the sensitivity and confidentiality of the topics.

The formal host-country report for Ghana is not yet available and its completion now depends on the initiative of the host-country organization. However, the results are known informally and are indicated in the outline planned for that report. A copy of this outline is reproduced for convenience as Appendix D. By pre-agreement with a request by the host-country counterparts, ADL participation in the Ghana experiment occurred in an episodic manner. ADL participation was thereby limited to the reconnaissance, a progress check, participation in the public conference, and preliminary evaluation of the project findings. The timing for ADL

participation was guided by the initiatives taken by the host-country counterpart organization. No opportunity was provided for follow-up.

Opportunities to reduce costs by more intensive use of indigenous construction materials are limited. The three experiments indicate that such materials are already completely exploited for uses that are obvious. Opportunities in indigenous materials arise instead from more sophisticated approaches where some physical or chemical transformation of an indigenous material occurs. Two examples are the prospects for the manufacture of a brick-laying mortar in Colombia from presently wasted blast-furnace slag and the manufacture of a pozzolan in Ghana to extend imported cement supplies from the tailings of bauxite beneficiation. We found, nevertheless, that a most-intense interest in the manufacture of materials of construction exists in Ghana, a high level of interest exists in Colombia, and almost no interest in the Philippines. Accordingly, the selection of topics in the three countries reflected these levels of interest.

On the other hand, significant cost reduction opportunities arise when the scope of interest is extended to construction technologies themselves, particularly in the evaluation of the mix of labor and capital entailed in a particular technology. We found that interest by the host-country government in this approach is most intense in the Philippines. In Colombia, considerable attention is given to this subject, and interest in it also existed in Ghana. Accordingly, the selection of topics in the three countries reflected these levels of interest.

4. The Guidelines

A set of guidelines have been assembled from the specific results obtained in the three countries and the generalized experiences we accumulated from our participation in the three experiments. The guidelines contain illustrative examples of the specific results presented in three

appendices. The main body of the Guidelines is the result of an evaluation of our generalized experiences organized for ready comprehension and easy application.

A preliminary version of the Guidelines was the subject of a conference in Washington, D.C. in November 1974, in which representatives of the three host-countries participated. Aspects of the Guidelines were presented and discussed, and audience comments noted for evaluation in the preparation of the present version of the Guidelines. The program for this conference appears as Appendix E.

The guidelines materials that we consider suitable for general circulation are annexed to this volume as Appendix A in a format ready for publication. The format should allow the Guidelines to receive a wide unrestricted distribution. The major revisions that resulted from the Washington conference was the reorganization of Appendix A of the Guidelines to present actual results from the Ghana experiment comparing national economic and market costs of three alternative highway bridge constructions.

The contents of the Guidelines are a comprehensive exposition of the technical, economic, and institutional approaches which we believe, from the results of the experiments, promise the best prospects of achieving significant cost reductions in developing countries. The Guidelines are intended thereby to be an effective means for interesting host-country governments to consider, organize, and conduct projects in their own interest to achieve cost reductions in public-works construction.

The methodological basis for the guidelines is the concept of appropriate technology as it may apply to the selection of materials of construction, and to the manner in which the selected materials may be worked by equipment and manpower to produce the finished structure. The criterion adopted for identifying the appropriate technology is that of least national economic cost. Thus the guidelines incorporate national costing as well as financial costing.

The expectations are that formidable institutional barriers to implementation of an alternative construction practice will arise and engender conflict primarily when the technology carrying the lowest national cost is different from the technology that minimizes financial cost. The Guidelines cover the techniques that may be considered to overcome such barriers.

5. Role of External Technical Assistance

Although the Guidelines are intended to be self-sufficient in assisting the work of cost-reduction projects, the experiences in the three countries indicate major roles for external assistance in assuring successful results. These major roles are of two types:

- rendering assistance specifically tailored to country-by-country applications of the Guidelines; and

- encouraging the continuing development of the state-of-the-art upon which the Guidelines are based.

Specifically-tailored assistance is indicated for specific cost-reduction opportunities in the three host countries. Such assistance may be viewed in terms of a retrospective and after-the-fact application of the Guidelines for situations that are already well-defined. The indicated first step is a check of the present day aspects of the cost-reduction opportunities defined in this report for each of the three countries. In addition, specifically-tailored assistance is indicated for new situations that may arise as a result of the publication and circulation of the Guidelines. We would expect in these instances that each case will be evaluated on its merits.

Illustrations of actions that encourage a continuing development of the state-of-the-art represented in the guidelines are: the identification, measurement, and categorization of alternative technologies that may be

considered in any cost-reduction evaluation; technological research to find methods of raising productivity of men and machines; methodological research to introduce national costing into administrative practices; and the educational and training efforts to introduce the awareness of the appropriateness of construction technologies.

II. INTRODUCTION

A large proportion of any nation's resources is consumed in the public construction sector, and this is particularly true in the developing countries. Obviously, if construction costs can be reduced, available resources can be stretched to cover projects that might otherwise need to be deferred; alternatively, resources freed through cost reduction can be diverted to needed projects in other sectors. This report covers a project which Arthur D. Little, Inc. (ADL), in cooperation with agencies concerned with public construction in three developing countries, undertook for the United States Agency for International Development (AID) to develop a methodology whereby any developing nation could launch, on its own or with external assistance, a set of efforts to reduce costs in the public construction sector.

In order for the methodology to be practicable, the project incorporated the design and accomplishment in a consecutive manner of three experimental construction-cost reduction projects, one in each of three cooperating countries -- Colombia, Philippines, Ghana -- followed by a conference in Washington in which representatives of each country participated. The results and experiences from the three experiments provided the basis for the compilation of a tentative methodology, which was presented for comment and critique at the conference.

The detailed procedures and the results of each experiment are reported separately as the host-country report as follows:

Colombia - Oportunidades de Reduccion de Costos en Obras Publicas
(Opportunities to Reduce Costs in Public Works)

Document UINF-T-04 (February 1973),
National Planning Department, Bogota

Two Volumes (In Spanish)

Philippines - Achievement of Opportunities to Reduce Construction Costs in Public Highways,

Report of the Pilot Technical Assistance Project (April 1973),

Department of Public Highways, Manila

Two Volumes

Ghana - Informal 4-volume report available. The formal report is expected to be published in 1975.

Building and Road Research Institute, Kumasi

Copies of the three host-country reports were submitted to AID at the conclusion of each experiment. The Ghana report, however, is not yet in final form, nor has the summary volume been made available by the counterpart organization. Their summary sections are included in this report as Appendices as follows:

Appendix B - Colombia

Table of Contents, List of Tables, and List of Figures. Pages I-1 through I-21, the summary section. In Spanish with English translation.

Appendix C - Philippines

Table of Contents, List of Tables, and List of Figures. Section I Summary, pages 1 through 34.

Appendix D - Ghana

Minutes of the Meetings in July 1974 during which the basic content of the host-country report was outlined. The expectations are that the informal version of the host-country report so far submitted to AID will undergo considerable revision and reorganization. Volume I, the summary volume noted on page 2 of Appendix C, has not yet been prepared.

The organizational structure within which the experiment in each host-country was conducted was the following:

Country	Name	Function	Scope
Colombia	Departamento Nacional de Planeacion (Bogota)	Staff planning group for the executive branch of the Government.	All governmental areas of professional planning activity.
Philippines	Bureau of Public Highways* (Manila)	A division of the Department of Public Works, Transportation and Communications, responsible for the construction and maintenance of national roads and highways.	Line responsibility for the implementation of approved road and highway construction projects.
Ghana	Building and Road Research Institute (Kumasi)	A unit of the Council for Scientific and Industrial Research, which reports to the Ministry of Economic Planning.	Technical research of knowledge in the construction of roads and buildings.

The project work activities occurred in each host-country during the following periods:

Colombia	December 1971 - September 1972
Philippines	November 1972 - May 1973
Ghana	June 1973 - July 1974

The project work in Colombia and the Philippines involved essentially a continuous participation in the field until the completion of the English version of the host-country report in Colombia and the completion of the formal host-country report in the Philippines. The project work in Ghana

*As of May 1974, an independent Department of Public Highways.

involved periodic participation as the needs of the work dictated with the initiative to maintain progress located entirely on the side of the counterpart organization.

The program of the conference in Washington, during which the tentative version of the Guidelines was presented, is provided as Appendix E. The final version of the methodology is entitled "Guidelines for Identifying and Implementing Opportunities to Reduce Costs in Public Construction in Developing Countries", and is submitted as Appendix A.

III. PROJECT FINDINGS

Findings from the project fit into two broad types: (1) specific identified opportunities to reduce costs, and (2) methodological findings that may be helpful to any agency that may be interested in cutting construction costs. Both types are referred to in this chapter, but most of the methodological discussion is placed in Chapter IV.

A. OPPORTUNITIES TO REDUCE COSTS

One of the two general findings of our work in the three countries is that there are significant opportunities to reduce construction costs for which implementation efforts could begin without delay. These opportunities are detailed in the host-country reports, and a summary follows.

1. Colombia

- An improved method of distribution of cement could reduce construction costs through reducing the market price of cement, or at least by limiting price rises and avoiding construction delays because of localized and periodic cement shortages.

- The use of wasted blast-furnace slag, produced at the country's only integrated steel mill, as a base for the manufacture of brick-laying mortar could avoid the use of the more expensive portland-cement mortar which is now in general use in the country as the only available material.

- The establishment of a technologically-oriented information exchange and coordination institute in the country to serve the building construction industry could reduce costs through a more effective use of the available resources.

- The completion of a national inventory of construction equipment and the use of the results to increase the availability of the equipment to construction projects could reduce construction costs through a greater utilization of costly imported equipment and a more effective importation of spare parts. Implementation of this opportunity began during the project activities.

- The results of a quantitative analysis of the operations of the labor-intensive "pick and shovel" rural road building program could help find new employment opportunities through making appropriate changes in the technologies used to construct an infrastructure project and thereby reduce the national cost of the project.

- An improvement in the accuracy whereby quantity surveys are established, through the application of available computer-oriented techniques, could reduce the cost of a road construction project through an ability to choose more effective road alignments and an ability to negotiate lowered costs in the construction contracts.

- Encouragement of improvement in the manufacturing practices of the smaller brick producers could reduce wall costs by making brick more widely available throughout the country and encouraging a competition by brick and tile with cement block.

2. Philippines

- Construction costs in the country's widespread road-building program could be reduced (a) by improving the nationwide distribution of cement in terms of establishing factory-owned depots at strategic locations consistently supplied by water transport and (b) by increasing the use of cement by the consumer in bulk rather than in bags.

- The large construction equipment inventory in the country could be made more effective and use costs reduced by establishing a rationalized policy for deciding useful service life, by encouraging preventive maintenance through lube-oil analysis techniques, by introducing more appropriate personnel motivation policies, and by encouraging additional local manufacture of spare parts.

- Encouraging a more labor-intensive set of construction technologies in road construction could help reduce the national costs of road construction projects. A significant start in this direction has already occurred.

- Increased use of the computer during the design stages of a road project could help reduce costs by enabling quick evaluation of alternative construction approaches and the choice of the least costly alternative.

3. Ghana

- Conversion to brick-arch highway bridges where applicable could reduce road construction costs through avoiding the use of expensive, basically imported cement.

- Continuing the development of the technologies for the manufacture and use of pozzolans from locally available and otherwise wasted tailings from the bauxite mining operation in the country is a means of reducing construction costs by extending the imported cement supply.

- Encouraging local manufacture of low-cost cement in the remote northern areas from suitable limestone deposits using local charcoal fuel is another means.

- Reducing the use of imported cement by expanding local brick manufacture using the appropriate manufacturing technology and

local fuel and clay resources which has already been demonstrated to produce a low-cost brick is still another means.

- Encouraging the use of clay tile roofing materials instead of the more expensive imported corrugated metallic materials could help reduce the cost of housing.

- Developing the country's timber resources to serve a local market effectively, in addition to the export market already served, could reduce construction costs by introducing a competitive building material.

B. METHODOLOGY

The second of the two general findings from the three experiments was the derivation of a methodology that facilitates the identification and implementation of cost reductions. There appear to be sufficient similarities among the different facets of public construction activities that the methodological lessons learned in the three countries can be applied in other developing nations. Most of these lessons have been formulated into the recommended Guidelines that are described in Chapter IV and presented in full as Appendix A. The lessons not incorporated into the Guidelines are those of particular interest to technical assistance agencies rather than to the developing countries themselves; these lessons are cited in Chapter V.

C. CONCEPT OF COST REDUCTION

In each of the three countries, discussions to select topics for investigation turned to cost-reduction opportunities in the usual financial sense and also to the effects of alternative construction practices on employment and on foreign exchange. It was recognized that if employment generation and/or foreign exchange conservation were taken as an objective without integration into a conceptualized cost-reduction framework, construction practices could be adopted that would be more costly

rather than less so. In order for us to help the host countries accommodate all of these fully legitimate concerns the concept of cost gradually became broader. During our work in the Philippines, the comprehensive concept of national economic cost was frankly adopted. This concept of reducing the national cost was adopted in order to assure an evaluation technique that would reflect the overall benefits of building a given structure with fewer national resources. The Guidelines, accordingly, provide an explanation of the national cost concept, and the methods for its computation. That concept typically results in costing local unskilled labor and inputs from abroad at levels that lead in many instances to the selection of practices that raise local employment and conserve foreign exchange.

The Guidelines explain the concept of national costs as it can be applied to public construction and indicate procedures for calculating such costs as well as for calculating the more narrowly conceived measure called financial costs. The third-country experiences (i.e., Ghana) provide an example to illustrate the comparison of alternative highway bridge construction methods both on a national cost and on a financial cost basis. We recognize, of course, that while minimum cost (financial or national) can be neatly conceptualized, in this respect the most one should expect in practice is to identify the technology that carries a lower cost than does any of the alternatives that have been identified and measured. This expectation applies for either the financial or the national economic cost basis.

The calendar period during which the three experiments were conducted, coincided with a marked and continuing world-wide interest in the appropriateness of the technologies used in developing countries. Much current discussion is concerned with the definition of the term "appropriate." We do not propose to enter into the discussion, but we have found it sometimes convenient to refer to the minimum-national-cost technology as the appropriate technology.

D. OBSTACLES TO IMPLEMENTATION

Our exposure to conditions in each country during the project work provided the opportunity to note the impediments or obstacles to the modification of prevailing procedures and practices. The awareness of these obstacles and the interactions with our counterparts in the three countries have allowed their significance to be assessed and techniques to overcome them to be devised.

We noted three kinds of obstacles to cost reduction. One is the existence of firmly-established procedures for undertaking and completing a construction project--procedures that involve legal requirements or established and customary practices. Another involves the local capability to implement, while the third concerns prevailing attitudes. Methods for overcoming such obstacles are available, such as an outright prohibition of undesired practices, educational efforts, or providing compensation or alternative employments to parties that are adversely affected by change. Obstacles of these types can, we believe, be encountered in almost any developing country. Thus obstacles and potential remedies are included in the Guidelines.

The most formidable of the obstacles to be overcome arises in cases where the least-national-cost construction practice is not the least-financial-cost practice. The specific remedy here may involve altering financial prices through taxation or subsidization of elements entering into the financial cost of the practice such that the desired practice has a low financial cost as well.

IV. SUGGESTED METHODOLOGY: THE GUIDELINES

The suggested version of the Guidelines for identifying and implementing opportunities to reduce costs in public construction in developing countries is in Appendix A of this report. We recommend this version for publication and for distribution in whatever manner AID may find useful. The function of this chapter is to describe the rationale and the topical organization of the Guidelines.

The contents of the Guidelines are organized to provide a step-wise logical development and description of the activities that can be undertaken by any government desiring to reduce costs in the public construction sector. Moreover, relevant experiences from the three-country experiments are presented in three appendices to the Guidelines to illustrate elements of the methodology, such as by presenting some evaluations that were made of alternative construction practices, by describing some of the topics that were selected for study, and by discussing some of the details that characterized the three experiments.

Finally, in the organization of the Guidelines we recognized a need to provide explanatory content as well as guidance content. The experiences in the three countries indicate the need for explanation particularly with respect to the concept of cost reduction to be adopted, and to the recognition of the kinds of obstacles that can stand in the way of implementing any alternative, more appropriate, construction practice.

The first six chapters of the Guidelines cover what needs to be done to reduce costs in the public construction sector. We believe that for many occasions of use, these six chapters of the Guidelines will suffice. In order to accommodate those situations where a government concludes that it is in the nation's interest to organize a formal project, we have included a final Chapter VII containing guidelines for establishing a comprehensive cost-reduction project.

Chapter I (Introduction) declares the ultimate goal of the Guidelines, which is the achievement of cost reductions in the public construction sector, and the intention that the recommended procedures be generally applicable to developing countries. The Chapter also emphasizes that the Guidelines focus on cutting the costs of any given construction project, rather than on choosing the least costly among alternative projects each of which produces a somewhat different good or service. Thus, for example, the Guidelines are not concerned with reducing costs through selecting the lesser cost project for two highway projects connecting different population centers; rather, the Guidelines concern reducing the cost of the highway project selected for implementation.

In Chapter II, the procedures and concepts for project cost reduction are discussed. Two areas of activities in public construction are stressed, namely, the technical design and specifications of a construction project, and the implementation of the project. The discussion is intended to provide background information on procedures that are customarily followed and to permit better understanding of the meanings of terms.

Also, in Chapter II, cost reduction is presented and described in terms of the concept of financial (market) costs and national economic costs. Three types of cost-reduction opportunities are noted, namely, the substitution of less-costly materials of construction for those currently in use; the alteration of the mix of capital and labor resources used in a construction task; and the improvement of productivity of the resources used in accomplishing a task.

In Chapter III, the first guidelines are presented. They cover identifying the alternative practices that are candidates for evaluation in terms of cost-reduction potential. First, the process of constructing any public work is separated into components; then the components to be evaluated are selected; in some instances the entire process may be evaluated. Next, given a selection of project components, alternative construction practices need to be identified and specified. The

Guidelines suggest the means for identifying alternatives. Finally, the alternatives must be prepared for evaluation by estimating the quantity of national and imported resources--human and material--that the conventional practice and each alternative will require.

In Chapter IV, the guidelines for evaluation are described. A tabular presentation of evaluation procedures is included. Alternatives should first be screened before undertaking a detailed evaluation in order to reduce the amount of effort. The objective of the evaluation is to select from a group of alternatives the practice that incurs the least national cost. The presentation includes accounting formats for both financial costing and national costing and an explanation of the procedures whereby time is accounted for by discounting and national costs are derived from financial costs. The development of shadow coefficients for use in this derivation is discussed.

Chapter V deals with the obstacles to the adoption of minimum cost alternative practices. The chapter contents are intended to be informational by listing and describing the types of impediments that might be encountered. Included in the listing are:

- obstacles of a procedural nature that tend to (a) distort financial costs of a material or technology out of proportion to its national economic costs, (b) bias results in favor of certain practices, or (c) confirm established technologies or materials;

- obstacles that relate to the capability of a nation to implement a change in practice, such as a lack of expertise needed in a given instance for managing the technological aspects of a change or for managing of labor, or an inability to maintain equipment properly;

- obstacles of an attitudinal nature that tend to favor the status quo at all costs, tend to oppose change because of

threat to self-interest, tend to favor status technologies or sophisticated materials, or tend to oppose because of unfamiliarity or prejudice.

Chapter VI deals with the implementation of cost-reducing practices and, in effect, takes the types of obstacles discussed in the preceding chapter and considers them in terms of the government actions that might be taken to overcome them. If the market price of any input is distorted and is thus misleading, the price may be altered by the imposition of taxes and/or the award of subsidies. By this means a government can make it attractive to adopt a low national cost technology because the financial cost of the technology is also made low. An alternative may be the prohibition of the use of the undesirable input to the technology. Prescribed procedures may be reconsidered and modified to overcome biases and prejudices. Educational and training programs can raise capabilities and eliminate opposition rooted in ignorance. Providing facilities for technical research and development, providing amenities to raise worker productivity, providing for the legitimate concerns of adversely affected parties, and policing to ensure the use of the nationally desirable practices are all other methods.

V. RECOMMENDATIONS: THE ROLE OF TECHNICAL ASSISTANCE

No matter how useful the Guidelines and other communications carrying the same purposes turn out to be, and no matter how energetically and effectively developing countries undertake to reduce costs of public construction, much more remains to be done--a range of tasks that can best be undertaken by external organizations that have assumed technical assistance responsibilities.

Some of these tasks pertain directly to procedures suggested by the Guidelines. Because the Guidelines have been written in the form of a "do-it-yourself" textbook, they provide technical, economic and implementational recommendations such that any government wishing to apply them could rely entirely on its own personnel and resources and, as a result, achieve significant cost-reduction results. Nevertheless, the three experiments have shown that, if such a successful application is to be assured, the experiences and capabilities of local personnel and the extent and composition of existing capital resources may not be adequate. Then, additional help may be needed from a development-oriented agency which provides technical assistance as a matter of course.

There are, moreover, a variety of tasks that external agencies can and should perform that are formally unassociated with any nation's activities pursuant to the Guidelines. Generally, these are tasks that will enlarge the number of cost-cutting opportunities that can be available, will enhance the capabilities of developing country personnel in identifying and implementing reductions, and will reduce the obstacles to cost-cutting, particularly the obstacles that are caused by attitudes and practices prevalent outside the developing countries.

The purpose of this chapter, then, is to provide recommendations covering the role that only an external technical assistance agency can play. The technical assistance role falls into two categories. The first pertains to assistance to a particular cost-reduction effort on the part

of a country. There are already two instances in this category, namely, the informal, or before the fact, use already made of the Guidelines in the countries where the three experiments were conducted; and the instances in the future when governments may desire to undertake efforts of cost reduction in the construction sector in accordance with the Guidelines. The second category pertains to the promotion of a continuing development of the technical and economic factors involved in the reduction of construction costs, i.e., the continuing development of the state-of-the-art.

A. IMPLEMENTATION OF THE IDENTIFIED OPPORTUNITIES IN THE THREE COUNTRIES

The opportunities to reduce costs in public construction have already been noted for each of the three countries in which the experimental projects were conducted. Specific technical assistance efforts are indicated if the countries are to receive the benefits from the implementation of these cost reduction opportunities.

1. Colombian Opportunities

Four distinct opportunities to reduce costs in public construction in Colombia are apparent in which the need for technical assistance is indicated. Three relate to materials of construction and one to promoting the efficiency of housing construction.

a. The Distribution of Cement

The production units of the Colombian cement industry are distributed throughout the country in correspondence to the population centers. The industry is intensely regional in character because of the difficult internal transport pattern arising from the mountainous terrain between the population centers. Thus, shortages of cement can occur in inland locations while, at the same time, the country exports cement from the coastal areas. Shortages delay construction and add to costs.

The growth of cement production capacity in the country has been managed to match assured market growth. The industry is privately owned and investment funds for new capacity are managed with caution. From the technical point of view, capacity increases have occurred in rather small increments so that almost all producing plants consist of a number of smaller units operating in parallel, thus losing economies of scale. Periodic shortages of supplies and internal cement prices reflecting unusually small production units tend to increase the costs of construction in the country.

Colombia possesses a railway network whose route structure in a large measure tends to link the population centers. In addition the country possesses a navigable centrally-located arterial river. In recent years, a world-wide development of technology involving the large-scale low-cost bulk transport of commodities through dedicated shuttle-trains has evolved. Noteworthy are the developments in this respect in England for the transport of bulk cement, and in the United States for the transport of coal.

An opportunity accordingly exists to apply these technological developments to the situation in Colombia in terms of first converting the regional character of cement markets and supply in the country to one that is more national in character, and then allowing new future production capacity to arise in large-scale low-cost production units strategically located so that its product can be distributed at low cost by the transportation network.

The remaining work to be done before the bulk-cement transport opportunity can be implemented should be the development of sufficient information on the changes in railway practices needed to apply the technology to Colombian conditions and on the actual size of the cost reductions in cement transport that will result; the work needs also to provide the assurance that such a transport mode will be reliable from the point of view of producers and consumers in the country. The demonstration of cement-transport cost reduction and reliability of service will permit cement to move over larger distances, eliminate local shortages,

and permit the size of future production units to increase.

The scope of the work should involve the use of the little-used existing railroad line between Belencito (north of Bogota) and Bogota to demonstrate the transport technology by serving to transport the output of Cementos Boyaca at the northern end of the line to its market which is primarily in the Bogota area. This company presently ships its output to Bogota in a fleet of bulk tank trucks, using the highway that parallels the rail line, at a cost that appears higher than the prospective cost for shipment by rail both on a financial and national cost basis.

The technical assistance required from an external agency involves participating with a Colombian group that will set up, coordinate and administer the demonstration program, and to provide objectivity in the evaluation of the results. The precise nature of the participation needs to be identified through discussion with the Colombian authorities in the light of present day conditions.

b. A Non-Portland Cement Mortar

Burned-clay brick is one of the primary materials for the construction of housing in Colombia. The only binder in general use in the country for laying-up brick walls is conventional portland cement-sand mixes. As already noted, shortages of portland cement can delay construction projects; cement, moreover, is a relatively expensive material. In more-developed countries the conventional binder is a mortar made by grinding blast-furnace slag with lime and/or portland cement clinker in selected proportions; this material with sand is a less-costly formulation than portland cement and sand in achieving acceptable quality in the construction of brick walls.

Colombia already possesses the blast-furnace slag as an indigenous material which, at the moment, has no alternative use. The country's blast-furnace steel industry at Belencito produces this material and

wastes it in a dump. The only operating change needed to produce the slag of a proper quality for formulation in cement products is to quench the molten material as the blast furnace is tapped with water instead of air. A major cement producing facility is nearby. The local needs are for the technological development to establish a formulation suited to the conditions in the country, the analysis of the costs involved to manufacture, introduce, distribute, and use the alternative mortar, and the training of brick masons to use the material effectively and properly.

The specific objective in providing assistance to implement the introduction of an alternative binder material for brick walls in Colombia should be the support of a local Colombian group which would be responsible for undertaking the specific technical, economic, commerical and educational efforts involved. The precise nature of this support needs to be identified by discussion with Colombian authorities in the light of present day conditions.

c. Improving Indigenous Brick Making

Concurrent with our work, the Colombian Institute for Technological Investigations completed a study of the technical performance of the burned-clay products industry and produced a clear and unified set of technological recommendations whereby the efficiency of the small and medium producers of brick can be increased. The result could be a more profitable, or stronger competitive, position for the industry vis-a-vis the large producers, a more effective utilization of skilled labor, and an increase in productive capacity with a relatively small demand for a new investment capital. Of particular interest are the smallest producers, the "chircales," whose operations are labor intensive.

An opportunity appears to exist to transfer features of the technological and organizational experiences of the Building and Road Research Institute brick-making project at Asokwa in Ghana to Colombia, and thereby improve the performance of the smallest brick producers in Colombia. The prospects are that the smallest producers can achieve a level of quality

control of their product which can serve to expand their markets and achieve control over the costs of their operations while retaining the labor-intensive nature of the manufacturing process.

The assistance required in implementing the opportunity to improve the performance of small-scale brick manufacture and expand employment opportunities should be participation in a Colombia effort to achieve these results through providing technological, economic and educational support. One aspect of the participation should be serving as the vehicle for the transfer of the relevant Ghana experiences to Colombia.

d. Promoting Efficiency in Housing Construction

As part of our work program in Colombia, a firm of independent consultants undertook and completed an investigation of the technological and cost aspects of vertical multi-unit housing construction. As a result of their analysis of building costs and of the costs of construction alternatives, they were able to identify some problem areas which represent obstacles to the reduction of building construction costs through a better productivity of men and machines.

They pointed out that ineffective channels of communications exist among the many Colombian organizations engaged in the building construction sector. Bottle-necks are generated which delay schedules, increase costs, and in general significantly decrease productivity when the volume of construction activity markedly increases. Also, the construction industry finds itself to be operating as a training institution for workers, who then tend to migrate to other sectors; the industry thus loses the benefit of increased productivity from skilled people. Variations in the qualities of the materials used in construction lead to inefficiencies because more work is needed to accommodate the materials to the installations. Finally, equipment ownership by construction firms is one of the qualifications needed for bidding on major building construction projects financed by large groups in Colombia, and this results in hoarding of

equipment, inefficient use patterns and long idle times. Because much of the technology, particularly for the construction of large structures is imported, opportunities for labor employment or for a reduction of imports are not necessarily present.

The problem areas are discussed more fully in Appendix C of the Colombia Host-Country Report and the recommendation aimed at a solution to these problems is the establishment of an institution competent to attempt the needed solutions. Because of the importance of the building construction sector, solutions to the problem areas could represent significant reductions in the costs of building construction. An institution needs to be created in Colombia which would have the necessary legal status and is competent to investigate the problem area, find solutions, and enforce the results.

The objective of external assistance to implement the opportunity to reduce building construction costs through resolving the problem areas should be participation in a local governmental effort to identify the nature of the institution required and the methods to be adopted for its operation. The scope of the participation should be limited to the technical, economic, and organizational aspects of the effort, and the precise nature of the participation should be identified by discussion with the Colombian authorities in the light of present day conditions.

2. Philippines

Basically, one single topic emerges in the Philippines as warranting follow-up, and this relates to the current government actions to promote new employment generation in public works construction, and the need to relate these actions to reductions in national costs. The governmental effort involves, for a number of selected road construction projects, the shifting away from highly capital-intensive technologies to more labor-intensive technologies. In effect, analyses of the Philippines results show that the shift is toward the use of more-appropriate technologies

and the reduction in the national economic costs of the construction projects. The design of labor-intensive construction methods and the implementation of the results in actual road construction work is being assisted by the International Labor Office (ILO).

The objective of technical assistance in the area of employment generation in road construction should be participation in an effort to assure that the nation receives the maximum benefits from the greater use of labor in construction. The effort should focus on three areas; namely,

- the degree to which the labor-intensive technologies are efficiently applied through achievement of high productivity in the labor force,

- the degree to which mechanical equipment is used productively in the technologies practiced in the country, and

- the degree to which the technologies being applied in labor-intensive construction are appropriate.

The vehicle for accomplishing these objectives should be the Cost Reduction Study Project (CRSP) already established in the Philippine Department of Public Highways, adding to this effort the cooperation and support of the National Economic Development Authority of the country (NEDA). The action plans in the Philippine Host-Country Report for the labor-intensive construction and equipment life topics provide the proper inputs.

The external technical assistance should be limited to participation with an augmented CRSP in the technical and economic aspects of the work. The precise nature of the participation needs to be identified through discussion with the appropriate Philippine authorities in the light of their current activities.

3. Ghana

Ghana's needs focus on materials of construction, and opportunities for technical assistance lie in three areas, namely:

- extending cement supply by developing indigenous pozzolanic materials;
- the more-intensive use locally of timber for construction; and
- the development of wood-charcoal as an energy source for cement manufacture on a commercial scale.

The remaining opportunities for cost reduction, namely expansion of local brick manufacture and alternative highway bridge and house-roof designs do not appear to require external assistance.

a. Pozzolanic Materials

Waste materials, the tailings from the Ghana bauxite mining beneficiation operations at Awaso, develop strong pozzolanic properties when calcined under controlled conditions of temperature and residence time. Test work already accomplished in Ghana on a small-scale through admixture of the calcined material with portland cement, or through intergrinding with portland cement clinker, shows that a resulting concrete possesses strength characteristics almost identical with portland cement mixes, when proportions up to almost 50% pozzolans are used.

The pottery-kiln calcination equipment used in this work is not amenable to scale-up for process development and small-scale calcination work is needed in order to demonstrate the elements of a commercial process and, as well, provide larger quantities of calcined materials for more extensive test work.

The incentive to continue the development work is large, since Ghana imports all of its portland cement clinker needs, and since known limestone reserves so far pose problems of quantity of reserves, accessibility, and possibly quality as far as local clinker production is concerned. Moreover, the energy needs for local clinker manufacture would be almost entirely imported. The unit consumption of energy in the manufacture of a pozzolanic-portland cement mixture would be significantly less than for portland cement alone. Finally, the market for non-structural uses of cement in Ghana, where it would be easiest to introduce pozzolanic materials, appears large.

The immediate need is for a program, managed by the Building and Road Institute at Kumasi, in which a small-scale unit would be established and operated to procure the following information:

- the temperature-time characteristics to produce a pozzolan material equivalent to that produced in the research work so far;

- a more precise knowledge of the change of particle-size distribution between the initial material and final calcined material for use in selection of large-scale equipment; and

- further confirmation of the strength properties of the range of pozzolanic-portland cement mixtures.

The program would conclude with recommendations, as warranted, for the continuing work into a semi-commercial stage.

External technical assistance would be needed through participation with the Building and Road Research Institute program in the design, procurement, and erection of the equipment, and in the design of the operations and evaluation of the results. Discussion with the Institute could develop the precise nature of the participation.

b. Local Construction Timber

Ghana has a well-developed timber export industry, but the focus and orientation of this industry is almost entirely on exports, usually of logs. Some saw mills exist whose output is sold for local consumption, but the situation is one in which a domestic consumer has no assurance of adequate supplies of timber of predictable quality. Nor does a developed timber preservation industry exist.

It appears, moreover, that in the operation of the timber-export industry, the management of the timber resources is not in the best interests of the nation in terms of preservation and renewal of the resource for future extraction. The efficiency of an extraction may be low, and inadequate attention may be given to timber species that are non-exportable because of quality or size of trunk. Wasteful cutting may occur merely to obtain access to desirable timber. No thought may be given to a concomitant harvesting of scrap timber for local charcoal production.

The need is for a broad-scope concerted effort that will result in the formulation of a timber industry development plan, which will define the national economic interest in making available a construction material that is significantly cheaper than some of the materials now used, such as portland cement. The work element in this effort should include assessments of the efficiency with which the timber industry now extracts the resource, and the extent to which the resource is being replaced; establishment of a plan for harvesting the forest resource in the best interest of the nation in terms of regeneration and maximum supply of species of interest; and identification of the potential market for timber within Ghana at the various prices at which timber might be sold competitively with alternative materials; the postulation of an industry structure which effectively will match potential supply to the potential demand; and the identification of an action plan which can enable a situation to be reached of appropriate use of the resource in the domestic market.

The need for external technical assistance lies in participation in such an effort in an appropriate manner to supplement the resources of the local personnel in connection with organizing and conducting the efforts and with evaluating the results. Discussion with the appropriate Ghanaian authorities is needed to define the needed participation.

c. Wood-Charcoal Based Cement Production

Ghana's supply of portland cement is derived entirely from imported clinker. The local limestone deposits so far appear to be difficult to develop for large-scale cement production for technical reasons or for reasons of location. Moreover, all Ghana's fossil energy needs are imported.

An incompletely evaluated opportunity exists for the production of portland cement in northern Ghana. The project would depend on an apparently sizable deposit of limestone at Bonga-Da, and would use as fuel either wood charcoal or rice husks, both of which are locally available. The manufacturing technology is still to be selected; the relatively small market suggests that a shaft kiln may be more appropriate than a more conventional rotary kiln.

The fuel question requires further research. The wood for charcoal may need to be produced by the plantation farming of quick growing trees perhaps in areas that can be irrigated with waters from the now-expansive Volta Lake. The lake might also provide low-cost water transport of charcoal from already wooded areas. It is possible that while charcoal or rice husks can be supplied to the cement plant more cheaply than fuel oil in a national economic sense, fuel oil may still be financially cheaper. In such a situation, taxes and/or subsidies may be needed to promote a nationally economical pattern of resource use.

The need for external assistance lies in participation with local personnel to identify innovative management of timber resources and charcoal production to produce the fuel needs and the selection of process technology to suit the scale of cement production. Discussion with the

appropriate Ghanaian authorities is needed in order to define the precise nature of the participation.

B. GUIDELINES APPLICATIONS ASSISTANCE

As applications of the Guidelines are undertaken in developing countries, the government concerned may conclude that its own personnel and resources need to be supplemented through external technical assistance. We would expect that each instance of a technical-assistance request will be evaluated on its own merits. But, once an affirmative decision is taken, we would suggest that the assistance grant be covered by a formal agreement to the extent that assures at least that the obligations of the host-country government to complete the work are clearly defined. In such an agreement, the technical assistance agency should be guided in the obligations it undertakes by the following:

1. Level of Project

The project, or the portion of it, with which an agency providing external assistance may be concerned, may range from the extremely small to a comprehensive program to identify and implement cost reductions throughout the public construction sector. A small project might, for example, call for technical assistance in the design of a small kiln, or for help in the specification of certain types of highway construction equipment to be subjected to a special import duty. At the other extreme, the comprehensive program may embrace the full span of public construction and call for external assistance by a variety of experts over a period of years. Whenever the assistance project fits within this range, the organizational level at which help is provided should be high enough in the governmental hierarchy that the research findings will have exposure to government policy makers who will be receptive and willing to act on the results of the project work. Moreover, in the case of a large project, it would be desirable for the government policy makers to form a steering committee, the members of which represent a number of ministries, especially those concerned with matters of finance, labor, education, and social welfare.

2. Local Personnel

It should appear to the technical-assistance agency that the key local personnel are sufficiently experienced and motivated so that the external-assistance personnel will not be used to do the work directly, but rather to guide the efforts as required. The selection of the host-country personnel will play a large part in determining the extent to which the services of external technical assistance personnel will be required or the extent to which they will need to furnish conceptual guidance to the local project team.

3. External-Assistance Personnel

The services of external-assistance personnel can fall in two specific categories. The first is the services of personnel whose presence and actions motivate the local team members to do effective and productive work. They can provide an objectivity in the project activities that makes the work more effective and the results easier to implement. Through the opportunity for close observation of the capabilities, attitudes, and personalities of the project personnel, they can provide conceptual guidance at the appropriate time. Their presence on such a basis tends to prevent the slowing down or stopping the work because of other work pressures on the team members. The duration of their services may coincide with the duration of the project. The leader of the external-assistance group should concentrate on establishing a rapport with the local project leader such that he may act for him on occasion when the project leader is occupied with non-project duties. This is likely when the local project leader needs to be at a high capability level such that he has a variety of responsibilities.

The second category includes the services of personnel who can bring specialized knowledge and experience to bear on the topics selected, particularly in the area of identification and evaluation of alternative practices. These services are usually provided on a spot basis as the need for them is identified.

4. Public Exposure

In instances in which a comprehensive cost reduction program is undertaken, wide public exposure may be wanted for the activities of the project. To this effect, the publication and distribution of a project statement is significant and important. Also, as well, the opportunity for a public conference, or seminar, designed to elicit reactions to the project will increase public exposure, while providing needed inputs to the work. External technical assistance should be organized to encourage this approach.

5. Host-Country Expectations

Again with reference to comprehensive projects, technical assistance cooperation should be extended in observing the national priorities, such as those expressed in a national development plan, that may govern the selection of topic areas. Topic areas should be responsive even when this restricts the project scope by, for example, confining a cost-reduction project to housing construction, or to highway construction, or to the manufacture of more cost-effective construction materials.

6. Promise of Implementation Assistance

To the extent that its policies permit, an external technical assistance agency should provide motivation for the project by holding out the prospect that its assistance could continue in an appropriate manner into the implementation stage. Examples of the opportunities for implementation assistance arising from the experimental projects have already been cited earlier in this chapter.

C. STATE-OF-THE-ART ASSISTANCE

The state-of-the-art is, in effect, the prevailing practices of selecting appropriate materials and construction technologies for projects, whether or not the construction component involves the selection of construction materials, the application of construction materials, or the erection of structures in any form. State-of-the-art refers to:

- knowledge, anywhere, of more appropriate technologies, or any aspect or component of such technologies;

- prevalence of such knowledge;

- presence or availability of institutional channels by which such knowledge can be, or is being, (1) generated or (2) disseminated or transferred; obstacles within these channels are also part of the state-of-the-art; and

- extent to which the knowledge - the known more-appropriate technologies - is being used.

Technical assistance agencies may individually, or jointly, advance the state-of-the-art through specific programs such as the following.

1. Alternative Technological Practices

At the present stage of development of the art, there is a need to identify, measure, and categorize the construction technologies that have been actually employed in the past. In this research, the various interfaces between labor and machinery need delineation on a far greater scale than seems to have been reported in the literature.

The World Bank's study of the substitution of labor for capital in road construction has shown the need for such research, particularly to cover the intermediate range between the highly capital-intensive methods favored by western-oriented construction organizations and the highly labor-intensive methods prevailing in countries like India. It appears, furthermore, that the appropriate technology for a developing-country environment almost typically falls into this intermediate region of the labor-capital mix. The answers probably will come from concerted efforts to innovate, through conceiving new equipment, preferably equipment that is suitable for local manufacture, or to adapt equipment used in other

sectors of the economy to construction uses. As an example of the latter, carabao-drawn agricultural carts have been used in the Philippines, after adaptation, for earth moving in the repair of levees and in the prototype labor-intensive construction of the Capas-Botolan road. Prototype motorized versions of the cart, evidently suitable for local manufacture, have been built by the International Rice Research Institute in the Philippines.

The results of such a research and development program should provide a useful and significant expansion of Chapter III of the Guidelines, which is concerned with the identification of alternative construction practices. The format whereby the results may be widely disseminated in the developing countries could be a handbook of appropriate engineering, somewhat analogous to any engineering handbook. The handbook could contain material such as the following:

- A complete bibliography of the literature to support the data and the other content of the handbook;

- Cost and productivity data, and the contexts in which the sets of data were obtained;

- Methods for identifying and applying low-cost technologies, such methods being needed by any user who has a role in the choice of technology for projects;

- Methods for costing, in the financial and in the national economic sense, to enable anyone who has a role in the implementation of projects to manage the appropriateness of technologies employed; such methods should include the rationale and techniques for calculating and using the shadow prices of inputs to construction projects;

- Methods and processes whereby alternative feasible technologies

can be organized by the usual tasks encountered in civil engineering works;

- Technological methods and administrative procedures for the maintenance and scheduling of construction equipment of the many types commonly used in developing countries; and

- Techniques (and evaluations of techniques) for the management of construction labor forces for effective performance in terms of achieving high levels of productivity.

2. Technological Research

A second needed activity to promote the state-of-the-art is the encouragement, sponsorship or conduct of research to design new technologies that may be more appropriate. Such technologies, which may be innovations or adaptations of existing technologies, are likely to be intermediate as between the highly capital-intensive technologies practiced in industrialized countries and the traditional non-mechanized technologies. The research should focus on finding methods for raising productivity as well as on questions of the mix of labor and equipment. The applicable results of such research should be incorporated into subsequent editions of the handbook. A good example of the type of investigation required is the program for Phase III of the World Bank study.

Some measure of agreement among the various development-oriented agencies should be reached on the standardization of the methods for the research such that data and results from different investigations can be assembled, correlated, and generalized. Included in the agreement should be plans to collect reliable productivity data, primarily on the performance of labor in different modes of employment, different in terms both of the kinds of tasks being performed and of the ways in which labor is recruited and managed. Similar data on the performance of machines

in developing-country environments are also needed. Much of the activities and the points of view of the International Labour Office could be relevant in implementing this task.

3. Methodological Research

A third area of needed research comprises the development of improved methods for the costing and the administration of projects containing technologies that are appropriate in terms of national costs. Such research would include:

- the national costing of alternative technologies, particularly through the use of shadow prices;

- the design of governmental administrative instruments to induce private contractors and other market price-oriented agencies to adopt appropriate technologies that are relatively expensive in terms of market costs, instruments such as taxes on imported equipment and subsidies to encourage the employment of unskilled workers; and

- the design of methods for the financing of projects involving appropriate technologies that are financially more costly than the less appropriate technologies that might otherwise be used.

This area of research could provide significant inputs to supporting Chapter IV of the Guidelines which concerns the evaluation of alternative practices.

4. Encouraging the Use of Appropriate Technologies

A needed action is the adoption of procedures by development-oriented agencies that finance projects or have the responsibility for approving projects, to encourage the use of appropriate technologies.

For example, a lending agency could insist that, when any project is submitted for approval, analyses be incorporated which demonstrate the appropriateness of the technological approach chosen for the project, whether this relates to materials selection, erection techniques, or both. It may be necessary for the lending agency to adopt rules for the evaluation of projects by its own staff, rules that require the use of minimum-national-cost technologies; these rules need then to be communicated to clients. The procedure would require the use of shadow as well as market prices and would require that clients show that workable administrative devices are to be used that will assure the use of low-cost technologies.

5. Encouraging a Revision of University-Level Degree Programs

Suitable programs in the university systems of both developing countries and advanced countries are sorely needed. In the former, new civil engineering curricula are needed which will be significantly different from present programs, since the courses will supplement topics in science and engineering with a substantial infusion of topics covering economics and the other behavioral sciences, as well as techniques of management. The student should be required to become as facile in estimating costs in the national economic sense as he is expected to be in the financial sense.

In the advanced countries, where study by nationals from developing countries often is at the graduate level, courses should emphasize such an economics-technology interface. In all programs, students will need to become fully acquainted with the concepts, the design, and the implementation of low-cost practices, respecting both materials and technologies.

6. Provision of Training Programs

There is a need also for non-university type programs, designed to

provide opportunity for the highly-motivated and intellectually-capable individual in the labor gang to be recognized and given an opportunity to advance through training. Two major tracks of training courses should be offered, one aimed at the management of people and the other at the management of machines; both tracks would be focussed on the achievement of higher productivity levels. An illustration of the need for training 'n machine management is contained in the Philippine host-country report in the action program concerned with prolonging the service life of heavy construction equipment.

APPENDIX A

SUGGESTED VERSION

GUIDELINES FOR IDENTIFYING AND IMPLEMENTING OPPORTUNITIES TO REDUCE COSTS IN PUBLIC CONSTRUCTION IN DEVELOPING COUNTRIES

GUIDELINES FOR IDENTIFYING AND IMPLEMENTING OPPORTUNITIES TO REDUCE COSTS IN PUBLIC CONSTRUCTION IN DEVELOPING COUNTRIES

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

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Prepared by

Arthur D. Little, Inc.

Cambridge, Massachusetts

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PREFACE

A large proportion of any nation's resources are consumed in the public construction sector, particularly in the developing countries. If construction costs can be reduced, available resources can be stretched to cover projects that might otherwise need to be deferred or, alternatively, resources freed through cost reduction can be diverted to needed projects in other sectors.

This document is intended to provide a guide to the organization, design, and accomplishment of projects for achieving reductions in the cost of public construction, particularly in developing countries. The Guidelines are based on the experiences gained in three experimental projects conducted consecutively by the Governments of Colombia, the Philippines, and Ghana during 1972, 1973, and 1974, in which Arthur D. Little, Inc., participated on behalf of the United States Agency for International Development.

At the outset of the three experimental projects it was expected that cost-reduction opportunities would be framed entirely in terms of financial (market) costs. Moreover, reductions in budgetary and foreign-exchange outlays were to be sought. As project work proceeded, however--especially in the Philippines and in Ghana--it became clear that authorities in the project countries were also concerned with achieving cost reductions that depend on recognizing the distinctions that may exist between financial (market) costs and national (social, real) costs. Costs associated with unemployment, for example, were of particular concern. Accordingly, project activities were modified to include consideration of the real costs that might not be comprehended by financial costs. As would be expected, it was learned that reducing national costs might occasionally be at odds with reducing financial costs. Thus, the guidelines to cost analyses to be presented here are based on the most appropriate

concept of costs for the particular situation or project.

Since the Guidelines are inferred from actual experiences in the three experimental projects, they carry empirical merit. Their application in any developing country should enhance possibilities for achieving significant reductions in the cost of public construction.

I. INTRODUCTION

A. PURPOSE

The Guidelines are intended to provide direction for the identification and implementation of opportunities to reduce public construction costs, both financial and national, in developing countries. An aspect of the purpose of the Guidelines is to help users to recognize and overcome the effects of institutional obstacles to implementation. The purpose of the Guidelines is also to delineate the organizational structure of cost-reduction projects. Thus, the comprehensive goal of the Guidelines is to aid the achievement of cost reductions in the public construction sector.

The Guidelines are designed to have general applicability to the developing countries. They are written for use by governmental agencies and financial institutions which are responsible for selecting, financing, or implementing public construction projects. They may also be useful to manufacturers of construction materials, architects, engineers, consultants, and private and public contracting firms which participate in public construction projects.

B. SCOPE

The Guidelines cover the identification of opportunities for cost reduction in the selection and application of construction materials, in the selection and implementation of alternative construction technologies, and in the functions and methods of operation of the institutions which manage or are involved in construction activities. These institutions include the parties to agreements for construction and their agencies: i.e., those which act on behalf of the government, such as architects, designers, and consultants; those which act on behalf of the contractor,

such as trade associations and equipment leasing (plant hire) firms; and those which produce construction materials, manufacture construction equipment, finance construction projects, and educate and train personnel employed by the construction sector.

The Guidelines focus on cutting construction costs of a given project. They do not cover the identification of opportunities for cost reduction by choosing among alternative projects. A given project is one defined in terms of its providing an installation capable of a specified performance, even allowing for leeway in deferring part of the initial cost in favor of incurring additional maintenance costs in the future.

The concept of a given project can include not merely alternative materials but also alternative patterns of initial construction cost and of subsequent maintenance. For example, a given project can be a highway to be paved with either asphaltic-concrete or cement concrete, with the former entailing lower construction costs but higher maintenance costs. The concept of a given project can be usefully stretched to include alternative construction periods, i.e., one technology may require more calendar time than another thus posing alternative time points at which the enjoyment of project benefits can begin. The assessment of such alternative technologies requires the evaluation of benefits as well as the evaluation of costs.

In no respect are the Guidelines intended to provide descriptions, either suggestive or definitive, of recommendable materials or technologies. Rather the intention is to provide procedural guidance to those who are endeavoring to identify and to implement lower-cost materials and technologies.

C. ORGANIZATION OF GUIDELINES

The organization of the Guidelines permits the user to identify in an orderly way all of the factors to be considered in examining the potential for reducing costs in the public construction sector of any developing country.

First, procedures are discussed for reviewing the public construction sector and for determining the prevailing concepts of cost and cost reduction, particularly to clarify the distinction between financial and national costs.

Next, attention is directed to the means by which the user can identify (a) the various components of a construction project and (b) the alternative practices that should be considered. The discussion then turns to the ways in which the user can evaluate these alternatives in terms of the potential for reducing financial costs and/or national costs. After that, the Guidelines discuss the kinds of obstacles to the implementation of potential cost-reduction opportunities that are posed by the practices and conventions of the institutions involved. Next, suggestions are made for implementing the cost reduction opportunities that have been identified and evaluated.

Finally, procedures are elaborated for organizing and establishing a formal program of cost reduction in the public construction sector.

There are three appendices to the Guidelines. The first models the evaluation of a cost-reduction opportunity. The second draws upon the three experiments to illustrate identification and implementation of cost-reduction opportunities. The third describes features of the organizational structure and project activities effected in the three countries.

II. PROCEDURES AND CONCEPTS FOR PROJECT COST REDUCTION

The public construction sector is concerned with the installation of civil engineering works whose costs are financed wholly or partly with public funds, regardless of whether these funds are appropriated from current tax revenues or borrowed from lending agencies for the specific purpose. Civil engineering works include all combinations of earthworks and structures which generally make up the infrastructure of a nation. They also may include auxiliary works such as surfacings and finishings. Thus, roads, canals, harbor installations, airports, power plants, factories, public buildings and housing, and dams are examples of civil engineering works.

Three broad areas of activities, taken as a whole, constitute the process whereby a public construction need in a country--particularly a developing country--is identified and an installation subsequently completed.

The first area deals with the detection of the need for a particular installation and the selection of the quality desired in its performance. The Guidelines do not cover this aspect of public construction. The activities to detect needs and select performance quality generally are similar to those in other public sectors (e.g., health, education, defense). Public construction needs and performances compete with those of other public and private sectors for the allocation of the national resources. So, generally, the quality desired in the performance of a civil engineering work is not selected until after the resource allocation to pay for its construction is clear. Hence, the quality of performance selected is frequently a function of what the country can afford.

Following the selection of a public construction project and the quality of its performance, identification of opportunities to reduce cost focusses on two areas of activities:

- the technical design and specifications of the project; and
- the implementation of the project.

These are the areas of public construction in which the Guidelines are intended to provide guidance.

The design and specification activities generally indicate the materials to be used, the quantities that will be demanded, and the technologies that will or may be used to assemble the materials. In turn, the technologies determine the requirements for labor and for construction equipment, whether domestically manufactured or imported. The types and quantities of material and human resources required determine the cost of the project. One facet of these activities is consideration of necessary repair or even reconstruction, as wear and tear occurs through use of all or portions of the project installations to maintain performance at least at the originally specified level. Occasionally, the decision-maker must effect a trade off between the costs to be incurred during initial construction and those to be incurred later for maintenance.

The implementation activities of the project generally include the preparation of initial cost budgets, the determination of the financing method, the award of one or more construction contracts for each project, and the supervision and control of contractor performance.

A. CONSTRUCTION PROJECT DESIGN

The procedures involved in the construction project design are generally selected to achieve one goal, namely, the production of a set of documents whose contents assure that:

- an established construction organization can produce the complete installation as specified; and

- the construction organization's cost to produce the completed installation will not exceed the construction budget; and
- the completed installation will function as specified.

Ordinarily, the set of documents contains drawings of the installation, a quantity survey of the required materials, specifications of the construction materials, standardized constructions to be employed, and descriptions of construction methods. The set of documents containing this information can serve as the statements of the scope of work when a contract for execution of this work is being negotiated.

The selection of design features for a project may anticipate the maintenance needs of the completed installation, but in general there is no assurance that adequate maintenance will be performed. Ideal maintenance policy avoids any deterioration of functional capabilities by specifying repairs or reconstruction at periodic intervals. Deterioration may be caused by wear and tear, or by the forces of nature.

In reality, maintenance practices may vary considerably from the ideal. One major reason is that the responsibility for maintenance, especially of roads and highways, may be delegated to local governmental units and thus are not the concern of the agency responsible for construction. Actual maintenance practices depend on:

- the availability of funds,
- the ability to tolerate a measured amount of deterioration before any repair is considered, and
- the intent to reconstruct an installation to upgrade it to a higher performance level.

The responsibility for the preparation of the set of documents generally depends on the method selected for financing the cost of the work. If the work is financed entirely from government funds, the preparation may be undertaken by the technical personnel in a ministry or department of public works, or a branch of such an agency, or may be delegated to local design and consultant firms. If the work is financed by a major international development-oriented lending agency, then the preparation of the documents may be subject to the policy requirements of the lending agency, and these can require the services of an internationally recognized consultant group to design and supervise the project.

B. IMPLEMENTATION OF CONSTRUCTION PROJECTS

The customary practices of the institutions involved in the public construction sector generally control the activities involved in the implementation of a construction project. These practices can determine the progress of the work, the effectiveness of the results, and hence the ultimate cost of the project. The diversity of the practices that may be encountered in the implementation of a construction project is illustrated below:

On the government side, they may be:

- the criteria for the registration of contracting organizations seeking work in the public construction sector;
- the depth of detail and the finality of the design in the project documents at the time contracts are negotiated;
- the intervals adopted for making payment to the contractor as his work progresses toward contract completion;

- the effectiveness of the method specified for certifying the completion of work items of the construction program at the end of each interval;
- the decision-making process adopted for the award of contracts in competitive bidding or in a negotiated bidding, especially with respect to proper matching of scope of contract work to the capability of the contractor;
- the criteria set for deciding when a construction project is to be undertaken by non-contract methods, i.e., by administration, the direct hire of labor and services, and the direct purchase of materials;
- laws and regulations governing the conditions for employment of labor;
- the adequacy of the appropriation process to provide funds to support the volume of construction actually committed.

On the private sector or contractor side, they may be:

- the methods prevailing for the supply and for the procurement of construction materials;
- the pattern of ownership or of leasing the services of construction equipment;
- the prevalence of subcontracting practices;
- the accuracy of cost-estimation procedures;
- the ease of procurement of spare parts for the maintenance of construction equipment, and the quality of the spare parts supplied;
- the availability of labor at the requisite skill levels;
- the motivation of the labor force as it affects productivity levels;

- practices for recruiting and training skilled construction and managerial personnel;
- the adequacy of the testing procedures for control of the quality of construction materials and emplacements.

C. CONCEPTS OF COST REDUCTION

Financial Costs Vs. National Costs

In general, for public construction in developing countries, two alternative concepts of cost may be used. One is the conventional concept that views costs in financial (market) terms--that regards the magnitude of the funds that must be outlaid as the pertinent measure of cost. The other, which has been developed within the last quarter century, deals with national (social) costs. This more comprehensive concept arose in recognition of the kinds of costs to a society that might be wrongly measured or even ignored by the markets that determine financial costs.

Formerly, it would have been commonly asserted that financial costs provide a satisfactory measure of costs to a nation or to society as a whole--or, at least, that financial costs would be proportional to national costs--in which case a single concept would be fully relevant to the assessment of the national as well as the financial costs. It is now recognized that two separate concepts are needed. From a national standpoint the concept of financial costs is deficient for two principal reasons: (1) taxes (and subsidies) are not costs, but merely transfers; (2) many of the market prices used in calculating financial costs are distorted (from a national or social viewpoint) and must be adjusted if satisfactory national costs are to be calculated.

(A third reason should be mentioned even though it is more likely to be relevant to the choice of projects rather than the choice of construction

practices: costs to society in the form of adverse environmental impact or the health of workers may not enter market costs all all.) Any failure to calculate national costs can lead to choices that are defective from a comprehensive social standpoint.

The financial cost of adopting any construction technology or material can be regarded as the sum of a series of money outlays to secure the domestic and imported inputs to the construction. The outlays include capital expenditures and current expenses for labor, equipment rentals, construction materials, utilities and supplies, insurance, and interest. Financial costs include also the profits of all the enterprises that participate in the construction work or provide materials to the project.

In concept, national costs need to be defined in terms that are fundamentally different from those descriptive of financial costs. The national cost of adopting any construction technology or material is the value of the products that would otherwise be created by the resources needed for the construction practice. Essentially, the concept of national cost recognizes that national economic resources, both human and material, are by definition scarce--that resources allocated to one use are perforce not available for another. Thus, reduced national cost for any construction activity means that a given amount of real national income or product can be created with a smaller package of national resources, i.e., more income or product can be obtained from a given resource package.

The differences between national cost values and financial cost values deserve elaboration. First, the elements counted as costs may differ. Taxes minus subsidies are costs in a financial sense; but from a national standpoint they are transfer payments that can be disregarded--no real resources are involved. Second, the market price paid for any resource that enters into financial costs may differ from the national cost value of the resource. The difference is ordinarily attributable

to non-competitive forces in the market place that press the market price away from the marginal value productivity price that is appropriate to use in national costing. The marginal productivity price is typically called an accounting price or, more commonly, a shadow price. National costing replaces misleading market prices with shadow prices that are better measures of resource values. Thus national costing facilitates the identification of the cost reductions that are most significant from a national standpoint.

The national cost concept is often presented as one half of a cost-benefit accounting system. In the context of these Guidelines, however, the construction project and its benefits are treated as given--the only alternatives concern costs. Both financial costs and national costs deserve to be calculated as a single present-time value which is the sum of a series of discounted annual cost flows. Such a calculation permits the comparison of construction alternatives that have different time cost profiles, especially high initial cost and low maintenance cost versus low initial cost and high maintenance cost.

Price Distortions

In practice, in many if not most developing countries at least three kinds of market prices may be regularly distorted: market wages, especially at the unskilled level, tend to be distorted upward; interest rates on borrowed money and exchange rates on foreign currencies tend to be distorted downward. If costs were estimated from such distorted prices, the result might be, for example, the adoption of a highly capital-intensive technology employing imported equipment; if national costs were calculated which requires removing the distortions, it would be recognized that a far more labor intensive technology will be more consistent with the national economic interest.

Wages

In developing countries, devices such as legally imposed minimum wages tend to distort market wages--especially for unskilled labor--upward

to levels above those justified by labor productivity. Evidence of such distortion is provided by the massive urban unemployment (and under-employment) that is characteristic of most developing countries. One adverse consequence of excessive market wages is that the selection of construction technologies leans in the capital-intensive direction.

Interest Rates

Just as developing country governments try to support the incomes of low-paid workers by enacting wage minima, they try to help consumer-borrowers and small business-borrowers (and also governments as borrowers) by placing ceilings on interest rates. These ceilings reduce interest rates below the levels that would otherwise prevail. Like wage minima, they reduce the market cost of capital-intensive technologies vis-a-vis more labor-intensive alternatives.

The interest rates used in choosing a technology or a construction material that appears to be appropriate by the minimization-of-market-costs criterion include not only domestic rates but also the interest rates attached to loans from abroad that may be incurred to finance the importation of equipment. Such foreign rates are in many instances subsidized. In this respect the developing nation is encouraged by artificially low interest rates, both domestic and foreign, to choose relatively capital-intensive technologies. There is one essential difference, however: the suppressed domestic rate understates the national cost of employing capital equipment that is domestically financed; the low interest rate on loans from abroad, whether it be regarded as a subsidized rate or not, correctly states the cost to the nation of such financing.

Foreign Exchange Rates

The distortion of foreign exchange rates appears in developing countries typically in the direction of international overvaluation of the national currency. Such exchange rates encourage the choice of

technologies and materials that generally require a large amount of imported goods in proportion to domestic resources. The imports generally consist of capital equipment which, because of the low price of foreign exchange, appears to be inexpensive compared to local resources, such as labor. Thus distorted foreign exchange rates combine with low interest rates and high market wages to encourage (a) excessively capital-intensive technologies and (b) undue reliance on imported versus local inputs.

Foreign Exchange Savings and Employment as Goals

Governments of developing countries are often so concerned about reducing foreign exchange outlays and/or reducing unemployment that either or both of these objectives may be given greater priority than the reduction of costs in the financial or the national sense. As indicated above, if a country has problems of foreign exchange shortages or of unemployment, national rather than financial costing takes into account both of these kinds of problems.

When governments are not yet familiar with shadow prices and national costs, the foreign exchange and employment aspects of alternative technologies or materials may be addressed directly without use of national economic costing--and the wrong decisions can be made. For example, the government may not recognize that the alternative that minimizes foreign exchange outlays, or maximizes employment, may not minimize the total national cost. Minimizing national costs might require imported equipment that would be ruled out by consideration of foreign exchange effects alone; preoccupation with choosing construction technologies that provide large numbers of jobs for unskilled workers might result in excessive national costs associated with a prolonged period of construction. While these two separate cost-related concepts (foreign exchange and employment) need to be mentioned in these Guidelines, measuring alternatives directly in terms of the foreign exchange and employment effects is straight-forward and need not be given further attention.

Three Types of Cost-Reduction Opportunities

Within the field of public construction, opportunities to reduce costs--whether financial or national--are generally of three types. First, there are, or may be, opportunities to substitute less costly construction materials for those currently in use. Numerous alternatives, typically involving local materials, have been studied in the experimental projects (see Appendix B for examples). Opportunities of this type are likely to be eagerly sought in almost all developing countries.

The second type of opportunity involves an altered mix of resources on site, typically an alternative technology that involves a different capital/labor ratio from the technology currently in use.

The third type of opportunity to reduce costs centers on improvements in productivity rather than on changes in materials or capital/labor ratios.

The Guidelines are intended to facilitate the identification and implementation of all three types of cost-reduction opportunities.

III. IDENTIFICATION OF ALTERNATIVE PRACTICES

A. SELECTION OF CONSTRUCTION PROJECT COMPONENTS

The first step in the process of identifying alternatives is to select the construction activities and the construction materials that are to be studied. Generally, the selection will reflect national priorities in the public construction sector, probably as defined by the government.

The selected construction activities and materials will vary in scope and in detail depending upon the situation. At one extreme, an entire set of contemplated construction projects may be selected as the focus of attention. In such a case, the results of the cost-reduction analyses can be estimates of the total potential for cost reduction if identtifiable and definable alternative practices are employed. At the other extreme, particular problem areas in the construction sector may be selected. In this instance, the results of the cost-reduction analysis can be estimates of the cost-reduction potential by task in each problem area.

Selections during the three experiments have tended toward analyses of problem areas, such as:

- opportunities for local construction materials to substitute for imported materials;
- opportunities for more-effective internal distribution of the supply of construction materials;
- opportunities for technologies that are more labor-intensive; and
- opportunities to improve the maintenance of construction equipment now hampered by lack of spare parts and by inadequate labor skills.

(See Appendix B for a brief description of some actual experiences with these problem areas.)

Obviously, the more thought one gives to selecting projects or problems that are amenable to alternative technologies or materials, the more likely one is to achieve cost reductions. The output from the selection process may be a set of projects, or problem areas, or a combination of both.

It may be easy for the reader of these Guidelines to slip into the assumption that the typical cost-reduction opportunity lies in the direction of: (a) greater reliance on domestic (rather than imported) materials, and/or (b) the substitution of domestic labor (often unskilled) for capital equipment (typically imported). However, many attractive alternatives may not fit these patterns; and in some instances the opposite direction may be necessary. The patterns are likely to fit if a developing country has previously adopted the technologies and materials of an industrialized country without checking their adaptability to local conditions. However, if in the specific situation a nation is still using traditional technologies and materials, the appropriate cost-reducing changes are likely to be in the direction of more capital and more imports. At the same time, the danger is that the least financial-cost alternative to any existing practice may be one that goes too far toward a complex highly capital-intensive technology.

Thus, regardless of the current practice and of the direction of the needed change, the lowest financial-cost criterion will typically point to a more capital-intensive technology than would be called for by the lowest-national-cost criterion.

B. IDENTIFICATION OF ALTERNATIVE CONSTRUCTION PRACTICES

Having selected the construction project components, the next step is to identify the alternative practices that may be used to construct the projects or to overcome particular problems. To facilitate the identification, the relevant current scene in the construction sector should be described in terms of:

- the construction materials available, including quality, quantity, and price, and the structure of the construction materials manufacturing industry, including its distribution network; and

- the conventional construction technologies.

The desired performance of the finished project should be born in mind. No alternative practice that will change the specified performance should be entertained. The search is for an alternative practice which changes not the performance but the method of achieving it. An example would be the substitution for a high-quality cement-concrete road pavement of an asphaltic-concrete road without sacrificing specified road performance. Such a substitution, however, might present an opportunity for a reduction of cost in a tradeoff between initial cost and ultimate maintenance costs.

Next, alternative technologies need to be identified and listed be they the traditional ones currently or formerly employed in the country, or the more advanced technologies used in that country or elsewhere. While many of the possible alternative technologies can be found in the literature, the experiences of the participants in a cost-reduction project can provide possibilities. Alternatives may also be found by investigating the following:

- current government, academic, and private analytical and experimental research on improving the properties of construction materials and adapting them to new uses;

- development of the construction potential of indigenous natural or artificial materials;

- the degree to which material specifications have been frozen (perhaps inappropriately) into formal standards;

- the possibility of increasing, with the current technology, the productivity of labor and capital resources by eliminating lost time and motion and/or by reducing or eliminating waste of materials;

- the possibility of increasing, for a given mix of labor and capital in the technology, the productivity of the workers by increasing their motivation, by changing the allocation of tasks among them, by changing the number of personnel under a supervisory unit, or by modifying the method of payment;

- the possibility of increasing the usefulness of capital, again without changing the labor/capital mix, by replacing one unit of capital equipment by an alternative, more productive piece of equipment; and

- the possibility of devising an alternative mix of labor and capital, for example, by using another technology which can accomplish the identical task.

The illustrations in Appendix B show selected experiences bearing on the identification of alternatives.

Finally, one must assess the nation's technological capability to adopt each of the identified alternatives and discard those which appear to be beyond its current capability.

C. QUANTITY ESTIMATIONS

Once the alternative practices have been selected, they should be prepared for evaluation. The preparation involves the estimation of the quantities of the nation's resources--human and material--that the conventional practice and each alternative will require. The quantities to be considered are the consumptions of construction materials; the requirements for unskilled and skilled construction labor and for supervisory and managerial personnel; and the capital equipment, including spare parts, fuels, and lubricants.

To get a valid comparison, it may be necessary to define both the conventional practice and the alternative practices by preparing drawings and specifications in sufficient detail that:

- the scopes of the conventional and the alternative practices are of comparable magnitude; and
- material takeoffs can be made in the usual manner for each practice; and
- the technological practices involved in the constructions are clear.

The last item is required for the estimation of labor and construction equipment requirements. The accuracy of the estimations in these respects may need to be limited because the available data on productivity of labor and equipment are sparse and inadequate to describe productivity, especially when the alternative involves a significant change in the environment of the field activities from that conventionally practiced.

IV. EVALUATION OF ALTERNATIVE PRACTICES

The objective of the evaluation of alternative practices is the selection for eventual implementation of those practices that incur the least national cost. Much effort can generally be saved by screening the alternatives in advance of the detailed evaluation. If there is more than one alternative to the existing practice or if there is doubt that any of the alternatives has cost-reduction potentialities, the preliminary screening is an essential first step in the evaluation.

In these Guidelines, however, the evaluating techniques are discussed and then the screening. This sequence is used because the evaluating techniques must be understood before the screening elements can be selected. Nevertheless, in an actual application of the Guidelines the screening would be the first step.

To evaluate and compare the cost-reduction potentialities of one or more alternative technologies or materials to any existing practice, the quantity estimate discussed in the preceding chapter must be costed out in financial and then in national terms. Although financial-cost estimates are needed, the costing ultimately should be done from a national economic standpoint. Even if a nation has decided that technologies or materials will be selected entirely on a national cost basis, financial costing is necessary, for at least two reasons: (1) financial costs need to be assessed in order to plan the financing of the alternative technology or material; (2) the easiest way to calculate national costs is to make adjustments in financial cost numbers. Accordingly, the financial costing should be done first, then the national costing.

A. FINANCIAL COSTS

The financial costs of any construction practice should be calculated on the basis of the ordinary market cost prices expected during each year of the construction and selected maintenance periods. Costs should be tabulated on a full cash basis culminating in a series that shows that total outflow of funds in each year (or part of a year). Flows for each practice or component within a construction project can be summed for each year to provide a series of aggregate annual flows for the entire period to be covered by the costing.

Table 1 provides a format for tabulating summaries of the calculations of both financial costs and national costs. The combination is not only convenient but also helps the understanding of the relationships between the two types of costing. The format is comprehensive enough to accommodate an entire project or it can be used for handling the costs of a single practice. The financial costing of the project requires only the first of the three columns provided for each year. Entries should be numbered to facilitate reference to specific results.

As the format suggests, expenditures of all kinds need to be tabulated: e.g., land (purchase or lease), equipment (purchase or rental), labor by type and skill category, materials, supplies, fuel and utilities, and interest and profits. The inflow and outflow of loan principal should be entered along with the outflow of interest, although such flows are usually calculated with respect to the project as a whole rather than for each practice or component. With regard to equipment, however--particularly if purchased abroad--it is possible to show loan flows for individual project components. Finally, in anticipation of national costing, the taxes paid and subsidies received (whether direct or indirect) need to be entered.

TABLE 1

FINANCIAL COSTS AND NATIONAL COSTS OF A CONSTRUCTION PRACTICE OR COMBINATION OF PRACTICES
(In Domestic Currency Units for the Period Covered by the Costing)

	Year 0			Year 1			Year n		
	Financial Outlays	Shadow Coefficient	National Outlays	Financial Outlays	Shadow Coefficient	National Outlays	Financial Outlays	Shadow Coefficient	National Outlays
OUTLAYS TO FOREIGNERS									
1.1 Equipment (purchase or lease) and Spares	xxx			xxx			xxx[1]		
1.2 Imported Materials	xxx			xxx			xxx[1]		
1.3 Personnel	xxx			xxx			xxx		
1.4 Other Operating Outlays	xxx			xxx			xxx		
1.5 Loan or Equity Principal (from)/to abroad	xxx			xxx			xxx[2]		
1.6 Interest or Dividends to abroad	xxx			xxx			xxx		
1.7 TOTAL, FOREIGN	xxxx[3]	xx[4]	xxxx	xxxx[3]	xx	xxxx	xxxx[3]	xx[4]	xxxx
DOMESTIC OUTLAYS									
2.1 Labor, classified by skill level	xxx	xx	xxx	xxx	xx	xxx	xxx	xx	xxx
2.2 Land Rents	xxx	xx	xxx	xxx	xx	xxx	xxx	xx	xxx
2.3 Natural Resource Depletion	xxx	xx	xxx	xxx	xx	xxx	xxx	xx	xxx
2.4 Equipment Use	xxx	xx	xxx	xxx	xx	xxx	xxx[1]	xx	xxx[1]
2.5 Materials, Supplies, Utilities and other inputs not covered by items above	xxx	xx	xxx	xxx	xx	xxx	xxx[1]	xx	xxx[1]
2.6 Loan or Equity Principal (from)/to domestic investors	xxx	n/a	n/a	xxx	n/a	n/a	xxx	n/a	n/a
2.7 Interest or Dividends to domestic investors	xxx	n/a	n/a	xxx	n/a	n/a	xxx	n/a	n/a
2.8 Taxes, net of subsidies	xxx	n/a	n/a	xxx	n/a	n/a	xxx	n/a	n/a
2.9 TOTAL, DOMESTIC	xxxx		xxxx	xxxx		xxxx	xxxx	xxxx	xxxx
TOTAL FINANCIAL COSTS	xxxx			xxxx			xxxx		
TOTAL NATIONAL COSTS			xxxx			xxxx			xxxx
SUM OF PRESENT DISCOUNTED VALUES OF TOTAL FINANCIAL COSTS[5]: xxxx									
SUM OF PRESENT DISCOUNTED VALUES OF TOTAL NATIONAL COSTS[6]: xxxx									

[1] ...ancial or national values of equipment and materials earlier charged to project but remaining at end should here be credited.

[2] ...le may treat all obligations of principal as paid at end of final construction year (year n) even though actual amortization period may be longer.

[3] ... be used as a measure of foreign exchange costs.

[4] ...dow foreign exchange rate.

[5] ...h year's total to be discounted at market rate of interest at which project is likely to be financed.

[6] ...h year's total to be discounted at national time-preference rate.

[n/a] ...ot applicable to national costing.

It is useful to compile and arrange outlays to foreigners separately from outlays to domestic suppliers of inputs to a project. This separation does not, of course, affect the magnitude of total financial costs, but it facilitates making the adjustments that convert financial costs into national costs and, in particular, it helps the reader of an evaluation report to understand the relationships between the two cost concepts.

The format is designed for cash outlays which means that all inputs of materials, equipment, and services are treated as if they are paid for immediately. All inflows and outflows of loan and equity principal, along with payments of interest and dividends, are included as well. Inflows of principal are of course entered as credits. The accounting time units are taken to be years, but shorter units can, of course, be used. The time span of a format should be at least as long as the actual construction period. If each of the construction practices being compared entails a different set of maintenance costs for the finished structure, the time coverage of the format should be equal to the period of construction plus maintenance. The value of all liabilities at the end of the evaluation period can be entered in the final year. The format also accommodates the costing of capital items that can be either purchased or leased. If the item is purchased, provision is made for crediting its value at the appropriate time.

To develop a single figure that represents the total of the financial costs of each practice or component, the total cash flow for each year should be discounted back to the beginning of the project. The appropriate discount rate is the average interest rate that the government pays on its long-term borrowings. Then the several discounted annual values can be summed to obtain a single discounted present value of all financial costs, which can then be compared with similar sums of financial costs for existing or alternative technologies or materials. The final financial evaluation step can be the calculation of the present discounted cost value for the project as a whole or for each combination of alternative practices that has merited full financial analysis.

Once the financial costing indicated by the format has been completed, the national economic evaluation can be done. Prior to the national costing of any alternative, it may be worthwhile--depending upon the government's attitude--to assess the impact of the alternative on foreign exchange reserves, and to measure the employment effects of the alternative. The employment numbers can be drawn from the quantity estimations described in Chapter III, and the foreign exchange magnitudes can be read from the row entitled "Total, Foreign" (Entry 1.7) that concludes the OUTLAYS TO FOREIGNERS panel. Neither of these two attributes of a practice carries the fundamental merit of a national cost evaluation, but they can be useful to governments that are interested in these two superficial measures of the national worth of a technology or a material practice.

B. NATIONAL COSTS

As the tabular format suggests, the amounts for national outlays are obtained by applying shadow coefficients to the financial outlay amounts. Each coefficient is the ratio of the shadow or accounting price of an input to the market price of that input. The conceptual basis of a shadow or undistorted price was discussed in Chapter II. The process of estimating shadow prices can range from simple inference with little or no calculation to elaborate mathematical procedure.* Ideally, the shadow cost prices to be used in the national costing of projects should be prepared in a central economics office and then used by project evaluators throughout the government. Not just construction projects but all kinds of projects should be provided for in the preparation. To the extent that they utilize the same national resources under the same circumstances, industrial projects, power plants, mining installations, investments in agriculture and fishing, and others should be evaluated using the same shadow prices.

Although each country needs a set of nationally agreed upon, and frequently revised, shadow cost prices, it should not be inferred that the national costing of construction projects cannot take place until the nationally approved shadow coefficients are available. Any shadow prices estimated, however crudely, by the evaluators of construction projects are likely to be closer to the true shadow coefficients than would market prices. Thus, such provisional shadow prices should be used until more carefully researched prices are available. The use of provisional shadow coefficients will at least push the choice of technology or material in the right direction.

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* The exposition of such procedures lies outside the scope of the Guidelines. cf. I.M.D. Little, and J. A. Mirrlees, Manual of Industrial Project Analysis, Volume II, Social Cost Benefit Analysis (OECD, Paris) 1969 or the successor work, Project Appraisal and Planning for Developing Countries (Basic Books, New York) 1974; also UNIDO, Guidelines for Project Evaluation (New York) 1972.

The format table is set up to measure costs in domestic currency units; it could be set up to utilize foreign currency units instead, but doing so would make the format more cumbersome, as will be indicated shortly.

The tabular arrangement which lists outlays to foreigners in the upper panel facilitates the adjustment of financial costs--an adjustment that is needed if market foreign exchange rates are distorted. Because all outlays to foreigners would be distorted to the same degree, the correction in the form of multiplication by the shadow coefficient may be made only once for each year to the foreign total for that year. If the domestic currency is overvalued internationally, the correction will raise the domestic currency value of outlays to foreigners. If it is expected that the degree of distortion will change during the course of the project, the coefficient for each year may be different in accordance with the expectations. The coefficient applies not only to current account imports, but also to interest, dividends, and loan or equity principal moving in either direction. The national cost of foreign outlays in year n (the final year of the evaluation period) will be reduced by the value of any imported equipment or materials that are expected still to be on hand at the end of year n.

Under "Domestic Outlays" there are five categories of real resources which in any calculation of national costs can be divided into as many sub-categories as are needed to accommodate each shadow coefficient that may be called for. Labor, for example, is likely to be divided into a number of classes. The shadow cost prices appropriate to a given skill level of labor will probably vary from locality to locality within the country and perhaps from season to season. If unskilled workers are being shadow priced and they can be recruited from sizable reserves of unemployed workers in the cities, the shadow wage may be close to zero; at the same time, unskilled workers in rural areas may warrant higher shadow wages because they must be recruited from farms at some cost to the level of agricultural output. Shadow wages in rural

areas are likely to vary seasonably: during times of active farming, such as the harvest season, shadow wages may be high; during the off-season, shadow wages may be virtually zero.

One practical difficulty in computing the shadow wages of workers to be drawn from the farm is the lack of knowledge in many societies of the extent to which agricultural output will be curtailed as farm workers are recruited into other activities, such as construction. It is agreed that in developing countries there is ordinarily substantial underemployment in agriculture--that the typical farm worker is not productively busy full time during the working season. The question becomes, then, to what degree total farm output falls as men leave the farm for construction work. If the remaining farm workers fill the gap, and thus lessen their own underemployment, the marginal productivity of the men who have left tends to be nil and shadow wages can be corresponding low. If, on the other hand, the remaining workers apply themselves no more diligently than before, the marginal decrement to agricultural output, which determines the shadow wage, may be sizable.

Coefficients to be applied to land rents and the depletion of natural resources would, of course, reflect the values that would otherwise be produced by these resources. Equipment and materials, etc., would need to be adjusted in accord with the shadow prices of the resources that compose them; insofar as these materials contain imported inputs, a foreign exchange shadow may need to be used. Ideally, the foreign elements in all domestically purchased inputs such as equipment, materials, supplies, and utilities, should be separated from the values added domestically, and the latter should be further separated into shadow-priced pieces. Insofar as such calculations have already been made for other national costing purposes within a country, the calculated prices should be adapted and used in computing the national costs of construction practices.

A significant difference between the financial and the national columns in the table is that the latter contains no provision for flows of loan or equity principal and associated interest and dividends flows. The omission follows from the fact that such flows are not costs in the national sense; they are merely transfers. The real national cost of the passage of time is provided for by the discounting of all national cost flows back to the time point at which the project begins.

Similarly, there is no provision in the national outlays column for any taxes, net of subsidies, that may be levied on the project or any component practice. Again, such financial outlays are transfer payments; they do constitute payments for the use of real resources.*

Once all the cells in the national outlays columns have been filled, the columns can be summed and each year's sum can be discounted back to the beginning of the project calendar. The discount rate to be used is the third type of shadow price; the rate is commonly called the national (or social) time preference rate and may be thought of as the basic long-term interest rate that would prevail in the absence of ceilings or other manipulative forces. If the national rate is expected to change over time, each column sum will need to be discounted two or more times, each discounting operation taking the sum back to a time point at which the

* It can be argued that net taxes (taxes minus subsidies) should not be ignored because taxes are a measure of the resources used by government in providing services to a construction project or to those who provide the taxed input. If the level of taxes on any good or activity were commensurate to prices of governmental services, the argument might be plausible; typically there is no such relationship. Indeed, the taxes that are to be abstracted may have been levied more for regulatory than for revenue-producing purposes. It is not being suggested here that construction projects do not entail government services; rather, because of the difficulty of isolating and measuring such services, construction practices and projects can best be compared as to national costs by removing all taxes and subsidies.

national rate changes; then the sum is discounted at the changed rate, etc., the process ending at the calendar start of the project.

The total of the discounted national outlay sums is, then, the present value of the national cost of the practice or combination of practices measured in the table. Valuations in this manner of a number of alternatives should allow the identification of the one carrying the lowest national cost.

In a somewhat more complicated problem of national cost comparisons, alternative practices of different time durations means differences in the time at which the flow of project benefits can begin. In such a situation, the national evaluation must embrace not just costs alone, but both benefits and costs.

The adoption and eventual implementation of the lowest-national-cost alternative can be awkward if that alternative differs from the one that promises the lowest financial costs. Budgetary costs will then be larger than if the second alternative were chosen. (See Chapter V for a discussion of the attitudinal obstacles posed by those who do not understand national costs and/or those who concentrate on problems of financing projects.) But the higher budgetary costs in no way impair the low national costs. The higher financial costs to the Treasury should be regarded as intra-national money transfers needed to pay the financially more expensive national resources--typically unskilled labor.

C. SCREENING

If there are several alternatives to an existing practice or component and a full financial and national evaluation of each is not warranted, the several options may be screened to narrow the field to a number that can be fully evaluated.

Screening techniques will vary from instance to instance, but the process is ordinarily one of selecting the cost elements, for the existing practice and each of the suggested alternatives, that are likely to be changed most drastically and estimating them roughly, usually without discounting. The most likely cost elements are imported equipment, domestic versus imported materials, and unskilled labor. Financial and national cost estimates should be made for these elements. The evidently higher cost practices can be discarded and detailed evaluation can be given the remaining more promising candidates. Occasionally, the full evaluations may indicate that a previously discarded possibility deserves evaluation, also. In any event, the screening stage is useful in avoiding a detailed assessment of every alternative practice that has been found to be technically feasible.

V. OBSTACLES TO THE ADOPTION OF COST-REDUCING PRACTICES

Unfortunately, the selection by a government of a practice or set of practices for implementation because of their cost-reducing virtues is ordinarily not sufficient to prompt the needed action. Typically a host of obstacles, some of them rather formidable, has to be overcome. Each country needs to identify the kinds of obstacles that may hamper the realization of lower costs; each type of proposed practice may carry its own unique set of obstacles.

This chapter provides lists of some of the kinds of obstacles that may be encountered. The list is no more than suggestive. In each country the obstacles that beset cost-reduction need to be identified and scrutinized. Moreover, each project and each practice within any project deserve separate examination, because remedies are often specific to the particular obstacle to be overcome. Many of the obstacles beset those situations in which the lowest-national-cost practice does not coincide with the lowest-financial-cost practice, but there are some obstacles that hamper the implementation of even those opportunities where the two minima coincide.

Obstacles can conveniently be categorized as: (a) those that are legal or procedural, including financial; (b) those that follow from the nation's lack of full competence to implement the desired practice; and (c) those that derive their strength as impediments from the attitudes of people. Many of these various obstacles are sometimes described as institutional, but endeavoring to segregate those that can be aptly called institutional serves no particular purpose.

A. LEGAL AND PROCEDURAL OBSTACLES

Distorted Prices

It can well be argued that the distorted prices, which necessitated the separate calculation of national costs in the first place, constitute the basic set of obstacles to the implementation of low-national-cost practices. In most countries, these distortions are brought about by governmental action, although in some nations, strong autonomous labor unions may have forced wages to levels above those justified by marginal productivity. Distorted prices are obstacles precisely because they tend to make the lowest-national-cost technology or material more financially expensive than some alternative practice.

Price distortions are typically caused by governmental control or administration of prices such as foreign exchange rates, interest rates (via ceilings), and wage rates and supplements (via floors). Excessive wage rates and fringes may also be occasioned by powerful labor unions. Some private companies may have the monopolistic or monopsonistic power to set the prices at which they sell or buy. Prices may be distorted too by governmental taxes and remissions of taxes. Taxes that are a function of wage payments, such as taxes to finance government-paid labor supplements, operate like increments to legal wage minima. Whether in the form of reduced rates or of full remissions, remissions of customs duties on imported capital equipment have the same effect as an unduly low set of exchange rates on foreign currencies.

Persons in the public and private sectors responsible for financing construction projects understandably resist the adoption of practices that require larger money outlays. Within the private sector, the resistance may be almost overwhelming; the private contractor, for example, has no incentive to adopt any altered technology or material unless he can thereby reduce financial costs. Any government that takes reducing national costs seriously must eliminate or offset the adverse impact of distorted prices. Most times, the corrective action is fiscally expensive.

Labor Requirements

Quite apart from distorted prices in the form of excessive wages, labor laws and practices insisted upon by powerful labor unions may stand in the way of using labor in a lowest-national-cost pattern. Thus, laws and practices that are intended to protect labor may nevertheless stand as obstacles to the sensible use of that resource. Laws and contractual provisions stipulating the minimum number of workers to be retained for any task, or hampering the right of the employer to terminate redundant employees, may in the short run enlarge employment but over the longer pull discourage the choice of technologies or materials that are relatively labor-intensive. Rather, the contractor--typical of firms in such a situation--elects a more capital-intensive practice that appears to promise escape from problems of expensive compliance with the rules to which he would be subjected if he chose a labor-intensive practice.

Government Procedures

In many developing countries, there are rules and patterns that are followed within government, and between government and other parties, such as architects and contractors, that stand as barriers to change either by: (a) plainly confirming established technologies and materials or (b) including procedures that bias results in favor of certain practices. The former obstacles appear in rules for design and specifications and in approved contractual language. The latter can be exemplified by the rating of contractors in terms of their ownership of equipment, a procedure that results in relatively capital-intensive technologies.

Bank Lending Practices

A similar situation is the tendency of banks to more readily provide funds for investment in capital equipment than for the coverage of operating expenses, such as wages. The bias toward equipment becomes a bias toward imported equipment as governments turn to international or

foreign banks that seem to have more funds available and on better terms than do strictly domestic banks. (These better terms may be essentially a subsidized interest rate that is costly to the outside world but not to the developing country itself; thus the subsidies operate to encourage more capital-intensive methods that are costly from a world standpoint even if not from the standpoint of the developing country.)

Sequence of Project Formulation

One sequential aspect of construction project formulation typically operates as an obstacle. In planning construction projects, the technologies and materials that compose each component and the project as a whole are selected prior to costing. Such a procedure effectively blocks the creative search for less costly practices in everyday project planning and exemplifies the reasons that can be advanced for the undertaking of a comprehensive cost-reduction project in each developing country.

Faulty Records

Finally, among the legal and procedural obstacles may be listed the inadequate and often inaccurate cost accounting records that are kept in many countries. Accounting procedures may not have been established to produce the needed cost data, and often the actual record keeping is even less satisfactory than the prescribed procedures. Occasionally, the accounting conventions in use are appropriate to an advanced country but not to a developing country. A particular example of an inappropriate convention is the all-too-common practice of depreciating equipment according to life schedules prepared by manufacturers for use in advanced countries. Such schedules assume a degree of competence on the part of operators and a level and schedule of maintenance that are not characteristic of developing country situations. Furthermore, often in developing countries equipment that is still operable is abandoned because of the high cost of moving it to the next site. Because of these features of construction in developing countries, equipment needs to be depreciated more rapidly.

B. LACK OF NATIONAL CAPABILITY TO IMPLEMENT

Shortage of Expertise

Once an opportunity to reduce costs has been firmly identified and evaluated, implementation may have to await the nation's attainment of the needed capabilities. The low-cost-technology or material may call for expertise that is not yet available within the country. If the practice is newly devised, even the advanced countries may not yet have people qualified to implement it. Realization of such opportunities will have to be postponed until the deficiency can be overcome.

The needed expertise may be technical or it may be managerial. A significant example of the latter is the felt lack of ability to manage the large crews of workers that would be called for if relatively labor-intensive technologies are to be applied. Some countries had this competence at one time but lost it as relatively capital-intensive technologies became the conventional practice.

Poor Health of Labor Force

There is evidence that a principal obstacle in many countries to the enjoyment of reduced costs through labor-intensiveness is the poor health and associated low productivity of the candidate labor force. Only as this basic obstacle can be overcome through adequate nutrition and sanitation, can many of the otherwise promising cost-reduction opportunities be realized.

Shortage of Wage Goods

A formidably similar but less crucial obstacles is the unwillingness, if not the inability, of some countries to undertake labor-intensive technologies because of the non-availability of the kinds of goods and services (apart from those essential to health) on which construction workers would want to spend their wages. Plainly, construction programs -- especially those in rural areas -- need to provide not only for operating supplies and fuel for equipment, but also all that is needed to fulfill the consumption expectations of workers and their families.

Seasonal Availability of Workers

An obstacle frequently encountered in rural areas to the adoption of relatively labor-intensive technologies is the seasonal availability of workers. Labor may be available for construction activities only during off-seasons in agriculture. An obstacle of this type is to be accommodated rather than overcome.

Supply Faults

Just as the human resources needed for implementation may not be available, the requisite material resources in the form of equipment or newly formulated materials may be immediately lacking. In some instances, the new practice may have been proved in the laboratory but is yet to be produced on a commercial scale. Or the problem may be that the realization of the low-cost potential depends upon economies of scale that require adoption of the new practice in a number of countries.

Impaired Equipment

Another example of this type of capability obstacle is the characteristic inability of developing countries to maintain equipment properly. This fault, along with incompetent and careless operation of equipment, impedes the cost-reduction potentialities of many relatively capital-intensive technologies.

C. ATTITUDINAL OBSTACLES

In addition to the types of obstacles that can be categorized as legal and procedural, and as capability-related, there is a set of pervasive and remarkably stubborn obstacles that can be called attitudinal or psychological.

Inertia

The most important of these obstacles may be sheer inertia. Once a given practice has become accepted and established, everyone who comprises the public construction sector in the country tends to become emotionally attached to the current practice. This attitudinal attachment becomes a formidable obstacle to any proposal for change, even if the cost-reduction implications are clear and rationally convincing.

Self Interest

Inertia as an obstacle is regularly reinforced by outright opposition that may be based on self-interest with an admixture of prejudice. Opposition is likely to be encountered from anyone who believes his income or his position in society is threatened by the proposed cost-reducing practice. Opponents can thus include architects and designers, manufacturers and suppliers of equipment, repairmen, public employees, bankers and insurance companies, contractors and their staffs, skilled and semi-skilled construction workers, and even unskilled workers. All of these types of persons who are receiving incomes associated with existing practices and who are not certain that alternatives of which they are aware will benefit them, are likely to become opponents of change.

Preference for Capital Intensiveness

A third type of attitude that can beset some technologies is exemplified by the typical preference of the engineer for capital-intensive practices employing the most recently developed technologies and the most sophisticated materials. This preference becomes an obstacle if the national cost evaluation suggests a practice different from the one to which the engineer is attracted. The engineer may have a congenital as well as a conditioned preference for managing machinery and against managing men. The crucial task of motivating crews of men to high levels of cooperative productivity may be particularly outside

his preference bailiwick. All of these attitudinal characteristics stand in the way of labor-intensive technologies relying upon domestic labor, materials, and equipment.

Unfamiliarity with National Costs

Finally, many decision-makers are not sufficiently acquainted with the concept of national costs and its merits. Such persons are likely to concentrate on reducing financial costs and to resist the adoption of any practice which cannot be justified financially.

VI. IMPLEMENTATION OF COST-REDUCING PRACTICES

Once alternative practices that promise to reduce national costs have been identified, they must be implemented by appropriately modifying the plans for individual construction projects. Some projects may require no more than one substitution of a replacement practice. In other cases, the changes in technologies and materials may be many and drastic.

Regardless of the simplicity or complexity of the cost-reductions, the government will have to prepare an implementation plan, or perhaps a set of implementation plans, to overcome the obstacles to the desired changes so that the reductions in national costs can be realized. In some instances, the implementation plans will need to be tailored to particular construction projects. In other instances, the implementation plans can be formulated and carried through without links to particular projects.

This chapter concentrates on the portions of the implementation plans that are intended to overcome obstacles. The most workable approach is to take the types of obstacles that were discussed in Chapter V and consider them in terms of the government actions that might be taken to overcome them.

In the instance of particular patterns or construction projects, the distortions that concern us are those that point to minimum financial cost alternatives that are different from minimum national cost alternatives. One group of remedies calls for inducing an alteration in market prices as seen by the decision-maker so that, in choosing practices on the basis of financial costs, he will select those that also minimize national costs. One rather obvious means for affecting market prices is by placing taxes on the principal inputs of the practices that are to be discouraged and/or providing subsidies to the principal inputs of the practices that are to be encouraged.

A. ALTERING FINANCIAL PRICES THROUGH TAXES AND SUBSIDIES

Price distortions have been presented as forces that operate to direct resources into practices inconsistent with low national costs. It is, accordingly, tempting to want to urge governments to repeal or amend all laws and regulations that have such distorting effects. While such changes in laws may occasionally be in order, most times the offending legislation was enacted for purposes that appear to the government to be more important than reducing costs in public construction. In practical terms, a good technique for inducing the needed alteration in market prices is to remove the particular distortions affecting construction costs by taking specific exceptions to the governmental policies that have caused the distortions in the first place.

The most workable ways of removing the distortions are: (a) to tax the principal input items in the undesired practice so as to raise their market prices, or (b) to subsidize--either outright or by remission of taxes--the principal input items in the desired practice to reduce their market prices. A combination of the two can, of course, be used. It should not be supposed that, in the instance of a combination, the taxes on unwanted inputs will generate funds that can finance the subsidies on wanted inputs. Rather, if the taxes have their intended effect of halting the undesirable practice, no revenues will be produced. On the other hand, tax remissions mean revenues foregone, and outright subsidies mean expenditures of tax revenues. In either event, if government outlays for other purposes are not to be curtailed, means of providing additional revenues must be found.

Apart from the administrative costs of collecting revenues and distributing proceeds, such flows of funds into and out of the treasury impose no real cost on the national economy. The nation's total product is in no sense impaired; such subsidies and tax remissions

essentially are nationally costless because they are merely transfer payments. Moreover, not only do these fiscal flows not entail real (national) costs, their effect is, of course, to reduce real costs by inducing decision makers to do a given construction job with fewer real resources. This does not mean that it is easy for the government to devise the needed revenue-producing taxes: the problem is one of distribution of income, not of the amount of that aggregate income.

The difficulty with a subsidy is the awkwardness of finding the tax revenues with which to finance it. Moreover, money payments as a form of subsidy open the way to political difficulties that would not be faced by imposing deterrent taxes on the nationally undesired inputs. On the other hand, the use of deterrent taxes means that the financial price of the entire construction project is higher than it would be if subsidies were used. Thus in either instance taxpayers provide the funds (except, of course, as the construction project is paid for by those who receive the benefits of the project).

As an example of the kind of approach that is required, the government's evaluation may have shown that national costs can be reduced by not importing certain pieces of equipment. However, the equipment is imported because: (a) the domestic currency is overvalued in foreign exchange markets, and/or (b) the government, to encourage industrialization, has declared machinery and equipment to be free of import duty. Thus, the appropriate remedy may be the levying of an import duty of sufficient magnitude to deter purchases. Similar taxes on other imports involved in the undesirable practices may lift the total deterrent to a level adequate to make the desired practice the financially least costly. If taxes alone cannot correct this distortion, subsidies or tax remissions may be necessary.

The offsetting of the distortions caused by high minima for wages and supplements poses a special problem. The stipulated levels of remuneration are always intended to provide minimum levels of living for workers and their families, levels that a nation may not be ready to compromise for the sake of national cost reductions. The most promising course of action is the providing of wage (and supplements) subsidies -- either directly or through the remission of employment taxes -- high enough so that government officials responsible for public construction and private firms engaged in public construction see the net financial cost of labor as being low enough to warrant the level of labor use called for by the lowest-national-cost practice. (Such subsidies would appear to be far preferable to any coercive requirement by government that certain numbers of workers be hired for certain tasks, since it might not be enforceable and probably would jeopardize morale at every level.)

While no firm guidelines can be drawn as to the particular combination of taxes and subsidies necessary to achieve the desired financial price patterns, one or more such combinations should be sufficient to accomplish the principal purpose.

B. PROHIBITIONS

On occasion, rather than taxing an undesirable material or piece of equipment to raise its cost price to a deterrent level, it may be advisable for government to prohibit the objectionable item. Such an instrument is most likely to be workable when the item to be proscribed is an import. Occasionally, the government may prohibit the local manufacture of the material or equipment. In some circumstances, rather than prohibiting importation or domestic manufacture, the government can specify the materials to be used for a given project in a way that excludes those that are undesirable. For example, if all cement is imported and the government wishes to exclude cement for certain uses while not penalizing other uses by taxes on cement, the exclusion can be handled by specifying the specific materials that are to be used.

Prohibitions that require on-site enforcement for their effectiveness are not likely to be workable. If a given type of equipment is to be used for certain tasks but not for others, the correct approach is probably a level of tax that renders the undesired use uneconomical from the standpoint of the contractor.

C. PRESCRIBED PROCEDURES

To overcome obstacles in the form of faulty designing and contracting procedures, the need is plainly to alter the procedures. If they have been written to require or show a preference for a given material or piece of equipment or process which is nationally costly, the language must be modified. Similarly, if labor laws and regulations operate to deter technology decision-makers from choosing processes that are labor-intensive as lowest national costs dictate, revisions are in order. Appropriate for revision are any regulations that render the hiring, management, and firing of labor so difficult that the employer is induced to use imported equipment-intensive technologies instead.

Another pertinent procedural area is accounting. Systems must be introduced that: (a) provide complete and timely records of financial costs; and (b) incorporate all the data needed for the national costing of any practice or construction project. For example, records of equipment cost and use should facilitate proper machine maintenance, inventorying of spare parts and depreciation charges.

One procedural change that deserves general adoption would require construction project planning to take into account the financial and national costing of alternative technologies or materials that had, by earlier evaluations, been found to carry attractive low national costs. Such a procedure is needed to obviate the sequence in which the tech-

nologies and material components of a project are locked-in before the project is costed. The procedures should facilitate, for example, the planned recruiting and scheduling of labor. Rural labor may be available only in agricultural off-seasons. The government should formulate and cost alternative plans and schedules that consider transported urban labor or less labor-intensive techniques as alternatives to episodic progress using local rural labor.

D. EDUCATION AND TRAINING

A number of the potential obstacles are, fundamentally, ignorance of one kind or another. The elimination of ignorance is ordinarily not, of course, a suitable component of any construction project implementation plan: essential to the elimination of this obstacle is a program of education and training. But in planning any construction project, this obstacle must be faced, and this often requires provision for the importation of the needed expertise and possibly, for large projects, for on-the-job training of indigenous personnel.

Lack of knowledge may range from an absence of technical or managerial know-how to the type of ignorance that manifests itself as opposition to any sort of change in construction technologies or materials.

Almost every developing country has a shortage of construction and materials engineers and of managers, including managers of labor. Education of such people, both domestically and abroad, is needed. Furthermore, the type of education that is now provided needs to be altered and enriched, since the typical engineering curriculum in the universities of both advanced and developing countries conditions students to regard the most heavily capital-intensive technologies as almost inherently superior; students are led to regard indigenous materials and techniques as almost necessarily inferior. Curriculum changes are

needed to prevent such indoctrination. Furthermore, students need to be adequately grounded in cost analysis, both financial and national, in order for them to become cost-conscious and appreciative of the theoretical basis of national costing. More education -- or at least more appropriate education -- is also needed for accounting personnel who contribute to the planning of projects and the keeping of project performance records.

Training of labor is also needed to enlarge the supply of skilled construction craftsmen, equipment operators, and repair mechanics. The training can impart not only skills but also a flexibility of outlook that fosters cost-cutting innovations.

E. RESEARCH AND DEVELOPMENT

To help overcome obstacles associated with introducing technological innovation, every developing country should have, or have access to, research and development facilities that can develop or adapt equipment, materials, technical processes, etc. These facilities can and should be especially helpful in perfecting the material aspects of practices whose national costs have been found to be low but which must be refined or adapted by a research and development facility before they can be used on specific projects.

F. PROVISION OF AMENITIES

To help overcome obstacles associated with health and morale, the government may need to plan for and perhaps stipulate within the contracts for each project the provision of nutritious diets, sanitation facilities, medical care, worker housing, etc. Generally, these goods and services will be provided to workers without charge as part of the wage package; in some instances, workers may be entitled to receive cash instead of such wages-in-kind. If recruitment and morale is

jeopardized by a lack of consumer goods on which wages can be spent, either in the project area or in the country as a whole, the government may wish to take corrective action.

G. HANDLING ADVERSELY AFFECTED PARTIES

Change, however beneficial to society as a whole, is bound to hurt someone, relatively if not absolutely. Accordingly, the implementation of alternative practices is occasionally jeopardized by the opposition of the persons involved in the existing practice who realize that they will be either economically or socially hurt by the proposed change. Insofar as their fears are not well-founded, education may be the answer. If their concerns are legitimate, government may quite properly want to take ameliorative action. Programs to retrain, to find outlets for skills or services within the alternative practices or elsewhere in the national economy, to compensate for inventory losses, etc., may be very much in order.

H. POLICING

Finally, to the extent that the nationally desirable practices cannot be made economically (i.e., financially) preferable to everyone involved in their implementation, the government may need to provide for construction project monitoring and for policing action within its own oversight program. Such action should be taken only as a last resort. It is pertinent, however, that just as inspections and approvals may be needed with respect to the physical construction, so also may they be called for to insure that the technologies and materials conform to lowest-national-cost criteria.

I. IMPLEMENTATION

Once obstacles have been identified and assessed, and the means for removing them have been selected and designed, a comprehensive implementation program may be called for that effectively eliminates or neutralizes obstacles and that assumes that lowest-national-cost practices are actually used in the planning and implementation of construction projects.

VII. ESTABLISHING A COST-REDUCTION PROJECT

Previous chapters have concentrated on what needs to be done to reduce costs in the public construction sector. This chapter discusses how to undertake these actions in a formal manner.

Efforts to achieve cost reductions need not be undertaken formally, of course; they can be ad-hoc and involve numerous activities of many more or less unrelated individuals or groups. If so, the guidelines in the previous chapters are pertinent and should be useful, but the disadvantage of numerous ad-hoc activities is that seldom can a cost-reduction opportunity be implemented in isolation. Rather typically, the national obstacles to cost reduction will be too formidable and too widespread to be overcome by the managers of a given construction project. In a given national situation, a formal organization of the cost-reduction efforts into a single project can result in far greater cost-reduction benefits in public construction than an ad-hoc approach. Moreover, a formal organization, especially if it is a top-level one, can generate an esprit de corps that should help to motivate the personnel engaged in the work.

The guidelines in this chapter apply to such situations. The results of their application--the plans of the cost-reduction project--should be formally recorded for convenient reference during the life of the project. The record may be in the form of a Project Statement. It may be desirable to issue the Project Statement as a public document for wide distribution, under the name of the organization responsible for its accomplishment. Its contents may be organized as indicated in Table 2.

TABLE 2

OUTLINE OF A TYPICAL COST-REDUCTION PROJECT STATEMENT

1.0 Introduction

1.1 Background of the project: The mutual interests which brought it about; the importance of the project to the country; the functions of the project statement.

1.2 Basic procedure: Its short-term nature, and its context for the longer term; concepts of cost reduction; and the scheduled calendar of the project.

2.0 Objectives and Scope

The specific objectives in the context of the country conditions, and the scope of the work in terms of the specific topics which have been selected.

3.0 Work Programs

A list of the programs, incorporating for each: background supporting the choice of the program; the objectives for the program to be achieved in the work; the elements of the work plan; and the forecast of the final product.

4.0 Methodology

General policy statements covering the method for collecting and evaluating data and information relevant to the work programs, such as level of detail, sources of information, use of a conference or seminar, and the specific steps or stages in the project.

5.0 Responsibility and Participation

Designation of the responsible organization, a technical assistande organization (if appropriate) and the organizations in the country that are potentially available to participate in selected areas on a part- or full-time basis.

Appendices:

This is a flexible component of the project statement and should record information detail already known that may be useful in the work. An example is a brief summary of the construction goals of a current national development plan.

A Project Statement is useful because:

- It provides all participants with a common basis for understanding the goals and modus operandi of the project, whether or not they join the project at the beginning.

- It provides all field interviewees with a basis for a similar understanding of the project and thus encourages their cooperation.

- It provides a measure against which to assess the accomplishments of the project.

A. FUNCTIONS OF THE PROJECT

The functions of a specific cost-reduction project are the application of the guidelines established in the earlier chapters, as follows:

- identification of the alternative technology and materials practices for selected components of construction projects and, for each practice, estimates of the quantities of the nation's resources to be consumed;

- evaluation of the alternative practices on the basis of estimates of their financial and their national costs;

- recognition of the obstacles to implementation of selected practices posed by distorted prices and by the public construction sector through intransigency in its attitudes towards change, prevalence of legal restrictions and set procedures, and local inability to engage in unfamiliar activities;

- design of actions to overcome the obstacles to the implementation of less costly practices; and

- formulation of procedures for the implementation of construction projects using least-national-cost technologies and materials.

B. SELECTION OF PROJECT SCOPE

The selection of the project scope should reflect the ultimate goal of the project, namely, actual achievement of cost reductions rather than the mere promise of achievement. There may be unusual cases where the scope of the project work will permit such a goal to be attained outright, but it is more likely to be necessary to choose intermediate goals, the achievement of which constitutes progress and an encouragement to work towards the next step and eventual achievement of the ultimate goal.

To sustain interest in the project, each intermediate goal should be recognized when it is achieved. In fact, the intermediate goals may be all that can be reached within the contemplated time span for the project. Thus, the project as originally conceived and planned may be only a first stage of a longer and more elaborate cost-reduction project. The utility of the results of the first stage would provide justification to continue the project into a second stage. Specific knowledge of local conditions may be the best means to judge the appropriateness of the scope of a first stage.

If many construction project components are treated in the project, it may be found that some lend themselves to total completion and others to partial completion. A project scope that presents such a mix may be desirable. (Appendices B and C contain illustrations of the mix encountered in the three experiments.)

C. ORGANIZATIONAL ELEMENTS

1. Placement

The organizational placement of the responsibility for a cost-reduction project will depend largely on the way the activities of a government in the

public construction sector are already structured. If the kinds of responsibilities that bear on construction costs are at all scattered throughout the government, in interagency body is needed at the top to lead the project. If, on the other hand, the responsibilities are all centered in one department or ministry, only one person familiar with all the responsibilities may be needed to direct the work.

In either event, placement of responsibility for completion of a cost-reduction project should take account of three considerations:

- the extent to which the project personnel will be freed from the prejudices of a line organization in the government or elsewhere to which an individual may permanently belong, whether or not prejudices arise because of the conventional mode of operation of that line organization or because of the predominating opinions of authoritative individuals within that line organization;

- extent to which high-level attention will be given to the eventual findings and recommendations of the project; and

- the extent to which the personnel assigned to the project will feel that their professional careers are not harmed but rather enhanced by participation in a group that functions outside their own organization.

2. Structure

If an interagency type of project is needed, a policy-making function should be included. This function may be provided by a policy-making steering committee. If the project is placed within a ministry or department of the government, and, if the responsibilities for construction costs are spread among many divisions of that body, a steering committee may still be appropriate. If the placement is localized, a single high-level official may be the source of policy decisions.

The project leader should occupy a level in the government at least high enough to give him some freedom in day-to-day actions and in establishing minor policies related to the work. If he is to continue to have other duties, he should at least have a competent assistant to manage the project full-time under the leader's part-time direction.

Each construction cost component topic may have a leader assigned to it, who will take the responsibility for its completion, and for the direction of the project staff and other organizations engaged in the work. He should be expected to devote full-time to this effort. The timing of the recruitment of the full staff may be left to the topic leader's discretion, subject to the guidance of the project leader.

The number of project staff should be geared to the scope of the work program and to the extent that participation of outside organizations in the work may be anticipated.

The terms of service for the personnel assigned to the project need to emphasize the importance of the project and the benefits of their participation and effective work. A recognition that participation and successful achievement will have a beneficial effect on individual careers may be very important to individual motivation. This recognition emphasis may be needed to overcome a common impression of personnel assigned to temporary projects that they have been detoured from their chosen career goals.

D. WORK PROGRAM

The work program contains the objectives and the descriptions of the tasks for fulfilling the project functions. One important task is the collection of data. Comprehensive data and information need to be compiled insofar as permitted by the intensity of effort scheduled for the project. There are four major areas for data and information compilation (Table 3), the relevance of each depending on the selection of construction component topics for the work program.

TABLE 3

FOUR AREAS FOR DATA AND INFORMATION COMPILATION

1. Materials:

   - identification of the predominant materials of construction and the current patterns of usage (The usual construction materials are: cement, burned-clay products, sand and aggregates, structural and reinforcing steel, asphalt, wood, asbestos-cement, and aluminum.);
   - the current state of research in government, academic, and private organizations into the aspects of improvement of properties and adaption to new uses through analysis, testing and innovation;
   - the current emphasis in considering alternative materials on avoiding or encouraging future maintenance;
   - the potential to obtain construction materials from indigenous sources that may not have yet been developed;
   - the degree to which formalized material specifications have been standardized and the appropriateness of the standards that have been used; and
   - the extent to which foreign exchange is required to permit the current usage pattern of construction materials.

2. Construction Technology:

   - the labor/capital mix employed;
   - the design practices that influence maintenance needs;
   - the problems of supervision in the construction stage that affect quality control;
   - the productivity of capital equipment; and
   - the productivity of labor.

3. Public Construction Institutions:

   - the definitive description of practices followed by government organizations and private construction contractors between the time a construction project is conceived and the time that it is completed and turned over for use;
   - a description of the available facilities that could be useful when the change involves technological research and development; and
   - an assessment of the obstacles that may arise in attempts to introduce change into the practices.

4. Cost:

   - data for financial cost analysis; and
   - shadow prices and related data for national cost analysis.

Another important task of the work program is specific to the procedure of designing implementation, and depends on the difficulties encountered in overcoming obstacles. The difficulties may involve the identification of obstacles or lack of specific ideas as to how they may be overcome. One aid in resolving these difficulties is to provide a forum for discussion in which they can be aired and evaluated.

The discussion forum could be a broadly attended conference or seminar. In planning the conference, the following should be key considerations:

- the invitation list should include individuals from public and from private organizations, representing all shades of informed opinion relevant to the topics in the work program;

- alternative construction practices can be discussed at the conference;

- the conferees may be provided in advance with a set of conference papers reporting the findings of the work program as background for discussion;

- a sufficient number of people from the project organization should attend the conference, cover all the activities, and then be able to identify the information in the detail needed as input to design or evaluate the implementation plans; and

- the conference organization should provide for subdividing the conferees into groups according to the individual topics to be covered in order to avoid mixing unrelated interests.

A final task in the work program should be the formal reporting of the results. The frame for organizing this report can be:

- the segregation of the topics of the work program which have been completely treated, and for which specific plans of action have been formulated, justified, and recommended;

- the segregation of the elements of the work program which have been sufficiently completed to indicate the future work needs and the justification to continue the effort;

- an evaluation of the accomplishments of the cost-reduction project in terms of the promise they offer in the short term through implementation of the cost-reduction opportunities and the promise for achieving further cost reductions in the future through continuing the project into a next phase; and

- the recognition and the evaluation of any need to aggregate the implementation plans for the selected construction project component practices when many different components have been treated in the cost-reduction project.

The final element involves coordinating the different plans to make effective use of the personnel and natural resources that are foreseen to be needed to accomplish the implementation actions. Moreover, this coordination should assure that time schedules established for the completion of the construction projects affected will be met.

E. ACCOMPLISHING THE WORK PROGRAM

1. Approach

The method selected for the accomplishment of the work program should provide for the following elements:

- selection of the duration of the work program to allow a balance between providing sufficient time to produce meaningful results, but not an excessive time in terms of retaining interest (for example, by a steering committee) in the outcome of the work;

- subdivision of the work program, insofar as practical, into a series of definable tasks capable of being delegated to identifiable individuals or groups for accomplishment;

- conduct (insofar as the task may involve a large volume of detailed design of a routine nature) a survey to gather statistical data, solicit the cooperation of organizations outside of the project who can handle such tasks more efficiently than the project staff;

- retain (in cases where specialized tasks are to be undertaken requiring expertise not available within the project) the services of a local or foreign organization; and

- arrange for a formal presentation of the final results to the project directorate in order to obtain its approval and implementation.

2. Schedule

The project schedule should be established so that each task in the work program is identified and dates for starting and completion assigned.

The interrelationships between the tasks may have to be noted so that tasks occur in a logical sequence and promote effective use of the participants' time.

3. Budget

An autonomous budget for the project should be established.

APPENDIX A

AN ILLUSTRATIVE CALCULATION OF FINANCIAL AND NATIONAL COSTS

The studies conducted in Ghana by the Building and Road Research Institute as part of the experimental project in that country included the financial and national costing of a number of alternative materials and practices. Topics included (a) burnt clay bricks in terms of alternative manufacturing technologies and as an alternative material to cement-concrete blocks, (b) sand-lime bricks as an alternative to cement-concrete blocks, (c) pozzolans from bauxite wastes as an alternative to portland cement, (d) lime as a road stabilizer, (e) alternative roofing materials and roof designs, and (f) alternative road construction technologies, and (g) alternative materials for highway bridges.

The bridge alternatives were presented in a paper entitled "Comparison of Alternative Bridge Designs" by I. A. Allotey, Research Officer of the Building and Road Research Institute, to the Conference on the Achievement of Cost Reduction in Public Construction in Accra, June 1974. The cost tabulations in this appendix are adapted or inferred from data provided in that study.

The research was undertaken in order to check the possibility that brick masonry or timber bridges might be less costly than the reinforced concrete double box culvert bridges that are standard for small (20-foot span) highway bridges in Ghana. The results provided details which in summary are usefully illustrative of the costing techniques discussed in Chapter IV above.

Table A-1 is similar to the model provided in Chapter IV except that (a) only one construction year is needed and (b) no financial flows in terms of principal or interest are involved. The initial or construction costs for all three alternatives can be summarized in

the one table. Because the construction period is brief, no discounting was needed to arrive at the present value of construction costs. (Discounting was used respecting maintenance costs and lifetime differences as discussed below.)

In Table A-1, the Financial Outlays columns show the financial costs of each of the three alternative designs. Brick masonry is cheaper than reinforced concrete primarily because the needed materials, both imported and domestic, are less costly. The timber alternative is the most expensive, mainly because of the rental cost of the imported pile-driving equipment.

National costs--which cannot be compared to financial costs--are different from financial costs because of the shadow coefficients applied to imported inputs and to unskilled labor. The Ghanaian cedi was regarded at the time of the study as internationally overvalued by 40%; thus the shadow foreign exchange coefficient operated to raise by 40% the cedi cost of imported equipment and materials. Domestic inputs were regarded as correctly priced in the marketplace with the exception of unskilled labor; such labor warranted a coefficient of 0.26, meaning that unskilled labor is only about one-fourth as valuable from a national standpoint as from a financial or market standpoint.

Bridge construction costs, measured in national terms, do not rank differently: brick masonry is still cheapest and timber is the most expensive, again because of the cost of the imported pile-driving equipment. One might have considered here the prospects of local manufacture of pile driving equipment of less sophisticated design.

The comparison of costs of the three bridges should not be limited to construction costs only, however, because lifetime and maintenance differ. The timber bridge has a shorter life and requires more maintenance. Thus, timber is further disadvantaged, whether evaluated in terms of financial or national costs.

TABLE A-1

ALTERNATIVE BRIDGE CONSTRUCTIONS--INITIAL COSTS
(In Cedis)

	Reinforced Concrete Culvert			Brick Masonry			Timber		
	Financial Outlays	Shadow Coefficient	National Outlays	Financial Outlays	Shadow Coefficient	National Outlays	Financial Outlays	Shadow Coefficient	National Outlays
OUTLAYS TO FOREIGNERS									
Equipment (purchase or lease) and Spares	496			506			2530		
Imported Materials	960			640			260		
Total, Foreign	1456	1.4	2038	1146	1.4	1605	2790	1.4	3906
DOMESTIC OUTLAYS									
Labor, skilled	432	1.0	432	655	1.0	655	472	1.0	472
Labor, unskilled	1069	0.26	278	1046	0.26	272	334	0.26	87
Equipment Use	20	1.0	20	484	1.0	484	28	1.0	28
Materials, Supplies, Utilities and other inputs not covered by items above	5514	1.0	5514	4501	1.0	4501	5248	1.0	5248
Total, Domestic	7035		6245	6686		5912	6082		5835
Total Financial Costs	8491			7832			8872		
Total National Costs			8283			7516			9741

The needed further calculations are shown in Table A-2. These calculations are primarily the discounting of maintenance costs back to the time of bridge construction; the formulas that were used are indicated in the notes to the table. Because the expected life of the timber alternative is 25 years and those of the concrete and brick bridges are both 50 years, it was decided, to achieve comparability, to cost all bridges on a 25-year basis. This was done by calculating an annual cost equivalent or "rental" based on the actual expected lifetime of the bridge. The rentals for the first 25 years were then discounted back to the present to obtain the present value of the costs of 25 years of service from the bridge.

A commercial interest or discount rate of 9% was used in the financial costing of the three bridges. In Table A-2, the row stubbed Depreciation and Interest shows the component of the annual rental that covers depreciation of initial cost and interest at 9%. In addition each of the three bridges requires routine maintenance that costs, in a financial sense, ¢ 50 per year. The timber bridge requires, in addition, special maintenance costing ¢ 50 in the fifth, tenth, fifteenth, and twentieth years of its life; the procedure used for calculating the annual cost value of this maintenance is shown in a note to the table.

Once the total financial cost annual rental for each bridge alternative was calculated, the series of 25 annual flows was discounted back to the present to show comparable totals of construction and maintenance costs.

The same calculation was made on a national cost basis, using the shadow-priced inputs. Because maintenance is provided almost entirely by unskilled workers, the national cost of maintenance is significantly lower than the financial cost.

TABLE A-2

ALTERNATIVE BRIDGE CONSTRUCTIONS—COMPARATIVE COSTS
(In Cedis)

Lifetime	Reinforced Concrete Culvert 50 Years			Brick Masonry 50 Years			Timber 25 Years		
	Financial	National		Financial	National		Financial	National	
Initial Cost	8491	8282		7832	7516		8872	9741	
Annual Rental	@ .09	@ .12	@ .15	@ .09	@ .12	@ .15	@ .09	@ .12	@ .15
Depreciation + Interest[a]	775	997	1244	715	905	1129	903	1242	1507
Annual Maintenance	50	33	33	50	33	33	50	33	33
5-yearly Maintenance[b]	—	—	—	—	—	—	8	5	5
Total Annual Rental	825	1030	1277	765	938	1162	971	1280	1545
Present Discounted Value of 25 Years Service[c]	8100	8078	8247	7509	7355	7503	9538	10039	9985

[a] $= \dfrac{\text{Initial cost} \times r}{1 - \left(\dfrac{1}{1+r}\right)^n}$ in which r is the discount or interest rate listed in the column and n is the expected lifetime of the bridge

[b] Annual rental value of maintenance provided during 5th, 10th, 15th, and 20th years $= \left[\dfrac{m}{(1+r)^5} + \dfrac{m}{(1+r)^{10}} + \dfrac{m}{(1+r)^{15}} + \dfrac{m}{(1+r)^{20}}\right] \dfrac{r}{1 - \left(\dfrac{1}{1+r}\right)^{25}}$

in which m is the cost of the maintenance, at the time it is performed, ¢ 50 if financial cost, and ¢ 33 if national cost. The formula calls for calculating the present value of the four pieces of maintenance, and then for calculating the annual rental of that present value over a 25-year period.

[c] $=$ Total Annual Rental $\approx \dfrac{1 - \left(\dfrac{1}{1+r}\right)^{25}}{r}$

Two alternative rates of discount (national time preference rates) were used: 12% and 15%. The differential effect of the higher rate in the instance of the concrete and brick bridges is to lift the present discounted value of the first 25 years of service; the second 25 years carry less value because of the effect of the higher rate on those more remote years.

This pattern does not of course apply to the timber bridge because the lifetime is only 25 years. The present value, using 15% as the discount rate, is the lower of the two national values for that bridge because the maintenance costs carry a lower present value when discounted at the higher rate.

Conclusions as to the cost ranking of the three bridge alternatives are the same whether or not maintenance is included, whether financial or national costs are used, and whether the discount rate is 9%, 12%, or 15%. In all cases the brick masonry bridge is least costly and the concrete bridge is in second position. It is evident that if the timber bridge is to become competitive, a cheaper technology for driving piles in Ghana must be found.

APPENDIX B

SELECTED EXPERIENCES FROM THE THREE EXPERIMENTAL PROJECTS

1. THE POSITION OF CEMENT

In each of the three experimental projects, the work program was addressed in some form to the subject of cement as a basic material of construction. In Colombia, the emphasis was on the adequacy of industry planning for expansion of production in terms of a foreseeable future demand arising out of the implementation of the National Development Plan. In the Philippines, the emphasis was (a) on the inadequacy of the cement distribution to assure local supplies despite significant overcapacity and (b) on converting the pattern of cement distribution to highway construction projects from a bag mode to a bulk mode. In Ghana, the emphasis was on finding alternative materials to reduce the demand for cement.

The results expected from each work program involved cost reduction, either directly in the financial cost of the cement itself or in the foreign exchange requirement, or indirectly in the financial or national project costs by avoidance of construction delays arising from cement shortages or by encouragement of the use of cement alternatives.

a. Colombia

Colombia has a well-developed, essentially modern cement-manufacturing industry of 13 plants distributed throughout the country in accordance with the population. The industry management has periodically expanded the productive capacity in terms of foreseeable markets and the industry has experienced an impressive growth, but with the penalty of

not achieving the benefits of large-scale production economies. The limestone reserves for cement production in the country are excellent. The National Development Plan of January 1972 called for a major increase in the volume of public construction, particularly for urban multi-family dwellings. Consequently, concern arose that the plan implementation could be slowed and costs raised because of the inability of the cement industry to keep up with the surge in cement demand.

The results of the work program showed that the industry was essentially regional, primarily because of difficult transport problems due to the terrain (most of the population is along the higher altitudes of the three north-south mountain ranges in the country and along the Caribbean coast). Thus one part of the country may have surplus cement while another may have shortages.

The action plan for the short term was designed to eliminate the regional nature of the supply through the application of technology to transport cement in bulk, or as clinker, by rail in unit-trains shuttling between source and destinations; for the long term, it was designed to construct new centralized productive capacity at sites strategically located for low production costs and for low-cost transport via the existing rail network. Two distinct actions were specified and recommended: (a) a prototype operation of a unit-train shuttle transport on a substantial scale using existing rail and cement-production facilities; and (b) a cement-demand forecasting activity to enable new production facilities to be built at the appropriate times.

b. Philippines

The cement-manufacturing industry in the Philippines has overexpanded: capacity is about twice domestic demand. Eighteen plants are distributed throughout the northern, central, and southern islands. The industry management problem, in contrast to the situation in Colombia, is one of encouraging demand instead of increasing supply. Because of the high

indebtedness of the industry to the government development bank and the defaults in repayment because of the overcapacity in 1973, the Government assumed temporary control of the industry operations through the formation of the Cement Industry Authority.

Because of its policy of specifying cement-concrete instead of asphaltic-concrete pavements in order to cope with severe climatic water problems, the Department of Public Highways is a major consumer of cement. To support its announced construction program the Department needs about 20% of the national cement production and if current practices prevail, this quantity of cement will be handled largely in conventional bags.

The work program showed that: (a) despite the industry overcapacity, there are shortages and delays in acquiring cement, particularly for the major islands where no cement is produced, or where a consuming location on a major island is remote from the manufacturing plant; (b) a remedy is available through decentralizing factory-operated cement depots to locations near market centers and supplying the new depots by an inter-island or waterway unit-barge bulk shipment shuttle system; (c) considerable savings in road construction costs are possible, by conversion to a bulk handling; and (d) future efforts to decentralize and bulk-supply cement depots are compatible with efforts to convert to a bulk-cement handling mode in road construction projects.

The action plan was designed in two parts: (a) to acquaint the Cement Industry Authority with the cement distribution problem and the indicated solution; and (b) to identify the current and future road construction projects that lend themselves to bulk-handling of cement and the changes in cement-handling practices required.

c. Ghana

Ghana's cement industry is based entirely on the import of clinker at two locations on the seacoast. The clinker is ground to cement in

plants in the port areas and the cement is distributed from these points. Limestone deposits are known in the country, but none have yet been shown to be sufficiently attractive to eliminate the import of clinker through local production. In any event, it still would be necessary to import fuel for clinker production. Electricity for grinding clinker is readily available from the Volta River Authority hydroelectric supply.

Ghana has alternative construction materials in the form of extensive timber resources and clay deposits. The cost-reduction opportunities in the cement sector arise, therefore, mainly in encouraging the use of cement substitutes of equivalent performance that may be less expensive financially and/or nationally; but also in encouraging, where feasible, manufacture of clinker from local deposits, especially those located far from the seacoast.

The work program showed that: (a) timber or brick-arch bridges could represent feasible alternatives to reinforced concrete; (b) intensive manufacture of clay brick could compete and substitute for cement-block (sandcrete) in wall constructions; and (c) the possibility of cement manufacture remote from the seacoast in the distant north, using a wood-charcoal fuel and the Bonga-Da limestone deposit warrants detailed study.

The action plans accordingly specified: (a) efforts to establish a domestic-market-oriented timber industry to supplement the present export orientation; (b) activities for more-intensive construction of brick factories employing manufacturing technology developed in an experimental facility already completed; and (c) a technical and economic feasibility study of the manufacture of cement from the Bonga-Da deposits.

2. THE MORE-INTENSIVE USE OF INDIGENOUS MATERIALS

The work program in each of the three experimental projects addressed iteself to the extent to which indigenous construction materials were used in the construction sector. In all three cases, the obvious

local materials were adequately exploited or otherwise recognized: i.e., sand and gravel, the use of limestone for cement or lime manufacture, and rock for wall construction. In Colombia, rock was being used for wall construction by applying gabion technology; and the potential of using blast-furnace slag for cement manufacture had been recognized. In the Philippines, lava flows were intensively mined for sand and gravel. In Ghana, a unique opportunity was being investigated to produce artificial pozzolans from bauxite-mine wastes and to use the pozzolans to extend cement supplies.

a. Colombia

The integrated steel works at Paz del Rio produces large quantities of blast-furnace slag as a waste product--about 10 million tons since operations began. The slag is discharged from the blast furnace as a hot liquid. After it cools in the air, its composition is qualitatively that of a cement rock similar to that used for cement manufacture, except that its lime content is very low. The slag is now used for land fill.

A nearby cement manufacturing enterprise is interested in acquiring this by-product for inter-grinding with clinker to produce a conventional slag-cement. This would increase the firm's cement output without it having to install new clinkering capacity and incur the concomitant consumption of fuel. The net effect on the region's economy would be beneficial, but business disagreement has prevailed on the proper transfer price for the material. Moreover, for the material to be usable, the molten slag would have to be water-cooled instead of air-cooled.

Accordingly the problem was an institutional one involving two private organizations, and the recommended action plan was limited to encouraging discussion between the two parties. In a technologcial vein, an action plan was recommended to develop a formulation for the slag for a brick-laying mortar and to introduce this as a commercial product to reduce the demand for the more expensive portland cement for bricklaying.

b. Ghana

Ghana produces bauxite for export. In mining and beneficiating the mineral, a waste material is isolated and discharged to a settling pond, where it is stored. Experimental laboratory work on samples of these tailings has shown that a pozzolan material can be produced by calcining at elevated temperatures under controlled conditions. Conventional cement-laboratory testing procedure has shown that after intergrinding with cement clinker in proportions as high as 50%, a pozzolan yields a pozzolanic cement with long-term strength equivalent to ordinary portland cement. Thus this material offers Ghana the potential for a major use for an otherwise waste material, and a resulting major reduction in its clinker imports.

The work program, which concentrated on the evaluation of the commercial potential of the small-scale laboratory development, indicates that additional experimental work is needed, for two purposes: (a) the production of larger quantities of pozzolan for larger-scale test work; and (b) the pilot-scale testing of a possible commercial production process. Preliminary cost estimates for the commercial production of the pozzolan indicate that the tailings may have a substantial value and that the cost of using cement may be substantially reduced.

3. APPROPRIATENESS OF CONSTRUCTION TECHNOLOGY

The work program in the three experiments addressed itself to the appropriateness of the practiced construction technologies in terms of the mix of materials, capital, and labor. In Colombia, an ongoing program of highly labor-intensive road construction involved the construction of feeder roads by pick-and-shovel, using primarily the spare time labor of local people, mainly farmers who would benefit from the completed road. Construction equipment was used for the difficult tasks and for bridge construction. In the Philippines,

there was intense interest in generating increased opportunities for employment in the road and highway construction program. In Ghana, the interest dwelt on the construction of roofs for residential houses.

a. Philippines

In pre-World-War-II days, road construction technologies were largely labor-intensive. After the liberation of the Philippines in 1945, there was a large influx of war surplus mechanical construction equipment. This equipment, coupled with policies of international lending agencies that encourage capital intensive construction techniques, resulted in the current emphasis on largely capital-intensive road construction technologies which require a high input of foreign exchange and offer little opportunity to employ labor on a large scale.

The introduction of large quantities of heavy construction equipment into the construction sector has brought with it numerous technological and management problems associated with keeping the equipment productive. Local spare parts manufacture is significant but inadequate. Equipment service life is reduced by lack of spare parts and by cannibalization. Administrative and wage practices discourage labor stability and skilled mechanics and operators leave to find jobs elsewhere, even overseas. About 50% of the equipment is deadlined.

Currently, there is intense interest in increasing the useful employment of labor in construction. Consequently, the first 6-kilometer stretch of a road from Capas to Botolan in Tarlac province north of Manila is now (1974) under construction by labor-intensive means on an experimental basis, to test methods and to compile productivity data. Since determination of an appropriate technology presupposes a highly-productive labor force and highly-productive construction equipment, the work program focussed on these two areas. Criteria were established for the minimum capital equipment needed to assure the desired quality of the completed road. The factors influencing labor

productivity were identified, and a data-collection program for the Capas-Botolan project designed. Specific technological and administrative practices for assuring effective preventive maintenance of the inventory of construction equipment were identified.

The action plans addressed themselves to: (a) developing experiences from the Capas-Botolan project for analysis of the factors leading to labor productivity for ultimate nationwide application in appropriate projects; (b) defining a lube-oil chemical and physical analysis practice for identifying the precise preventive maintenance needs; (c) adopting a rational method for determining when an equipment item has reached its useful service life; (d) changing administrative and salary practices to motivate and increase the skills of maintenance and operating personnel; and (e) encouraging more-intensive local manufacture of spare parts.

b. Ghana

Construction of housing in Ghana is largely a matter of individual efforts by owner-builders, especially in the less urbanized areas. The construction is financed by current income, and the building progresses in accordance with income. When the roof is reached, the situation changes: i.e., the entire roof must be constructed at one time, thus there must be funds to cover this. Accordingly, the cost of roof construction becomes a critical factor, and the completion of the house may be delayed for years. Coupled with the cost barrier is the social aspect of the status given by the use of imported materials. In the 1950's, a special loan scheme was established to finance roof construction.

The work program included a comparative analysis of the financial and the national costs of a number of roof designs: e.g., imported corrugated galvanized iron and aluminum; wood shingles; and burned-clay tiles; and improved timber-support framing. The top candidates were

found to be clay tiles and wood shingles. Aluminum roofing was a third prospect.

The action plan calls for making readily available clay roof tiles at reasonable prices, through rationalized manufacture, and continuing research on the wood sources for manufacturing shingles.

4. A VALUE-ENGINEERING ANALYSIS

The extensive use of cement-concrete road pavement in the Philippines leads to frequent choices between this type and asphaltic-concrete pavements--for new roads and periodically when repaving the roads. The specifications adopted for each type of pavement lead to choosing between a high first-cost cement concrete design of superior performance under the severe climatic water conditions prevalent in most areas of the country and a low first-cost asphaltic-concrete design requiring more frequent maintenance. The Department of Public Highways had available a small electronic computer for such engineering-type computations, but it was not effectively utilized. Accordingly, the work program anticipated the development and use of a decision-making tool that would permit the quick selection of the appropriate pavement type as new road construction projects were formulated and evaluated.

Initially, the work plan was based on the use of part of the Highway Cost Model developed by the World Bank and MIT/U.S. Department of Transportation, which includes submodels covering the cost of highway construction and maintenance. An important component of the maintenance submodel was an empirical mathematic relationship which related road deterioration with traffic in terms of volume and axle loads, climate, original pavement design standards, and material types, the constants for which had been evaluated from limited data compiled in Jamaica. It soon turned out that the data needed to evaluate the empirical constants in the equations for Philippine conditions were not available and that a major research program would be needed to evaluate them. Moreover, alloca-

tions of cost to foreign exchange expenditures and labor payroll were not available.

The work program was, consequently, modified and was based on modeling the maintenance practices of the Department of Public Highways for each type of pavement, expressed as an allowable expenditure determined by recorded or estimated traffic volume, and on making assumptions of the foreign exchange and labor payroll components. A pavement-evaluator computer program was built and tested on this basis. Its capability enables total initial investment plus discounted future maintenance costs to be computed for each type of pavement. A two-part action plan was recommended: (a) further development of the pavement evaluator; and (b) further identification of the engineering usages to which the available computer could be put. An expansion of the computer memory capability was indicated, since it had been found that the installed memory capability did not permit the use of the Fortran language.

APPENDIX C

SUMMARIES OF THE PROJECTS ESTABLISHED IN THE THREE EXPERIMENTS

The summaries presented in this Appendix illustrate the degree to which the project organizations established in each experiment agreed with the Guidelines. Included is commentary on the constraints that shaped the project organization, the selection of activities, and the way the work was done. A project statement was issued and widely distributed as part of each of the three experiments.

1. Calendar

Colombia. The duration of the project was 13 months, from September 1971 through September 1972. The results of the project were evaluated in November 1973.

Philippines. The duration of the project was 7 months, from November 1972 through May 1973; the work program had been identified during a three week reconnaissance period in June-July 1972. The results of the project were evaluated in June 1974.

Ghana. The duration of the project was 16 months from July 1973 through October 1974.

2. Selection and Scope of Topics

Colombia

The selection became final in February 1972, five months after the start of project activity. The major reason for this long period was the coincidence of the final stages of the promulgation of the National Development Plan of 1972 with the project activities. The Plan was published in January 1972 and the topics to be selected were to be responsive to the

priorities it specified. Hence, they were to emphasize the assurance of availability of the major construction materials at an appropriately reasonable price level to support a major urban low-cost multi-family housing construction effort on a national scale by avoiding price rises due to shortages and higher costs due to construction delays. Prior to publication of the Plan, the priorities had been only mildly indicated to the project participants.

The scope of project activities and the identification of the limited goals to be achieved were published in a Project Statement, published and distributed in February 1972. Table C-1 contains a summary of the topics and objectives as they appeared in the Project Statement.

Philippines

The scope of the topics was narrower in the Philippines than in Colombia because of the siting of the project in the Bureau of Public Highways (BPH)* of the Department of Public Works, Transportation, and Communications (DPWTC). The BPH designated the efforts as the Pilot Technical Assistance Project (PTAP).

The source of authoritative information as to where national priorities lay in the construction of public roads and highways with respect to the identification of cost reduction opportunities, was the Infrastructure Operations Center (IOC) in the Office of the President of the Philippines. The Philippine National Development Plan (1971-1975) provided indicative information basically on the projects to be accomplished during the plan period and their estimated financial costs. The National Economic Council (later NEDA - the National Economic Development Authority) provided in the course of the reconnaissance an awareness of the importance of employment generation from the activities of the plan. The BPH itself

*In May 1974 the BPH became an independent Department of Public Highways (DPH).

TABLE C-1

PROJECT SCOPE FOR THE COLOMBIAN PROJECT

Title	Objectives
The Colombian Cement Industry	Identify alternative technical-economic methods by which industry can expand its capacity and the implications of each method with respect to the objectives of the National Development Plan
The Production and Distribution of Burned-Clay Products	Identify alternative policies within which the expansion of the industry may occur, and the implications of each to achieve the objectives of the plan.
Roads and Highway Construction and Maintenance	Information gathering and evaluation on selected topics appearing to offer significant potential for cost reduction.
Technological and Cost Aspects of Vertical, Multi-Unit Housing--A Case Study	Analyse actual examples of urban housing construction and determine the role played by the State in their implementation. Also, identify alternative roles for the State and the implications of each role on the costs of construction.
Technological and Cost Aspects of Future Urban Infrastructure Construction	Compile technological and cost data concerned with urban infrastructure construction for use as a quantitative tool in the analysis and optimization of new urban housing projects.

suggested that the project results should be responsive to needs as foreseen by the IOC.

During the reconnaissance period, discussions with personnel of the IOC led to the selection of two topics, namely BPH procurement of cement for road construction and the service life of heavy construction equipment. Also during the reconnaissance period a third topic was selected on the basis of indications that attention should be paid to the pattern of labor utilization in construction, even though on the surface this topic did not then seem to offer a potential for reducing costs in the conventional financial sense. The focus was to be on the selection of a typical road construction project for cost analysis and the establishment of guidelines for policy-making in order to promote labor utilization. In the latter stages of the work period itself, a fourth topic was selected as a spin-off from the cement topic. This was to increase the utilization by BPH personnel of computers as a means of managing large data-processing efforts which could be needed in the course of identifying and implementing cost-reduction opportunities. A comparison of cement-paved and asphalt-paved roads was selected as an illustrative exercise.

In the final form, the official titles of the four topics selected and their order of importance at the time were as follows:

- Labor-intensive construction of roads and highways.
- Prolonging construction equipment service-life.
- Improving the distribution of cement.
- Increasing the utilization of computers.

Ghana

The range of topics in Ghana was broad and corresponded more to those chosen for the Colombia project. The range fitted the interests of the organization in which the project was sited, namely the Building and Road Research Institute (BRRI) of the Council for Scientific and Industrial

Research (CSIR) in the Ministry of Economic Planning. The topics selected and specified in the Project Statement were the following:

- The Supply of Locally-Manufactured Construction Materials;
- Construction Alternatives for Building Roofs;
- Construction Alternatives for Road-Building Components;
- The Appropriate Use of Labor in Construction; and
- Improved Efficiency in the Construction Industry Operations.

3. Organizational Elements

The placement of the responsibilities for accomplishing the cost-reduction project in the three experiments is shown in Table C-2.

The project leader selections were:

Colombia: Chief of the Unit of Infrastructure, reporting directly to the Chief of the National Planning Department.

Philippines: Deputy Commissioner of the Bureau of Public Highways in the Department of Public Works, Transportation and Communication, reporting directly to the Commissioner of the Bureau.

Ghana: Director of the Building and Road Research Institute, reporting directly to the Chairman of the Council for Scientific and Industrial Research in the Ministry of Finance and Economic Planning.

The Philippines experiment provides the only example of the formation of a steering committee. The committee was set up by an official order of the Secretary of the Department of Public Works, Transportation and

TABLE C-2

THE CHARACTER OF THE ORGANIZATIONAL STRUCTURE IN THE EXPERIMENTAL PROJECTS

Country	Name	Function	Scope
Colombia	Departamento Nacional de Planeacion (Bogota)	Staff Planning Group for the Executive Branch of the Government.	All governmental areas of professional planning activity.
Philippines	Bureau of Public Highways (Manila)	A Division of the Department of Public Works, Transportation and Communications, responsible for the construction and maintenance of national roads and highways.	Line responsibility for the implementation of approved road and highway construction projects.
Ghana	Building and Road Research Institute (Kumasi)	A unit of the Council for Scientific and Industrial Research, which is in the Ministry of Finance and Economic Planning.	Technical research of knowledge in the construction of roads and buildings.

Communications, who became its chairman. The other members were the President of the Philippines Contractors' Association, the Dean of Engineering in the University of the Philippines, the Director of the Bureau of Public Works in the Department, and the Commissioner of the Bureau of Public Highways in the Department.

The personnel complement in each project was the following:

Colombia

Almost all the staff assigned to the project work functioned on a part-time basis so that they could continue with other assignments and duties not related to the project work. All professional personnel were university graduates, and many had advanced degrees. Some who left the project in mid-stream were proceeding for advanced education, while others who joined in mid-stream had just completed advanced education programs.

Recruitment occurred on an ad hoc basis. One Planeacion staff member worked full time for the period while the Project Statement evolved and was published. During this time the people needed for the work were identified and invited to participate. The Project Statement envisaged broad participation by 21 different organizations. In practice, only two organizations (the National Planning Department and Arthur D. Little) participated in the work with major assistance from the Ministry of Public Works. However, a number of the remaining organizations in the list cooperated through the furnishing of information whenever approached. Some participation was obtained from a local consultant organization by formal subcontract for specific services. The help of a United Nations Industrial Development Organization (UNIDO) consultant was obtained informally through an arrangement with the Instituto para Investigaciones Tecnologicas.

Philippines

The staff functioned on a full-time basis as required by the demands of the work. Each topic leader participated full time.

The qualifications of the personnel varied through combinations of experience and university education. The combinations varied from one extreme of many years of practical experience in the BPH and maturity of judgment to the other extreme of limited experience but with recent university education. All personnel functioned on a full-time basis through having been given temporary assignment to the PTAP and temporary release from their permanent assignment.

There was no need to recruit personnel since the BPH was able to assign personnel as required through administrative directive. The work in labor-intensive construction required the professional services of a sociologist, and this was obtained through a consultancy agreement. The Arthur D. Little participation occurred on a full-time residency basis, and specialist personnel services were obtained as needed from its home-office staff on an ad-hoc basis.

Ghana

Almost the entire staff of the BRRI was engaged in the work, along with their regular duties. Recruitment of personnel was not required.

The BRRI, as a research institute, possessed staff of good academic qualifications and a motivation to investigate and to ferret facts. Some of the staff were competent to undertake economic analysis and statistical work. It was possible to organize team efforts containing the blend of skills appropriate to the task. The Arthur D. Little participation was on an as-needed basis.

4. Accomplishment

Colombia

The original plan for accomplishment and the actual experience in Colombia are compared in Table C-3. The differences were:

TABLE C-3

COMPARISON OF ORIGINAL AND ACTUAL

PLAN FOR ACCOMPLISHMENT

COLOMBIA

	ORIGINAL		ACTUAL	
Stage	Activity	Location	Activity	Location
1	Selection of Program Topics	Colombia	Attempt to establish a project statement to avoid a division of the project with two independent approaches.	Colombia
2	Information Gathering, Analysis, and Evaluation; Conference Design and Preparation of Papers; Schedule and Tentative Program for Conference	Colombia	Publication of a formal project statement and the undertaking of intensive field work by the project team.	Colombia
3	Action Plan Preparation and Review: Formal Conference Program Adoption	ADL U.S.A. Home Office	Brief visit by ADL to insure that activity was continuing and that report writing would be completed on time.	Colombia
4	Conference and Reporting	Colombia	Wind up activities to produce action plans and host-country report.	Colombia
5	Follow Up of Results of Implementation	Colombia	Follow-up visit to assess the results of the Action Plan.	Colombia

- More time was required than originally was estimated.

- Work was performed entirely in Colombia because other non-project demands on the time of project participants did not allow them to be away from their home base for an extended period; and

- Conducting a public conference was not practical because of the sensitivity of some of the topics at the time to public attention.

The work program set forth in the project statement was accomplished essentially completely, the one important exception being the fifth program with respect to urban infrastructure. This topic turned out to be too complex for handling in the time available and with the limited staff. The results are tabulated in Table C-4. As of November 1973 implementation of items 1-4 was underway. In general, it appears that the project needs to be given some permanent role to assure implementation of the remaining results at the appropriate time. Table C-5 summarizes the responsiveness of the work results to the identification of cost reduction opportunities.

Philippines

The activities of the work program occurred in five consecutive stages, as follows:

- By 15 November 1972, preparation of final version of the project statement;

- By 2 March 1973, the completion of data-gathering and the host-country field work;

- By 28 March 1973, the preparation and conducting of a public conference;

TABLE C-4

THE COLOMBIAN RESULTS

Action	Description	Objective
Actions Already Implemented		
1 Establish a national inventory of heavy construction equipment	Develop full knowledge of equipment, characteristics location, and availability through a data processing system incorporating each item of heavy construction machinery in the country	Reduction in cost through better utilization of heavy construction equipment
2. Develop a nonportland masonry cement	Use available blast furnace slag as the base for a formulation, test its performance, and undertake market penetration activities	Reduce costs of masonry work by making available a lower cost satisfactory binder
3. Use appropriate labor-intensive construction methods	Undertake a quantitative analysis of labor intensiveness in the "pick and shovel" road building program to identify areas for improvement based on the World Bank capital/labor model.	Generate employment opportunities in construction appropriate to national goals and in the long-term build a tool for assessin, quantitative effects of major changes in the materials construction technology and institutional practices in construction
4 Check the accuracy of quantity surveys in road and highway construction contracts	Undertake a review of the accuracy of quantity surveys presently estimated in a sample of recent construction contracts based on the MIT/World Bank Highway Cost Model	Reduce costs through more accurate quantity surveys in the negotiation stage for given road alignments and later reduce quantity surveys through identifying the optimum alignment
Actions Requiring Decision before Implementation		
5 Unit-train/shuttle transport of cement	Reduce distribution costs for cement by undertaking two pilot transport schemes one based on bulk cement and the other on clinker	Reduce the cost of cement by converting the country's demand/supply pattern from a regional to a national one
6. Cement-demand Monitoring Scheme	Collect data on an on line basis, and formulate and test a forecasting model	Assure adequate supplies of cement to support the construction program resulting from the implementation of the national development plan
7 Improve manufacturing efficiency of the burned clay products industry	Arrange to implement technological findings of the work of the Institute for Technological Investigations	Reduce wall costs in buildings by encouraging competitiveness of brick and tile with cement block
8 Create institutional structure for promoting efficiency in housing construction	Investigate the five areas in housing construction where the existence of problems leading to inefficiencies are suspected	Reduce construction costs by defining problem areas and finding solutions
Actions Whose Implementation Should Be Postponed for The Reason That		
(a) Stepwise Progress Is Required		
9 Revision of standards and specifications	Adopt those whose labor/capital intensiveness ratios are appropriate to national costs	Reduction of costs in the broad sense of social costs.
10 Appropriate maintenance policies	Adopt those whose first cost and eventual costs reflect the country's current financial position	Reduction of costs through knowledgeable application of value engineering principles
11 Revised contract procedures	Increase accuracy of data on which contracts are based	Reduction of costs through more effective project management
(b) Prior Actions Should First Be Completed		
12 Importation of cement	Demand forecast and domestic supply position must first show this is necessary	Avoid shortages
13 Construction of new cement manufacturing capacity	Same reason as above	Begin construction as soon as forecast of demand warrants
14 Establishment of a Service Center for Building Construction	Problem-solving institution	Potential cost reductions

SOURCE: Compilation from the publication of the Departamento Nacional de Planeacion, UINF-T-04, (February 1973), Oportunidades de Reduccion de Costos en Obras Publicas.

TABLE C-5

RESPONSIVENESS OF WORK RESULTS TO COST REDUCTION OPPORTUNITIES

Action Numbers in Table C-4	Title	Responsive to Change in
1	Heavy Construction Equipment Inventory.	Institutional practices to reduce future imports of equipment.
2	Development of Nonportland Masonry Cement.	The adaptation of materials.
3	Labor Intensive Methods.	Technology appropriate to generating new labor employment.
4	Quantity-Survey Accuracy.	Institutional practices to help avoid shortage of finance.
5	Unit-Train Shuttle Cement Transport.	Technology appropriate to reducing transport costs.
6	Cement-Demand Monitoring.	Institutional practices to avoid shortages in supply.
7	Burned-Clay Products.	Technology to increase efficiency in manufacturing.
8	Institutional Structure in Building Construction.	Institutional structure to enable problems impeding cost reduction to be identified and solved.
9	Revision of Standards and Specifications.	Technology appropriate to employment generation and to improvement in balance of payments.
10	Maintenance Policy.	Technology appropriate to the consideration of value engineering.
11	Revision to Contract Procedures.	Institutional structure in road and highway construction.
12	Importation of Cement.	Institutional structure affecting balance of payments.
13	New Domestic Cement Manufacturing Capacity.	Technology appropriate to reducing manufacturing cost of cement.
14	Building Construction Service Center.	Technology and materials appropriate to housing construction.

- By 18 April 1973, formulation of conclusions and recommendations; and

- By 9 May 1973, production of final report.

The work program began in early November 1972 and followed the original plan, although the originally contemplated completion date of 15 March 1972, needed to be extended.

After the topics were initially selected, the scope, and even the objectives, had to be revised or reconsidered (or even new topics introduced).

- Labor-Intensive Construction. This topic and the manner of its specification in the Project Statement were originally conceived as an attempt to provide some useful support to the government's interest in generating new employment opportunities from the construction activities foreseen in the national development plan. By the time the work period began (actually beforehand, in October 1972), the DPWTC, as an action totally separated from the PTAP had established a departmental committee on labor-intensive construction methods which had just begun to function. This committee was concerned with a pilot project then underway to use labor-intensive methods to repair a section of a levee destroyed during the 1972 floods. The committee was slated to participate in a forthcoming pilot road construction (Capas to Botolan) project, in which a six-kilometer stretch was to be selected for construction by labor-intensive methods. Through a policy of close cooperation between the PTAP and the departmental committee, the end product of the project work became in effect an assessment of the current state of knowledge, experience, and attitudes in the Philippines on labor-intensive road construction methods and a presentation of details of a plan to apply this knowledge to a prototype project (the 100-kilometer Marikina-Infanta road project).

- Construction Equipment Service-Life. Five Philippine government agencies (including the BPH) are the owners of almost all of the large inventory of heavy construction equipment in the country, which has been purchased almost entirely with foreign exchange. The service-life experiences for this equipment have been poor, and a number of reasons for this had been suggested. The objective in selecting this topic was to reduce costs of construction through identifying changes in maintenance practices for heavy construction equimment which could extend service life. The PTAP found during its work that considerable opportunities which could be classified as cost reductions had already been detected in the subject area by the work of another technical assistance project engaged in a reorganization study of the BPH. Furthermore, implementation of some of its major equipment management recommendations had already begun (i.e., the establishment of two pilot regional mechanical-service depots at Bauang and at Cebu City). Accordingly, the best prospects for implementation seemed to be those offering action plans to improve the effectiveness of the operations of these depots in prolonging equipment service life.

- Cement. By the time the work program started, the original basis for selecting the topic, namely the government industry agreement on cement procurement for government projects, had become obsolete. Later, in fact, the policy direction and the operations of the Philippine cement-manufacturing industry were essentially taken over by the government by a presidential decree establishing the Cement Industry Authority (CIA), and the need to reconsider the price paid for cement to be used in government-funded projects disappeared. It was learned, however, during field interviews that a pattern of poor distribution of cement in certain areas of the country had led to high local delivered-costs. A change in the purpose and the scope of the topic to emphasize improving the distribution of cement from factory to markets, became warranted. The intention in the original scope of work to compare

the total present-and-future (global) costs of asphalt and cement concrete road pavements was transferred to a new topic involving computer utilization.

- Computer Utilization. This topic was introduced late in the work period. It had been noticed that the BPH possessed a small IBM-1440 electronic data processing system which was apparently little utilized in connection with engineering calculations. Also, a need for a rapid method of deciding between the use of a cement-concrete pavement or an asphalt pavement in planning for new road construction or in major road maintenance projects had been detected, which might be fulfilled by a computer program.

A specific action plan derived from the results of the project work was provided for each topic designed to lead to cost reduction, as follows:

- Labor-Intensive Construction. Reduction in national economic cost of construction through achieving a more-appropriate balance of labor and capital utilization in the construction technology used.

- Equipment Service Life. A reduction in the national cost of importing construction equipment through extension of service life.

- Cement Distribution. Reduction in the market cost of cement in a number of locations through improving the effectiveness and efficiency of transportation mode employed in the distribution channels.

- Computer Utilization. Improvement in designs, and reduction in cost of design work. The potential to make quick design decisions more appropriate to the needs to be fulfilled by the construction.

Ghana

An assessment needs to await the final report of the BRRI, which at the time these Guidelines were prepared, was in the process of preparation.

APPENDIX B

COLOMBIA

SUMMARY SECTION
HOST-COUNTRY REPORT

1. English Version

~~2. Spanish Version~~

~~(Version in English)~~

DEPARTAMENTO
NACIONAL DE
PLANEACION

UNIDAD DE INFRAESTRUCTURA

ACHIEVEMENT OF OPPORTUNITIES TO REDUCE CONSTRUCTION COSTS IN PUBLIC WORKS

Report of the Ad-Hoc Group

Documento UINF-T-06
September 1972

Circulation:
Restricted

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I. SUMMARY

A. PURPOSE AND SCOPE

Construction is a significant activity in Colombia by virtue of the funds spent on it annually, and by virtue of the current emphasis on the National Plan of Development on this activity as one of the strategic sectors for development, since it offers good prospects to generate more and better paying jobs. At the same time, there is recognition that costs of construction in Colombia may be distorted and thereby could impede the progress desired. The reasons are the use of technologies possibly inappropriate to Colombian conditions, and the recognition of institutional practices in the construction sector that can lead to inefficiencies in the implementation of public construction projects.

Accordingly in January 1972, Planeacion Nacional formed an Ad-Hoc Group of Planeacion personnel, assisted by the services of a consultant (Arthur D. Little, Inc.) provided by the Agency for International Development of the United States, to undertake a project of investigations aimed at identifying appropriate cost reduction opportunities. The modus operandi of the Group was then set forth in a published Project Statement (Document DNP 846-UINF, 22 February 1972).

To enable the vast and diverse field of activities comprising the construction sector to be managed in the available time, the Ad-Hoc Group focused its attention on two sectors of construction, roads and highway and urban multifamily dwellings, which are important currently and will be so in the future; and on the materials-of-construction sector, cement and burned-clay products specifically. Also, the Group followed a set of specific policies in order to guide its investigations toward producing results that could be implemented immediately and that would be responsive to the goals for economic progress that have been identified in the National Plan of Development.

The policies were:

- Undertake the work program for the project as the initial effort of a longer-term effort that ultimately could provide detailed analyses of all activities within the construction sector, i.e. from the planning, the programming, and the design stages through to the actual construction efforts, the project completion, and the maintenance of the facility constructed.

- Adopt as the immediate aim of the work emphasis on those activities that could produce cost-reduction results of immediate usefulness.

- Identify the immediately-useful cost-reduction opportunities sharply, so that the actions to achieve them are clear and enable decisions to implement to be taken readily.

- Recognize that costs of construction involve not only the financial costs of the projects but also the implications that reductions in these costs can have on the use of labor-intensive technologies, on the demand for foreign exchange, and on the relations between initial value of a construction and the ultimate value.

B. FINDINGS AND CONCLUSIONS

1. Specific actions to achieve reductions of cost in each of the three sectors investigated have been identified, and for each sector they have been organized as an action plan. The specific actions may be classified into three categories as follows:

- actions for which implementation steps have already been taken;

- actions for which decisions are required in order to enable implementation steps to be taken;

- actions for which decisions to implement should be deferred until the time is appropriate.

2. Implementation steps have already been taken for four opportunities to achieve cost reductions.

a. By Improved Usage of Heavy Construction Equipment

The preliminary planning and the estimation of the cost of the work to complete a national inventory of heavy construction equipment in the country has been completed by the Unit of Infrastructure (UINF) with the cooperation of the Colombian Association of Engineering Contractors (ACIC). On completion, the results will enable Government and private organizations engaged in heavy construction to improve the utilization of the equipment already in the country, restore equipment that may have been retired prematurely, and reduce the unjustifiable import of new construction equipment.

Funding the program of work and selecting the method of supervision are still required.

The Ministry of Public Works will fund a study by a local consultant firm to explore the establishment of a "Bolsa de Equipo," in which the members would interchange the use of construction equipment they own individually as the needs are identified. The objective will be to reduce idle time of equipment available for use while demand exists. UINF has suggested specific measures to the Ministry of Public Works in this respect and in relation to the broader inventory of equipment on a national scale.

b. By a More Appropriate Masonry Cement

The Industrial and Agrarian Study Unit (UEIA) of Planeacion Nacional has arranged to receive a proposal from Instituto de la Construccion de la Universidad del Valle (ICUV), expected in September 1972, concerned with the development of a non-portland cement binder material, which will define the problems, scope of work, the technical aspects, and the raw materials. Planeacion should arrange to fund this proposal if it is found responsive and administratively acceptable. The results of the work will be useful in introducing a new product which can reduce the cost of constructing masonry walls in building and in other construction, and also which can help to reduce the cost of brick walls with respect to walls of cement-block formulations. The formulation of the product could involve the use of blast-furnace slag produced by the country's only integrated iron and steel complex at Belencito (Boyaca). This material is now being wasted in a dump.

c. By More Appropriate Construction-Labor Intensiveness

UINF has established the terms of reference whereby the Capital-Labor Model (CLM) developed by the World Bank will be applied in a limited way to the evaluation of the effectiveness of the labor-intensive "Pick-and-Shovel" secondary-road construction program in Colombia, which is sponsored by the Fondo Nacional de Caminos Vecinales. UINF intends to acquire the details of the CLM from the World Bank and to obtain its guidance to accomplish the data collection effort for Colombian conditions, the first step in the application of the CLM on a broader scale.

d. By Accurate Quantity Surveys

UINF is arranging to acquire the Highway Cost Model (HCM), completed by the Massachusetts Institute of Technology for the Department of Transportation of the United States. UINF expects to apply this model to a sample of recently completed Colombian road

and highway construction projects. The short-term objectives are to check the accuracy of the quantity surveys used as a basis for award of construction contracts, and also to check the appropriateness of the road alignments actually selected in terms of alternatives that could have reduced the quantity survey.

3. The following actions require decision in order to enable implementation steps to be taken to achieve additional cost-reduction opportunities.

a. By More Intensive Use of Transport of Cement by Rail

Unit-train transport of bulk cement or cement clinker from factory to market could in the long term temper pressures to raise cement prices by eliminating the regional character of the cement demand/supply pattern in Colombia through reduction in the cost of transport between factory and market; and in the short term for a similar reason stabilize cement prices in Bogota. The technology to achieve this type of transport for cement in bulk can be transferred, but a successful demonstration in the country is first needed. The specific technology has been successfully applied in England, and an attractive candidate for piloting this technology transfer in Colombia is available. It is based on the transport of cement in bulk from Cementos Boyaca at Nobsa to its marketing depot in Bogota using the existing rail line. A pilot technology-transfer project in this respect is technically feasible. The primary objective will be the development of complete knowledge of changes needed in details of technique, the actual cost experience that will result, and the reliability of the transport method. Another attractive candidate, but based on cement clinker, is the transport by unit train from Nare to Bogota.

b. By Anticipation of Future Cement Demand

It is difficult as the National Development Plan is implemented, to forecast cement demand rise in the country with an accuracy

that justifies construction of new cement manufacturing capacity. The reason is the new constant-value savings and loan policy of the Government to finance housing construction. Conceivably, progress in implementing the Plan through this policy could be rapid enough so that the country will face chronic and extensive shortages of cement to the extent that construction activities could be cut back. Such shortages could occur before new cement manufacturing capacity can be built. Some mechanism is needed to monitor demand and supply of cement on a current basis so that quick knowledge of imminent shortages will be detected, as well as indications of how much and when new cement manufacturing capacity should be made available.

c. By Increasing Efficiency in Burned-Clay Products Manufacture

The investigations of the technical performance of the burned-clay-products industry, which has now been completed by the Instituto de Investigaciones Tecnologicas (IIT) with assistance from the UNIDO, has produced a clear and unified set of technological recommendations whereby the efficiencies of the medium and small Colombian producers of burned-clay products can be increased. The result can be a more profitable or stronger competitive position for the industry with respect to alternative wall and partition materials, a more effective utilization of skilled labor, and an increase in productive capacity with a relatively small demand for new investment capital. However, there has been little, if any, evaluation of the findings by those engaged in the day-to-day activities of burned-clay product manufacture, who would be directly affected by the implementation of the IIT recommendations. Such an evaluation could be useful in identifying a method of implementation that assures a successful result particularly with respect to the cooperation the industry could offer.

d. By Creating the Institutional Structure to Focus on Specific Areas of Housing Construction

A number of opportunities to improve operations in the building construction sector and thereby reduce costs seem to be possible by further investigation of specific areas such as the following:

- Communication channels among the organizations involved in the sector, which facilitate the planning and acquisition of the labor and managerial resources to accommodate an expanded construction volume, and the procedures involved in accomplishing such construction.

- The adequacy and stability of the skilled labor supply in the sector.

- Control of material quality and conformance to standards.

- The pattern of utilization of equipment.

- The appropriateness of technological methods.

No institution exists in the country legally competent to investigate these areas and enforce the results.

4. Decisions to take steps to implement the following actions should be deferred until the time is more appropriate because:

a. Stepwise Progress is Needed

This reason applies particularly to the introduction of the computer-based modeling techniques, already noted above, as analytical tools. In the longer term these will provide the quantitative data necessary to support recommendations for significant changes in institutional practices which can result in attractive cost reductions. Step-wise progress permits a gradual build-up of confidence by those

organizations involved in the construction sector and affected by its performance. Such confidence is a prerequisite, if implementation of change is to be practical and the expected results achieved. Therefore, the consideration of such changes as

- a revision of construction standards and specification to reflect a labor/capital balance more appropriate to the conditions in Colombia and its national goals;

- the adoption of maintenance policies for the country's road and highway grid reflecting a balance between first costs and deferred costs more appropriate to the nation's financial position; and

- new procedures for award of contracts reflecting a more accurate quantitative definition of work scope and the avoidance of delays in making progress payments;

should await the results of the analytic work involving computer-oriented models already described above.

b. Actions Depend on Results of Prior Actions

Examples of actions which fall into this category are the following:

- Consideration of an import of cement through international tender, until it becomes clear that serious shortages in cement supply for the country are imminent, and new construction of manufacturing capacity cannot be completed in time.

- The construction of new cement-manufacturing facilities based on the Rio Nare limestone reserves. The construction should be carried out in a manner that will stabilize cement prices and assure adequate future supply. The construction should begin as soon as both the demand for cement clearly justifies this and unit-train bulk-cement trans-

port is successfully demonstrated and prospective costs are known. With these preconditions, the limestone reserves along the Rio Nare provide the best assurance that new production capacity can employ modern technology, offer low production costs, and provide unlimited quantities to match growing national demand.

- Consideration of a Technological Service Center for the Building Construction Sector that can from the point of view of data and evaluation of systems of construction and alternative materials of construction help solve some of the problem areas in this sector.

5. The concept of a single conference/seminar described in the project statement (paragraph 4.5.3), in which all the results of the investigations by the Ad-Hoc Group would be considered, should be modified, as should also be the intention to incorporate the results of such a conference in the final report of the Ad-Hoc Construction Cost Reduction Project. The modification should recognize that the nature of the technical findings from the work specifically indicate that conference topics should be narrowly defined rather than all inclusive, and that each topic can warrant a separate conference more or less unrelated to that for any other topic.

C. RECOMMENDATIONS

We recommend as follows:

1. That the preliminary efforts by UINF to transfer the two model-oriented approaches to provide analytical tools for the road and highway construction sector be supported in the following specific manner.

a. Form a working group comprising personnel representing experience in the different disciplines required for the technology transfer.

b. Assist this group with personnel from the different government organizations involved in road and highway construction.

c. Arrange for the services where indicated of a consultant firm of appropriate qualifications, and seek funds to cover the cost.

d. Designate UINF of Planeacion Nacional as the organization responsible for the success of the effort.

2. That the specific efforts, already begun to bring the HCM computer program to Colombia for adaptation to the DANE computing center, be continued. These are

a. to request from MIT, the card deck, the user's manual, and their final report to the U. S. Department of Transportation. Also, to request a set of sample input cards,

b. on receipt, to adapt this program, written in FORTRAN IV for an IBM 360-50, for use with the DANE computer. The program requires a 230,000 bit core, which can be reduced by the use of disks as supplementary memory; or by taking advantage of the overlay structure,

c. to designate a staff member from the Ministry of Public Works and from Planeacion to be responsible to manage the computer program in the way that will be responsive to the limited application foreseen in the early stages of the work.

3. That the two implementation efforts already begun, namely the equipment inventory and low-cost masonry binder cement, be continued. For the inventory of heavy construction equipment, proceed with the recommendations already submitted to the Ministry of Public Works regarding responsibility and finance for both the national inventory and the study of the "Bolsa de Equipo" concept. For the investigation of a substitute for portland cement as a masonry binder, arrange for Planeacion

Nacional to evaluate the proposal from ICUV, to provide the supervision of the work, and to secure the funds to cover the cost.

4. That Planeacion Nacional management exert a concentrated and intense effort to bring the managements of Cementos Boyaca and the National Railways together at a conference, whose objective will be reaching formal agreement in principle to share the responsibilities and the costs of a pilot program of unit-train transport of bulk cement from Nobsa to Bogota. The topics to be covered at the conference should be the following:

a. The formula by which the actual cost experience generated by the pilot program will be translated to the rate to be charged later for the transport service.

b. The formula for the maximum cost of transport Cementos Boyaca will ultimately accept based on their present total cost of transport by road.

c. The formula by which the total capital cost of the pilot program will be shared.

d. The method by which the optimum single train capacity will be established such that the capital cost of the pilot program will be minimum while the train capacity will still be large enough for the experience to be meaningful.

e. The schedule under which the planning, the construction work, and the pilot operations will be conducted.

f. The cost accounting procedure for the pilot program.

5. That Planeacion Nacional undertake a similar effort oriented toward transport of cement clinker from Nare to Bogota.

6. That Planeacion Nacional sponsor a technical conference for participants who would be concerned with the design, implementation, and operations of a cement demand monitoring group. The function of this group will be to operate a fact-gathering system that will be capable of monitoring cement demand at frequent intervals (perhaps monthly or quarterly) and to compare this demand with the actual current industry supply position. The objective of the conference should be to determine the manner for creating this function. Organize the conference in the following manner:

a. Invite participants from the manufacturing industry, the major consumers, trade or industry associations, DANE, cement distributors and dealers, architect associations, among others.

b. Prepare papers in advance for discussion covering techniques that could be employed to process facts, such as development on an empirical simulation model, method for updating the model constants, the kind of data that should be collected.

c. Secure from the discussions suggestions for the methods of collecting data, the cooperation that may be expected, and who would take the responsibility for the efforts.

Use the results to design the method of operation, and consider whether it would be useful to monitor construction-steel demand; and if warranted, add this to the functions of the monitoring group.

7. That Planeacion Nacional sponsor a technical conference for participants involved in the burned-clay products industry. The objective of the conference should be to determine the manner by which the recommendations of the IIT/UNIDO study should be implemented. Organize the conference in the following manner:

a. Invite participants from brick and tile manufacturing enterprises, government organizations involved in setting standards and having interest in quality control, major building contractors experienced in brick utilization, wholesalers and distributors, among others.

b. Distribute the findings of the IIT/UNIDO study as the basis for discussion.

c. Provide a forum that encourages free exchange of ideas and the formulation of a set of recommendations by the conference participants.

After the conference, Planeacion Nacional should consider the conference results, particularly the receptivity of the audience to technological improvement, and then formulate an action plan for implementation.

8. That Planeacion Nacional sponsor a conference for the building construction sector designed to offer a forum for the free exchange of ideas on two specific aspects in the areas identified for investigation:

- the identification of the nature and extent of the problems that exist in this area, and

- the solicitation of suggestions on the nature and possible powers of an institution which could find solutions to the problems identified, and then enforce them.

9. That the work continue on an Ad-Hoc basis until such time as it becomes evident that a more formal organization is convenient.

APPENDIX C

PHILIPPINES

SUMMARY SECTION
HOST-COUNTRY REPORT

Republic of the Philippines
Department of Public Works, Transportation and Communications
Bureau of Public Highways
PILOT TECHNICAL ASSISTANCE PROJECT
M a n i l a

ACHIEVEMENT OF OPPORTUNITIES TO REDUCE CONSTRUCTION COSTS IN PUBLIC HIGHWAYS

Report of the AD-HOC Group

VOLUME I

APRIL 1973

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Sub-table Letter	Discount Rate %
a	6
b	8
c	10
d	12
e	14
f	16

Sub-table Letter	Discount Rate %
a	6
b	8
c	10
d	12
e	14
f	16

I SUMMARY

A. PURPOSE AND SCOPE

The construction of roads and highways in the Republic of the Philippines is currently a major activity in the infrastructure development sector. This emphasis is expected to continue into the future. Considering only the road and highway projects handled by the Bureau of Public Highways, the sums to be expended in the coming years will be considerable, about 30% of the total expenditure foreseen for all facets of the nation's development.

The expenditures will be made in the context of national planning policy, which is embodied in the current Philippine Four-Year Development Plan (1972-1975). Since the formulation of this Plan, one particular policy for its implementation has been given an increased emphasis. It is a greater utilization of labor-intensive methods in public works construction in order to create new opportunities for the employment of people. In addition, the potential of another implementation policy has become clear. If reductions in the costs of construction could be achieved, then the demand on the nation's resources to support the road and highway construction program could then be reduced correspondingly.

With such potential in mind, on 13 November 1972 the Department of Public Works, Transportation and Communications (DPWTC) formed an ad-hoc group from personnel in its Bureau of Public Highways (BPH) to begin work in a project of investigations aimed at identifying appropriate cost reduction opportunities. This group, identified as the Pilot Technical Assistance Project (PTAP), was provided the services of the consultant firm of Arthur D. Little, Inc. of Cambridge, Massachusetts, (ADL) by the United States Agency for International Development (USAID). The modus operandi of the PTAP was set forth in a published project statement, dated 15 November 1972.

The specific objectives adopted by the PTAP to guide the initial efforts of its work were:

- to identify the areas in road and highway construction on which its efforts should be concentrated;
- to select from such areas those that promise opportunities to reduce cost at the earliest time;
- for such cost-reduction opportunities, to recommend practical means for achieving them; and

- from the overall results of the work, to recommend whether further efforts should be undertaken in the future, the nature of these efforts, and the forms of organization that could be considered to take the responsibility for completing these efforts.

Thus the work of the PTAP has been envisioned as the first phase of a possible further effort. However, the contents of this report have been organized to be responsive to the objectives in the first phase of the PTAP.

The specific areas on which PTAP has concentrated its work of identifying cost-reduction opportunities are:

- the Projection of the Future Construction Program of the BPH;
- the Labor-Intensive Construction of Roads and Highways;
- the Prolongation of the Service-Life of Heavy Construction Equipment;
- an Improvement in the Distribution of Cement; and
- an Increase in the Utilization of Computers.

With respect to prolonging construction-equipment service-life, the PTAP narrowed the area for its concentration to two types of equipment which together account for the major portion of value of equipment in the mix for a road construction team. The reason was the need to reduce the scope of this topic to proportions which could be managed within the allotted time and with the staff available to the project.

B. METHODOLOGY

The PTAP adopted and followed a specific set of policies to guide its investigations. The set was selected to assure that the results could be implemented immediately in a manner responsive to the goals for economic progress which have been identified in the current National Development Plan. The policies have been:

- to undertake and complete the work program for the project as the initial effort of a longer-term effort, in which detailed analyses and evaluations that were not practical to cover in the first phase could be considered;
- to emphasize those features in the topics selected which can produce cost-reduction results of immediate usefulness;

- to avoid any overlap with the work areas delineated for the longer-term project of the Kampsax-Berger consortium (within whose period of scheduled activities the PTAP schedule fell), while at the same time taking advantage of the findings the consortium has already produced.
- to identify the immediately-useful cost-reduction opportunities sharply, so that the actions to achieve them are clear and enable decisions to implement them to be taken readily;
- to recognize that costs of construction involve not only the initial financial costs, but also the effect of the future costs which are associated with the maintenance of the completed facilities and which are incurred periodically during the life of the project; and
- to recognize that financial costs are interrelated with national economic costs, and that because of this interrelationship an opportunity to reduce a financial cost should take into account the implications of such a cost reduction on the national economic costs which arise from new opportunities to provide employment to people and/or to reduce demands for foreign exchange.

The PTAP began active work on 13 November 1972 and its investigations were formally completed on 30 March 1973. During this period, the work involved undertaking and managing a number of distinct stages of activities, which were the following:

- the definition of the prospective work topics in detail and the incorporation of changes in their purposes and/or scopes as the need for this became evident;
- the establishment and accomplishment of a number of visits to field offices of the BPH to secure data and information which required the compilation beforehand of a questionnaire covering the topics selected;
- the organization of the field work as a series of one-day conferences in the offices of the Regional Directors of the BPH, with the local engineering staff as the participants and with discussion in these conferences based on the questionnaire;
- the organization and accomplishment during 26-28 March 1973 of a three-

topics were presented to a varied audience for discussion and argumentation; and

- the formulation of action plans from the overall results of the work.

C. FINDINGS AND CONCLUSIONS

1. The Future Road-Building Program and Its Implications

Projects already envisioned for the BPH, also information regarding the future availability of funds for road building, show the following forecast of the future road-building program for the BPH between FY 1973 and FY 1980.

Road Category	Total Accomplishment (Kilometers)	Estimated Expenditure (Millions of Pesos)
Paved		
Asphalt	5,033	836.6
Portland Cement Concrete	8,746	2,860.2
Unpaved		
Feeder	21,210	959.1
TOTAL	34,989	4,655.9

These eight-year totals may be compared with the four-year totals in the current Philippine National Development Plan, in which an expenditure of slightly over 2,000-million pesos is envisioned during the period FY 1972 through FY 1975. Therefore, the heavy emphasis in the present plan on road and highway construction (a 500-million peso annual average expenditure over 1972-1975) should continue through FY 1980 (a 580-million peso annual average expenditure over 1973-1980).

The forecast of the road and highway construction program shows that the large volume of road and highway construction can magnify the savings from a specific cost reduction opportunity even though at first glance the savings may appear prosaic.

The large volume of road-construction activity forecasted could represent a major means to provide the new jobs needed to occupy the increasing size of the country's labor force. Statistics from the 1970

census indicate that from 1970 to 1975 the size of the male population in the 20-49 age bracket will increase by about 1,120,000; distributed 360,000 in urban areas and 760,000 in the rural areas. These statistics also indicate that the corresponding increase between 1975 and 1980 will be even larger.

To support the road-building activity forecast, the lot of heavy construction equipment in the current BPH inventory may have to be multiplied three times. Specifically, for selected types of equipment, the following is apparent when current construction technology and service life expectations are basically unchanged:

Crawler-Tractors	Present Inventory	FY 1973-FY 1980 Acquisitions
120 HP	130	527
180 HP	451	1298
Dump Trucks		
4 cubic-yard	810	2985
6 cubic-yard	2100	6900

Therefore, if labor were to be substituted for equipment, and/or if equipment life were to be prolonged, a significant reduction in foreign exchange requirements over the period of the forecast could be achieved.

The road construction program forecast should consume over the period a total of 5.1-million metric tons of portland cement. This consumption will be distributed over the eleven regional areas of the BPH administrative organization. The consumption, distributed as an annual average over the 8-year period, represents about 9% of the current installed productive capacity of the Philippine cement industry, and about 18% of the current production of the industry.

2. Labor-Intensive Construction of Roads and Highways

a. Institutional Practices

The technology currently used by the BPH in the construction of roads and highways emphasizes largely capital-intensive technology, which requires a high input of foreign exchange and offers little

opportunity to employ labor on a large scale. The reason for this emphasis seems to be the combination of the effects of policies of international development-oriented lending institutions with the large influx of mechanical construction equipment to the Philippines after the liberation in 1945.

On the other hand, pre-war road-construction activities in the Philippines were labor-intensive. But because of the post-liberation shift to capital-intensive methods, very little of the pre-war experiences remains in the BPH. The senior staff who supervised the pre-war activities have largely retired. But, furthermore, even if their experiences were readily available, they may not be entirely applicable to the construction of present-day roads with the geometric and compaction specifications which are suited to modern vehicles.

The DPWTC seems to have recognized this lack. Recently, projects have been designated as "pilot" so that they can be organized to develop experience and to accumulate a body of financial-cost data. Two projects to reconstruct levees damaged by the 1972 floods have already been undertaken by labor-intensive means. A six-kilometer stretch of road between Capas and Botolan is scheduled for completion by labor-intensive technology in June 1973, but as of this writing work has not yet begun.

But for the meantime, the indications are that almost no capability exists in the BPH staff, or even within the DPWTC itself, to provide reliable financial-cost estimates of infrastructure projects which could be constructed by labor-intensive means. Nor does it appear that such a capability will be available early enough to permit the BPH to implement effectively the government policy to encourage labor-intensive construction.

The BPH will face two major problems in any serious attempt it makes to implement the government policy. They are:

- to know in advance the financial cost of construction of a given road by labor-intensive technology, and
- if the financial cost is higher than for construction by capital-intensive technology, to calculate the national economic cost

under each of the technologies under consideration, and then to adopt the technology that indicates the lowest national economic cost.

The solution to the first problem can begin with organizing the pilot construction of the six-kilometer stretch of the Capas-Botolan road in a manner that produces as comprehensive a compilation of data as practicable, which relate labor costs and labor productivity in the major unit operations of road building. The indications are that reliable and comprehensive data of these types will not be produced in this pilot construction project.

The solution to the second problem lies in establishing the justification for absorbing possibly higher financial costs, arising from the use of a labor-intensive technology. Labor-intensive methodologies that may result in increases in financial costs nevertheless may deserve to be adopted either because they operate to reduce national economic costs or because they carry additional national benefits. These two possibilities can be expressed as one possibility by referring to national economic costs per unit of benefits.

The procedure for assuring successful implementation of the government labor-intensive construction policy should incorporate the following elements:

- the recognition that certain government, or BPH, policies and procedures can serve to discourage the use of labor in road and highway construction. Examples of these are: the Contractor's License Law and the BPH prequalification requirements for prospective bidders which have equipment ownership and possession as one of the factors for licensing and prequalification; and the existing technical specifications for construction of roads and bridges which are capital-equipment oriented. Such policies or procedures can serve to obscure labor-employment opportunities which may be financially competitive and technically as acceptable as the equivalent capital machinery employment.
- the recognition of good examples of labor-intensive applications to projects such as those whose remote geographical location makes

it costly to move in equipment; those whose size is so small that financial costs of moving equipment to and from the site are extraordinarily high; and those incorporating excavation for drainage ditches, or culverts, in locations where considerable underground useful infrastructure is already installed.

- the recognition that opportunities for large-scale employment of labor in road construction requires that new social and economic benefits be generated because labor primarily has been employed in the construction. One method of assuring that such benefits will in fact be generated is to consider the construction of the road as the means to open and develop a new geographical area rather than as a project primarily to connect two population centers. Then, if higher financial costs have been incurred because a labor-intensive construction technology has been used, the justification to go ahead anyway will lie in recognizing that national economic costs may be reduced thereby.
- the recognition that conventional contracting procedures practiced by the BPH may have to be reconsidered because these procedures do not fit in with undertaking a major labor-intensive road construction project having broad social and economic considerations. As an example, the present ceiling of about two million pesos set for the construction of roads by administration (i.e., without the letting of a general contract) is too low for any labor-intensive road construction project longer than perhaps five kilometers.

b. Construction Technology

The construction of roads and highways by 100% content of labor, or by labor supplied with a nominal quantity of hand tools, is obviously impractical. Such an approach leads to extraordinarily slow rates of progress, non-compliance with specifications, and most likely an extraordinarily high financial cost. Accordingly, the intent of the government policy to encourage the employment of labor in road construction should be taken to mean a shift away from the capital content of current road construction technologies employed by the BPH and its contractors toward a lower capital content, with labor filling in the gap in the

technology thereby created.

The extent to which such shift should be made is not clear, nor can it become clear until there is a thorough analysis of the parameters affecting the appropriate size of the shift. For those instances in which the shift to a labor-intensive technology does in fact raise financial costs, the need is to choose the project design and the degree of labor-intensiveness in a manner that will minimize national economic cost per unit of benefits. The additional parameters that affect national economic costs and the generation of benefits then need also to be analyzed. Illustrations of some of the parameters involved in complete analyses are: the size of the labor force available to the project; the current employment distribution in that labor force; and the technical nature of, and the potential economy for, the terrain to be traversed.

An ideal procedure to determine the appropriate size of the shift for any given road construction project is as follows:

- identify the alternative technically-feasible technologies that may be considered to meet the two main objectives of the project (i.e., completion of the project to schedule and compliance with the construction specifications);
- for each alternative technology considered, analyze the parameters in order to produce the set of national economic costs that would be incurred to construct the project and the corresponding financial costs;
- select the appropriate construction technology for the project on the basis that the national economic costs will be the minimum when that technology is used;
- finally, determine the budgetary adjustments to be made internally within the government agencies affected, to accommodate an increase (if any) in the financial costs for the project which arise from the use of the appropriate technology. For example, savings in financial costs attributable to the reduction in unemployment because of the road construction project could be applied to help support the additional financial cost of the construction

project itself.

A minimum content of capital equipment must be incorporated in any construction technology that may be considered as one of the alternatives in the determination of the appropriate technology. This content is:

- the use of a powered mechanical compaction equipment to meet the specifications for compaction, and the use of motorized equipment for water transport and watering to the extent necessary to avoid loss of productivity from the equipment;
- the use of air compressors, pneumatic drills, and explosives for the removal of rock formations in order to meet construction schedules with the available labor force; and
- the use of motorized equipment for the transport of laborers to and from the site, when distances are excessive, to provide the maximum rest and relaxation periods for the laborers in order to encourage higher levels of productivity.

Furthermore, it is likely that the appropriate technology, when found, would contain a higher content of capital equipment than as just noted.

Therefore, ideally the first step in the construction of any major road project by labor-intensive means should be to identify the appropriate construction technology. This technology, when found, will have the following characteristics:

- it will represent the construction of the road project at the lowest national economic cost, as far as this cost can be reasonably determined;
- it need not be the same for every road construction project for which labor-intensive methods are to be encouraged;
- it may require a higher financial cost than has been experienced so far in the BPH from the technologies now employed;
- it will still represent a blend of capital equipment and labor, although it is likely that this blend will be labor intensive compared to the blend currently practiced in the Philippines; and

- its capital/labor content will depend on the state of the national economy and also on the state of the local economy in the area of influence of the road at the time the identification is made, and will change as the state of the economy changes.

But, it is not feasible to make such an identification unless an adequate compilation of data especially relating labor and equipment costs with labor and equipment productivities is available. As already noted above, the data for the labor aspects are lacking and will have to be especially compiled from road construction projects which the government has designated as "pilot" or "prototype".

c. Project Management Techniques

The project management techniques that would be employed in either labor-intensive or capital-intensive construction are both different and similar. For example:

- it is easier to predict the productivity of machines than it is to predict that of human labor;
- the productivity of capital equipment depends primarily on the mechanical condition of the machine, whereas the factors that influence the productivity of labor are far more complex. Some of these factors are: worker's physical condition and psychological attitude; conditions of employment, including incentives and amenities; and tools and working methods;
- on the other hand, the productivity of both equipment and labor depends on the planning and organization of the work and the quality of supervision of management;
- just as thoughtfulness in preparing the work plan can produce a maximum productivity from machines, similar thoughtfulness with respect to the work plan can produce high productivities from the labor.

The "paquiao" system, or the "takay" basis, which is the method historically employed in the Philippines for payment for accomplishment rather than for time spent on the job, contains many cultural and anthropological overtones which can lead to increased productivity. Although

its effectiveness has been demonstrated in the past, and its use wherever labor is a factor in construction is official DPWTC policy, nevertheless even in this system human factors are still present and these can act to prevent attainment of maximum productivity.

Therefore, an entire new discipline needs to be identified to relate the experiences of modern labor-management to historical labor practices in the Philippine cultural environment in a way which can help to assure that the performance of a large construction-labor force will involve a high level of motivation, and hence yield a high productivity. Otherwise, the use of a labor-intensive construction technology in the Philippines may become inefficient, the financial costs in such construction may then be found to be unjustifiably high, and hence not acceptable. Ultimately, the opportunity to utilize idle labor forces in the Philippines in the appropriate manner for infrastructure construction work will have been lost.

The personnel in the BPH (and also probably in the DPWTC) have not yet been exposed to such experience. Large-scale employment of labor in road construction would generate a need for such experience.

d. <u>The Marikina-Infanta Road</u>

About 100 kilometers of alignment of the proposed Marikina-Infanta road traverses public land and has not yet been committed for construction. This stretch of road represents an ideal candidate for construction as a prototype by labor intensive means for a number of reasons. These are:

- the public lands are probably available for resettlement by the workers engaged in the construction, and this can lead to new social and economic benefits not normally taken into account in a road feasibility study;
- the indications are that higher levels of unemployment exist in metropolitan Manila than is the case nationally;
- the road is close to Manila where the offices of the Bureau of Public Highways, government agencies, and university research groups, which would participate in different aspects of the project, are located;
- the metropolitan Manila area offers a large market for the new agricultural production from the lands opened by the road, and moreover

these products could have a higher value thereby allowing for smaller farm plots to be viable; and

- other potential benefits for this road have already been identified in a prefeasibility study recently issued.

Progress so far in implementing the government policy to encourage labor-intensive construction of roads seems to be slow. For example, the pilot project for the Capas-Botolan road already noted has been under consideration for about seven months and serious work has not yet started. It is likely that the project may have to be deferred until after the rainy season. Some of the problems that cause delay seem to involve difficulties in coordinating the efforts of the different agencies involved, or the efforts of persons who still have other commitments to fulfill.

To accomplish an effective prototype construction by labor-intensive methods for the Marikina-Infanta road, the need exists to establish a master plan for the road project, and to use such plan to direct the efforts of all government agencies that could be involved in its implementation. The plan should be designed to contain features which will maximize the national economic net benefits. One aspect is the choice of road alignment, which requires considerable advance thought in terms of the precise objective (or modification, when conflicting objectives are involved) to be achieved. The reason for this emphasis is the possible need to enlarge benefits relative to the national economic costs and to the financial costs. The two objectives which may be in conflict for the Marikina-Infanta road are:

- to provide the shortest feasible link between the two towns connected, which has the potential of minimum travel time; or
- to open as much as practical publicly-owned new land area for settlement and development.

3. <u>Prolonging the Service Life of Heavy Construction Equipment</u>

a. <u>Incentives</u>

It is clear that capital equipment will remain an important factor in the future construction activities of the BPH, and that prolonging the service life of equipment units now in the BPH inventory could offer an opportunity to reduce the financial costs of construction. The reasons are:

- Current government policies to encourage greater use of labor in road and highway construction, as noted above, do not obviate the need to employ substantial amounts of heavy capital equipment.
- The shift from the present construction technology to the appropriate construction technology will take some time to accomplish, which probably could be measured in years.
- Major capital expenditures will be required for new construction equipment to implement the future road building program presently facing the BPH, resulting from Government planning in this sector.

On the basis that current BPH equipment management practices remain substantially unchanged, total future equipment purchases can be estimated to be the following for the period between FY 1973 and FY 1980 inclusive:

Service Life (Operating Hours)	Purchases (US$)	Savings (US$)
10,000	187.9-million	-
20,000	97.7-million	90.2-million
30,000	65.5-million	122.4-million

Thus, the incentive to identify and attempt to change BPH equipment management practices that can extend service life is with little doubt a powerful one.

b. Current Efforts to Increase Service Life

Some changes to the equipment management practices of the BPH are currently in the process of implementation, and these can have the effect of increasing service life by overcoming ineffective maintenance practices of recent years. They result from the work of the Kampsax-Berger Consortium, and their implementation should be completed by 1 July 1973. The changes fall into two categories, which are:

- the establishment of regional mechanical depots and the area shops, which are to be properly equipped and organized for the necessary servicing of equipment and the training of operators and mechanics; and
- the institution in these shops of a comprehensive system of preventive

maintenance, designed to detect operating problems in the equipment and to provide for them in advance.

Two ineffective practices which have prevailed in recent years will not be eliminated by the changes. These are:

- Lack of standardization in the makes of the equipment units which have been imported. A pattern of demand for spare parts has resulted characterized by small requirements for many different part items. Such a pattern not only discourages local industry from investing and undertaking spare parts manufacture, but also complicates the management of parts inventories.
- Choice of makes of equipment whose manufacturers do not maintain adequate stocks of spare parts, or provide service facilities in the Philippines.

Some thought is currently being given to segregating different brands of the same type of equipment in specified geographical locations to simplify maintenance and spare part procurement problems. But, such a reallocation will require a significant expenditure for the one-time equipment transport that would be involved.

c. New Opportunities to Extend Service Life

Two specific technological non-destructive testing practices are available which, if introduced to the regional depots and to the area service shops, can serve to extend equipment service life. They are:

- the technique of analyzing periodically a sample of lubricating oil taken from a given equipment unit, to identify the trace elements present and their quantities; and then evaluating the accumulated data for that equipment unit to alert the repair shop to probable locations of deterioration, and at the same time to specify the urgency for attention; and
- techniques based on the use of radiation, ultrasonic, and electromagnetic analyses, and on the use of liquid-dye penetration phenomena, which can detect the extent to which metal fatigue failure has already occured in a given equipment unit so that the replacement needed can be identified and procured before major damage

from the failure of such parts occurs in the unit.

However, no use of either of these techniques is yet planned for the regional service depots.

Two specific administrative, or management, opportunities are available for consideration in terms of their effects on extending service life of construction equipment. They are:

- evaluating the relative merits between (1) providing the services of the operator with the equipment so that the operator feels an attachment to the machine, and a responsibility for its proper operation and the prevention of abuse, and (2) permitting the construction engineer to provide the operator on an ad-hoc basis so that the engineer can have control over the productivity of the equipment; and
- regardless of the source of the operator, establishing personnel policies that compensate the operators commensurate with his abilities, attitudes, and performance as well as providing for the security of his position, through offering opportunities for him to transfer to permanent staff when his performance justifies.

Local manufacture of spare parts can serve to extend equipment service life, not only because they would be readily available, but also because they could avoid equipment obsolescence when a foreign equipment manufacturer changes models and ceases spare part manufacture.

The Philippine manufacturing industry as now constituted seems to have the capability to manufacture most of the spare parts which are needed for heavy construction equipment. Recent surveys of the industry indicate that much of the parts-manufacturing capability required for construction equipment support exists today. The only lack seems to be local forging capability for crankshafts and bulldozer structural parts. Also, there could be problems to be solved in materials and dimensional quality control.

The Metals Industry Research and Development Centre (MIRDC) of the Board of Investments can be an important factor in developing the capability of the industry to supply a complete line of spare parts. The MIRDC already has such a program planned, although it is not yet funded. Also, the MIRDC is excellently equipped physically to undertake the quality

control aspects of such an industrial development program.

Since costs will be incurred in achieving longer service-life periods, which would have to be measured against savings in the reduction of new equipment purchases, the need exists for the BPH and its funding agencies in the Philippine government to adopt a rational method of determining when the service life of a given equipment unit has ended. The method should recognize certain factors which have apparently not been previously recognized in the past practice of determining service life, which as noted below is now under review. These are:

- the foreign exchange component of the maintenance costs for an equipment unit is a considerably smaller fraction of the total maintenance cost than is the foreign exchange component of the cost of new equipment replacement unit;
- the foreign exchange component of maintenance cost can be decreased further if more spare parts could be manufactured locally of satisfactory quality;
- locally available spare parts could extend service life through avoiding obsolescence because foreign manufacturers have ceased spare parts manufacture for a specific model;
- more intensive maintenance involves a labor-intensive technology, which is attractive because it has the advantage of offering the labor force the opportunity to raise the level of their skills and training; and
- more intensive maintenance of an equipment unit is technically feasible only when the user is satisfied with the productivity he is able to obtain from that equipment unit.

The criterion which has been followed by the Bureau of Public Highways up to recently is to repair equipment until a needed maintenance job costs 60 to 70% of the financial replacement cost of the unit. Presently, this guideline is under review as part of the work of the Kampsax-Berger consortium.

4. <u>The Distribution of Cement</u>

Two opportunities exist to reduce the cost of construction through

reduction in the cost of cement. One is a conversion of the cement handling operations of the BPH from the handling in bags to the handling in bulk. The other is through purchase of cement from decentralized factory depots either in bulk or in bags.

a. Bulk Handling

The BPH presently purchases cement almost entirely in bags. For the cement consumption anticipated through FY 1980, the total of the individual costs attributable to the use of bags is about ₱110-million, or about 22 percent of the value of the cement. The major cost item is the cost of the bags at about 63 percent of the total cost of handling in bags.

Not all of the cement consumption is amenable to bulk handling. In general, when cement-concrete is mixed in one or two bagger mixers, bagged cement is appropriate. Bulk cement is suited when cement concrete is mixed in central batching plants. Thus, all of the savings indicated above cannot be realized.

Some cement is already distributed in bulk, primarily in the greater Manila area. Interest exists currently in the cement manufacturing industry in the concept, but the financial problems the industry has been experiencing can prevent serious large-scale application.

From the point of view of the Bureau of Public Highways, a large-scale introduction of bulk handling of cement will cause two problems to arise. These are:

- the need to provide an opportunity for a Bureau of Public Highways personnel to become experienced in the technique; and
- the need to provide new investment to convert central cement-concrete batching equipment to accept bulk-cement (by installing additional silos in the batching plant, to purchase truck trailers designed for transporting bulk cement in tanks and provided with piping for unloading by compressed air, and to install devices in silos to loosen cement to make it flow more easily.

With respect to the method of pricing the supply of bulk cement, a need exists to analyze the savings from changing from bag handling to bulk handling in a manner that can allow the allocation of these savings in an

equitable manner among the participants. Thus, since the change involves the system of activities starting with cement in the storage silo in the factory and ending with cement being fed into the concrete mix, the gain should be allocated equitably among the cement manufacturer, the transporter, and the consumer.

b. Decentralization of Depots

It appears that significant reductions in the delivered cost of cement may be achieved by making better utilization of low-cost water transport when a major island in the country does not have a cement manufacturing plant, or when distances of transport by land on the same island are large. Achieving such reductions will require that:

- storage depots for bulk cement be located at selected market centers and be operated by the cement manufacturer as an extension to his factory;
- the depots be supplied constantly through water transport in barges programmed to make maximum use of the transport equipment;
- the cement be transported in bulk; and
- the depots be provided with bagging machines to accommodate the sales made in bags.

Some locations have been identified where depots operated as extensions to the cement factory can act to reduce cement costs. They are:

- Pasacao in Camarines Sur
- Legaspi City in Albay
- Bacolod City in Negros Occidental
- Zamboanga City in Zamboanga del Sur, and
- Tacloban City in Leyte

The scheme is technically feasible and would serve to reduce construction costs through reducing delivered cement prices, but it appears financially difficult for the cement industry at this time to undertake the investment necessary in new facilities. Therefore, the concept merits the attention of the Cement Industry Authority, which currently seems to

have the legal authority to act as the implementing agency.

5. Increasing the Utilization of Computers

a. Computer Facilities and Capability

The Bureau's IBM 1440 computer, used for accounting and data handling, is presently too small (8 K) in core size to process any Fortran program. Expansion to 12K or 16K would allow this, at a cost quoted by IBM in 1970 at about US$ 35,000. Other machines are locally available for rent, e.g., the IBM 360 at IBM/Makati for 1,000 pesos per hour, and the IBM 1130 at the Bureau of Telecommunication (BUTEL) for 150 pesos per hour (on weekends only), on which Fortran programs can be run until such time in the future that the Bureau's machine would be upgraded.

At least one BPH employee already has been writing Fortran programs and running them on a rental basis on the IBM 1130 at BUTEL, but there is a general unawareness of this capability and what it could mean to the Bureau. IBM/Makati periodically offers two-week training courses leading to capability in Fortran programming. These are free at IBM/Makati until January 1974. After that, there will be a fee involved.

The physical computer facilities available to the BPH are adequate for its foreseable needs. Expansion of the BPH IBM 1440 to 16K size (the size needed in order to handle Fortran programming) is not justified at the present time. Instead, rental time as necessary on external computer facilities should be satisfactory. When rental costs exceed, say 1,000 pesos per week, expansion could probably be justified. Then almost all program applications of interest to the Bureau could be run within the Bureau's own facility.

b. Development of a Pavement Evaluator

A pavement-evaluator computer program in the Fortran language, for comparing the initial and continuing costs for various alternative road and highway pavements, has been demonstrated successfully on the IBM/Makati computer. The demonstration was based on an example containing many assumptions for each pavement type considered, especially with respect to road maintenance costs, local labor component, and the foreign component of initial pavement installation costs.

Results on such a basis showed the total (global) costs were comparable

for asphalt concrete pavement at low discount rates; but at higher discount rates the total cost was favorable for the pavement with the lower initial cost (asphalt, in this example). But the results have value only for illustrational purposes.

There is a lack of reliable data with which to supply the program, and this lack is sufficiently widespread to make the results calculated by the program unrealistic for decision making. There are clear needs for the compilation of data regarding:

- costs to maintain roads actually experienced rather than costs equivalent to annual allowances arbitrarily given the BPH highway districts (on which the present evaluator is based);
- the allocation of the different items of cost for the initial installation of the pavement to foreign exchange and to local labor.

c. Other Applications

Data collection for use in the planning of the labor-intensive construction of roads and highways and for prolonging the service life of heavy construction equipment will require convenient use of high speed data processing facilities.

The Bureau of Public Highways Computer Center is focussing its attention on matters largely of an accounting or inventory control nature. The personnel have the capability to undertake work of a technical nature despite of the lack of capability of the IBM 1440 installation to accept a Fortran compiler. To illustrate, the personnel rewrote the pavement-evaluator program from its Fortran version to a machine-oriented language and ran it successfully, i.e., they produced the same output results for the input data used in the development of the Fortran version pavement evaluator.

6. Nature of the Cost-Reduction Opportunities

Labor-Intensive Construction Through the multiplier effect of wages paid and the corresponding reduction in the use of imported construction equipment, the cost-reduction opportunity here is basically the reduction in the national economic cost of a road construction program. The financial costs may rise, although this is not necessarily so and possibly could be avoided by careful implementation of any plan of action designed to achieve

labor intensiveness. In any event, the application of labor-intensive construction to roads and highway requires a close and effective coordination among the agencies of the government concerned with economic planning, budget allocations, and road and highway construction.

Equipment Service Life The extension of service life of heavy construction equipment should have the effect of reducing simultaneously the national economic cost, the foreign exchange cost, and the financial cost of the use of the equipment. Local employment opportunities for skilled labor (mechanics) will increase, especially if a greater demand for spare parts leads to local manufacture on a wider scale.

Distribution of Cement The improved distribution of cement offers an opportunity to reduce financial costs in the Bureau of Public Highways road building activities. The investment to improve cement distribution will be capital intensive, and this may have the effect of increasing the corresponding national economic costs. However, the longer-term social benefits of eliminating the unrewarding, repetitive manual labor involved in handling cement and absorbing the displaced labor into the labor-intensive construction activities should justify any national economic cost increase by making it temporary in nature.

Use of Computers The work load of engineering personnel in the Bureau of Public Highways need not be affected by intensive computer use because appropriate use of such a facility will enable the personnel to explore alternatives in the design procedures, and to handle the large masses of data that will arise, as already noted, for which there is no realistic alternative. The ability to choose among alternatives allows criteria to be adopted which aim to reduce, where practical, all three costs simultaneously.

D. ACTION PLANS

The PTAP recommendations incorporate detailed plans of action based on the findings in each of the four topics of investigation now presented.

1. Labor-Intensive Construction of Roads and Highways

The PTAP recommends that:

- immediate opportunities to increase labor employment in road construction be identified in those areas of the conventional technology where

the use of manual labor can be substituted for the use of machinery at competitive financial cost;

- the portion of the proposed Marikina-Infanta road not yet committed for construction be established as the prototype for the appropriate application of the large-scale employment of labor in road construction,

- a master plan be established to guide all activities of government agencies which would be engaged in the implementation of the two recommendations above.

- the master plan provide for the incorporation of specific procedures and activities coordinated as an action plan.

First Set of Activities

The objective of the first set of activities is to identify, as far as practicable, quantitative opportunities for immediate labor substitution based on:

- a compilation of the experiences from the labor-intensive construction of the six-kilometer stretch of the Capas-Botolan road in a form such that it can have maximum utility for financial-cost and national economic cost estimating work;

- an analysis of the work tasks defined in the detailed construction drawings prepared by the Bureau of Public Highways for the stretches of the Marikina-Infanta road that are now committed for construction in a conventional manner, which is to include physical observation of work in progress; and

- the identification of the changes to the Bureau of Public Highways contracting procedures, necessary to remove impediments to realizing those opportunities for using labor more intensively that can be justified by competitive financial costs.

The final action for the first set of activities in the action plan is to be the dissemination of the results throughout the Bureau of Public Highways district, city, and regional offices, together with recommendations for their implementation.

Second Set of Activities

The second set of activities is to be undertaken with several objectives as follows:

- the demonstration that the construction of the prototype Marikina-Infanta road is technically feasible by labor-intensive methods;
- the demonstration that the construction of the road by labor-intensive methods is economically feasible in terms of national economic costs;
- the demonstration that a schedule for the completion of the project can be established in advance with reasonable expectations that it will be met; and
- the demonstration that the quality of the construction will be equivalent to the quality expected in current construction projects involving similar terrains and environments.

Achieving these objectives is to involve also achieving a number of interim objectives. These are the following:

- the compilation of comprehensive knowledge of the resources of the area traversed by the prototype road, especially those which were identified in the prefeasibility study of the PES, for further investigation in relation to the road construction;
- the compilation of comprehensive knowledge of the labor resource available for the construction program;
- the compilation of a body of sociologically-oriented knowledge about the Philippine laborer and of modern techniques for labor management aimed at identifying candidate methods to increase his motivation;
- the identification of the labor-intensive technologies that may be appropriate for the construction of the road in terms of achieving the construction at minimum economic cost;
- the estimation of both the national economic costs and the financial costs for the construction of the road if conventional capital-intensive technology were to be employed and when the appropriate technology is employed;

- a comprehensive description of the area development to be realized as a result of the construction of the road and its capability to absorb the labor force, and others, as permanent settlers; and
- the estimate of the amount and the schedule of the employment that can be offered, both when the appropriate technology and if the conventional technology were to be employed in the road construction.

In order to achieve the overall and the interim objectives, at least the following specific work tasks are to be undertaken:

- compilation of experiences in other countries where roads of similar scope as the Marikina-Infanta project have been constructed using labor-intensive methods (such an experience seems to be available in Taiwan in connection with the construction by 10,000 laborers of a 300-kilometer network during 1957-1960, now known as the East-West Cross-Island Highway);
- the formulation of the project management plan which anticipates the problems to be solved related to managing and supporting large numbers of men in a work force laboring over a number of years, including the problems of maintaining their motivation, their efficiency, and the required construction progress;
- definition of the non-road construction activities that must be incorporated in the master plan in order to generate the new social and economic benefits. (Examples are: construction of viable agricultural land; community development incorporating health and educational services; financial services e.g., a special bank, particularly during the early stages of settlement in new agricultural land, development of mineral resources; and the development of industry);
- incorporating in the designs dealing with the earthmoving operations (particularly in the mountainous areas) the prospects for contour leveling the land adjacent to the road to provide additional areas for agricultural purposes;
- giving consideration to the feasibility of incorporating such techniques for stimulating and raising motivation levels in the labor force as:

  (a) educating the workers to a clear understanding of the

social and financial aspects of the road project,

(b) providing a level of savings acceptable to the workers such that they will have working capital should they eventually settle in the land opened by the road,

(c) providing feeding and food items on the job to assure adequate levels of nutrition, aside from this use as compensation for the work, and

(d) the educational and training needs to be incorporated in the support services to the work force to prepare the workers for the problems of resettlement, or to train them in skills and crafts for future employment.

- establishment of a plan for recruiting the labor force which will consider the feasibility of recruiting from squatter settlements in the metropolitan Manila area, as well as from other sources;
- establishment of a plan for discharging the work force as required to take advantage of settlement opportunities as they arise.

As the final action for the second set of activities, the intermediate and final results, as they become available, are to be organized and evaluated as a series of written guides for the selection and implementation of road projects throughout the country which may then be found appropriate to construction by labor-intensive methods.

Organization

The satisfactory accomplishment of the two sets of activities is to be made the responsibility of a task force. This task force is to have the following character

- all members are to serve full time, and to have no assignment carried over from their regular employment;
- capability in all disciplines necessary to accomplish the professional content of the work is to be represented in the full-time staff;
- separate and independent office support is to be provided;
- careful consideration is to be given to the experience, qualifications,

motivation, and general capability of the person designated to lead and direct the task force; and

- the task-force leader is to be responsible to, and receive policy direction from, the Cabinet Coordinating Council for Labor-Intensive Operations.

The task force is to remain in existence until all its responsibilities have been discharged.

With respect to the delegation of authority to the task force, the following authority delegation seems to be the minimum to permit the force to act efficiently and to conform to its schedule:

- be authorized to take over the responsibility for the data monitoring and gathering operations of the pilot project to construct the first six-kilometers of the Capas-Botolan road by labor-intensive methods;
- be enabled to control the expenditure of its funds in a manner that clearly will not hinder or delay its progress;
- be given upon application, funds to continue its operations at periodic intervals upon the submission of the estimate, and the submission of a report of its financial operations during the previous period; and
- be authorized to contract with local Philippine firms, organizations, and institutions qualified to undertake investigations to preagreed-upon terms of reference.

Immediate Task

As its immediate task upon creation, the Task Force is to formulate and submit to the Cabinet Coordinating Council the overall work program covering its entire responsibility together with the schedule for its completion and an overall estimate of its cost. The work program is to be divided into stages, or phases; and a detailed work program, schedule, and cost estimate is to be submitted for the first stage. Particular emphasis is to be placed in the work program for the first stage on the immediate take-over of the data accumulation and evaluation aspects of the Capas-Botolan pilot project.

2. Prolonging the Service-Life of Heavy Equipment

The PTAP recommends that:

- efforts begin now to formulate and implement additional changes in the operations of the preventive maintenance program now being introduced to the new regional depots, area shops and mobile shops;
- the additional changes be geared to reduce the costs of the operation of the preventive maintenance program and to increase its effectiveness in prolonging equipment service life;
- initially, attention continue to focus on the two equipment types so far considered, namely: 120 and 180 HP tractor-crawlers and 4 and 6 cubic yard dump trucks; and
- later, as the initial task of implementing the recommendations eases, efforts be undertaken to (a) bring in other equipment types in the BPH inventory for similar treatment, and (b) bring in other equipment-owning agencies of the national or local governments who may be interested in applying the results to their own operations.

The PTAP recommends further that four separate action plans be adopted in order to implement the recommendations.

Determination of Service Life (Action Plan No. 1) The objective of this Plan is to establish a rational method

- for use within the Mechanical Service Division of the BPH, to enable it to determine when to recommend that a given equipment unit should be disposed because its service life has reached its end; and
- for use within the planning and funding agencies of the Department of Public Works, Transportation, and Communications and of the Government, to enable them to determine whether or not a replacement unit is warranted from the broader point of view of government budgeting demands and knowledge of the forthcoming road construction program.

The method eventually selected is to operate as follows:

- all financial cost records and all technical details of preventive and other maintenance work performed on any equipment unit of the two types considered are to be supplied by the area to the regional shops,

and thence to the central office of the Mechanical Services Division;

- the data in the records are to be processed during each interval of equipment operation (for example, after each 2000 hours of operation) to calculate the appropriate financial cost function during that period, in order to compare it with the criterion adopted in the method for measuring the end of the service life;
- when the criterion suggests that the service life of a particular equipment unit has ended, the Mechanical Service Division is to recommend its replacement to the BPH management who, in turn, is to determine whether the needs of the current construction program warrant the replacement;
- when the BPH determines that a replacement is warranted, it is to recommend the replacement in the budget plans for the forthcoming fiscal year, by forwarding in its budget request the complete details of the financial-cost analysis and breakdowns of costs into those paid in local currency, those paid in foreign exchange, and those paid for the employment of labor;
- the budget planners are then to decide from the national economic costs of the current maintenance on the particular equipment unit, measured against the national economic cost of the replacement of the unit, whether (a) to approve the replacement, or (b) to defer consideration of replacement until the request is raised again with the submission of new data, for example, after the next interval of operation;
- in the event the decision is in favor of (b) not to replace, appropriate adjustments are to be made in the budget for the BPH in order to accommodate the higher financial cost of maintaining that particular equipment unit during the next interval of operation; and
- if the decision is (a) to replace, the purchasing procedure is to take account of the accumulated cost experiences from the unit being replaced in order to secure the replacement, i.e., to use the experiences in weighting one brand of equipment against another during the procurement.

A technical description of one method which can enable the functions

described above to be achieved is contained in Section V of the Report.

Transfer of Testing Technology (Action Plan No. 2) The objective of this Plan is to transfer appropriate non-destructive testing technology, available in advanced industrial nations, for use in the regional mechanical service depots of the BPH as an aid to achieving a less costly and more-effective preventive maintenance program.

The elements to be incorporated in the Plan are to be the following:

- the identification of the technologies which can fit into the operations of the regional depots, the area shops and the mobile shops;
- the identification of the methods for operation and the training needed by the personnel involved in the operations;
- for each method selected, an assessment of the potential to reduce the cost of preventive maintenance practices in the various repair shops; and
- for each method identified, an estimate of the cost of its installation and operation.

Personnel Motivation (Action Plan No. 3) The objective of this Plan is to review the personnel practices in the Bureau of Public Highways, related to the operation and maintenance of its equipment in order to identify those changes which can serve to motivate (a) the operators to take conscientious and competent care of the equipment during its operation and (b) the mechanics to perform conscientious and competent maintenance work.

The elements to be considered in the review are to include the following:

- wage and salary scales including the benefits conventionally paid in the public and private sectors of the country;
- relating a particular operator to a particular equipment unit to generate a pride in the operator from effective operation and avoidance of abuse; and
- providing more intensive on-the-job training than is presently envisioned, which can lead to promotion to positions of increased responsibility.

Local Spare Parts Manufacture (Action Plan No. 4) The objective of this Plan is to provide a basis for the Bureau of Public Highways to cooperate with the

Board of Investments in the desire of the latter to encourage greater local manufacture of spare parts through employing the efforts of the Metals Industry Research and Development Centre (MIRDC).

The cooperation is to incorporate the following elements:

- compile from the BPH maintenance records the spare parts items that are consumed, their delivered cost, the details of their design, the specifications for the materials of fabrication, and the dimensional tolerances; and compile these in a manner that both describes the market offered to local manufacturers by the BPH and describes the technical requirements of the parts to the MIRDC;
- explore the feasibility of modifying component designs without detriment to the operation of the machines, to enable local manufacture instead of import (for example, by the use of an alternative design of diesel-engine turbocharger to that of the original equipment manufacturer);
- formulate a purchasing policy for locally-manufactured spare parts, whenever these are offered, which does not (a) burden the manufacturer with extraordinary working-capital problems because payments may be delayed, and (b) burden the BPH with spare parts of inadequate quality with respect to the materials of fabrication, the design, and the dimensional tolerances; and
- identify the role of the MIRDC in the control of the quality of locally-manufactured spare parts.

Organization

In view of the transitory situation currently prevailing in the Bureau of Public Highways with respect to reorganization, the PTAP is not now in the position to recommend regarding the implementation agencies for the four plans.

3. The Distribution of Cement

The PTAP recommends that

- the Bureau of Public Highways provide opportunities for its personnel to become experienced in the large-scale handling of cement in bulk by selecting specific road construction projects, supplying them with bulk cement, and permitting them to serve as pilot projects;

- the Bureau of Public Highways call the attention, through official channels, of the Cement Industry Authority to the findings and recommendations that are relevant to the decentralization of factory depots; and
- the Bureau of Public Highways encourage actions by the Cement Industry Authority toward such an end by cooperating with the implementation efforts undertaken by the Cement Industry Authority as far as the Bureau's interests are affected.

Only one action plan needs to be adopted with respect to these recommendations. Accordingly, the PTAP recommends further the adoption of an action plan to deal with conversion to bulk handling from cement factory to road construction projects in which portland-cement concrete is prepared in centralized batching plants. The Plan is to have the following character:

- the efforts are to be recognized as a pilot operation in which the accumulation of data and experience is one important objective;
- key BPH personnel are to be given opportunity to study the problems and observe the solutions as they become evident in the pilot projects;
- the Construction Division of the BPH is to be given the responsibility and the necessary funds for the implementation; and
- the results are to be evaluated and recommendations formulated so that a detailed plan becomes available to guide the BPH in the use of bulk handling of cement for cost savings in future road construction programs.

A list of candidates from which the pilot projects may be chosen is the following:

- Batangas City-Lobo Road, Batangas City section, which will serve primarily the Fortune Cement Company which must use this road for access to all its markets. The PTAP understands that the cement plant management has already offered to assist in the construction of this road by supplying cement-concrete components free of cost. The company already has the bulk carriers, and also needs the road for evacuation of its output. This project can offer the BPH the opportunity to implement conversion to bulk handling at low investment;
- the Layac-Mariveles Superhighway (Layac-Balanga Section) now under

construction by the Construction and Development Corporation of the Philippines;

- Digos-Cotabato Road in Region XI which is now under construction with Philippine Rock Products Inc. as general contractor. The cement source for this road is the Baenotan plant north of Davao City. Philrock has already used the bulk-transport method in the Greater Manila Area;
- General Santos-Cotabato City road in Region XI which is now in the stage of contract negotiation; and
- Iligan City-Cagayan de Oro-Butuan City road which is now in the detailed design stage. The cement sources for this road are the two plants in Iligan City, and one in Misamis Oriental. One of these companies is already interested in the bulk handling concept.

4. <u>The Greater Utilization of Computers</u>

The PTAP recommends that the Bureau of Public Highways

- marshal its forces to provide the capability to undertake computer processing of the data which will arise during the implementation of the Action Plans;
- continue the work to develop the pavement-evaluator further with the objective of achieving a level of reliability from its use acceptable to the Bureau's road design personnel; and
- use its assets of trained personnel to develop additional uses for the computer facilities it owns, or has access to.

The PTAP recommends further that two action plans be adopted in order to implement the recommendations.

<u>Pavement Evaluator Program (Action Plan No. 1)</u> The objective of the Plan is to improve the accuracy and sophistication of the pavement-evaluator program through a continual data collection and compilation of road maintenance experiences beyond that which is currently being undertaken. The work is to incorporate the following elements:

- quantification of the BPH actual maintenance experience (costs) with various pavements as a function of traffic density and weather, and the allocation for several new projects with different pavement

designs, of the foreign exchange and local labor component; and

- the review in terms of relying on its results, of the sophistication of the present pavement-evaluator program when reliable data has been accumulated, to determine whether other parameters should be incorporated, such as weather conditions and traffic patterns.

The primary responsibility for the data collection work is to be given to the Maintenance Division of the Bureau of Public Highways, which is to be provided the assistance of the Computer Center with respect to the technical details of computer programming.

Additional Usages (Action Plan No. 2) The objective of the Plan is to identify and implement additional opportunities to employ the computer in the technical activities of the Bureau. The work and organization is to incorporate the following features:

- appointing a small task force to list and categorize the major calculation activities within the BPH, and to identify individuals who have already had, or who might profit from, computer training;
- carefully selecting and sending the order of a dozen of its engineering personnel to IBM/Makati's periodic two-week training courses;
- carefully selecting a few areas in which increased use of the computer should be encouraged;
- including as one of the priority areas, the computer work foreseen in the implementation of the Action Plans recommended;
- arranging rental contracts with whichever of the externally available computers is cheaper at the time, to allow BPH personnel to run the programs that they may subsequently develop during the course of their work;
- upgrading the Bureau's IBM 1440 when the external Fortran-run rentals routinely exceed the order of, say 1000 pesos per week, or when other data processing loads at the Bureau dictate expansion of the machine to 12K or 16K size; and
- publicizing within the BPH the programming capabilities that may already exist, or which subsequently will be developed within the Bureau.

APPENDIX D

GHANA

MINUTES OF MEETING HELD TO PLAN THE FINAL REPORT FOR THE CONSTRUCTION COST-REDUCTION STUDY

MINUTES OF THE MEETINGS HELD BETWEEN 2ND JULY - 10TH JULY, 1974 INCLUSIVE TO PLAN THE FINAL REPORTS FOR THE CONSTRUCTION-COST REDUCTION STUDY

COPIES TO:

Dr. J.W.S. de Graft-Johnson
Dr. M.D. Tidiganu
Dr. K. Ankoh-Teizer
Mr. V. [illegible]van
Mr R.S.[illegible] Humphrey-Ackumey
Mr. D.J. O[illegible]
Mr. E.F. [illegible]
Mr V.D.[illegible] Aftafua
Mr A.K. Chatterjee
Mr A.A. [illegible]
Mr J.D. Riverson
Mr. C.F. [illegible]
Mr I.A. Allotey
Mr. J.C. Gogo
Mr L.K. Afele
Dr. J. [illegible]
Mr. C. Bliss
Mr. J. Mensah Quainoo
Mr D.A. Sanafoo
Mr. S.L. Yeboa
Mr. J.N. Okyere

PURPOSE

These minutes represent the basis agreed to by the project team members during the series of meetings on which the final project reports will be prepared. However, the details of the outlines presented may be changed as the writing work may indicate.

OVERALL FORMAT

The final report will consist of five separate volumes, titled as follows:

ACTIONS TO ACHIEVE COST REDUCTION IN GHANA'S PUBLIC CONSTRUCTION SECTOR

Vol.I Summary
" 2 Roads Programme
" 3 Housing Programme
" 4 Construction Materials Manufacture
" 5 Construction Industry Efficiency

COMPLETION DATE

Final completion date is agreed to as 15th October, 1974.

FORMAT FOR VOLUME I

The man-in-charge of preparation will be the Director. The details will depend on the action plans as they will be precisely defined in the remaining volumes of the report. The contents should also include the details of budgeting and scheduling of the work of implementing the action plans specified.

The possible elements of the action plans as they were defined during the meetings are included in the outlines for each volume of the Final Report.

FORMAT FOR VOLUME 2 (Roads Programme).

The man-in-charge will be Dr. Gidigasu. The following is the general outline of contents.

1.0 Summary
2.0 Background
  2.1 Ghana's future programme (Mr. Francois' paper. Appendix if necessary).
  2.2 Present technological practices. (papers by Abbey-Sam, Yeboa, Gidigasu, Danso, Afele, Allotey, Okyere, Riverson).
  2.21 Geometric Design
  2.22 Structural Design

2.221 Road Base

2.222 Bridges and Culverts

2.23 Construction Technologies

2.231 Equipment

2.232 Labour

2.233 Materials

2.3 Ghana's Resources

2.31 Equipment (paper by Okyere applies)

2.32 Labour (Papers by Ewusi, Wright, Clark, Coleman, Hammond may apply)

2.33 Materials Adaptation (Paper by Yeboa applies).

2.4 Measurement of Costs

Topics

Concepts of Cost

Need to Cost Present Practices.

Need to Cost Alternatives

Need for Identification

Base for Evaluation.

(This section may be an "essay").

(Note: The Introduction should contain factual non-controversial information as background for what follows).

3.0 Types of Cost Reduction Opportunities

3.1 Present cost levels. (Base on data, if available -- otherwise qualitative discussion should be enough).

Reach a conclusion to limit to technological matters.

3.2 Contributory Technological Factors.

3.21 Design Standards

3.212 Geometric

3.213 Structural

3.22 Appropriate Construction and Maintenance Technologies.

3.221 Labour

3.222 Equipment

3.23 Quality Control Procedures

3.3 Nature of their Dependence

3.31 Choice of Alignment

3.32 Choice of Base Design

3.33 Choice of Equipment.

3.4 Cost Measurement Methodology.

3.5 Conclusion

Separate investigation of topics as follows:-

Design Standards

Construction Technologies

No consideration of quality control per se.

4.0 Design Standards

4.1 Adherence to Geometric Design Standards (Opportunity is in the Maintenance of Roads by not exceeding road width specified).

4.2 Appropriate Use of Stabilization

4.3 Alternative Bridge and Culvert Design

4.4 Effect of Drainage Design on Maintenance.

5.0 Appropriate Construction and Maintenance Technologies.

5.1 Equipment Resource Management

5.11 Identification of the Optimum National Spare Parts Inventory System

5.11 Distribution of Stocks in Warehouses

5.12 Effect if equipment types are standardised.

5.12 Identification of the Optimum National Equipment Inventory.

5.13 Improvement in Equipment Maintenance Technology.

5.2 Labour Resource Management

5.21 More effective utilization of unskilled labour.

5.211 Compensation systems

5.212 Social Attitudes

5.22 Alleviation of shortages of skilled personnel.

5.221 Foremen

5.222 Craftsmen

5.223 Managers

5.224 Engineers.

5.3 Appropriate Labour/Equipment substitution

Topics.

- Availability of Productivity Data
  - (1) Labour
  - (2) Equipment
- Candidate substitution methods
- Basis for Evaluating Appropriateness.

6.0 Findings and Conclusions

6.1 Effects of Standard of Cost Reduction

List Findings

Draw conclusion (state so that Action Plan becomes obvious).

6.2 Effects of Construction Technologies on Cost Reduction.

List Findings

Draw Conclusion (state so that Action Plan becomes obvious).

7.0 Recommendation for Action.

7.1 Establish more Appropriate Design Standards.

7.11 Identify the Appropriate standards

7.12 Manage the Adoption

7.13 Assignment of Responsibility

7.131 Identification

7.132 Adoption

7.2 Identify More-Appropriate Construction Technology

7.21 Establish Experimental programme.

7.221 Test Alternatives

7.222 Produce Productivity Data.

7.223 Evaluate Results

7.22 Define Procedure for Adoption.

7.23 Assignment of Responsibility.

7.3 Define National Manpower Needs

- 7.31 Recapitulate Present Resource.
- 7.32 Estimate Future Needs
- 7.33 Assess Capability of Present Training Facilities.
- 7.34 Estimate Need for new facilities.
- 7.35 Assignment of Responsibility

7.4 Rationalise National Equipment Resource.

- 7.41 Recapitulate Present Resource.
- 7.42 Identify Appropriate Spare Parts Supply and Maintenance Policy.
- 7.43 Estimate Future Equipment Needs.
- 7.44 Assignment of Responsibility.

The above Section 7.0 represents the organization of the action plan. The elements which were previously discussed, but which may not now be totally applicable or fit the outline were as follows:

It appears that an Action Plan will include the design and construction of an experimental road project of reasonable length to permit the alternative technologies of construction to be tried and evaluated. The immediate foreseeable benefits are:

(1) It would demonstrate the effect of proper drainage on the road performance for a given traffic level.

(2) It provides an opportunity for training supervisors and engineers on the management of labour in a construction project.

(3) It also provides an opportunity to determine productivity level of labour and machinery for various operations.

(4) This would provide the guidelines needed for planning and estimating for future road project in a way that can reduce the cost of construction.

FORMAT FOR VOLUME 3 (Housing Programme)

A man-in-charge needs to be identified.

1.0 SUMMARY

2.0 Conclusion

Development of New Materials, e.g. brick in relation to supply of craftsmen, e.g. bricklayers.

3.0 Conclusion

Development of Good supply of tiles and timber to support use of clay tile roof design.

4.0 Conclusion

Increase in productivity of craftsmen employed in housing construction.

5.0 Conclusion

Local manufacture of simple handtools and equipment

6.0 ACTION PLAN

The above outline is brief by stating the nature of the conclusions to be reached in each section. The elements of an action plan had previously been identified as follows. Note that Volume 4 (Construction Materials Manufacture) may contain the action plans arising from Section 3.

Building Construction News

At present, a Building Construction News Survey is to be established beginning 1st July, 1975. There is an urgent need to plan the details of these surveys as soon as practicable, so that the first publication can be issued shortly after 1st July, 1975. A budget is required for this planning work.

The Comparison of Alternative Roof Constructions

1) The two alternative candidates for appropriate roof construction for residential houses are clay tiles and wood shingles.

2) The third candidate is aluminium sheet roofing, when the market reaches a size to support domestic roofing.

3) Of the two remaining candidates, clay roofing tile is essentially more acceptable and granting price variations may have universal application in the country. The Action Plan, therefore, is based on this alternative.

The plan of action is to make clay tile readily available at reasonable prices and tiles have already been established in the research and development plan under building materials.

Research and development work to identify the appropriate markets for the methods of manufacture of wood shingles should be continued.

FORMAT FOR VOLUME 4 (Construction Materials Manufacture)

The man-in-charge will be Mr. A.K. Chatterjee. He has appointed Dr. Amonoo-Neizer to act for him when he is on leave.

1.0 SUMMARY

2.0 Introduction

- 2.1 Scope statement
- 2.2 Demand for Materials
  (All five materials)
- 2.3 The Resources
  (Clay, limestone, bauxite tailings, timber).

3.0 CEMENT

(Action Plan - very end)

1. Drilling (and fuel source?)
2. Marketing (and fuel source?)
3. Process

4. Cost Analysis.

4.0 CLAY PRODUCTS

4.1 The Asokwa/Ankaful Experience.

4.2 Basis for a 30,000 B/W Plant.

4.21 Technical changes

4.3 Estimates of Cost

4.31 Financial

4.32 National Economic

4.4 Potential for Alternative Products.

4.41 Roof Tile

4.42 Drain Pipe

4.5 Findings and Conclusions

4.6 ACTION PLAN

5.0 LIME

5.1 The B.R.R.I. Demonstration Plant.

5.2 Findings and Conclusions

5.3 Action Plan

5.31 Build Prototype kiln

5.32 Produce Demonstration Samples

5.33 Perfect Production Process

5.34 Design Commercial Project.

6.0 POZZOLANA

6.1 Previous Research work

6.11 Scope

6.12 Findings and conclusions

6.2 Cost of Production

6.21 Financial

6.22 National Economic

6.3 Remaining Problems

6.31 Process

6.32 Market acceptance

6.4 ACTION PLAN

6.41 Bench-Scale Stage

6.42 Pilot Plant Stage.

7.0 TIMBER

7.1 Present supply/demand position (Asmah, Allotey)

7.2 Findings and conclusions.

Export orientation

Uncertain supply and quality

Unclear standards

High price structure

Need to rationalize entire sector.

7.3 ACTION PLAN.

Elements of the action plans had previously been identified as follows. They may be adapted to the outline above.

CEMENT

The high-calcium-limestones in the Bongo-Da region appear sufficient from the small-scale drilling programme of the Ghana Geological survey for small-scale production of cement. A feasibility study of the production of cement from this limestone should be undertaken using appropriate technology. The B.R.R.I. should be responsible and may seek the help of the Ghana Geological Survey. The feasibility study should cover the evaluation of limestone reserves, market characteristics, design of manufacturing facilities, supply and cost of forest-derived fuel including characteristics of carbonization of saw dust.

CLAY PRODUCTS

Bricks:

The Action Plan is based on the use of the most appropriate technology for clay and tile manufacture in Ghana which is labour-intensive of the type used in the manufacture of bricks at Asokwa. An exception to the technology is that continuous firing of kilns should be used instead of intermittent firing. Prototype of such a continuous kiln is now under construction at Fumesua. Takoradi is selected the construction of a new factory for specific reasons, which are:

(a) It does not compete with the sites selected by the Bank of Ghana.

(b) Good marketing area, and

(c) Good supply of fuel.

Technical Areas:

The Action Plan should be supported by definitive capital cost and manufacturing cost, etc., and financial analysis and national economic cost analysis for a 30,000 brick per week tentative site at Takoradi.

In the execution of the project the B.R.R.I. will present a complete set of drawings and specifications and offer its services for supervision during the construction.

The B.R.R.I. will train the operating staff. The initial project will be financed and managed by the B.R.R.I. with the aim of disposing of the completed smoothly-operating factory by sale at a proper time. The experience in brick quality generated at Asokwa will become the basis for suggesting for Ghana standard for common face bricks for building - engineering projects. The work programme for the prototype continuous kiln will be based on the design for Takoradi Plant.

Roofing Tile:

The manufacture of roofing tile in Ghana is a research in and development project to be undertaken by the B.R.R.I. which will have the following features:

1. Examination of Clay: Suitability of clay [illegible] of characteristics analysis and physical properties.
2. Moulding and drying characteristics such as warping characteristics.
3. Firing Characteristics: The rate of heating, [illegible]mination of temperature; time of retention.
4. Cooling Characteristics
5. Design of a down draft kiln for the manufacture of tiles.
6. Design a screw press for small-scale production of tiles.

The research/development programme will be planned with the objective that ultimately a roofing-tile manufacturing operation can be integrated with the Takoradi Plant.

Pipes:

Ultimately, upon completion of the research and development programme for the roofing tile, the B.R.R.I. will undertake a similar programme aimed at local production of glazed and unglazed clay pipe.

LIME

It has been demonstrated by work in the Building and Road Research Institute that lime can be produced in a simple kiln built entirely from local materials. The operation and output of this kiln are considered adequate for lime production on a small-scale.

The following action plan would seek to support a recommendation that the small-scale plant demonstrated by the B.R.R.I. be considered

the prototype for lime production in this country with the B.R.R.I taking the initiative in seeking financial and other support for its implementation.

1. The need is to establish two factories initially, one in the northern half and the other in the southern half of the country.

2. It is proposed that the locations of these factories be at Bongo-Da and Oterkporlu (near Koforidua). In choosing these sites, the future development of a sand-lime brick industry in the northern region and a lime-pozzolana industry at Kibi have been considered.

3. B.R.R.I. should take the initiative in getting government to induce enterpreneurs to establish these factories. B.R.R.I. should give technical advice and help in quality control.

4. An undertaking should be sought from the P.W.D. that it will purchase and use a major portion of the lime produced for base stabilization in its road construction projects.

5. The phase of the action plan dealing with increased use of lime in buildings will be taken up as a follow up of its successful use in road construction.

6. Attention will be paid to the production of both dolomite and non-dolomitic limes.

7. <u>Production of Sandlime bricks</u>: In the Northern Region using lime from the high-calcium limestone deposit in the Bongo-Da Region may be a more suitable proposition compared with production of clay bricks from the point of view of the requirement of fuel (fuel requirement for sandlime bricks is about half that for the production of equal number of clay bricks). It will be necessary

to examine the availability of sand deposits in the region as to their suitability for production of sandlime bricks. The action recommended is that laboratory work should be undertaken on such limes and if the lime and sand are found suitable for the purpose of production of sandlime bricks then ultimately a feasibility study covering markets, production methods and the cost of production should be undertaken.

POZZOLANAS:

The technical feasibility of admixing Pozzolana made from bauxite tailings with imported clinker to produce cement concrete equivalent to those conventionally used is established. The indications are that the admixture may be as high as 50-50. The economic incentive to undertake such manufacture commercially is strong. The remaining technical problem is the choice of a process for commercial manufacture that can be demonstrated on a pilot scale. One primary need for a pilot-scale operation is to establish market acceptance for pozzolana-portland cements. Before such a pilot plant can be worked out there is a need to know conclusively the attrition characteristics of the bauxite tailings as produced at Awaso during rotary-kiln calcination. Such characteristics can be best determined through the construction of a small-scale unit at the B.R.I., the design of which is to be developed which will be operated for a period of time to produce the following information:

(1) The temperature/time characteristics to produce pozzolana material equivalent to those produced in the research work at U.S.T.

(2) Knowledge of the change of particle-size distribution between the initial material and the final after calcination is complete.

Upon completion of this work the B.R.R.I., will be in a position to specify precisely the nature of the pilot plant operation. The expectation is that this will be rotary kiln equipment.

The second stage of the Action Plan will be the acquisition and operation of rotary-kiln pilot plant to be established at an appropriate location. The probable locations seem to be, at the moment, either at Awaso or at Takoradi, perhaps within the boundary of the Takoradi Cement Plant. The objective of the pilot plant operation will be to enable bankable commercial projects to be designed. The work will include the testing of products on a large-scale among the major engineering firms in Ghana of pozzolana-portland cement and the establishment of appropriate operating conditions and cost estimation for a commercial plant.

TIMBER

Some guidelines were identified for this item as follows:

(1) Identify a timber-industry development plan that will represent the national economic interest. Justification of this is the present national self-reliance development plan.

(2) Such a study needs to include the following elements of research to define the way the current industry operates in terms of supplying export demand and local demand:

   (a) Assess the efficiency, whereby the present industry extracts the resource.

   (b) Assess the extent of which the resource is being replaced.

   (c) Establish a plan for harvesting the forest resource in the best interest of the nation in terms of regeneration and maximum supply of the species of interest.

(3) Identify the potential market for timber within Ghana in terms of competition by alternative materials, and sale at the financial price at which it can substitute competitively.

(4) Postulate an industry structure which effectively will match the potential supply to the potential demand.

(5) Compare the postulation of industry structure with the actual situation at present.

(6) Identify actions which should be taken to reach a situation of appropriate use of the resource and supply, and full supply of the domestic market.

(7) The responsibility of the management of the effort could be given to the Forest Products Research Institute, together with giving this Institute specialised assistance that it will require from other sources such as the B.R.R.I., Timber Marketing Board, etc.

BITUMEN SUBSTITUTE

The objective of the Action Plan is to explore whether wood tars have any potential to substitute for all, or some of the uses of imported bitumen.

FORMAT FOR VOLUME 5 (Construction Industry Efficiency)

The man-in-charge is Mr. Mahadevan. Mr. Attafua is to act for him while he is on leave. Careful thought needs to be given to the contents because of the sensitivity of the topic and the degree to which the B.R.R.I. wishes to avoid the position of recommending changes.

1.0 ABSTRACT

1.1 Purpose

1.2 Scope (Extent of completion of the work).

1.3 Method of Approach.

2.0 Government Side.

2.1. Delays in project completion inefficiency due to Financing and Budgeting procedure. (Unauthorised projects).

Routin of certificates of payment.

2.2 Adequacy of Project Design Data and information change orders.

2.3 Selection of Contractors

Tender Board Activities

Basis for Registration to assure competence .

2.4 Adequacy of Detailed Project Planning e.g. enough materials and equipment, spare parts.

2.5 The role of the consultant (may be in item 2.2).

2.6 Findings.

3.0 Contractor's Side

3.1 Business Structure

3.11 Legal form

3.12 Balance sheet

3.121 Assets

3.122 Liability

3.123 Net worth

3.13 Recent profitability

3.14 Recent performance .

3.15 Findings

3.1 Financial Managerial Competence

3.11 Accuracy of estimates for tendering

3.12 Analysis of current expenditures.

3.13 Forecast of Fund Needs (Estimate of working capital).

3.3 Technical Competence

3.31 Selection of Technology

3.32 Management of Activities (keeping to schedule e.g.)

3.33 Supervision of works

3.34 Attitude of labour force

3.35 Availability of equipment.

3.36 Findings.

The following elements of action are presented for record purposes.

1) Conduct an executive session Conference for Government and private sector members of the construction industry sector of the country.

2) Schedule such a Conference after the end of 1974.

3) Sponsorship of the conference to be by the Special Action Unit of the N.R.C. on behalf of the Ministry of Economic Planning and the Ministry of Works and Housing.

- Accra seems to be the appropriate location.
- Three days appears to be an adequate time.

4) The objective of the conference shall be to establish specific recommendations for a significant improvement of the efficiency of the entire construction sector through providing an open forum for participants to identify problems and oppose solutions.

5) Participants should be invited from all sectors in the Government and all sectors in Private industry concerned with the construction of building, roads, highways and other civil engineering works included with the organizations and

persons concerned with design planning programming, as well as with field construction operations. Tender Board members of the Northern Region should be included.

6) Topics to be presented for discussion through papers should include the following:

a) Registration practices for Contractors.

b) Effectiveness of the method whereby Contractors are registered to be eligible for Government contracts.

c) Is the project definition frozen at a time project execution begins?

d) How effective is Government policy to prepare full details for projects before asking for tenders?

e) Is the P.W.D. adequately staffed to do the job required on it, namely, complete definition of the scope of work for all projects which is responsible for it?

f) How effective are the efforts of the resident engineer in determining actual quantities of work done in the field?

g) Failure to make payment to the Contractor in accordance with the schedule of payments specified in the <u>contract</u>?

h) Does budgeting and allocation of funds match the programme of plan and Ad Hoc projects?

7) <u>Tendering Procedure</u>: It appears that some unknown complex administrative procedure in the Ministry of Finance causes the work of the tender board to be uneven during the year. This puts a large amounts of pressure towards the end of the financial year on the Tender Boards to award contracts quickly.

This procedure also affects the ability of the Government to pay Contractors' bills on time, thus delaying jobs, etc. It seems desirable that the Conference should provide for its speaker for the Ministry of Finance to explain the situation, and the problems of change to alleviate the situation.

8) Composition of Tender Board Can the balance of membership of the Tender Board be improved toward more professional content? The effect of decentralising the tender procedure by increasing the maximum amount of tender in the regions.

9) Should the P.W.D. rely more on private local consultant firms to distribute their work load?

10) A paper prepared by the B.R.R.I. on the subject of Government stimulation of an indigenous contracting industry, based on the resource of the country people and the Institute.

11) Should the G.N.T.C. do a more effective job in the distribution of building materials, so that they are available in all regional centres?

Alternative elements generated in a later discussion were the following:

1) The Bank of Housing and Construction could take over or share the task of collecting payments for certificates of completion giving the contractor his money on presentation of the certificate.

2) The stimulation of contractor growth, efficiency, and effectiveness by prohibiting advance payments on contracts by the P.W.D., and forcing contractors to obtain working capital from commercial banks secured by assets.

3) The role of the Management and Productivity Institute in raising the competence of the indigenous contractor firm.

4) The usefulness of introducing a subcontracting firm sub sector in the construction sector.

NOTE

This set of Minutes of the meetings supersedes the versions previously issued, which should be destroyed.

E.O. SEFAH
SECRETARY
10/7/74.

APPENDIX E

PROGRAM OF WASHINGTON CONFERENCE ON COST REDUCTION IN PUBLIC CONSTRUCTION FOR DEVELOPING COUNTRIES

NOVEMBER 1974

PROGRAM

CONFERENCE ON
COST REDUCTION IN PUBLIC CONSTRUCTION
FOR DEVELOPING COUNTRIES

NOVEMBER 12, 13, AND 14, 1974

Lecture Room, National Academy of Sciences
2101 Constitution Avenue
Washington, D.C.

United States Agency for International Development

Arthur D Little, Inc.

Curtis Farrar

Curtis Farrar is Acting Assistant Administrator of A.I.D.'s Technical Assistance Bureau, which is the central staff office for research and development in agriculture, education, development administration, science and technology, nutrition, health and the problems of the rural poor.

Prior to joining the Technical Assistance Bureau in 1973, Mr. Farrar spent ten months as a Fellow with the Urban Institute. At A.I.D., he has been a Deputy Assistant Administrator of the Bureau for the Near East and South Asia; a Special Assistant to the A.I.D. Administrator; and Deputy Assistant Administrator of the Bureau for Program and Policy Coordination. Mr. Farrar joined A.I.D. in 1963, after having been with the Asia Foundation in Pakistan, Cambodia and the U.S. for eleven years.

Mr. Farrar received a B.A. degree in Political Philosophy from Yale University and a Ph.D. in Economics from the London School of Economics.

Bruce S. Old

Dr. Old is a Senior Vice President of Arthur D. Little, Inc. Since joining the staff in 1946, he has been responsible for several novel developments in iron and steel manufacture, employment of radioactive tracers, and engineering applications of atomic energy.

Dr. Old has undertaken a number of studies of research management including studies of numerous industrial laboratories, basic research in the Navy, research strategy in the Department of Defense and criteria for project selection for NASA. He is the inventor of the jet tapper used for tapping open hearth furnaces and also headed the project which developed the use of high-top pressure operation of blast furnaces.

Dr. Old is the former President of Cambridge Corporation, formerly a subsidiary of Arthur D. Little, where he was concerned with the transistion engineering and fabrication of cryogenic equipment. From 1953-1956, he was a member of President Eisenhower's Science Advisory Committee.

Dr. Old is a member of the National Academy of Engineering and serves as its Foreign Secretary. He is also a member of the Advisory Committee to the Office on Emergency Planning and the Board on Science and Technology for International Development.

He received a B.S. degree in Chemical Engineering from the University of North Carolina and an Sc.D. degree in Metallurgy from the Massachusetts Institute of Technology.

Henry Arnold

Henry Arnold is the Director of A.I.D.'s Office of Science and Technology. He is directly involved with the development and implementation of means to incorporate science and technology for the support and increased effectiveness of A.I.D. programs in developing countries. At the Office of Science and Technology, he coordinates A.I.D. relationships with other government, private and international agencies concerned with science and technology.

As Deputy Director of A.I.D.'s Office of Science and Technology, Mr. Arnold was specifically responsible for projects and programs relating to industrialization and engineering technology.

For nine years, he served as Assistant to Chief Scientist, United Aircraft Corporation, Hartford, Connecticut, where he was engaged in the long-range planning and implementation of advanced technology.

Mr. Arnold, a graduate of the U.S. Naval Academy is a retired, U.S. Navy captain. He has a B.S. and M.S. degree from the Massachusetts Institute of Technology.

Charles Bliss

Since joining ADL in 1960, Mr. Bliss has undertaken projects in two main areas. One concerns the technological fields of energy utilization and conversion, iron and steel manufacture, chemical process development, and industrial operations analysis. The other involves economic development internationally among the lesser developed countries. Prior to 1960, Mr. Bliss was employed by Foster Wheeler Corporation.

Mr. Bliss has headed the Agency for International Development project to develop a methodology for identifying and achieving opportunities to reduce costs in public construction in Colombia, Philippines and Ghana. He has worked in many countries having developing economies in the development of new industrial techniques.

Mr. Bliss is a graduate of Cooper Union Institute of Technology in New York City, where he received a B.Ch.E. and Che. E. degree, and is licensed as a professional engineer in Massachusetts and New York.

Conference Chairmen:	**Mr. Curtis Farrar** Acting Director, Technical Assistance Bureau U.S. Agency for International Development Washington, D.C. 20523 **Dr. Bruce S. Old** Senior Vice President Arthur D. Little, Inc. Cambridge, Massachusetts 02140

Background

Public construction projects in developing economies consume a large proportion of national resources. Thus, if costs can be reduced, available resources can be stretched to cover construction projects that might otherwise be deferred. Alternatively, resources freed through cost reduction can be diverted to projects in other sectors. For these reasons, the United States Agency for International Development (AID) is interested in helping organizations in developing countries identify opportunities to reduce the cost of public construction, and ultimately to achieve the benefits promised from their implementation.

Since 1971, three countries, Colombia, Ghana, and the Philippines, have hosted representatives from Arthur D. Little, Inc. (ADL), who were conducting experiments on behalf of the U.S. Agency for International Development (AID). These experiments had a twofold objective: (a) to identify useful, implementable cost reduction opportunities in each country and (b) to find a methodology for achieving cost reduction in the public construction sector and generalizing the methodology as a set of *Guidelines* for wide use throughout the world.

Why A Conference?

The conference's three objectives are to:

- Acquaint officials of governments and institutions interested in construction technologies with the cost-reduction project and its results.
- Stimulate discussion and exchange of viewpoints on the *Guidelines*, especially with respect to the variations among the three host countries; and
- Generate feedback of information and opinion to revise and improve the *Guidelines*, and to enhance their usefulness;

Conference Approach

The conference will be organized to facilitate maximum discussion and interaction. A copy of the current draft of the *Guidelines* is included in the conference folder for participants. Each session of the program will present a brief summary of the relevant issues from the Guidelines. The papers presented at the session will describe specific experiences from the three experiments, while also presenting concepts appearing useful to the subject. A discussion period will conclude each session in which participants will identify useful revisions to the Guidelines draft.

What Will The Conference Cover?

The *Guidelines* and the conference cover the total spectrum of activities in the public construction sector and will address questions in such areas as:

Materials Application

- What are the predominant materials and the current pattern of availability and usage within a country?
- What is the current state of research in government, academic and private organizations into improvement of properties and adaptation to new uses?
- How can value engineering be employed (i.e., seeking the proper balance between long-term and short-term costs) in selecting from alternative materials?
- Are there potential uses for indigenous construction materials that may not yet have been exploited?
- What is the state of standardization of formal material specifications and appropriateness of the standards employed?
- What is the demand for Foreign Exchange in the current usage pattern of construction materials?

Appropriateness of Construction Technology

- Is there a proper balance between capital and labor-intensiveness?
- Is there a proper balance between first cost and maintenance cost (or between short-term and long-term costs)?
- Are construction activities supervised so that anticipated quality is achieved?
- What is the pattern of utilization of capital-intensive construction equipment?

Public Construction Institutions

- What factors are most significant in ultimate implementation of cost-reduction opportunities?
- How can one best manage the utilization of materials and the application of construction technologies?

TUESDAY, 12 NOVEMBER
SESSION ONE

8:00 – 9:30 a.m. **Coffee Hour**

8:00 – 10:00 a.m. **Registration**

10 a.m. – 12 Noon **Topic: Introduction**

1. Welcome – Conference Co-Chairman – Curtis Farrar, Acting Director, Technical Assistance Bureau, Agency for International Development
2. The Context of Conference – Henry Arnold, Director, Office of Science and Technology, Agency for International Development
3. Three Experiments – Conference Co-Chairman – Bruce S. Old, Senior Vice President, Arthur D. Little, Inc.
4. The Purpose of the Conference – Charles Bliss, Director, Cost-Reduction Project, Arthur D. Little, Inc.

12 Noon – 2 p.m. **Lunch**

2 p.m. – 5 p.m. **SESSION TWO**

Topic: Identification of Alternative Construction Practices – Materials

1. Introductory Remarks – Session Chairman – E.Y.S. Engmann, Technical Director (Works), Ministry of Works and Housing, Accra, Ghana
2. Panel Presentation
   a. Cement Supply and Distribution
      - Colombia – John Naranjo, Deputy Chief, Department of National Planning, Bogota, Colombia
      - Philippines – Leoncio O. Limjuco, Department of Public Highways, Manila, Philippines
      - Ghana – J.W.S. de-Graft Johnson, Director, Building and Road Research Institute, Kumasi, Ghana
   b. Cement Substitution
      - Brick (Colombia) – John Naranjo
      - Brick and Timber (Ghana) – J.W.S. de-Graft Johnson
   c. Brick Manufacture
      - A Small-Scale Approach – (Ghana) – J.W.S. de-Graft Johnson
      - The Industry in Colombia – (Colombia) – John Naranjo
   d. Indigenous Materials
      - Synthetic Pozzolans – (Ghana) – A.A. Hammond, Building and Road Research Institute, Kumasi, Ghana
      - Blast Furnace Slag – (Colombia) – John Naranjo

3:30 – 4:15 **Coffee Break**

3. Panel/Audience Discussion

9 a.m. – 12 Noon **WEDNESDAY, 13 NOVEMBER**
SESSION THREE

Topic: Identification of Alternative Construction Practices – Construction Technology – Part I

1. Introductory Remarks – Session Chairman – John Naranjo
2. Panel Presentation
   a. Construction Equipment Utilization Experiences
      - Philippines – Antonio Garcia, Department of Public Highways, Manila, Philippines
      - Colombia – Fernando Isaza, Chief, Unit of Infrastructure, Department of National Planning, Bogota, Colombia
      - Ghana – E.Y.S. Engmann
   b. Housing Roof Construction Alternatives in Ghana – J.W.S. de-Graft Johnson
   c. Alternative Bonding Techniques in Building Wall Construction – The Use of Sulfur – David Black, Southwest Research Institute, San Antonio, Texas
   d. Highway Bridge Design Alternatives in Ghana – J.W.S. de-Graft Johnson

10:30 – 11:15 **Coffee Break**

3. Panel/Audience Discussion

12 Noon – 2 p.m. **Lunch**

2 p.m. – 5 p.m. **SESSION FOUR**

Topic: Identification of Alternative Construction Practices – Construction Technology – Part II

1. Introductory Remarks – Session Chairman – Leoncio Limjuco
2. Panel Presentation
   a. The Labor-Capital Resource Mix Question – Peter Thormann, Office of Policy Development and Analysis, Agency for International Development
   b. The World Bank Project – Mr. Clell Harral, Chief, Transport Research Division, International Bank for Reconstruction and Development, Washington, D.C.
   c. The World Employment Programme – Geoffrey Edmonds, International Labour Office, Geneva, Switzerland
   d. The Philippine Capas-Botolan Project – Carlos Rivera, Department of Public Highways, Manila, Philippines
   e. The Pick and Shovel Program in Colombia – Fernando Isaza

3:30 – 4:15 **Coffee Break**

3. Panel/Audience Discussion

9 a.m. – 12 Noon

THURSDAY, 14 NOVEMBER
SESSION FIVE

Topic: Evaluation and Implementation of Cost-Reduction Opportunities

1. Introductory Remarks – Session Chairman – Robert C. Snell, Office of Engineering, Agency for International Development
2. Panel Presentation
   a. Evaluation of Alternatives
      - The Use of Computers – Edwin L. Field, Arthur D. Little, Inc.
      - Methodology – John H. Reedy, Arthur D. Little, Inc.
   b. Design of Implementation – Charles Bliss
   c. The Implementation Plans for:
      Colombia – John Naranjo
      Philippines – Leoncio Limjuco
      Ghana – J.W.S. de-Graft Johnson

10:30 – 11:15 **Coffee Break**

3. Panel/Audience Discussion

12 Noon – 2 p.m. **Lunch**

2 p.m. – 5 p.m. **SESSION SIX**

Topic: Organization of a Cost-Reduction Project

1. Introductory Remarks – Session Chairman – Charles Bliss
2. Panel Presentation
   a. The Organization in Each Country
      - Colombia – Fernando Isaza
      - Philippines – Antonio Garcia
      - Ghana – J.W.S. de-Graft Johnson
   b. Project Outlook in Each Country
      - Colombia – John Naranjo
      - Philippines – Leoncio Limjuco
      - Ghana – E.Y.S. Engmann

3:30 – 4:15 **Coffee Break**

3. Panel/Audience Discussion
4. Concluding Remarks
   Conference Co-Chairmen – Curtis Farrar
   – Bruce Old