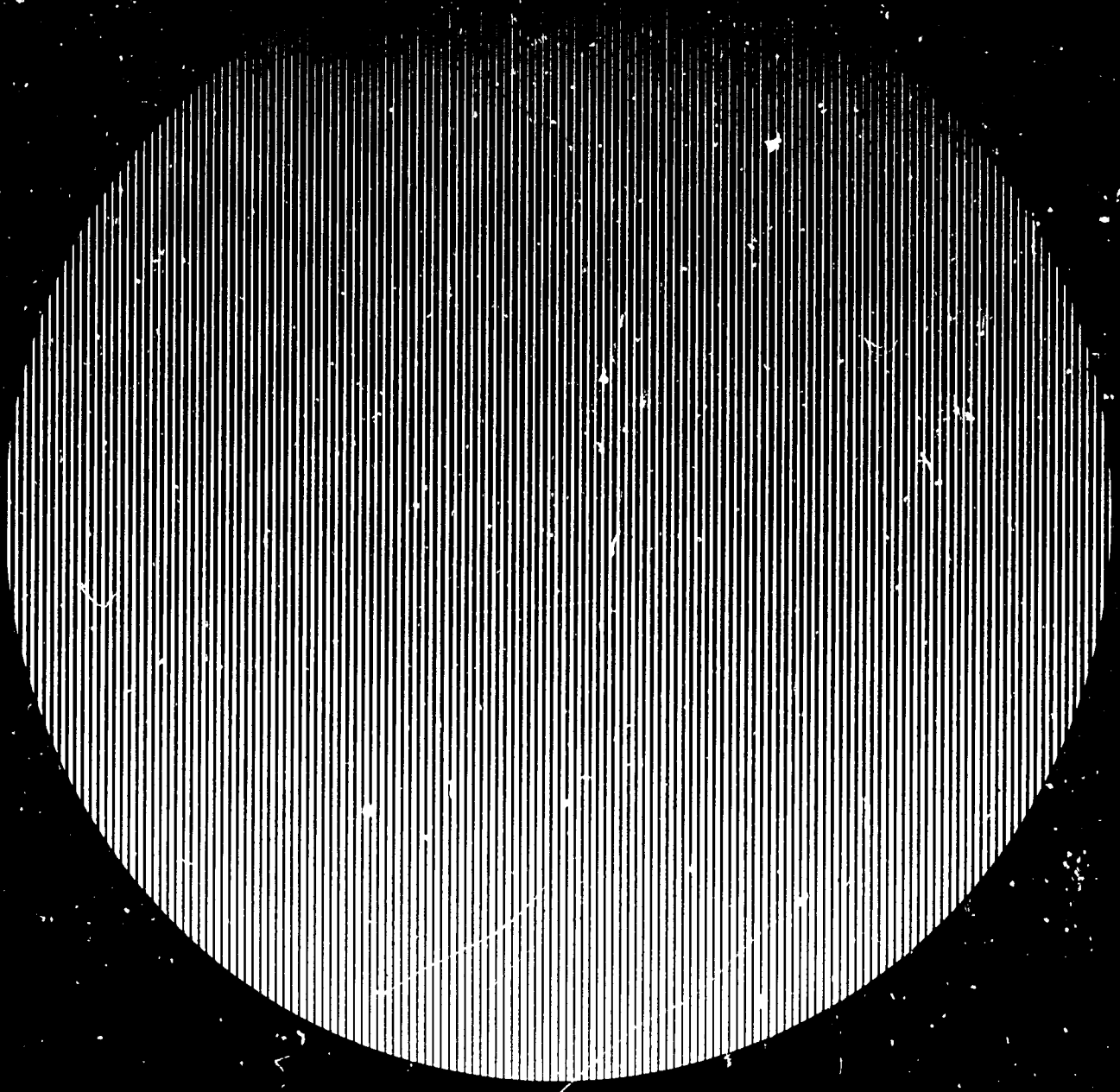
Cairo Urban Transport Project
Project Programming: Final Report



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CAIRO URBAN TRANSPORT PROJECT

FINAL REPORT

VOLUME I

"Project Programming"

March 1982

Prepared by M.I.T./Cairo University Team

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PREFACE

This report is one of a series of publications which describe various studies undertaken under the sponsorhsip of the Technology Adaptation Program at the Massachusetts Institute of Technology.

The United States Department of State, through the Agency for International Development, awarded the Massachusetts Institute of Technology a contract to provide support at M.I.T. for the development, in conjunction with institutions in selected developing countries, of capabilities useful in the adaptation of technologies and problem-solving techniques to the needs of those countries. This particular study describes research conducted in conjunction with Cairo University, Cairo, Egypt.

In the process of making the TAP supported study some insight has been gained into how appropriate technologies can be identified and adapted to the needs of developing countries per se, and it is expected that the recommendations developed will serve as a guide to other developing countries for the solution of similar problems which may be encountered there.

This research is carried out by Cairo University/M.I.T. Technological Planning Program, under the auspices of the M.I.T. Technology Adaptation Program, which is funded by the United States Agency of International Development (USAID), Cairo, Egypt. The view and opinions expressed in this report, however, are those of the authors and do not necessarily reflect those of the sponsors.

Fred Moavenzadeh

Program Director

ACKNOWLEDGEMENTS

The work described in this report has been sponsored by the United States Agency for International Development under the Cairo University/MIT Technological Adaptation Program, with the cooperation of the Transport Planning Authority of the Ministry of Transport and the Cairo Transportation Authority. Many individuals have generously contributed their time, talent, and spirit of cooperation to this effort; their participation is gratefully acknowledged.

The report was prepared by Ralph Gakenheimer.

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This report is a project overview intended for swift, non-technical reading. For all the topics memoranda are cited that are available to the reader desiring more technical detail.

Background: The project programming work was part of a larger research activity to develop methods for urban transportation analysis and planning in Cairo, Egypt during the period January 1977 to July 1981. Principal investigator for the first two and a half years was Professor Ralph Gakenheimer, followed by Professors Nigel Wilson and Michael Meyer as co-principal investigators.

The persons principally involved in the project programming research on the MIT team were Ralph Gakenheimer, Martin Michael, Donald Keller, Anna Hardman and Hani Mahmassani. On the Cairo University team the principal participants were Professor Mohamed el Hawary and Dr. Tarek El Reedy. There was also active participation by Engr. Ali El-Daghestany and Engr. Abd-El Aal El-Salamawy, each in his times as Vice Minister and Director of the Transportation Planning Authority of the Egyptian Ministry of Transport.

PROGRAMMING AS A NEW COMPONENT IN EGYPTIAN TRANSPORTATION PLANNING

OBJECTIVES AND HISTORY OF THE RESEARCH

"Programming" is a means of identifying projects, moving them efficiently into implementation, and assuring a maximum flow of benefits through the sequencing of thier implementation. Creatio of methods to seek these goals in Cairo was undertaken within a larger research project with several objectives and numerous technical components.

The purpose of the overall project was to provide methods for planning transportation more effectively in the Cairo metropolitan area. Aspects included studies of government decision making, and local government project development. There were two major origin-destination studies accomplished, one of vehicular trips (April 1977) and one of public transit trips (April 1978). One stream of effort was devoted to choice and development of travel demand analysis methods, another to a model of central city parking. There were extensive studies of transit pricing and transit management. There was a strong element devoted to the efficient routing and scheduling of transit equipment. Comprehensive studies toward the improvement of transportation were understaken in an urban corridor planning format by one part of the study. There was considerable attention to techniques of project evaluation.

The emphasis throughout was on the issues of technique transfer. In each one of the activites mentioned there was a considerable departure from the norms of U.S. practice in an effort to find particular techniques or to design variations that would best fit the realities of Cairo; its economic, political, social, and institutional setting.

The role of programming within this set of activities was an important one. Those concerned with this part of the research conceived it as a vessel within which to contain many of the other components under concurrent development. It put many of the other methods in context, determining the role each would have in producing final results. Programming was a way of engaging the institutional environment of urban transportation in general that provided lessons valuable to the creation of compatible individual techniques. At the same time, it is clear that experiences in the preparation of each of these specialized techniques in turn helped determine the requirements on the programming method.

The sequence of activities over the four and a half year history of the research leading to a programming method can be thought of in three basic units.

First there were studies of (a) Egyptian national and local government decision making, (b) Cairo transport project histories, and (c) the U.S. backgrounds on project programming. Studies (a) and (b) are represented by "Toward Rationalizing the Transport Project Planning Process in Cairo, Egypt" (Gakenheimer, Hawary and Michael, Cairo Urban Transportation Project, December 1979).

Second there was a study of alternative methods to incorporate what we had learned in a unified methodology, culminating in the proposal of the "prototype programming method" in "Programming: Prototype Procedure" prepared by Donald Keller. This phase generated the basic information files which begin the process, and the technique of putting projects into sets for subsequent evaluation. The concept of "prototype" was to establish general roles for individual techniques, "cells" for the methodological components which in the future could mature gradually to meet the requirements of the process with increasing capability.

The third stage was one of further refining the basic information files, formalizing the rules for project set composition, and detailing the design of the evaluation techniques.

PROGRAMMING AND ITS FUTURE IN EGYPT

The method designed in this research for application to the Cairo case began with "programming" as defined for use in the U.S. but ends up being a rather distant relative to it. First, it assumes that our client, the Ministry of Transport, is sometimes fully responsible for project development, but often only convenes the participating agencies. That is, many urban transport projects are developed and implemented by other agencies of the government with a minimum of its guidance. There is a basic assumption here that there is multiple participation in urban transport project development; many agencies have a part.

The method assumes that there exists a "slate" of projects which, by mutual agreement among the participting agencies, will be entirely implemented in due course. Each particpating agency has interest vested in some projects of the slate; together the agencies' mutual support is demonstrated by their agreement to the entire slate. Projects cannot be deleted from this slate without unbalancing their agreement. Assumption of the slate represents a key finding of this research. While arising from observations in Egypt, we suggest it is likely to prevail in many national environments--developing and developed--and that the unitary or neatly arrayed pyramidic decision system usually assumed is not so widespread as we are accustomed to thinking.

Briefly described, our programming method begins with three sources of information. The first is a set of EXTERNAL ASSUMPTION that enable the structuring of SCENARIOS for the coming year, including the level of completion of the transportation facilities network and the size of the capital budget. The latter estimate is very important because the capital budget for transport changes dramatically from year to year. Second, is a PROJECT INFORMATION FILE which, for each slated project, includes detailed information on the time of construction and cost of components of each project, facility capacities and other basic information. Third is the INSTITUTIONAL PREFERENCE FILE, which contains information describing the preferences of participant agencies as to the sequence of implementation of the slated projects. The pattern of activities generated by these inputs is charted in Figure 1.

Based on this information, feasible sets of projects are selected for consideration. This is, sets of several projects are formed which are within anticipated annual budget constraints, and represent adequately distributed satisfaction to the agencies with interests vested in them. Then, for the sets of projects, there is an evaluation of their comparative desirability by projecting travel time savings, by evaluating their FUNCTIONAL IMPACTS (e.g., household dislocations, environmental impacts, etc.) and by evaluting their ECONOMIC IMPACTS (e.g., provision of employment and other local benefits of facility construction). Finally, these evaluations are put into single context by a MULTICRITERIA EVALUTION method that deals rigorously with the output of the foregoing techniques using special scoring techniques. This information, and intermediate outputs along the way, are intended to advise the Ministry of Transport toward a global policy on transport facility construction in Cairo and toward strengthening its position as a convener of the sector.

What is the anticipated role of programming in Egypt? It is important to understand that this method is offered to an environment in which project development is generated by a variety of independent government agencies, sometimes stimulated by proposals from private sector firms. The only general urban plan for the Cairo area is old, and its transport section is basically only an accumulation of projects generated by this ad hoc process of agency interaction rather than being an intervention into it. The comprehensive transportation plan, completed in 1972, was mainly focused on rail rapid transit improvements and traffic management planning. It too serves a minimal role in the guidance of overall project development.

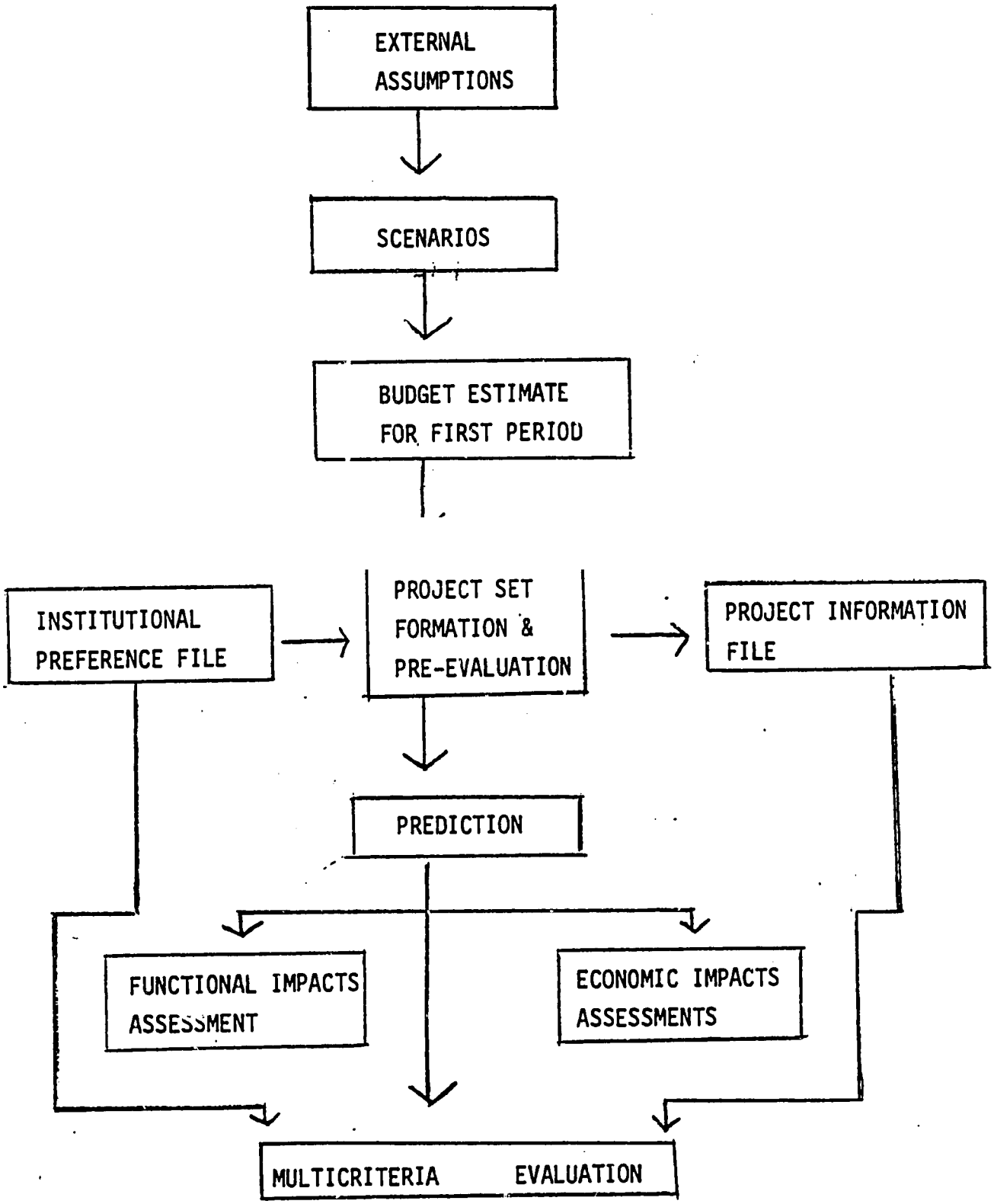


Figure 1: Structure of the Procedure

Expectations of the research group for programming in Cairo transportation are based on the conclusion that it is probably not possible in the foreseeable future to replace agency-based project development with classical comprehensive planning. Further, we concluded that agency-based project development is not necessarily bad as a form of urban transport planning. The slate produces a plan wherein each project is a focal concern of some agency, and the whole list has the undivided support of the whole sector. Further, the slate assures that the installed capacity of professional services of the nation is fully occupied even though there are many separate agencies. There are very few transport plans indeed that can make those claims. As a result, the slate is our basis of expectations.

Within the context of the slate, we feel the programming method can gradually improve sector collaboration because:

1. By generating a central framework it makes agency participation a more conscious process within the government in general.

2. The project information file can encourage uniform standards and information in the description of projects.

3. Development of the method within the Transport Planning Authority should help congeal a leadership position for the Ministry of Transport.

4. The subsidiary use of the set of evaluation methods is intended to encourage gradually greater attention to programming solutions within the conventional rational criteria of evaluation.

5. As a prototype framework with each of its cells temporarily occupied by techniques which can later be refined or replaced, programming constitutes a structure for the creation and evolution of transportation planning methodology. It reveals requirements on each new technique that will make it compatible with the rest.

6. It is a means of teaching students of the concerned professions to deal with urban transportation as a system, and within the context of institutional realism.

These are optimistic hopes, but they are within the scope of the product of research. Accomplishment of them in some modest degree will more than repay the efforts of the research team.

TECHNOLOGY ADAPTATION AS AN ISSUE IN PROGRAMMING

The Cairo programming method is a creative case of adaptation in technology transfer. It definitely has its roots in an American innovation and in U.S. practice, but with fundamental adjustment of both basic assumptions and application to fit the realities of a very different environment.

Programming was introduced in U.S. transportation planning because, unlike Egypt, there was so much planning that the number of good projects far outstripped the possibilities of implementing them. The job was to select the best, while postponing many of them indefinitely. The principal actors are the 50 states, so programming in the U.S. has been introduced basically as a state function, with only tentative applications at the urban level. This, again, means that the number of projects under concurrent consieration is very large--as distinct from our simple pending slate of 13 urban projects.

Most importantly, there is an assumption in U.S. programming that optimization is applicable to the problem. Any divergence from it in the course of implementation is due to considerations outside the scope of methodology and is taken to reduce the flow of project benefits. There is a substantial literature on transportation programming from these points of view.

The problems of adaptation in view of our perception of the Cairo environment are apparent:

1. The basic methodology assumes there is a single authority fully responsible for project selection and emplementation. We lacked such an agency.

2. It assumes that basic project evaluation technique will be persuasive in the forum in which selection is made. We had little reason to expect this when agency project sponsorships were at stake. It was difficult to believe that the rejection of slated projects would be acceptable by participating agencies. We focused instead on temporal sequencing for an approved slate.

3. The basic methodology assumes adequate data sources and small uncertainties, whereas our environment could not meet such requirements.

The adapted version, then, included some significant variations.

1. The slate is assumed so that the stake of each agency is respected; projects are sequenced, but not rejected.

2. Analysis is proposed to introduce the preferences of individual agencies into the process.

3. Effort is made to deal with many uncertainties--including the size of the capital budget.

4. Use of the prototype framework assumes growing capability in the field and enables methods to evolve within.

Thus general control over project implementation is sought in a form adaptive to very different conditions than those for which the methods were originally designed.

INSTITUTIONS: THE EGYPTIAN TRANSPORTATION DECISION SYSTEM

There are may institutional participants in the Egyptian project decision system. This is neither surprising nor bad. It is a product of history and the nature of transportation. Transportation is integral to many enterprises--housing, economic development, city building, and so forth. As a result, the sector appears wherever it needs to be closely tuned to another activity. This is particularly true where formal interagency collaboration may be difficult to achieve for lack of advanced management technology.

Distribution of authority in the creation of transportation systems also results from political commitment to meaningful representation of concerned groups. This means some horizontal exposure across government to include various agencies, and particularly vertical decentralization to involve participation by the governorates (civil subdivisions).[1] Like many developing countries, Egypt has an ideological commitment to increase participation by local representative government, but finds it difficult to do so in face of strong forces in the economy and the tradition which resists it. As a result there are temporary duplications of prerogative.

Historical development of the administration unavoidably complicates the scene, especially considering the troubled history of Egypt during the last decades. For example, after the destruction of the last war in the Suez Canal Zone, the Ministry (now called) of Development and New Communities took a comprehensive role in reconstruction of all infrastructure, including transport facilities. In view of their success at this task they began undertaking it elsewhere in the country as well, including Cairo. With time their attention to transportation has been reduced, responsibilities being returned to the normal agencies. But some special features of the institutional pattern remain from the earlier phases.

The Decision Actors

This section identifies the principal groups involved in transport decisions and their roles in the conceptualization, planning, design and execution of such projects.[2] No single organization or individual exercises controlling influence over the transportation decision system. While the Ministry of Transport has a major role as sectoral representative in the budgeting process, when resources are allocated for investment each year, it is not in an overall decision-making postiion with respect to the programming of transportation projects. The Ministry of Planning prepares the national Five-Year Plans and is officially responsible for evaluating investment projects submitted to it by individual agencies. It does not engage, however, in technical dialogue with the rest of the sector. The roles of the many agents involved in transportation project development and implementation in Cairo are in part defined by government mandate, but also established

by custom and needs, and hence are fluid and susceptible to change over time. The formal organizational relationships of the agencies involved are depicted in Figure 2. Brief descriptions are given below to define responsibilities, and describe some of the more subtle, informal patterns of interrelationships.

The People's Assembly which must approve the national budget is the national legislative body, consisting of 350 members elected by secret ballot from 175 geographically-defined districts. One of its 18 committees is the Committee on Transport and Communications, which oversees the transportation sector.

The Assembly passes final approval of the budget, after its preparation by the cabinet. As a result the Assembly has an important potential role in the urban transportation capital budget, although the principal determination of the investment program at present is by the technical agencies of the government.

The Cabinet of about 33 Ministers serves under the President as the national policy-setting and budget-making body; major governmental decisions are discussed and finalized at the cabinet level, and the cabinet is responsible for preparing the national budget for submission to the National Assembly.

The Ministry of Transportation is the official representative of the sector in the government. The Ministry is involved, through its subdivisions, in all phases of project development. It is responsible for transportation planning (urban, regional and national); this activity occurs primarily in the Ministry's Transportation Planning Authority. It is involved in operations; the Egyptian

Railway Authority, for example, is a subdivision of the Ministry. It is involved in budgeting (though not comprehensively); the Cairo Transportation Authority's capital funding is allocated through the Ministry. It occasionally becomes closely associated with project implementation, for example, as technical advisor to the Cairo Governorate supervising the execution of the signal sychronization project for central Cairo. In addition, the Ministry has the role of advisory review for all proposed projects. Over the last several years the Ministry's role has increased with adjustments causing the national companies that do road construction to report to it rather than the Ministry of Development. The Ministry of Transport is often the originator of new project proposals in urban transportation, particularly via the activities of its Transportation Planning Authority.

The Transportation Planning Authority (TPA) is one of several subdivisions of the Ministry of Transportation, and the agency within the Ministry most active in project initiation, planning, and implementation. It has coordinated technical advice and supervised implementation for a number of projects in the Cairo metropolitan area. These have tended to be projects involving new technologies and foreign loans, rather than more traditional transportation facilities. The agency has been the center of interest and cooridination of the project involving subway construction and commuter rail upgrading. Its attention to Cairo, however, is primarily via projects rather than comprehensive system planning. The TPA did supervise the preparation of a comprehensive transportation plan of the metropolitan area in 1971-73, which was done by a foreign firm. That plan unified

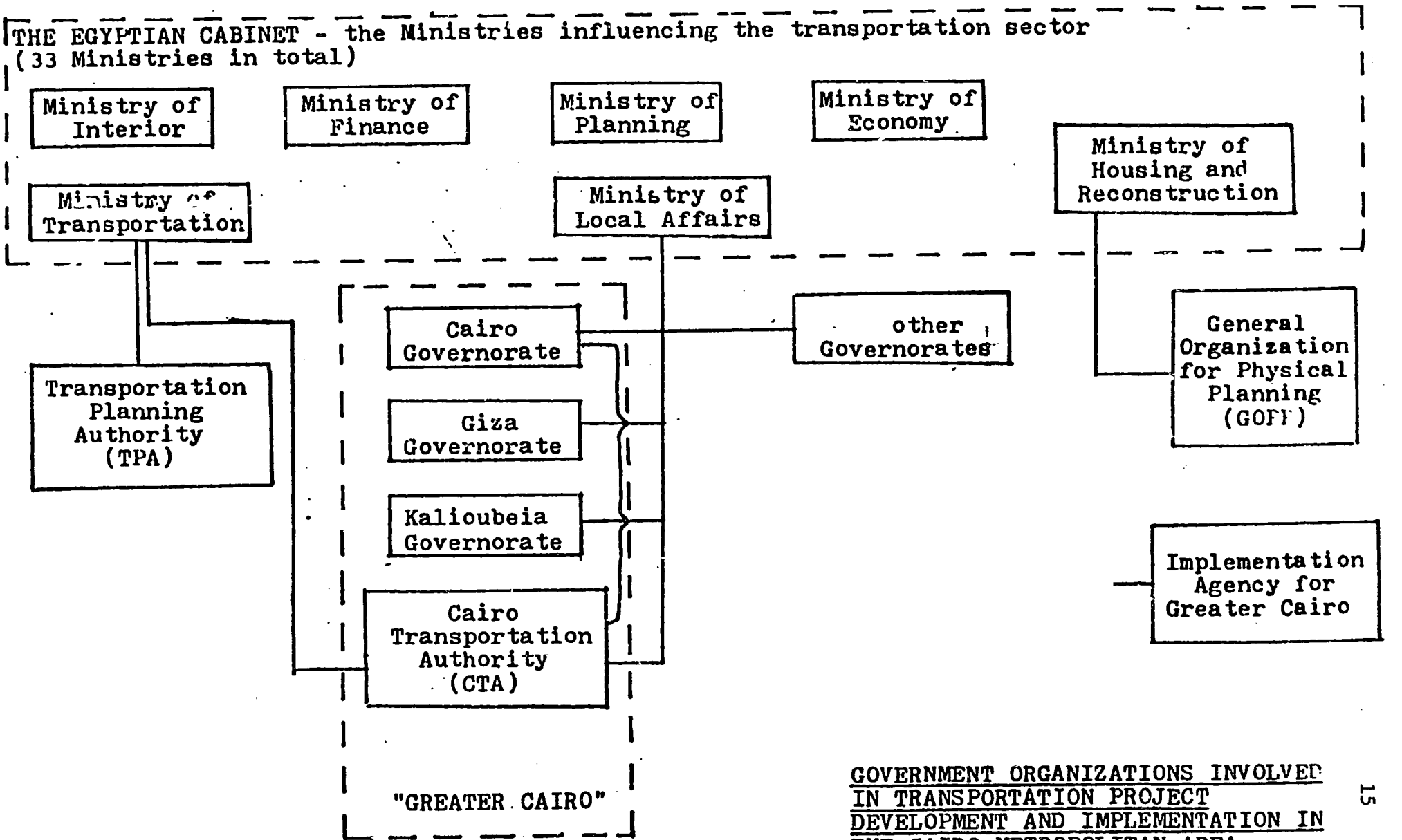
the perspective on urban transport projects to some degree, but shows little indication of having become in any sense a framework for the subsequent choice of projects.

The Ministry of Finance is responsible for preparation of the national budgets for operations and wages/salaries, and for setting outside expenditure limits within which the agencies' budgetary process takes place. Through its role in currency controls it also exercises a certain influence over the allocation of funds for transport facilities.

The Cairo Transporation Authority is responsible for the operation of nearly the entire public transportation system in the Greater Cairo area. The CTA normally initiates, plans and executes new projects and extensions of the existing mass transportation systems. As such, it is the principal agency concerned with the current street-car network extensions, the acqusition of new fleets of buses for service in Cairo, and the negotiations necessary whenever a new project alters or disturbs transit services--such as the Embaba Bridge. It is not responsible for supervising the development of the proposed metropolitan subway (this project is being guided by the Transportation Planning Authority), and it remains unclear how the operation of the Metro will be handled.

CTA receives its capital budget via The Ministry of Transport and its operating budget through the Governorate of Cairo.

The Ministry of Planning prepares the annual national capital investment budget for submission to the People's Assembly for approval. This authority allows the Ministry of Planning to play a major role in determining which projects will be constructed at what time.



GOVERNMENT ORGANIZATIONS INVOLVED IN TRANSPORTATION PROJECT DEVELOPMENT AND IMPLEMENTATION IN THE CAIRO METROPOLITAN AREA

Figure 2

Consideration is on a project by project basis, rather than involving any broader view of the problems in Cairo. In the course of project evaluation, the tradeoffs considered are first intra-sectoral, and subsequently between sectors.

The Ministry's policy is to favor (1) projects which maintain service standards to current levels, (2) the completion of projects already in progress (except in extreme cases), and (3) projects for which special foreign credit is assured.

The Ministry of Economy usually plays only a minor role in transportation project development. Projects involving high expenditures will often bring the Ministry of Economy to a more active position, especially if they require foreign exchange. For example, it was a decision of the Minister of Economy in June 1977 which postponed further consideration of rapid transit construction for several years. Projects dependent on foreign assistance are normally channeled through the Ministry of Economy.

The Ministry of Development has a background in preparing projects and supervising construction. Its role has been expanded from its original focus on housing, especially in the Greater Cairo area, where it has assumed responsibility for the development of several sewerage, water supply, and transportation projects.

The General Organization for Physical Planning (GOPP), an agency within the Ministry of Development is responsible for the overall urban planning for Cairo--as well as the whole of Egypt. A comprehensive plan for metropolitan Cairo was completed in 1970 and updated in certain details a number of times since. It is primarily a large-scale land development plan. The process of its development is independent from the programming of transportation projects.

GOPP's main current concern for the transport sector is mostly related to its mandate to prepare plans for new communities (new towns to absorb expansion) at the peripheries of major cities.

The Implementation Agency for Greater Cairo, a largely independent agency within the Ministry of Development and New Communities, is supervising the implementation of the Helwan Heliopolis Autostrade Project. This agency is a residual of the Ministry of Development's work in Cairo on transport that was generated by its success in the Canal region.

The Governorates. Among the key agents in the project development process in Egypt are the governorates (in Greater Cairo, the Governorates of Cairo, Giza, and Kaliubeya). Their responsibilities overlap those of many other agencies with responsibilities in transportation planning for the urban area. In a number of cases they were identified as the initiators of projects. They are responsible for overseeing construction, but implementation supervision of major works is not a job well suited to them, since it involves directing the activities of large, well staffed construction firms by public staffs that can scarcely match them.

The governorates' public works staffs are severely limited by the poor salaries they pay. Their project generating function, on the other hand, is a very appropriate one, since they are the only agencies in the project development process through which strictly local concerns and issues are incorporated. In Cairo, the Governorates appeared to be incorporated into the planning process. They prepare local plans and at any given time have on hand a number of unpresented project proposals, in the form of sketch planning exercises.

The role of the governorates in transportation planning, then, is important, but still emergent. The Egyptian government system is relatively centralized, with considerable central government involvement in public service provision and administration. The governors have always been appointed by the President. A presidential decree concerning local government issued late in 1978 now provides that each governor must be a native of his governorate. It also provides for local councils to have more power over the management of funds assigned directly to the Governorates. These funds include transport project support. Thus effort is made to move gradually toward more local determination. There were earlier reforms legislated in 1960 and 1970 with objectives similar to those of the 1978 reform: increasing local participation in governorate affairs and strengthening powers of the governorate officials. But the present is a time of specially high commitment to these objectives.

The governorates have responsibility for construction and maintenance of all local roads and for the operation of public transportation within city boundaries. They are in charge of the construction and maintenance of all local roads and for the operation of public transporation within city boundaries. They are in charge of the construction and maintenance of all regional roads and bridges linking towns and villages with the national highway network. The elected governorate council must be consulted about the route and alignment of national roads, railways and waterways within their boundaries. The governor must carry out any expropriation of private property, and hece his approval for all projects which require ex propriation is essential.

Two other institutions are occasionally involved in project implementation. The Ministry of Interior's Police Traffic Bureau is responsible for the enforcement of traffic regulations. This includes such activities as the installation of temporary roadblocks to manage traffic flow during project construction. It also includes an important role in approval and implementation of traffic management actions.

Steering committees (consisting of representatives from government agencies involved in a project) have sometimes been created on an ad hoc project-by-project basis as a coordinating mechanism. The committee for such a study meets informally before the project is approved for planning. It does a rough study and sets an approximate budget. The committee is then formalized after resources are budgeted for the project. In such a case the design work is usually given to a consultant, using funds assigned from the national budget for that purpose. The funds are assigned through the one or more governorates involved. (In some cases assignment is to one only to reduce the need for coordination. The 6 October Bridge design work, for example, was financed through the Cairo Governorate only although the bridge spans the Nile to Giza.)

Construction and design firms in Egypt are directly concerned in the design of many projects which are candidates for the "slate. In their spare time design engineers of these firms sometimes prepare project plans and promote them at the public agencies. Also, after approval of a public project, consulting project designers often change the project specifications considerably in the course of

final design. All this is appropriate to some degree. It constitutes the lending of the nations'best engineering know-how to the problem of civil construction, especially important since public sector services are generally weak. But this form of intervention needs public control.

The construction design firms' advocacy for the designs selected may express special interests. They are of course more likely to favor the adoption of projects which maximize the use of their own skills and capabilities rather than high technology imported solutions. This might imply that they are likely to prefer bridges and highways over elaborate electronic signalizations of existing roads and streets, for example, and road construction (for private auto use) over transit systems using imported equipment. If domestic firms are very influential, there is a danger that the benefits of projects which can be executed with domestic resources alone (or primarily) will be overestimated relative to projects which substitute technology (e.g., signal system). It could be argued, however, that the domestic firms' influence to some extent balances distortions introduced by the influence of foreign firms and their governments' aid policies.

Another concern deriving from the interests of the construction firms is their tendency to suggest designs and plans that increase the amount and cost of construction (e.g., unnecessary elevation agove grade of highway sections, unneeded interchange ramps, etc.). This is a serious complaint of public officials.

Another source of distortion in the project planning process was the past practice of having the same firm on one contract both to design and build a project. In the past (up to 1978-79) it was not the government's practice to permit either the TPA or the governorates to hire design consultants separately. The usual practice therefore, for projects too large to be designed within the governorate office, was for a construction contractor to be hired to design as well as to construct the project. Such a practice, of course, is especially open to the dangers discussed above. While governorate representatives have suggested that they did not see this as a severe problem (because the construction firms with which such contracts are signed are publicly owned firms, and thus any addition to their profits is retained within the public sector), it was clearly a serious concern of the Transport Ministry. After all, inappropriate design decisions can imply substantial cost beyond that of excess contractors' profits--such as by increasing long term maintenance of operating costs. Second, these are funds that might otherwise have been used for other transport projects.

The Process of Transportation Decision Making in Cairo

It became clear early in our study of the decision-making process that the "project" is the basic unit of decision in transportation planning in Egypt, and more particularly in Cairo. In order to understand the process of project generation and implementation in Egypt, we made use of the notion that each project has a developmental history, a "biography." The process of project development was studied by tracing the history of each of a number of projects.

Each project begins as an idea, generated by some individual or organization. The project then moves through a series of stages and finally reaches completion. Our examination of the projects was aimed at identifying these stages, the processes which influence project development, and the forces which move each project from idea to completion. This project development process is displayed graphically in Figure 3.

Both in order to clarify the framework upon which the study rests, and to introduce and begin to define terminology, it should be noted here that:

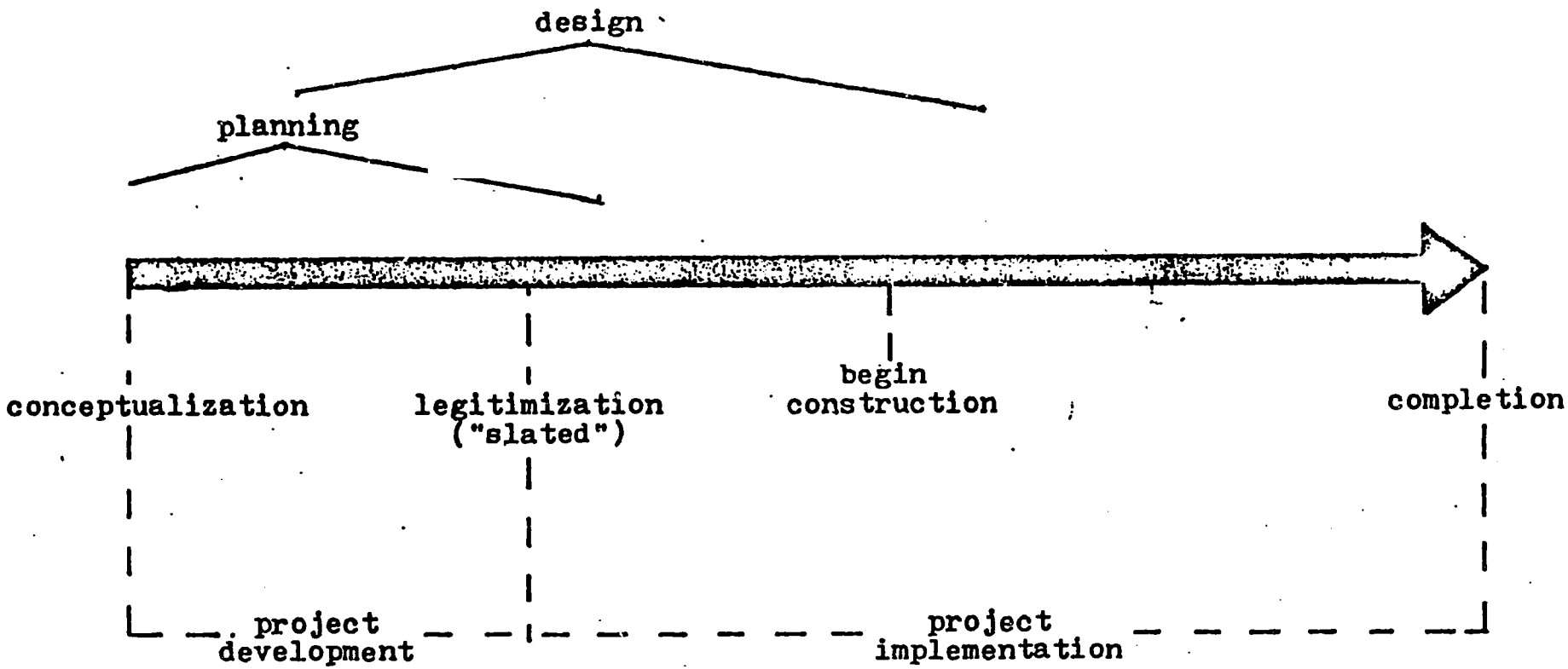
1. "Planning" means the defining project functional role and determining the relationship of this role to the surrounding environment;
2. "Design" means the detailed specification of a physical system to perform that role:
3. "Implementation" describes activities occurring after a project is "slated" and continues until the project is completed;
4. The movement of the project may not be continuous (i.e., project development may be interrupted);
5. The trajectory may loop back through previous stages with revisions which occur even after the initiation of construction;
6. At any point along the trajectory, a number of public and private organizations and individuals are separately influencing the movement of the project toward completion;

7. There are several projects--each one on a separate path toward completion--in various stages of development at any time. Projects influence each other, since they are developing simultaneously. They are calling on the same resources, fulfilling related commitments, and so forth;
8. There is a high degree of consensus on the elements of the "slate" of projects; disagreements tend to focus on the details of projects or the order of project construction, rather than on the conceptual validity of a project or whether it should be undertaken at all. The different perspectives of organizations and individuals involved in the transportation planning process will lead each of them to support most strongly a small subset of all proposed projects and to develop a sense of prioritization of these within the set of all proposed ideas. The "slate" thus, serves as a mechanism for narrowing the range of possible projects to a set of a manageable size for debate concerning detail and prioritization while retaining the involvement and support of the range of organizations and individuals involved. This helps to unify participants in the transport sector in competing with other sectors for resources.

Figure 3 is not intended to be interpreted as illustrating a rigid, well-defined process.[3] The activities may not always occur in the specific sequence indicated in the diagram. Planning and design activities, for example, may occur in alternating, incremental phases.

Figure 3

HISTORICAL PHASES OF PROJECT DEVELOPMENT AND IMPLEMENTATION



The relative duration of activities can change (e.g., planning may take place during many years and then design may be completed in a few months or vice versa). The periods of overlap between planning, design and construction may also vary from project to project.

Since its initial identification by the research team in 1977, the slate of urban transportation projects in Cairo has undergone some changes. The 1977 slate contained ten projects. Since then, three projects have been completed. We have also seen a major modification of the Abu El Ala Bridge and its splintering into two separate projects, the discontinuity in development of the autostrade because of cancellation of financial support by the original foreign source and continuation by Egyptian funds, the "deferment" of two other projects, with the status of the tramway extension project remaining unclear.

A few new proposals have been slated. These are characterized by a relatively lower level of capital cost, with only one project standing out as high cost, the Ramses Street extension to Abbassia. All the other new projects are relatively modest, and consist of grade separations at critical congestion points. Because of their relatively low cost and lack of comparability with the other projects,[4] they have not been added to the slate. These projects reflect an aggressive program of traffic and parking system management bound to significantly affect the performance of the transportation network. They need to be taken into account as part of the environment when evaluating slated project sets for programming decisions.

The growing effort in developing and implementing these low-cost improvements suggests the restructuring of the slate into a number of subclasses, each containing a particular type of projects In particular, our current view of the slate (as being made up of mainly high capital construction-oriented projects) would constitut one such subclass, while the traffic management projects would constitute another subclass, transit network improvements yet another subclass, etc. Such a restructuring would recognize the increasing awareness of non-construction transportation measures by the planning authorities in Cairo, which is to a large extent due to the involvement of international bodies such as the World Bank. It would require significant variations in the method. Our current programming is basically constrained by capital budget, whereas traffic management projects are princiapply constrained by required levels of administrative effort. In view of current trends in transport policy for developing countries, preparation of such variations would be well worth the effort.

The list of projects considered to be currently in the slate:

1. Abu El-Ela Bridge
2. Rod El Farag Bridge
3. Corridor El Nil Widening
4. Helwan Helopolis Autostrade
5. 26th of July Elevated Roadway
6. Ramses Street Extension to Abbassia
7. Sekket El Waili Bridge
8. Al Azhar/Port Said Overpass
9. Giza Square Flyover
10. King Faisal Street

THE MANDATE TO PROGRAMMING

The foregoing discussion has dealt with potential strengths of the programming method and with realities of the Egyptian decision system. How will these be put together? How can programming technique, based on conveniently simplistic assumptions about the institutional problem of decision, be put to the service of the Egyptian government. The following summary requirements are those to which technical developments reported in the following sections try to respond:

1. Project information created by a variety of participating agencies needs to be unified into a single format. This produces comparability between the projects and encourages unified planning.

2. Multiple participation in decision making and individual project advocacy by particular agencies have to be respected and guided. This means assuming the "slate" as part of the decision process. It means that slated projects can be sequenced in the course of programming, but they should not be rejected or prioritized on a one-by-one basis because that would disturb the balance of participating interests. To maintain a balance of prerogative among agencies, it is appropriate to handle the projects during programming in sets, rather than individually. It is the set, rather than the individual project that is the reason for validation. To incorporate multiple participation in programming, it is important to create some measure of the preferences of individual agencies among the slated projects. All of these requirements together can encourage an integrated procedure in which the interests of individual agencies are included, and yet the resulting single program is acceptable to all concerned.

3. Management of uncertainty must be undertaken. The most significant source of uncertainty in the programming process is the size of the capital budget. In recent non-war years the budget for facilities in Cairo has varied from year to year by as much as a factor of two. Specific estimates of risk of delay in project elements are required at the beginning in the project information file. Further, accurate updates on a rapidly changing programming environment and consistent extern assumptions are needed. There are many opportunities in programming to systematically confront the problem of uncertainty.

4. While respecting the multiple particpation in the programming process, it is also appropriate to introduce straightforward evaluation procedures to gradually move the process toward conventional project appraisal.

5. Since the number of project sets under consideration is potentially very large, it is necessary to find means to control the work load required to examine alternative programs. Means must be found to disqualify a number of alternatives at an early stage.

THE PROTOTYPE PROGRAMMING METHOD

THE CONCEPT OF PROTOTYPE

It is useful to clarify the concept of "prototype" as used here. The idea is to present a frameowrk of interrelated activity cells (Fig. 1), in which those activities them-elves are left open to alternative choices of technique. For each activity a tentative

technique is proposed, but the understanding is that it will steadily evolve into different form more adequate to the reality of Egypt.

The proptotype serves several functions. It encompasses the entire procedure without being delayed by the development of entirely satisfactory technique for all the activities. This is important because it provides from an initial stage a means of teaching to the profession a concept of planning, a structured sense of the whole process. In an area of difficult quantification and great uncertainties like urban transportation, the clarification of the overall concept to the profession probably serves a much more important role in improving the quality of technical services than the refinement of technique itself. Clarifying these functional interrelations improves the engineers' and planners' judgment and stimulates agreement on the nature of the planning process. This may well lead to wiser project development management than the mastery of methods in detail. The detailed techniques, on the other hand do anchor the procedure in practice, so it is important to embark immediately on selection and adaptation of them.

The proptotype is very flexible. Parts of it can be operated before the rest is prepared. It would be possible, for example, to use the procedure through PROJECT SET FORMATION before the assessment and evaluation procedures are prepared. It is possible to use simple initial methods (e.g., simply factoring up trip exchanges from the origin-destination study) while considering adoption or adaptation of more advanced methods.

The task of method development is assisted because the prototype methodology puts the job of creating each method into context with its related methods. This helps by suggesting, for example, how useful high levels of accuracy are in a method under development in view of the intrinsic limitations on accuracy in other parts of the procedure. This is an important way of keeping engineers from becoming absorbed by the popular topics of progressive refinement, likely to be difficult to operationalize anyway in Egypt, when the other methods in the procedure cannot sustain the levels of accuracy sought.

COMPONENTS OF THE PROGRAMMING METHOD--FORMING PROGRAM OPTIONS

A sketch outline of the method was provided early in this report through a brief explanation of the boxes in Fig. 1. We will now deal with these boxes in considerably greater detail.

Project Information File

One purpose of the project information file is to provide data for the subsequent steps of the programming process. But it serves other purposes as well. It helps to pull together the diverse institutional environment by inducing the participants to "speak the same language." In formalizing the presentation of project information, it may cause project designers to be more conscious about their assumptions in estimating time and cost. There, are after all, strong pressures on project designers toward biasing these figures. Even in an uncertain world, how can a designer be encouraged to anticipate setbacks and delays which increase the cost and reduce the viability

of his project--when there is no way to estimate the likelihood of setbacks and delays. It is the common experience of developing and developed countries alike that projects almost always cost much more than estimated.

Our project information file emphasizes recording of cost, time of completion and uncertainty. Forms were prepared by the research team and completed for each Cairo project by the Transportation Planning Authority. They were updated once during the life of the research project.

To describe the file we use Exhibit I, which is a sample from the forms prepared for the Abou El-Ela Bridge. This bridge crosses the Nile River, traversing Zamalek Island. "Small Nile" and "Big Nile" refer to the river branches on the two sides of the island.

The procedure begins with the specification of "project components." These are partly independent parts of the overall project. That is, if evaluated individually each "component" would have some net work benefits, even if the other components were not built. On the first sheet of the exhibit, estimated times of completion of the components are recorded. The components are numbered with prefix b for further identification.

Now "elements" of construction are identified. List as part C of the exhibit, these are phases of construction of transportation projects, each having a somewhat different cost structure. For example, they have different labor to materials ratios, and different levels of need for imported as distinct from domestic materials. The elements are numbered with prefix c for further reference.

Project Information File

A. Name of project: Abou El-Ela Bridge
(Revised, reduced project)

B. Project Components:

(b-1) Zamalek Bridge (over small Nile)

(b-2) Western Ramps from 26th of July Street to Zamalek Bridge

(b-3) 26th of July Bridge (over big Nile) and ramps in Zamalek

(b-4) Abu El-Ela Junction and eastern entrances to 26th of July Bridge

Planned time ("Normal Time") for completion of each component:

Component Number	Time Planned	Remarks
b-1	To be finished in September 1981	
b-2	To be finished in September 1981	
b-3	To be finished in September 1983	
b-4	To be finished in September 1984	

C. Division of each component into elements of construction:

(c-1) Investigation of area and soil

(c-2) Foundations

(c-3) Superstructure

(c-4) Pavement

(c-5) Parapets

(c-6) Lighting

(c-7) Utilities

D. Detailed information concerning the elements of each component:

Name of Conponent: b - 2 (about to be finished)

Element No.	C/1	C/2	C/3	C/4	C/5	C/6	C/7
1. Cost of element Million L.E.	0.100	0.500	1.18	0.010	0.100	0.06	0.050
2. Reliability of cost	90%	70%	70%	90%	90%	90%	70%
3. Location of availability (domestic or foreign)	dom.	dom.	80%dom.	dom.	dom.	dom.	dom.
4. Timing of availability (months after request	3	4	6	1	1	1	4
5. Reliability of availability (± number of months)	1/2	2	2	1/2	1/2	1/2	1/2

E. Elements (c-2), (c-3), (c-4) of all the components of the project need further project-specific refinements.

Forms are attached hereafter for this purpose, one for each component element.

PROJECT: Abou El-Ela Bridge

COST REFINEMENT FORM

COMPONENT: b - 1		ELEMENT: c - 3	
		Domestic	Foreign (LE)
LABOR	high-skilled	68.000	
	skilled	206.000	
	unskilled	140.000	
	total	414.000	
MATERIAL	cement	164.000	
	steel	580.000	270.000
	asphalt, bitumen, etc.	30.000	
	sand, gravel, etc.	140.000	
	other	60.000	
	total	974.000	270.000
MACHINERY	cranes, mixers, pumps ...etc.	180.000	142.000
	tools	80.000	
	total	260.000	142.000
OTHER			
TOTAL			

Remarks

As part D of the exhibit the elements of one component are arrayed with estimates of the variables of concern: cost, cost estimate reliability, domestic/foreign funding source, time for completion, and reliability of the timing estimate. One of these charts is prepared for each component, that of component b-2 being used here as an example.

The figures above are in fact gathered by use of Cost Refinement Gorms as exe-plified in part E of the exhibit. Here the detailed costs of element c-3 for component b-1 are arrayed, distinguishing expenditure areas likely to react differently to economic change (labor, materials, and machinery) and separating domestic from foreign expenditures. One of these charts is present-d for each component-element combination.

To the extent available at any given stage of project development, also estimates of the functions and impacts of projects are recorded in the Project Information File. This includes information on (1) Objectives: network effects of the project, travel volume served, clients served, (2) Impacts: building dislocations, air pollution and noice, transit operation, pedestrian movements, etc., and (3) Interferences: with other projects, with urban infrastructure services, etc.

This information is fed into the Project Information File from the initial development of the project, and subsequently from the programming process itself.

Scenarios and Budget Estimation

The central purpose of the scenarios is to update the transportation network, excluding the projects being programmed, as the base on which to examine the consequences of alternative project sets. Note that the scenarios are then the vehicle for introducing the network interactions between the projects being programmed and the actions taken on the transportation system which are not in the programming process. They include non-capital intensive traffic management projects and the new metro underground. The forecasting of these actions constitutes a kind of "programming" problem separate from our procedure. It is probably more uncertain than ours because of special political and economic problems affecting the advance of the metro, and the fact that the pace of accomplishment of traffic management actions is not governed by any firm constraint such as budget. Nonetheless, scenarios are assembled from these projects and assigned probabilities as prelude to the chose of one for use as the base for programming.[5] Since the impacts of most traffic management projects are small when compared to those of major high capital projects, the error from that source is probably not great. The irregular schedule of implementation of the metro and its unforeseeable impacts are probably the greatest source of potential error in scenario building.

The budget estimation problem received special attention. As mentioned earlier, the capital budget for transportation improvements in Cairo varies by as much as a factor of two from year to year. It

is the greatest source of programming uncertainty. This is to be expected because there is no ear-marking of funds in the Egyptian administration and priorities change from year to year as new opportunities appear in the nation's struggle toward development. The annual allocation apparently depends on a variety of things: the government's commitment to the sector and to the capital city relative to other budget needs, the availability of foreign matching funds in transportation, the attractiveness of the slate of projects itself, and so forth. Under these circumstances it is clearly not useful to attempt the use of "standard" measures of national budget growth, such as gross national product or other indicators of economic growth.

As always, our perspective on this problem was to find the answer most useful for the operation of the programming method. While in the early stages we felt it would be necessary to forecast budget over a long period of time (the ten years or so which is required for implementation of the present slate), we subsequently decided that the unpredictability of budget over so long a period made a more modest projection preferable. Accordingly, we sought to project budget for a two year period only, thus facilitating in each period the next step only of programming.

The purposes of the procedure for budget forecasting included (1) to obtain an estimate of funds available for implementation of the slate, (2) to assess the extent to which the decision-makers would agree with each other on this issue, (3) to gain insight on the forces shaping the outcome of the budget-making process, and (4) more

generally to gain insight into the decision-makers' opinions and attitudes concerning uncertainty.

We chose a group of responsible government transportation officials for the inquiry. They included:

1. High ranking administrator of the Transport Planning Authority (TPA) of the Egyptian Ministry of Transport (MOT).
2. Key economist primarily involved with budgeting in the above mentioned TPA.
3. Middle-level engineer at the Cairo Governorate, primarily involved with technical/physical matters.
4. High ranking engineer at the Giza Governorate, with wide administrative/planning responsibilites and a long time in residence with that agency.
5. High ranking administrator at the Egyptian Ministry of Planning (MOP), in the presence of part of his staff of technical advisers.

The method developed for estimating the next biennial budget is documented in the project report on "Budget of Estimation..."[6] and is represented here by the survey guide as Exhibit II. The responsible officials were provided with items of guidance in making their estimates of the capital budget for Cairo transportation projects. First, they were given the list of budget sizes for the last seven years from which to observe any trend that might be found useful (Exhibit II, p. 1). Second, they were provided with a list of the costs of the individual slated projects (Exhibit II, p. 2) and also a series of project sets that could be accomplished for specified biennial budgets (Exhibit II, pp. 2 and 3).

Based on this information, each official was asked to estimate the budget by assigning a probability to specific budget sizes at spans of 10 million Egyptian pounds (Exhibit II, p. 4). These estimates were the basic data we considered in selecting the budget size to be assumed in the programming process.

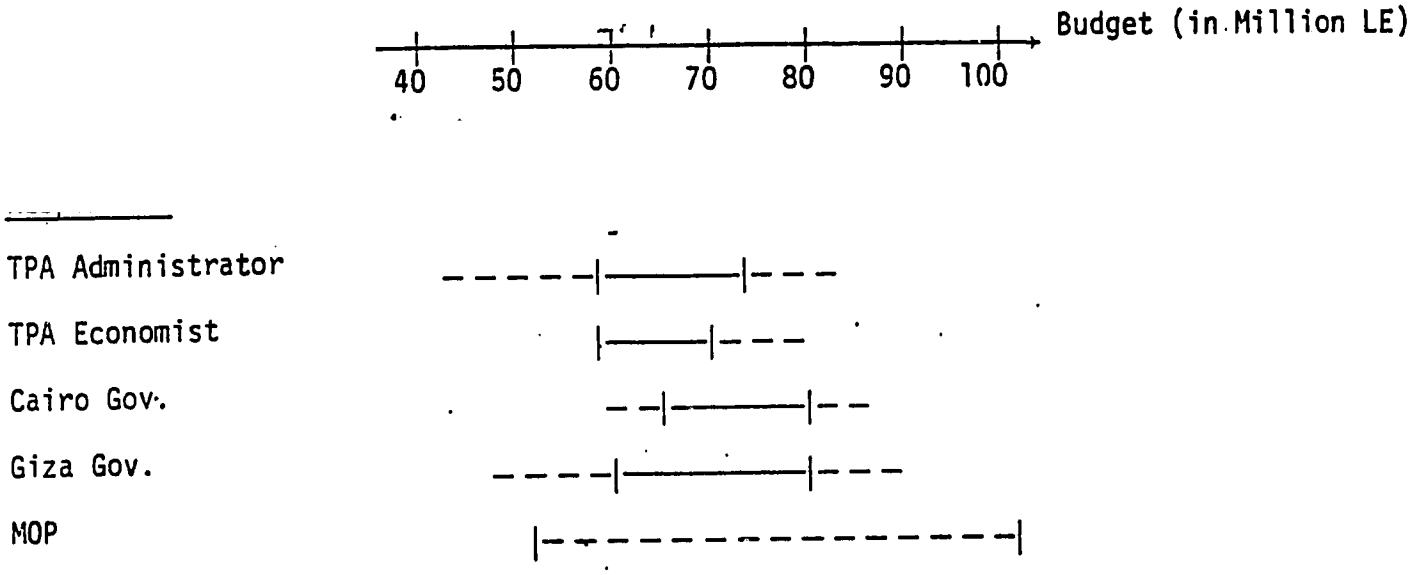
Experimental use of this method with the five officials mentioned was encouraging as to similarity of the separate responses. As indicated by Fig. 1 , the spans of estimate correspond reasonably closely with one another. Together with parallel information, this enabled us to propose that, however unpredictable the budget may be in fact, a sense among responsible officials of future possibilities may provide an adequately stable figure for project programming at the two-year horizon. This study is further analyzed in the paper last cited.

There was also discussion of actors that influence the size of the annual budget, with explanations proposed as indicated on page 5 of the Exhibit. Rank ordering of these candidate explanations by the respondents is reported on Table . On this subject, however, the exercise was very introductory. It is a difficult area that needs inquiry by means more indirect than questionnaire.

The Preference File

Observations on the de facto programming activities in Cairo highlighted the fact that many agencies participated. Our perception of a "slate" of projects was intended to portray this multiple participation. Accordingly, the assembly of sets of projects for implementation, and the sequencing of their achievement during specific periods requires incorporating the views of the agencies into the programming.

Figure 1: Graphical Representation of Responses Concerning Estimated Future Biennal Budget



legend

———— most likely range

– – – – – – less likely range

Table 2: Rank Orders of Factors Affecting Capital Expenditures on Urban Transport in Cairo

Factor	Respondent				Total
	TPA1	TPA2	GG	MOP	
Growth of National Economy	8	6	6	6	26
Growth of Metropolitan Population	2	5	5	4	16
Size of Total Budget	8	8	8	8	32
Policy on New Towns	1	2	1	3	7
Competitive Public Works Project	5	4	2	5	16
Availability of Complementary Foreign Funds	6	7	7	7	27
Status of Sponsoring Agencies	4	2	4	1	11
Pressures from Contractors	3	3	3	2	11

Legend

TPA1: Administrator from TPA

TPA2: Economist from TPA

GG: Giza Governorate

MOP: Ministry of Planning

Each agency can be seen as having some perspective on the relative priorities of the projects in the slate. The sources of these views are many and difficult to systematize. They include agency history, the relatedness of other projects for which the agency is responsible, and its dependencies on other concerned agencies. Views result from independent appraisals of public need, feasibility and anticipated project impact. They result from the analytical styles of professionals staffing particular agencies--economic analysis of new project contributions may lead to different conclusions than traditional engineering systems appraisals. Understanding the sources and structure of preferences among agencies is a long-range interest of the research group.

For purposes of equipping the programming methodology, however, it was necessary to short-cut the longer inquiry with more direct appraisals of agency preference. We might say that the foregoing discussion or preference would lead to a "value information subfile," and that we simultaneously undertook a "direct preference subfile." The direct preference subfile responds to our short-run need to form project sets, and to find the most viable of them for early implementation.

But the problem of how to appraise the strength of preferences of each participating agency is a difficult one. Is it that each has a project it wants to sponsor and does not care about the others in the slate, except to support them to the extent necessary to assure survival of its own? Or are the agencies primarily concerned with vetoing the early implementation of projects taken to be competitive with their own within the same time period? Or is it the case that

each agency in fact has a structured set of preferences over the entire slate determined by its own appraisals of project contributions and feasibility? Of course, any combination of these concerns is also possible.

One issue to settle is the order of aggregation when accounting for project preference. Assuming, as we have, that each agency has a relationship different from the others to any given project depending on its sponsor-like relationship to that project, it seems most appropriate to aggregate project preference up to the level of a set for each actor, and then to aggregate across actors to conclude on the strength of the set. There is another view possible: if we assume that scores are more intrinsic to the strengths of the individual projects, then we should aggregate for a single project across all actors, and then aggregate from projects to sets. The latter view might be taken as assuming that some projects are intrinsically better than others, and that any difference in view between agencies is a consequence of inaccuracies of perception or different criteria. We chose the first of these two views, consistent with the discussion in the early part of this report. It would be interesting to experimentally examine the applicabilities of the two points of view.

The team has proposed and detailed a series of four options for the direct examination of project preference.[7] The first scores agency preference for a set on the basis of the utility it places on the project in the set which is the best one from its point of view. This might be called the "sponsor model;" the one that assumes the

agency does not care about any projects but "its own." The second model scores agency preference on the basis of the project of the set that is the worst one from the point of view of the agency. This might be called the "veto model."

The third model offers a series of variations that score sets for individual agencies on the basis of desirability weightings awarded to each project. One form of the model simplistically gives cardinal valu-s to the rank ordering of the projects. Another form of the model compares each set with the agency's optimal set, that is the set which gets its highest score. The fourth model gives cardinal values to more intuitive project evaluations: high, low, indifferent and against. Means are incorporated in these models to normalize the sets in such a way as to make sets of different sizes comparable.

Thus agency views toward individual slated projects can be used to examine the validity of candidate project groupings.

Set Formation

A "set" is the group of projects that will be implemented in the same time period under a fixed budget. Sets are emphasized in this procedure, rather than individual projects, for reasons clear from discussion in sections above. The slated projects are firm commitments which seem reasonably robust individually; the initial problem is how to sequence them in such a manner as to maintain a balance of prerogative among the participating agencies, to keep the installed capacity for project developmet occupied in the entire group of participating agencies, and to maximize the stream of resulting benefits.

The criteria for assembling project components into sets emerge from the situation as described:

1. Stay under the term budget

2. Balance interests among participating agencies

3. Avoid physical interference between projects under simultaneous implementation

4. Maximize the long term flow of benefits (a criterion left mainly for evaluation by formal project appraisal models in subsequent sections, applied to sets of projects)

5. Continue prior commitments, projects already begun

6. Take advantage of special opportunities, such as foreign technical assistance or loans.

Views on this problem changed from phase to phase of the research, and are documented in our technical reports.[8] Among the problems considered as that while it was necessary for us to consider a fixed budget in advance for each programming period, it is sure to be the case that the size of the budget is related to the particular set of projects, and the inducements the set presents to the budgeting process. Decisions were made on the formal rules of set formation based on trade-offs between flexibility of process on the one hand, and the amount of work imposed by more numerous sets on the other. Such questions included whether it was necessary to hold that a given project could not appear in more than one trial set, whether the length of the implementation period for each set had to be the same, whether the entire slate should be programmed at the same time or only each set incrementally.

Exercises were performed on the bases of various rule frameworks in order to examine the project set outcomes and to get a sense of the required total level of effort. It was concluded that, in view of the substantial uncertainty of the whole process, the next period only should be programmed each biennium, rather than making an effort to get the best result for the entire slate at the same time.

It is appropriate to follow this stage with one of micro-staging. That is the phasing of project development within each set in order to assure a balanced call on resources, minimum problems of physical interference between projects within the set, minimum cost on account of the delay of arrival of materials and equipment, and so forth. This level of work was briefly explored in an early stage of our research[9] but is left for full development in some subsequent opportunity.

COMPONENTS OF THE PROGRAMMING METHOD--EVALUATION OF PROGRAM OPTIONS

Up to this point the procedure has been aimed at generating sequences of project sets which constitute <u>workable</u> programs of capital investment in urban transportation, given the realities of the Egyptian political economy and the particularities of the responsible institutions. From this point onward--still with those considerations in mind--the emphasis is on generating measures of benefit and tableaux of effect of these project sets. At the end, a scheme is proposed to unify those measures into evaluative portrayals of project consequences.

The fact that these matters follow program option formation is consistent with our view of the problem. This is an environment of reasonably robust slated projects to which the agencies of the sector are committed. None show indications of being poor "pet" projects, and the record shows that once the slating commitment is made in Cairo, the projects move gradually toward reliable implementation. Though national crises sometimes delay completion, there is no case of a slated project abandoned. In this kind of environment, the first obligation of programming is to assure a schedule that is workable from the point of view of the diverse parricipating agencies, rather than to throw the goodness of the projects into question.

The next stage, however, is precisely to address these workable programs with techniques that put relative merits of projects and sets into visible relief. This is intended to encourage the gradual movement of planning and project development toward classically "rational" form. As always with planning technique, the introduction of these methods has several simultaneous levels of intent. Most basically, of course, it is to expose the relative merits of projects in terms of their objectives. At the second level it is intended to systematize planners' and engineers' perspectives on the issues of project intent and benefit as a present concern during project design. Thirdly, it is a means of encouraging and understanding project appraisal as an aspect of overall planning. There are, of course, important occasional benefits: formal evalutions of these kinds are often required by international agencies contemplating technical assistance or financial aid.

Network Impacts

These are the effects of project sets on travel by auto and transit, both on the links changed by projects of the set and others interdependent with those links. The effects include reductions of travel time, reductions of vehicle operating costs, and decrease of accidents.

The other parts of the Cairo Urban Transportation Project Team provided ample basis for the computation of these impacts. There were complete origin-destination surveys, both of transit and auto trips. Techniques for trip forecasting were prepared. Trip assignment techniques are in use by which traffic on the streets can be forecast by specific hours of the day.

For purposes of computing travel time saved, given the rapid growth of Cairo traffic, our technique proposed tabulating the net present value of time savings over a ten year span. This permitted performance of new additions to the network to be evaluated in the environment of rapidly increasing congestion. The ten-year horizon is much shorter than normally used in the developed countries (24 years is usual in the U.S.). This responds to the substantial uncertainties of future network performance in Egypt, and to the use of a high discount rate (12%) reflecting the urgent short-run alternative uses of funds.

Values of the needed parameters came from the other parts of our Urban Transportation Study and from other studies in Cairo. Our study adapted the use of passenger car equivalents to Cairo to compute the street behavior (leading to travel volume-speed

relationships) of the different kinds of vehicles together. Values for vehicle operating costs were also prepared by the other parts of our team. Values for the cost of time in travel were obtained from prior studies in Cairo, in which members of our research team participated.

Consistent with the orientation of the programming format, this method was derived for application to project sets, but it is suitable for application to the level of individual projects or to entire programs as well.

Using the tools and parameters developed, then, the first task is to estimate new time of travel on links directly affected by proposed new projects. The origins and destinations for specific years are assigned to an updated network that accounts for these proposed projects. Time savings (by auto and transit) are then computed. The result can be used for some purposes in aggregate person-hours of time saved, or can be converted to economic savings by multiplying the time saved by the value of time. Further detail is found in the project memorandum.[10]

As an additional step in the development of this procedure, it is possible to isolate individual parts of the network or sets of origins and destinations with respect to which benefits could be separately measured. This would enable evaluation of options with respect to particular urban subgroups.

Among the special problems that need further attention toward the improvement of this method is the correction of prices against certain distortions. In view of the fact that petroleum is subsidized

in Egypt it is appropriate to compute a shadow price for the vehicle operating costs required for this part of the evaluation.

Non-network Economic Benefits

The previous section reviewed the evaluation of those project impacts which are directly related to the performance of the urban transport system. In this section we describe the evaluation of 'non-network economic impacts' of alternative patterns of investment in transportation facilities.

Whether the net benefits accruing to the particular region are consumed or invested, a part of them wil be respent within the region. To the extent that they constitute a transfer of income from elsewhere in the economy to the project region, they will result in a new round of benefits to the region. It is such 'multiplier' effects which we refer to as 'non-network economic impacts'.

Full assessment of the impact of transportation investments in the Cairo region should thus include a measure of the regional-income multiplier effects of the investments undertaken. Expenditures in different sectors (transportation, construction, services) have different regional multiplier effects. Consequently, the multiplier effects of different project sets will vary, depending on the mix of sectors in which resources are spent in each case. As an illustrative calculation, we estimated the multiplier effects of expenditures in the construction and transportation sectors for the Egyptian economy as a whole and found that, as in other economies, the construction sector had a high income multiplier effect: an increase of LE 1 in

final demand for construction results and an increase of LE 7.28 in value added, when direct, indirect, and induced effects are included. In comparison, an additional LE 1 of final demand for transportation services would result in LE 3.32 of value added (direct, indirect and induced effects).[11]

The estimates cited here are multipliers for the Egyptian economy as a whole: in the basence of regional input-output tables it is not now feasible to estimate multipliers at the regional level. However, regional multipliers are always less than national ones, because of the leakages to other regions of the country. When regional income data become available for Egypt, estimation of accurate regional income multipliers will be an activity to be included in programming of investment projects. Estimates of the national income multiplier effects of alternative investment programs for transport in Cairo could be undertaken; however, following the usual conventions of project evaluation, multiplier effects are not usually estimated for aggregate consumption benefits for the entire economy. This is appropriate only when there is an overall deficiency in effective demand, and hence underutilized resources which are mobilized as a result of the project(s). If resources are fully employed, income may be shifted from one region to another, but it is not possible to add to national income in any given period. Moreover, when programs all include transportation construction projects, the multiplier effects may be very similar for all, even if there are underutilized resources which are mobilized. Multiplier effects could not then form a useful basis for comparisons.

An exception is the case where the projects to be compared have a very different foreign exchange component. Resources spent abroad have no multiplier effect, whereas those spent at home do have such an effect. If there are underutilized resources at home, then those multiplier effects are appropriately measured and incorporated in programming. In the case of slated projects for Cairo for example, about one third of the total resource costs of the Ramses Street Extension are expected to be foreign, while only about fifteen percent of the costs of the Abou El-Ela Bridge will be incurred in foreign exchange.

Functional Evaluation

This deals with appraisal of impacts outside the framework of economic measures. Many effects of transportation facilities cannot be usefully quantified, or have consequences that may be differently interpreted from time to time and place to place.

In functional evaluation the objective is twofold. On the one hand it is directed toward discovering key project effects that ought in the next stage to become part of the multicriteria evaluation procedure. On the other hand it has objectives that do not attempt to simply label project effects as high or low. Rather, it attempts to perceive and record project effects in such a way as to be useful in improving the project through redesign. This latter objective is important to remember because it leads a different approach to measurement than would otherwise be the case.

The "categories" of impact are listed in Chart 4. They encompass the significant off-right of way, non-network consequences of transport investment. They can be organized to achieve different kinds of overview. For example, there is likely to be a perceived trade-off between impact on quality of life versus impact on economic welfare and livelihood. Anticipating special concern for this, we included "employment impacts" as a separate category, and have made interpretations within the other categories that will enable distinction between environmental and the economy under impact.

For each category there is an impact chart which divides concern for the category into "components" and describes a stepwise process for observing and improving the project design through use of each component. An example of the impact charts is provided as Chart which corresponds to the first category, land use impacts. The full set of five charts and much more detailed discussion of their use appears in the project memorandum.[12] In this chart, first notice the "components," serving as the row titles. These are aspects of the cateogry taken to be (a) observable, (b) indicative of significant impact, and (c) manageable in project refinement or redesign. Notice that they are <u>not</u> mutually exclusive. Since upon impact, "density change," "land value change," and "change in land use" are all measures of the same phenomenon. Any of them may be used for redes-- purposes, depending on planning objectives for the project environment and which can be most adequately forecast, but they cannot be added up. This method provides no definition for "total impact."

CHART 4

IMPACT CATEGORIES

These need to be considered as to summary value of impact and also the socially distributed characteristics of impact.

LAND USE IMPACTS

Land consumption by the pro
Density change
Land value change
Changes in land use
Incursions of external effect
Directions of land development as result of project impulse
Facility use impacts

SOCIAL IMPACTS

Removal of housing units, or addition of new units
Removal or addition of social institutions (including retail establishments as social institutions)
Changes in availability or utilities to households
Changes in physical access
Risk of fire, explosion, disease of other damage

URBAN NATURAL ENVIRONMENT IMPACTS

Air pollution
Water pollution and waterway disruption
Other change in ecological structures
Removal of addition of land uses offering amenity or recreation

EMPLOYMENT IMPACTS

Jobs created by project construction
Jobs created by project functions
Jobs displaced or superseded
Jobs attracted by the project
Urban service requirements of new jobs

FINANCIAL IMPACT

Altered capacity of the implementing agency for undertaking other responsibilities in respect to:

--management strength
--financial resources
--personnel strength
--cross-subsidizations

CHART 5

LAND USE IMPACTS: HIGHWAYS

COMPONENT	CONCERN	INPUT INFORMATION	METHOD	OUTPUT INFORMATION	GUIDELINE	RELATED DESIGN ELEMENTS
LAND CONSUMPTION	Consideration of competing uses of land. Displacement of valued land use. Avoid leaving unusable portions of parcels after condemnation.	Sites to be absorbed. Land scarcities for other critical purposes.	Evaluate need for land uses lost. Alternative locations for competitive land uses.	Highway use of land compared to other opportunites. Alternative pattern of land takings	Minimize consumption of valued land.	Location and alignment planning. Land planning in vicinity of highway. Plan close locations for competing land uses.
DENSITY CHANGE	Cause new density pattern to be in conformance with plan. Consequences of rapid density change immediately surrounding the facility.	Route alignment, urban plan, land use map. Model for estimating density responses to access. Land tenure pattern.	Comparisons with control parcels in the same area, of with similar cases--small scale land use model to follow impact at large scale.	Estimated future densities in immediate surroundings, and in larger zones surrounding the highway.	Assure that consequential densities are within acceptable maximum and minimum. Consider changes caused in utilities service costs.	Land planning in districts where highway passes through. Control of land use in immediate localities. Location and alignment planning.
LAND VALUE CHANGE	Manage increases taxes, creation of large value increases, speculation. Also a basis for study of changes in land use.	Route alignment, urban plan, samples of land values. Model for estimating land value response to access. Values of local control parcels or similar cases.	Comparisons with control parcels in the same area, or with similar cases.	Estimated land values , in parcels immediately surrounding (small scale) and surrounding zones (large scale). Value of taxables to government.	Controls on distribution of profits by income groups. Standards for density and land use change.	Location and alignment planning. Administrative practices for absorption of excess value.
CHANGES IN LAND USE	Avoid superseding important uses, or relocate them. Create new, desirable land uses.	Present land use. Availability of parcels to change in use. Characteristics of control parcels in same locality.	By inspection, based on experience. Use of the results of studies above as indicators.	Estimated changes in land use in the immediate locality of the highway.	Minimize impacts to desired uses. Restore services deleted by project.	Highway design. Zoning to exclude sensitive uses. Various kinds of payments to affected land holders. Baffles and buffers.
DIRECTIONS OF DEVELOPMENT	Minimize aggregate travel time. Maximize trip-making opportunities. Control land development costs. Objectives as indicated by urban plan.	Route locations. Linkages of highway with location of urban activities, highway capacity. Urban plan.	Analysis of linkages with location of urban activities. Use of access-sensitive land use model.	Estimated changes in land development locations (by traffic zones) based on highway.	Conformance to urban plan, local preference, maximum service efficiency, minimum land development costs.	Location and alignment of the facility. Access to highway (case of limited access). Planning of complementary utilities. Zoning.
FACILITY USE IMPACTS	Minimize damage to nearby activities by smoke, traffic, noise, etc. by highway use, and during the construction of the facility.	Average vehicle noise and pollution. Visual design of facility. Locally surrounding land uses. Impacts expected from construction.	Measurement of the incidence of impacts. Comparison with maximum standards.	Levels of expected nuisance or damage to surrounding land uses.	Minimize impact levels. Buffer impact receptors if possible.	Location and alignment planning. Zoning, controls through excess condemnation. Direct public use of abutting land.

The sequence of steps across the chart further clarifies the use of these measures. Note the captions serving as column headings. For each component there is a specifically stated "concern," a concrete reason for being preoccupied with the component. It is important to be specific about this. There is no point to listing, for example, "density change" as an issue unless there is some reason to be for or against it. And in many cases there is none. In such cases the component should be deleted from the exercise.

Then follow three steps of analysis including "input information," "method" and "output method." Looking at the different procedures proposed for the various components suggests again why overlapping components are permitted. Some of these analyses are much more demanding than others. For any given project the availability of data, availability of analytical skills, the existence of adequate control cases, etc., will determine which component analyses are feasible. By including several overlapping ones we maximize the possibility of getting some perspective on the phenomenon. The "output information" is a forecast of the state of affairs anticipated in the case of project implementation.

Next comes the "guideline" that describes the preferred state of affairs or the direction in which the phenomenon should be pushed by redesign or mitigating techniques. It is the comparison between the state reported in "output information" and the state preferred in the "guideline" which constitutes the statement of the problem for redesign.

The final column identified the "related design elements" that can be called upon to close the gap between forecasted and desired outcomes. Thus the method intends a process that is not so much an "evaluation" in the normal sense, as a "redesign."

The distinction between evaluation and redesign is important. As distinct from economic evaluation, which records summary results that tend not to have their origins in single conspicuous design features, functional evaluation has a highly visible aspect. As a result it may generate conflict among agencies, or between them and community groups. It is common experience in the developed countries that partisan response to functional evaluation often obstructs project development over long periods of time, and feeds feuds between unfriendly constituencies. Here we try to avoid this by emphasizing the feasibility of remaking the project around individual effect phenomena, rather simply than putting project "impact" in dramatic relief. Once again we are assuming, as in the program-making procedures above, that a slated project will be implemented. Thus we set about to improve it rather than to question it.

Functional evaluation is a big job because there are so many project facets to be observed. This makes necessary some means of controlling the work so as to focus on the principal issues for each project. At the same time, functional evaluation must be carried out at different stages of project preparation; some impacts cannot be perceived until the final stages of detailed design, but those that can be anticipated earlier should be cited then while the design process is more flexible and able to absorb requirements for change.

Joining these two concerns, we propose three levels of evaluation, at the stages of "initial concept," "functional design" and "detailed design." The first, "initial concept" is the level at which to prepare an "early warning" for project features likely to become special issues. Also, concrete recommendations can be made for impacts already foreseeable at that stage. The level of "functional design" is adequately revealing for most impacts--such as air pollutions spatial attribution of rise in access, and so forth--so it is the level at which the most analysis should be done. "Detailed design" is also an important stage, however, because some of the most important impacts are disclosed only when the facility is fully described--such as building dislocations. The evaluation procedure, then, is performed partly at each of these three levels of project preparation.

The redesign/refinement activity concluded from each pass at evaluation chooses appropriately from the design sub-activity most relevant to the problems revealed. Still following the example of an urban highway, the first disaggregation of subactivities includes:

(a) Route location--choice of the corridor in which the facility will be built. This determines many of the area-wide impacts.

(b) Route allignment--siting the highway, which determines many of the small-scale impacts on surrounding development and environment.

(c) Facility capacity--determining, e.g., the number of lanes to be provided, and therefore the level of travel demand served and the land occupancy of the facility.

(d) Choice of construction technique and materials--determining the employment to be provided by construction of the facility.

(e) Access control (i.e., at what locations vehicles can enter and leave the facility)--determining the extent to which the facility serves local traffic rather than through traffic, and the specific sub-populations served.

(f) Detailed geometric design-fully determining the levels of building displacement, impacts on water courses, noise intrusions, need for parcel acquisition, and so forth.

(g) Forms of financing--determining specific standards of design (if they are particular to the funding agency) and the extent to which the project reduces the resources of the responsible agency for the support of other projects.

Functional evaluation is followed by an integrative multi-criteria evaluative method. Only experience in the use of the functional evaluation method will create a judgment as to what observations should be transferred from it to the comprehensive evaluative environment of the multi-criteria method. The linkage would be easy to make.

Multi Criteria Evaluation

As we have seen so far, many types of impacts and attributes have to be considered in programming network investments. In addition to the fact that not all of those impacts are easily or reliably quantifiable, and that not all are known with certainty or with the same degree of confidence, two further major difficulties usually arise in conjunction with multiple attributes or objectives: their possibly conflicting nature and their non-commensurability. The conflicting aspect all be prevents the attainment of a "true"

optimal solution, i.e., one for which all the attributes are at their most desirable value. The second issue, namely non-commensurability, is what prevents the a priori reduction of all the attributes into a single measure, as is done in cost-benefit analyses whereby all impacts are converted to their so-considered monetary equivalent. In other words, it is not always possible to place a monetary value on every attribute and impact. However, implicitly or explicitly, trade-offs are inescapable is a decision is to be taken at all and there is not option which is superior to the others on all attributes. However, how trade-offs are handled, and where and by which means they are resolved are important aspects of the selection procedure, which can allow better informed and less "contrived" decisions than a straightforward linear weighting aggregation rule. For this reason, a marked shift toward the development and use of multi-criteria evaluation and decision-making can be detected in an increasing number of decision situations; a brief review of some of this body of work is provided in accompanying reference 13. A multi-criteria evaluation framework and its methodological aspects have been developed for the programming procedure, and are described in accompanying references 13 and 14.

We will describe the major features of the approach after briefly discussing the role of the multi-criteria evaluation approach in the programming procedure.

Role of Multi-Criteria Evaluation in the Programming Procedure. As described in reference 1, the evaluation of alternative options characterized by a multiplicity of attributes occurs at two different points in the programming procedure:

- at the pre-evaluation stage of project sets, prior to further impact assessment.

- at the final evaluation stage, after all impacts of alternative project sets have been assessed (in particluar the network dependent benefits).

The objective of the pre-evaluation activity is the reduction of the number of project sets for which further impact prediction (using the computationally expensive Eallre assignment model) is to be conducted. Since the programming procedure calls for the consideration of all project sets which can be formed for a given budget constraint, the conbinatorial aspects of the problems require the elimination of a large number of those possible sets from further consideration, using all available information not requiring the operation of the traffic assignment model (namely technical feasibility/functional compatibility criteria, the institutional desirability index and non-network dependents impacts). While most of these criteria have been identified throughout the course of this research activity, the procedure has enough flexibility to allow for any criteria judged to be of importance to be added at later stages.

The final evaluation stage is the culmination of the programming procedure, whereby all criteria are considered and integrated in the selection activity.

The methodology developed for multi-criteria evaluation in the programming procedure is applicable to both ot the two above stages. However, the final evaluation stage will require the use of more features of the methodology than the pre-evaluation stage. The methodological framework and some of its major features are discussed hereafter.

Methodological Aspects. The multi-criteria methodoldgy consists of two phases: 1. Pre-screening: which eliminates options that do not meet minimum level constraints on specified criteria, such as the institutional desirability index; 2. Concordance Analysis: which was adapted from the well known technique ELECTRE[15] to include a broader range of preferential information. This technique uses an intuitively appealing rationale for pairwise comparisons, which sums up the impact information along two dimensions: (a) concordance, indicating the extent to which an option outperforms another. This is done without directly compensating inferiority along a certain criterion by superiority along another (which monetary based approached usually do), (b) discordance, which encapsulates the negative information of an option relative to another by considering the worst case among the non-dominated criteria. For one option to be considered better than another, it is necessary that it performs better (or as good) than the other on a sufficient number of criteria (reflected by the concordance index) without however doing worse by more than an acceptable level on any one of those criteria where the other is better. A more thorough discussion can be found in reference 13.

The concordance analysis phase is thus used on those project sets which have not been eliminated in the pre-screening phase. Concordance analysis itself consists of a number of (inner) interactions (see reference 14 for details), whereby the initial set is progressively reduced by the manipulation of two parameters reflecting the minimum acceptable concordance and maximum tolerable discordance. Further representation of preferential information is possible via a set of weights which can be dynamically varied in order to progressively bring out less important criteria. In general, this approach should rely

heavily on the analyst's professional judgement in dealing with the appropriate responsible authorities and establishing communication between them and the evaluation methodology.

The outcome of this phase would then be a substantially reduced number of alternative options, which is small enough to allow and warrant closer scrutiny and evaluation. The formal steips of the methodology do not guarantee and will in general not lead to a single undominated option, but a small set containing the truly superior options such that selection can only be made by direct comparison of by bringing in more information which might set one apart from the others.

Since the pre-evaluation activity's purpose is primarily one of screening and elimination at a fairly coarse level, with relatively imprecise input data, including many non-quantitative factors, it was concluded that pre-evaluation is probably better conducted by imposing a set of constraints (in the form of threshold values or minimum acceptable levels, as descirbed in reference 13).

The multi-criteria evaluation technique should be viewed as a decision aid in the process of confronting all the information on the different criteria in order to come with the most desirable option. We feel it is a very flexible technique, which allows a wide range of criteria to be considered, including non-quantitative and imprecise data, which can be very effective as well in making this highly complex task manageable.

ACHIEVEMENTS, AND LESSONS LEARNED BY DESIGNING A PROGRAMMING METHOD IN EGYPT

System and Non-System Decision

The world geography of transportation planning can be divided between countries in which the engineering systems approach[16] is dominant among the responsible professionals and those in which it is not. This approach is useful and it makes sense to encourage its introduction where it is not currently in use. It is probably not a good idea, however, to address the job of improving urban transportation decision making by advocating this methodology single-mindedly where it has not gotten much use up to the present time. As an approach it needs to be matured professionally for some time before making an important impression on decision makers. And in any case, important institutional realities will continue to assert themselves separately which will not absorb this approach. For one thing, the engineering systems approach assumes the existence of a pyramidically structured decision system.

In Cairo we observed a multiple-participation scheme of decision in urban transportation planning in which there was no single arbitrator. We concluded that it is a sensible, strong form of planning that assures responsible support of projects, respects the prerogatives of judgment of separate agencies, assures the full use of the installed capacity of professional capability and--particularly in the basence of advanced management technology--may create the most efficient scale of system building responsibility.

The important contribution of this research is to propose that such a decision scheme can be managed technically. It cannot be optimized, but it can be helped toward greater effectiveness. This we sought by

such proposals as accepting the slate as a reality, analyzing institutional preference, dealing with projects in sets rather than individually, using a form of functional evaluation that redesigns rather than evaluates, and proposing a project information file to close the gap of communication.

Linking System to Non-System Design

The level to which we brought the development of the programming method has enabled us to suggest that it is possible to join improvement of the de facto planning system on the one hand, and the introduction of the engineering systems approach on the other. These correspond to the sections of the foregoing reports, respectively titled, "...Forming the Program Options." and "...Evaluation of the Program Options." The former seeks to guide the decision process as it is, the latter introduces contemporary evaluation techniques partly based on network planning. The former seeks "workable" programs, the latter seeks "the best" programs.

Dealing with Uncertainty

The question of uncertainty needs to be present at all times in the design of methodology. It has an application at every turn. In this report it has had a role in the design of initial project information listing, information to be contributed by the project designers themselves before programming begins. It has an important role in budget forecasting. It was crucial in choosing the length of assumed project life and in the choice of the term of future programming (when we concluded that the next set only should at each step be programmed). It has also an important role in building optional scenarios as the bases on which to examine the effects of proposed new projects.

Adaptation of Method from One Environment to a Widely Different One

The U.S. and Egypt are among the most different environments possible for public decision on urban infrastructure. Some commentators would question seriously a priori whether there is any hope of dealing with decision making in one of them by methods developed for the other. We submit that it was possible to undertake constructive adaptation which profits from the strength of its roots in one tradition, but flexes to applicability in another. The job was based on three tasks: (a) studying the original U.S. programming method, (b) comparing the political economies of application, and comparing the institutional environments of application. The first of these is normal for any technology transfer. The second is an obvious requirement. It is the third that was the less conventional, but to us has offered a high pay-off. It was the institutional studies of planning decision that revealed the paths and constraints that had to be honored by any new method. We feel there is an important future in method adaptation that takes comparative institutional environments into account.

FOOTNOTES

1 Anna Hardman. "Local Government in Egypt and Its Role in Urban Transporation Planning and Implementation." Cairo Urban Transportation Project, November 1978.

2 More detailed descriptions are given in Ralph Gakenheimer, Mohamed El Hawary and Martin Michael, "Toward Rationalizing the Transport Project Planning Process in Cairo, Egypt," Cairo Urban Transport Project, December 1979. (This paper is also available in published French and Spanish language versions.)

3 A step by step description of the planning, budgetary and implementation process is given in Hardman, "Transportation Planning for Cairo: An Analytic Description of Inter-Governmental Relations," Cairo Urban Transport Project, December 1979.

4 Among these projects, major areas include the Salah Salem-El Roadah Street improvements, the 26th of July route improvements, Port Said Street, El Geish Sh. Mohammed Ali improvements, Giza North-South Street and Al Ahram Street improvement.

5 Hani Mahmassani and Ralph Gakenheimer. "Network Scenarios for Project Programming in Cairo," Cairo Urban Transportation Project, August 1980.

6 Hani Mahmassani and Ralph Gakenheimer. "Budget Estimation for Transport Project Programming under Uncertainty." May 1981.

7 Hani Mahmassani and Ralph Gakenheimer. "Simple techniques for Incorporating Institutional Preference Information in Programming Transporation Investments," Cairo Urban Transporation Project, July 1981.

8 Donald A. Keller. "Project Set Formation," March 1979, and "Addendum to Project Set Formation," May 1979, and Hani Mahmassani. "Time-Staging of Urban Transporation Network Investments: An Alternative Procedure for Project Programming." February 1980, and Memoranda of the Cairo Urban Transportation Project.

9 Donald A. Keller. "Programming: Prototype Procedure." March 1978, pp. 32-34.

10 Hani Mahmassani. "Assessment of Network Dependent Economic Impacts," Cairo Urban Transportation Project, September 1980.

11 See Anna Hardman, "Economic Impact Analysis of Investment in Transportation in Cairo," Cairo Urban Transportation Project, 1980.

12 UNIDO Guidelines for Project Evaluation, U.N., N.Y., 1972.

13 Ralph Gakenheimer. "Functional Impacts: Guidelines for Urban Transportation Projects," Cairo Urban Transportation Project, 1982.

14 "Multicriteria Evaluation in the Revised Programming Procedure," by Hani Mahmassani, Cairo Urban Transportation Project, December 1980.

15 "Methodological and Applied Aspects of the Multicriteria Evaluation Technique for Project Programming," by Hani Mahmassani, Cairo Urban Transportation Project, June 1981.

16 Nijkamp, P., and Van Delft, P. Multi-Criteria and Regional Decision Making, Martinus Nijhoff, 1977.

17 By this we mean an approach focused on comprehensive network planning based on travel demand modeling techniques.

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