types of activities, and then between sub-budgets for activity groups. Thus, while infrastructure budgeting deals with only part of the national budget, it is an important part, both because of the size of the investment program ($76 billion in public spending in 1985) and because of its major influence on economic and social activity. 1/

Lastly, any management system that tries to improve budgetary choices requires resources for preparing studies and reports, and for implementing decisions. Therefore, systems must also be administratively efficient and practicable. Moreover, because goals are broad, and because policy emphasis shifts from time to time, infrastructure management must also be able to respond to change.

EVOLVING FEDERAL GOALS IN INFRASTRUCTURE

Several goals have led to a significant federal role in the provision of public infrastructure. First has been the goal of development. The federal government has traditionally sought to use infrastructure as a basis for regional economic growth, particularly in instances where the returns to infrastructure investments were realized by the nation or community at large. Thus, in the nineteenth century, the goal of balanced regional growth underlay federal initiatives in national navigation and rail systems. A second motivation has been coordination, particularly when large projects required efforts in every region of the country. This goal led to federal support for construction of a national highway network earlier in this century, and subsequently the provision of a national air navigation system. A different type of coordination concerns "externalities"--that is, activities conducted in one area that have important effects on other areas; for example, the federal government subsidizes the construction of wastewater treatment facilities in some localities in order to prevent polluting discharges in others. A third motivation has been equity and concern for the social welfare of different groups. Western irrigation development, also dating from the early 1900s, was begun to preserve the nation's family farming tradition while also encouraging settlement in sparsely populated areas. All of these programs began with a strong orientation toward construction to ensure that the physical assets supporting economic and social development were in place (*Box 1 chronicles the federal role in the two largest areas of public works infrastructure, transportation and water systems*).

1. These data cover all government purchases of structures and durable equipment except those for military purposes.

BOX 1
MILESTONES IN FEDERAL PUBLIC WORKS MANAGEMENT

Navigation

1826	Army Corps of Engineers undertakes building and maintenance of waterways and harbors.
1827–1866	Federal land grants offered for canal development and navigation improvements.
1920–1940	Federal Barge Lines operated.
1981	Barge fuel taxes began being paid into the Inland Waterways Trust Fund.
1984	Corps begins to negotiate cost-sharing agreements for public purpose navigation projects.
1986	Customs levies dedicated to port maintenance.

Rail

1837–1871	Federal land grants made for railroads.
1890s	Federal regulation established for railroads.
1970	Amtrak established.
1974	Conrail established.
1980	Staggers Rail Act reduces federal rail regulation.
1986	Sale of Conrail proposed.

Power and Irrigation

1902	Bureau of Reclamation to build irrigation systems in western states.
1933	Tennessee Valley Authority to develop water resources in the South.
1965	Local cost-sharing for recreation components of multi-purpose projects begun.
1983	Corps proposes negotiated cost-sharing for public-purpose projects.

Highways

1916	Federal government offers 50 percent financing for construction of state and local road systems.
1956	Highway Trust Fund established to finance 90 percent of the construction of the Interstate Highway System from earmarked tax receipts.
1970	Bridge rehabilitation and replacement program initiated. Federal aid extended to urban arterial systems.
1972	First planned completion date set for the Interstate network. Special federal aid for urban areas includes major repairs.
1974	Reconstruction and resurfacing aid offered for non-Interstate systems. Federal share for state/local systems increased to 70 percent.
1976	Restoration, resurfacing, and rehabilitation aid offered for Interstates.
1978	Federal 75 percent share offered for non-Interstates.
1982	Highway taxes and highway programs increased by 44 percent. Reconstruction on interstates begun.

1966	Department of Transportation established to manage all transportation programs except navigation projects.
1984	Parts of Interstate system designated for oversize vehicles.
1990	The current planned completion date for Interstate network.
	Aviation
1926	Federal regulation initiated to assure safe flying.
1938	Civilian air traffic control system established.
1946	Federal matching grants offered for airport construction and rehabilitation at 50 percent to 94 percent.
1958	Federal Aviation Act unifies civilian and military air traffic control.
1970	Airport and Airway Trust Fund established with earmarked aviation taxes.
	Water Supply
1926	Farmers' Home Administration begins to develop water systems in rural areas.
1958	Corps of Engineers and Bureau of Reclamation adds water storages to ongoing projects.
	Wastewater
1957	Federal grants of up to 30 percent of wastewater treatment plant construction costs made available.
1966	Federal government covers 50 percent of construction costs.
1972	Clean Water Act mandates secondary treatment of wastewater. Federal construction set at 75 percent of costs. Program goal to restore fishable and swimmable water by 1983 established.
1977	Management of federal aid to projects delegated to states. An 85 percent match for "innovative, alternative" technologies made available.
1981	Construction grants reduced to about one-third, and federal share reduced to 55 percent for projects after 1985. Goal for "fishable and swimmable" water deferred to 1988.
	Mass Transit
1961	Limited federal assistance offered for transit demonstration projects.
1964	Capital grants made available for up to two-thirds of modernization project costs.
1970	Highway transit projects allowed to substitute for urban highway projects.
1973	Federal share increased to 80 percent. Transit projects allowed to substitute for Interstate segments withdrawn from the uncompleted network.
1975	Federal subsidies of up to 50 percent of operating losses offered to transit systems.
1982	Mass Transit Account in the Highway Trust Fund established from revenues from a one-cent-a-gallon tax on motor fuel.

The general level of maturity in the national infrastructure systems reached in about the late 1960s led to a broadening of federal interest that focused mainly on making qualitative improvements in the construction-oriented programs. More attention was paid to issues of pricing and cost sharing, and rehabilitation of existing systems. In addition, to improve efficiency, transportation services were substantially deregulated in the 1980s, and management of other programs devolved to states.

THE FEDERAL RESOURCES IN INFRASTRUCTURE FINANCING

Today, the nation's infrastructure systems are owned and operated by federal, state and local governments. Budget choices at all levels of government influence the conduct of infrastructure programs. The federal government's most important role in infrastructure provision, however, is as a source of finance. In fact, it provides over half of the nation's gross investment in infrastructure, yet determines only 20 percent of the actual infrastructure project choices (see Figure 1).

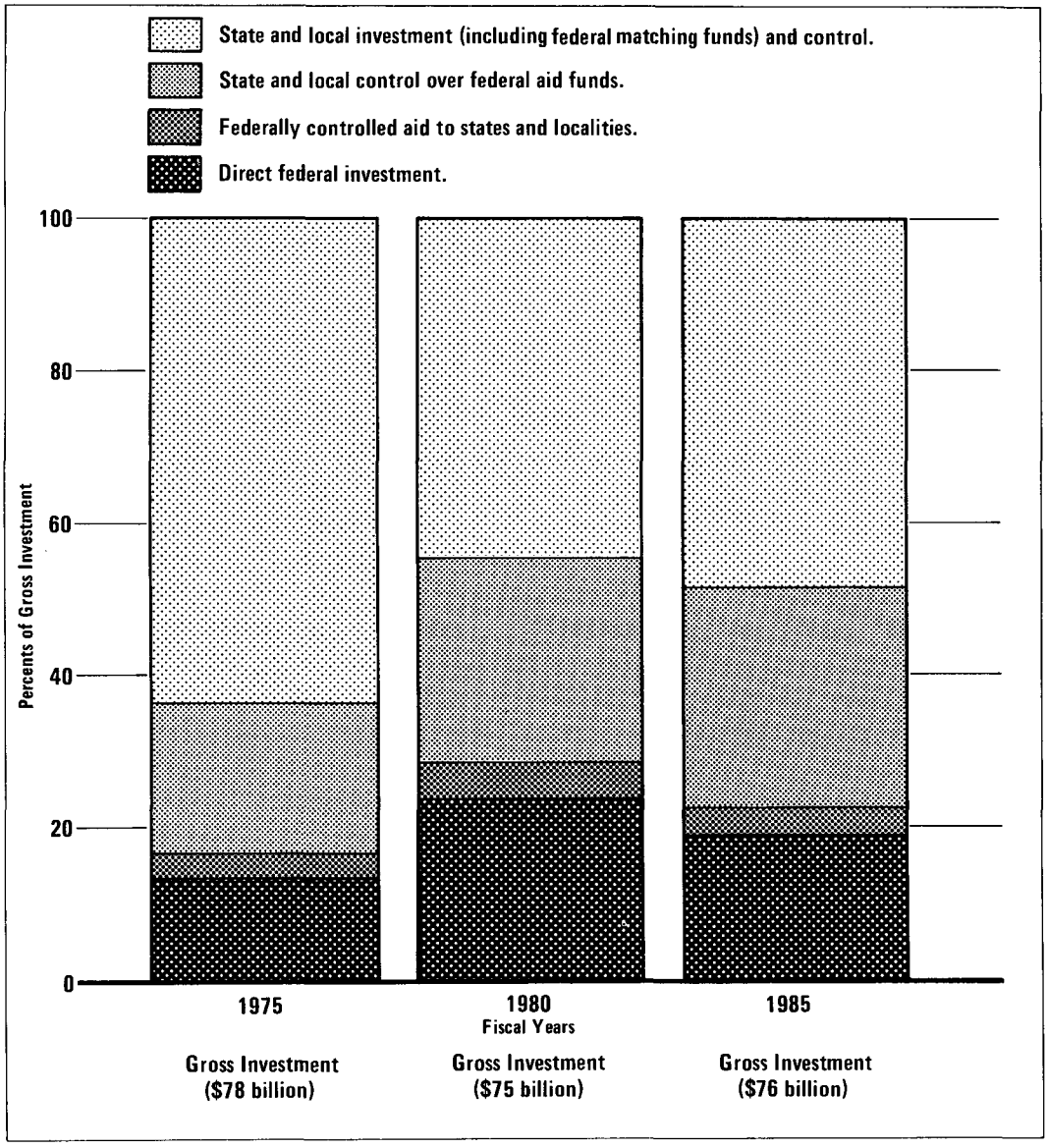
Federal funding for infrastructure occurs through a variety of mechanisms, including cost-sharing programs, block grants, or tax-free municipal financing. In most cases, the federal government's role is usually custodial. In exchange for funding assistance, its agencies oversee state, local, or regional governments' conformity with eligibility requirements or performance tests. Highways, airports, and wastewater treatment facilities are all constructed and operated under this arrangement.

In other programs, such as water projects constructed by the Corps of Engineers or new urban rail starts supervised by the Urban Mass Transportation Administration, the federal government acts directly, as either the project director or project approver. In these cases, federal management policies are used to choose among different project options. Once these assets are built, however, their management and operation commonly devolves to state or local authorities, whether ownership remains with federal agencies (as is generally the case with water resources developments) or whether it falls to nonfederal agencies, as under discretionary or demonstration projects approved individually by federal agencies but funded by federal capital grants.

Finally, in very few instances, typically only in the case of locks and dams for inland navigation, does the federal proprietary interest cover both the provision and operation of infrastructure systems.

Figure 1.

Federal and Nonfederal Financing and Control of Infrastructure Spending: 1975, 1980, and 1985 (In percents, based on gross investment in 1982 dollars)



SOURCE: Congressional Budget Office based on data provided by the Office of Management and Budget and the Bureau of Economic Analysis.

An important federal influence is therefore as overall "coordinator" of the nation's infrastructure. While the states, for example, select road segments to be built, the federal government coordinates those selections into the nation's Federal-Aid Highway Program, using its cost-sharing policy to induce the states to integrate their selections with the rest of the national system. As a promulgator of regulations, as in the cases of highway design or wastewater treatment, the federal government determines the minimum quality of acceptable infrastructure. It also collects large amounts of data in support of this coordination role. For example, a biennial inspection system for the nation's bridges provides virtually complete information on their physical condition; annual statistical reports from transit agencies offer comprehensive data on their operating and financial performance.

CURRENT PROPOSALS FOR CHANGE

Current federal policies for infrastructure provision is under pressure to change. Many proposals seek to increase the amount of information available to the Congress and to federal program managers regarding the condition of the nation's infrastructure facilities and the level of spending dedicated to them. The Public Works Improvement Act of 1984 established a National Council on Public Works Improvement and instructed it to report annually on the nation's infrastructure--its age and condition, its maintenance and financing needs, and its capacity to sustain growth. A second title to the same bill requires that the President's budget submission identify and project public capital investment levels; this identification has been done in a Supplement to Special Analysis D submitted to the Congress by the Office of Management and Budget. Others have proposed that the Congress should adopt a "capital budget," like that often used by state governments, which would segregate expenditures going to capital improvements from other operating expenditures. (*Box 2 discusses the usefulness of "needs estimates" and "capital budgeting" in infrastructure management.*)

The information gathered by these devices would be of geniune interest to the Congress. But the information itself does not advise decisionmakers what to do about the situations it describes. Inventories or "needs surveys" describe condition. Knowing that a certain percentage of roadways are in poor shape, however, does not inform decisionmakers whether those roads should be resurfaced, minimally repaired, or, in light of very low traffic, perhaps not repaired at all. Similarly, having a capital budget suggests that capital projects are the only recognizable means of solving infrastructure deficiencies. But operating rules, pricing policies, and other "nonstructural" alternatives may be just as effective, for example,

auctioning off peak-time landing rights may reduce airport congestion as much as building new runways.

Given the main federal role as a financier of infrastructure investment, it is also unclear that a federal "capital budget" would be effective in identifying infrastructure spending. Federal "capital" grants transfer resources to states and localities that invest in facilities; in many direct programs, ownership or operating authority of assets is transferred to local agencies on completion of construction. Federal capital accounting might therefore be inappropriate for infrastructure programs, where federal cost-sharing and block grants influence greatly infrastructure choices, but few federal assets exist.

A second class of proposal concerns changing the level of federal effort. Several, like H.R. 1776, and H.R. 2818, would increase resources available for infrastructure investments by subsidizing the establishment of revolving loan funds. Others, like the Administration's proposed fiscal year 1987 budget, would reduce federal involvement. Proposals that would expand the scope of the federal government's efforts, or increase the funding of existing efforts, are motivated by the perception that infrastructure spending is not keeping facilities in good working order. A previous CBO report, as well as the OMB special analyses, however, suggest that existing program spending levels could provide adequate infrastructure investments if accompanied by program changes.[2/] Moreover, total public investment since 1950 has been more than sufficient to offset depreciation of public assets and build a growing capital stock. In fact, major increases in spending in 1984 and 1985 have largely redressed the long-term decline in annual spending since 1968, and have restored growth in the nation's net additions to its investments in public facilities (see Figure 2).

A MODEL FOR AN INFRASTRUCTURE MANAGEMENT SYSTEM

These pressures for change raise basic questions. Are we spending enough on public infrastructure? Are we concentrating our spending on the right projects? Most simply, the existing system for managing public infrastructure provides us with no way of knowing. "Enough" infrastructure will have been provided when every project that is economic--in other words, that delivers benefits in excess of its costs when both are correctly measured--is

2. Congressional Budget Office, *Public Works Infrastructure: Policy Considerations for the 1980s* (April 1983), and Office of Management and Budget, *Supplement to Special Analysis D, A Report Required by the Federal Capital Investment Program Information Act of 1984 (Title II of Public Law 98-501)*, Washington, D.C. (February 1986).

implemented. The sufficiency of the nation's infrastructure cannot be measured in the aggregate; "sufficiency" is measured by the characteristics of the projects undertaken. The key to investing in the "right" infrastructure, therefore, lies in developing a system that recognizes the diverse possibilities for satisfying the demands for infrastructure services, evaluates them realistically, and implements the best available options. Such a system must cope with the different federal roles in infrastructure. When federal programs provide and operate the facilities, management requires consistent ways to identify and select improvements; in grant programs, federal financing and regulatory policies must set incentives for

BOX 2
CURRENT INFRASTRUCTURE MANAGEMENT CONCEPTS--
NEEDS ESTIMATES AND CAPITAL BUDGETING

Two planning tools recently considered--needs estimates and capital budgeting--would list infrastructure projects bidding for financing, identify amounts and sources of finance under current policies, and calculate the gap between the two. Yet neither provides a truly broad-based system for comparing options within and among programs. Both concepts rely on a static view of how systems suit community activities and a narrow view of the options available to improve services.

Needs estimating typically starts with a list of physical flaws or lacks measured against some technical standard. Then, to determine whether funding is adequate, a price list of remedies is totaled and compared against projected program levels.

For managers, this approach raises problems in making budgetary choices. First, remedies not requiring capital spending can often be found. And some deficiencies may not be worth fixing. Second, looking for solutions across a wide range of professional disciplines, even in an "engineering" project such as maintenance, usually pays off in productive innovations. Moreover, national or statewide needs estimates must be based on broad concepts or designs so that capital solutions can represent only the most preliminary estimates. The design and cost of any project seriously contending for approval can vary widely according to local conditions.

Finally, budgeting from needs lists cannot lead to informed choices among projects and across programs. Differences between present and future effects, between different programs, between dif-

state or local managers to make appropriate infrastructure choices; and in the middle ground, federal collaboration with other governments in planning or operating infrastructure systems must reinforce choices that further national goals.

The Infrastructure Management System

To build the "right" infrastructure, an infrastructure management system must accomplish three important objectives:

ferent problems, and between localities may all be overlooked. Nor are priorities ranked in any order. Furthermore, needs estimates fail to measure benefits, usually assuming that meeting engineering standards is objective enough.

Capital budgeting is a process that, in most U.S. public-sector contexts, separates proposals for investment from those for recurrent spending. As with trust funds, the aim is often to insulate capital proposals from general budgetary constraints.

In planning, however, capital budgets fail to recognize complementarities between investment and operating policies. Investment projects cannot be evaluated apart from their effects on the costs and efficiency of ongoing operations. The infrastructure budget needed includes a combination of current and capital projects, selection of which cannot reasonably be separated. Whether any infrastructure aim is better achieved through capital or operating aid should be influenced by what yields good services at low cost.

Capital budgets often suggest separate consideration not only of spending proposals but also of sources of financing for recurrent and capital projects. They are often used to evade budgetary constraints. They do so by earmarking tax revenues for current programs and debt financing or dedicated user fees for investments. Such resource divisions create the same restrictions as separating project consideration. Investments that provide significant savings in operating costs may find greater difficulty in attracting user support than can investments that enhance service quality. Incentives to improve efficiency for the wider benefit of the community served may be disregarded in favor of the interests of users.

- o Identifying all the available options,
- o Evaluating them correctly, and
- o Implementing the choices.

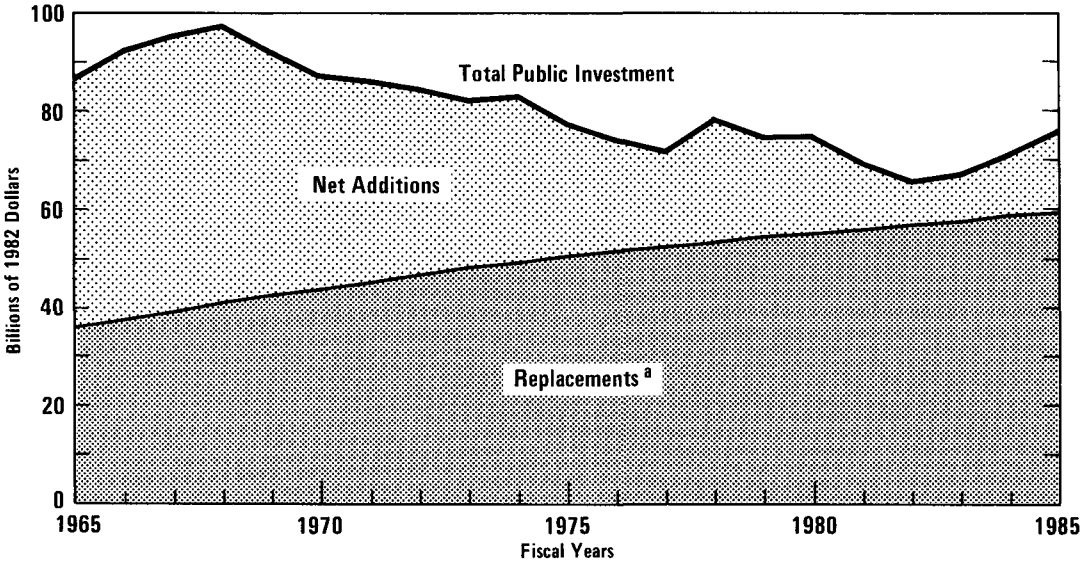
These three activities fit together to form a system that can help guide budgetary choices toward providing the "right" infrastructure investments.

Identifying Options

The first and perhaps most important goal of an infrastructure management system is to identify all possible ways of reaching objectives. Projects to improve or expand infrastructure are almost always alternatives to or complements of other actions directed toward similar goals. Investments in new infrastructure projects can lower costs or improve productivity, just as changes in operating procedures can. The wide choices available are perhaps most immediately obvious in infrastructure programs for newly

Figure 2.

Profile of Public Investment in Public Works Assets from 1965 through 1985: Total Investment, Net Additions, and Replacements



SOURCE: Congressional Budget Office based on data provided by the Bureau of Economic Analysis.

[a] Replacement data reflection depreciation of existing capital stock.

developing areas. Here, providing infrastructure according to preset standards, setting new standards, or intervening directly to modify demands through zoning or land-use controls are clear alternatives.

Noninvestment choices and options for alternative investments are equally relevant in planning for investment in older systems. Relieving congestion, for example, can be achieved by providing new facilities, improving those that exist, or manipulating demand for service through prices. Thus, the ultimate quality of infrastructure services is directly related to the ability of infrastructure managers to identify and consider the broadest possible range of solutions to infrastructure problems.

Evaluating Options

Once a broad range of options is identified, a management system must evaluate them logically and consistently. An efficient system for providing infrastructure requires that consistent choices be made between investment and operating solutions, between options imposing diverse good and bad effects on different groups, and between options bearing results later rather than sooner. Evaluations necessary for such choices have two essential features:

- A life-cycle approach measuring costs and benefits over the life of assets in capital options, and
- The use of comparable measures of worth that can span differences in technology among options and differences in the timing of such events as maintenance and renewal cycles.

A final step in the evaluation process is to rank the choices in order of merit. Ranking options assures that projects selected of the highest worth are for the budget program. Similar techniques to those comparing diverse effects of project choices can be applied in ranking projects under a range of programs.

Implementing Choices

An infrastructure management system must incorporate the preferences of local users into program objectives and, at the same time, help induce localities to make choices consistent with national aims. For the most part, federal agencies provide funds for projects selected largely by others; they do not make the project choices. When federal discretion over projects is exercised, it usually favors choices with strong local backing.

Federal infrastructure management, therefore, must organize federal financing in ways that will lead users and local infrastructure agencies to make choices consistent with federal goals. Pricing systems that reflect the costs users impose on infrastructure can encourage marketlike forces to ration use, so that demand patterns reveal users' preferences. Subsidies for certain types of infrastructure development encourage their provision at the expense of less preferred categories of spending. Federal practices relating to infrastructure pricing and the provision of financial assistance thus strongly influence the outcome of the programs.

CHAPTER II

IDENTIFYING INFRASTRUCTURE PROJECT OPTIONS

The first goal of a systematic approach to managing infrastructure is to identify the broadest possible range of projects to realize federal policy goals. The greater the range of possible solutions considered, the better the likelihood that the best solution will be chosen. This chapter examines how arbitrary restrictions on the search for solutions have so far impeded the effectiveness of federal programs.

LIMITS ON SEARCHES FOR SOLUTIONS

Searches must have limits, of course. Protracted searches for possible courses of action can lead to expensive administrative and technical studies that do not improve the quality of decisions. As a practical matter, therefore, sound agency management will tend to limit searches for options, given scarce administrative resources. But other types of limits are likely to work against effectively implementing the policies that infrastructure programs pursue.

In fact, federal policies do not consistently encourage broad searches for ways to improve the productivity of infrastructure systems. Most federal programs are managed not to support and promote broad policy goals but instead to provide capital for predetermined types of projects. Though these projects were generally chosen to promote broader goals, the criteria and standards for completing the projects themselves, rather than their effects on community well-being, have tended to become the focus of management. For example, careful attention is paid to engineering standards for roads, while little is paid to the effects of road improvements on transportation efficiency. How, then, can the search for solutions be expanded?

First, identifying options for improving infrastructure systems and services must focus on the goals to be served, rather than on finding ways to improve or expand existing facilities. Clean water and urban mobility, for example, are objectives; constructing wastewater treatment plants and modernizing bus fleets are merely two possible actions for furthering those goals. Limiting project choices to expansions or improvements of existing

facilities obscures the potential gains that may be available from better management (imposing standards for wastewater discharges, for example, or reorganizing bus schedules) or from productivity gains (perhaps from improved maintenance or labor training). Limiting options considered to those improving physical facilities risks ignoring large potential improvements from changes in operating practices that raise the quality of services provided. These are just as important to a program's overall success as is expanding existing facilities. (*Box 3 illustrates one approach to a broad search for improvement options.*)

Second, limiting infrastructure options to those under the control of a particular agency or jurisdiction runs the risk that the agency's aims, rather than national objectives, will be furthered. Ways to improve commuter services, for example, include new subway systems, dedicated lanes for high-occupancy vehicles, and changes in downtown parking regulations and prices. But restricting choices just to those for increasing mass transit services risks a chance that the most efficient or least-costly way of improving an urban transport network as a whole will be overlooked, or at best, that transit services will be improved with little reduction in overall commuting costs. Questions of authority or eligibility are thus best left until after the most appropriate plan of action has been determined.

A third problem concerns timing. By limiting options to those involving capital improvement or to those under the control of designated managers, decisionmakers can lose sight of the operational nature of infrastructure systems and of the long lives of structures and equipment. Building later is an alternative to building now, just as postponing investment and managing demands through pricing is an alternative to building at all. Infrastructure systems deal mostly with gradually rising user demands over the life of established facilities. *When* to expand is as important a consideration as *whether* to expand. Considering the effects of infrastructure options over the useful lives of facilities is critical to sound program management. Different actions can be effective over different time spans, and the most efficient long-term solutions may include a mix of operation rules and investment projects. Searches for options must consider choices not as "either/or" matters but as potential parts of combinations of complementary actions.

The remainder of this chapter looks at two features of current federal infrastructure management that have influenced the scope of searches for ways to improve services:

- **The choice between design specifications and performance standards for meeting program goals.** Federal programs differ widely on this score. But in two programs in which managerial emphasis

BOX 3
IDENTIFYING A BROAD RANGE OF OPTIONS-- VALUE ANALYSIS FOR LONDON TRANSPORT-RAIL

London Transport-Rail, responsible for London's underground rail system, uses Value Analysis to search broadly for proposals that would improve maintenance productivity and to meet annual targets for reducing maintenance costs. The procedure relies on decentralized suggestions subject to central, standard review to find ways of lowering costs and/or improving effectiveness. Any staff member may suggest a new technology, equipment change, organizational change, incentive scheme, production technique, or procedural revision. The different technical backgrounds and experience of the engineers, finance officers, and managers responsible for maintenance generate diverse operational, investment, and tactical proposals.

Before final selection, review of the proposals includes preliminary screening for the more promising options. All parts of the organization affected by any option suggested participate in the screening, and anyone may propose either modifications to the suggested change or a new option for achieving a similar result. Options selected for final review are subjected to rigorous cost and technical study, but the final proposal presented to management with recommendations includes an overview of all options, including a summary of those put aside at the preliminary screening. Thus, no option is finally discarded until deemed clearly inferior by final decisionmakers.

London Transport has found advantages in this wide approach. Engineering and financial planning functions have become much more closely integrated with line operations. The better understanding between the disciplines involved and the coordinated approach to working through the effect of suggested actions on operations has increased the likelihood that beneficial changes in standard operating procedures, staffing levels, and job responsibilities will be approved.

SOURCE: For more on this subject, see Douglas W. Carter, Jeffrey E. Purdy, and William R. Steinmetz, *Getting Control Over Operating Budgets: A Methodology for Evaluating Productivity Alternatives* (Washington, D.C.: Transportation Research Board, January 1985).

has switched from project design specifications to actual project performance--pollution abatement and transit for the disabled--the use of performance targets has allowed consideration of wide ranges of options. As a result, managers using performance standards have been able to achieve program goals faster, more efficiently, or at lower cost than under technology-based specifications.

- **The limits on eligibility for federal aid to certain types of project.** A look at how localities have substituted their preferred projects for uncompleted segments of the Interstate Highway System shows that, when programs cover a wider range of eligible projects, a better mix of projects is likely to result.

DESIGN STANDARDS *VERSUS* PERFORMANCE STANDARDS

Perhaps because of the relative ease of monitoring or verifying compliance with physical standards, or perhaps more simply because federal programs have emphasized assistance for physical facilities, management in many infrastructure programs has tended to concentrate on physical data, particularly on unfinished elements. How many miles of highway, or how many wastewater treatment plants, have yet to be built? The condition of these facilities then dominates decisionmaking. How high are the infiltration and seepage rates of sewer and water systems? How many miles of pavement are in poor condition? How old are the transit bus fleets? At the same time, program efficiency is often measured in terms of minimizing costs, leading to such techniques as "value engineering" (a system for finding the least-cost method for implementing a specific design), or to an emphasis on improving construction management. Tactical choices are also scrutinized as possible cost reducing measures. Modernizing the Coast Guard's fleet, for example, has been deferred pending a review of the cost effectiveness of hiring contractors to inspect navigation aids. The Federal Aviation Administration used contractors to reopen 12 air traffic control towers closed during the 1981 controllers' strike, and overall it plans to convert the towers at 55 low-activity airports to contract operation.

All these techniques reduce federal costs. But they all assume some fixed specification for the facilities to be built or the activity to be undertaken. Assessing the advantages of choices that do not meet the pre-set physical standards, even if equally effective in meeting goals or more so, can be done only clumsily under these management approaches.

Realizing this difficulty, some programs are monitored against performance targets reflecting program goals, instead of against design standards. Several have switched between using specifications and applying performance standards or targets as goals for action. A review of these examples shows that when performance is the focus program efficiency is more likely to improve.

Using Performance Targets: The Case of Pollution Abatement

When the Water Pollution Control Act of 1972 (Public Law 92-500) mandated goals for achieving fishable and swimmable water by 1983 (since extended to 1988), and established a program of federal construction grants for secondary wastewater treatment plants to assist in achieving this goal, the Environmental Protection Agency (EPA) issued regulations for meeting minimum federal standards for treatment. 1/ These regulations required virtually every community to construct a chemical treatment plant. The law has since evolved. First, in 1977, amendments provided for the delegation of water quality program management from the EPA to the states. Also, the focus changed to favor "best practicable" technologies. 2/ New incentives encouraged the use of innovative, less costly alternatives to chemical treatment (including oxidation ponds, lagoons, and ditches, trickling filters, and ocean discharges) when these led to water quality equivalent to that achieved by chemical treatment. Pollution abatement policy for treating industrial wastewater has similarly broadened to allow cheaper techniques that can meet water quality standards.

In the case of water treatment, using "best practicable" technology has lowered treatment costs without impeding water quality goals. Use of advanced design and innovative treatment techniques has been found to offer cost savings of half those required by technologies approved by the EPA. 3/ By 1981, treatment systems were removing 65 percent more of critical pollutants than in 1973. 4/

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1. EPA regulations (40 CFR 133.102).

2. Public Law 95-217 offered an extra 10 percent, or an 85 percent federal grant, for innovative or alternative secondary treatment technologies. Public Law 97-117 subsequently reduced the federal match for innovative technologies to 75 percent, and the match for other treatment plants to 55 percent in 1985.

3. See Congressional Budget Office, *Efficient Investment in Wastewater Treatment Plants* (June 1985).

4. House Report 97-270.

In air pollution abatement programs, however, the reverse occurred. In 1978 amendments to the 1970 Clean Air Act, minimum treatment standards were added to maximum emissions targets for new electric power plants. 5/ Plants burning coal were no longer permitted to meet national standards by using low-sulfur coal; instead, all new plants were obliged to install flue gas desulfurization equipment (called "scrubbers") to remove between 70 percent and 90 percent of all potential sulfur dioxide emissions. Nationwide, these changes have been estimated to have increased utilities' long-term costs for air pollution abatement from below 7 percent of capital expenditures to around 20 percent. From the consumers' perspective, these costs have been significant. The mandatory use of scrubbers is estimated (taking account of operational costs and adjustments in coal sources) to have increased electricity rates for new power plants by as much as 10 percent.

A cleaner environment is of real economic value. But according to some analysts, the investments in scrubbers have produced a much lower net benefit than the emmision limits in force during the 1970s. Studies using methods developed by the National Academy of Sciences for estimating the value of health benefits, for example, conclude that the emission reductions following from the 1970 Clean Air Act have provided long-term improvements in health that, by themselves, would outweigh the costs of achieving them. But applying the same estimating technique to the 1978 technology standards shows that investments in scrubbers are likely to have had negative returns over cost. 6/

Using Performance Targets: The Case of Mobility For the Handicapped

How management approaches have evolved in the federal program for making public transit available to handicapped people illustrates the problems of adopting a design-oriented approach. At the same time, it also demonstrates some of the reasons such approaches are taken.

Despite the clear policy statement in 1973 that a handicap should not exclude anyone from participating in or benefitting from programs financed with federal assistance, and despite Department of Transportation (DOT) guidelines of 1976 emphasizing "special efforts" to meet this goal in transit, no widespread moves were made to improve access where it was limited. 7/

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5. This section of the report is based on Congressional Budget Office, *The Clean Air Act, the Electric Utilities, and the Coal Market* (April 1982).

6. See Lewis J. Perl and Frederick C. Dunbar, *Cost Effectiveness and Cost-Benefit Analysis of Air Quality Regulations*, The American Economic Review, vol. 72, no. 2 (May 1982).

7. Rehabilitation Act of 1973 (Public Law 93-112).