A 1977 survey, for example, revealed that about 5 million people (or one-fifth of all counted handicapped people in the United States) were still unable to use public transit services, or could use them only with difficulty. 8/

In response to this inaction, DOT adopted a set of facility standards for transit operators in 1979. 9/ The standards mandated that, within varying time frames, key subway stations be equipped with elevators, that at least one car per train be adapted to accommodate wheelchairs, and that all new transit buses be equipped with lifts. Pending installation of these facility changes, transit agencies were to provide temporary services in either taxis or refitted buses or taxis. Though wholly oriented toward facilities, this mandate translated the policy objective of excluding no one into a manageable project, and began progress toward achieving that goal. (*A different approach to compensating for disabilities that limit personal mobility is recounted in Box 4.*)

The expense of complying with the DOT standards to improve mobility for the disabled prompted a wider search for an appropriate mix of transit facilities and special services that would also further the policy aim. During 1980 and 1981, four variations on DOT's regulation were proposed, each allowing different combinations of the capital improvements mandated and other arrangements. Costs for the proposals ranged from roughly $44 per ride (for implementing DOT's initial mandates) to $4.50 per ride (for subsidized taxi rides). 10/ The proposals also showed wide differences in the quality of services. Some, for example, imposed advance request times or required preregistration for use; others restricted trip purposes and limited hours of service, trip durations, or numbers of trips each rider could request.

The federal program now in force gives communities flexibility to provide capital improvements or to develop special services that demon-

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8. See U.S. Department of Transportation, *Technical Report of the National Survey of Transportation Handicapped People* (October 1978).

9. Federal Register, vol. 44, no. 106, May 31, 1979. Some flexibility was granted to localities through the Appropriations Act of 1981 (Public Law 96-400).

10. Statement of Alice M. Rivlin, Director, Congressional Budget Office, before the Subcommittee on Housing and Urban Affairs of the Senate Committee on Banking, Housing and Urban Affairs, May 20, 1981. Dollar amounts are in 1981 prices.

BOX 4
SEARCHING BROADLY FOR SOLUTIONS-- MOBILITY FOR THE HANDICAPPED IN BRITAIN

In January, 1976, the British government introduced a noncontributory cash benefit payable to eligible disabled adults and children to help defray their transportation costs. The allowance replaced a system of providing vehicles to those handicapped persons able to drive. The old system had been criticized because it excluded the most severely disabled who were unable to control a car, and because the vehicles supplied to civilians--motorized tricycles--were inconvenient and unsafe. The mobility allowance adopted was preferred to a more expensive alternative that would have widened the vehicle program by issuing automobiles to all eligible disabled people.

The cash allowance granted (initially, five pounds a week) was not limited to reimbursement for transportation costs. Nonetheless, a survey of recipients in 1977 showed that the majority kept the amount separate from other household income and spent it on transportation. For households with cars, the allowance was most commonly spent on fuel and maintenance; households without cars spent it on taxis. At its initial rate, the allowance covered 35 percent of weekly transport costs of adult recipients and 42 percent for children, though its coverage was much higher for households without cars, for which it supplied 69 percent and 80 percent of weekly trips respectively.

In 1978, the current "Motability Scheme" was introduced. This allows recipients to put mobility allowances toward car rentals or lease-purchase installments for vehicle purchases negotiated through an independent charitable organization supported by auto manufacturers and financiers. In leasing or purchasing cars, a recipient assigns his or her mobility allowance payments for three to four and a half years to Motability, and makes cash payment of the difference between the sum of these amounts and the car's lease or purchase value. Mobility allowances cover all payments for the smallest car available; these cover maintenance and up to 10,000 miles of travel a year. Drivers must pay to adapt the car, but simple kits costing less than 100 pounds can be installed at neighborhood garages. (In 1981, the purchase scheme was extended to approved secondhand cars.) Allowance recipients are exempted from road taxes, and they pay lower property taxes for garages, carports, or land used for parking. They also enjoy extensive parking privileges.

SOURCES: For further information, see Kenneth R. Cooke and Frances M. Staden, *The Impact Of the Mobility Allowance, An Evaluative Study* (London: Her Majesty's Stationery Office, 1981), and *Door to Door, A Guide to Transport for Disabled People* (London: Department of Transport, April 1982).

strate special efforts to improve mobility where it is inadequate.[11] Costs are to be compared with service levels. But the standards DOT prescribed in 1979 were designed to make transit systems accessible to all handicapped people, not just most. As a result, DOT's rules were written to ensure access for the most severely disabled riders, although minor modifications to existing systems--lower steps, handrails, priority seats, smoother acceleration--would have given access to 80 percent of those unable to use transit services.

In establishing facility standards according to the needs of the most severely disabled, the 1979 regulations narrowed the debate on achieving the policy aim to options serving this group. Federally acceptable levels of funding that demonstrate special efforts for providing accessible transit services follow from estimated national amounts needed to provide adequate service levels for the most acutely disabled. In any given community, the resources needed for special groups will vary around this average. In addition, the minor modifications that would grant access to existing transit systems to the majority of disabled people must now compete for funding with the special requirements of a relative minority. While a wider range of choices can now be considered for alleviating severe handicaps, spending may not be sufficient to make transit accessible to all disabled people.

ELIGIBILITY LIMITS

A second type of arbitrary limit on the range of possible solutions concerns eligibility for federal aid. Some programs have encouraged wider searches by allowing wider ranges of options to be eligible for aid. To encourage local managers to write off unconstructed segments of the Interstate Highway System that local jurisdictions do not need, for example, federal rules were changed to allow officials to apply the equivalent federal aid to projects that improved urban transportation. Substituting highway transit for highway projects was first allowed by the Federal Aid Highway Act of 1970 (Public Law 91-605), which also introduced federal aid for urban

11. DOT's final rule requires recipients of federal transit aid to develop a program for transit services for handicapped people. The program may combine special services and facility changes, but must meet six service criteria subject to an upper limit on its cost set at 3 percent of the transit agency's operations. DOT also proposes to develop rules for commuter rail services. See Department of Transportation, Nondiscrimination on the Basis of a Handicap in Financial Assistance Programs; Final and Proposed Rules, Federal Register Part II, Friday, May 23, 1986.

arterial roads not on other classified systems. Changes made in 1973 permitted transfers between urban Interstate construction and mass transit aid. Reviewing the "swaps" made since 1980 shows that choices of Interstate construction projects to be undertaken are now better aligned with traffic needs.

Broadening Federal Aid: The Example of the Interstate Highway System

Recipient cities may reallocate federal funds for the Interstate Highway System in two ways. First, they may transfer the monies available for segments that would complete the Interstate system from these segments to projects that improve mass transit or, since 1976, other federally aided highways. Second, they may substitute projects to improve road-based transit facilities (such as bus lanes) for assistance in improving urban roads. The cities themselves nominate the transfers and substitutes; beyond that, rules for such transfers vary. Exchanges favoring highway transit projects carry only the requirement that the substitute project offer transportation capacity equivalent to that of the project cancelled.

The DOT approves withdrawals from the Interstate network so long as it considers the project to be cancelled neither essential to the Interstate system nor important to local traffic, and so long as the recipient jurisdiction has devised what DOT finds to be a reasonable alternative plan. 12/ Local and state authorities must also agree that the Interstate project is not significant for local purposes, and substitute transit projects must be jointly prepared under the Urban Mass Transportation Administration's (UMTA) alternatives analysis procedure.

Thus, the two-decade-old program that once focused solely on transit has been broadened to encompass several facets of urban transportation systems. Program changes now encourage cities to seek improved local mobility with a mix of transit fleet modernization and general roadworks. Moreover, federal aid programs now permit cities to set priorities among programs that benefit long-distance and local traffic.

These wider choices allow localities to reappraise their infrastructure priorities. By the end of the 1970s, the average cost per mile of uncom-

12. The Department of Transportation has published determinations of significance for all uncompleted segments of the Interstate network in 1977. Report of the Secretary of Transportation to the United States Congress, *Interstate Gap Study, 1977*.

pleted sections of the interstate network was some five times the overall average cost for the system as a whole (after correcting for inflation since the 1950s). The portions of the Interstate network still unbuilt today are the most expensive sections to construct. The withdrawal process therefore, provides a means of reassessing whether these expensive road sections should still be given priority over other undertakings.

A Model for Project Selection. An analysis presented to the Congress in March 1983 gives a model for assessing how withdrawals of Interstate projects have changed priorities for Interstate construction projects. 13/ The Congressional Budget Office (CBO) has adapted that analysis to separate those Interstate segments traded in since 1980 from the remaining gaps in the system. (CBO has also changed the ranking system from a form of benefit/cost ratio used in the original analysis to a measure of return on investment.) (*Table 1 shows the results of CBO's update.*) Segments classified as "overdue" are those on which the first-year return following immediate construction is estimated to exceed greatly the borrowing cost of capital needed; those "due now" provide first year returns of around the cost of providing finance; and those "due later" are estimated to have such low returns as to fail to cover borrowing costs. Within these categories, subgroups show the broad timing at which--allowing for construction of contiguous road sections and for traffic growth--road construction could be economically justified. Thus, in shares of construction cost, 31 percent of all the gaps that existed in 1980 would have justified construction in 1970 or earlier, and thus were overdue by more than 10 years, while only 9 percent of the gaps that cities elected to withdraw appeared comparably overdue. Benefit measures, however, reflect only savings to highway users, so the results reflect only the priorities based on traffic needs. 14/

This review indicates that, at least on the highway side, the withdrawals seem to have induced cities to trade in Interstate segments for which there was relatively little anticipated traffic need. In dollar terms, 71 percent of the Interstate gaps withdrawn since 1980 would have been poor investments, with zero or negative returns judged on transport per-

13. Skrotzki Associates, "Economics of Completing the Interstate Highway System," submitted for the record by Senator Armstrong on March 21, 1983. This analysis presented estimates of the benefits to users and costs of completing each remaining unconstructed gap in the interstate network.

14. For any particular link, for example, some nontraffic feature, such as, say, the disruption of large scale demolition needed in an urban area may outweigh traffic needs in decisions to postpone construction. For the network overall, however, traffic requirements are a reasonable representation of priority.

TABLE 1. INVESTMENT PRIORITIES FOR GAPS IN THE INTERSTATE HIGHWAY SYSTEM

	Priority Based on Traffic Cost Savings					
	Construction Overdue a/			Construction Due Later a/		
	More Than 10 Years	5 to 10 Years	Construction Due Now a/	In 1990s	After 2000	Total
All Gaps in 1980						
Number	53	14	20	11	69	167
Construction Cost (In billions)	7.6	1.9	3.4	1.1	10.7	24.7
Benefit/Cost Ratio	1.2-7.9	1.0-1.7	0.8-1.3	0.7-0.8	0.0-0.6	0.0-7.2
Internal Return (In percents)	12-80	10-16	9-12	5-7	-20-4	-20-80
Percent of Cost	31	8	14	4	43	100
Gaps Withdrawn Since 1980						
Number	5	3	4	1	6	19
Construction Cost (In billions)	0.3	0.2	0.5	b/	2.6	3.7
Benefit/Cost Ratio	2.5-5.1	1.2-1.6	0.9	0.8	-0.3-0.2	-0.3-5.1
Internal Return (In percents)	25-50	12-16	9	7	-17-0	-17-50
Percent of Cost	9	6	13	1	71	100
Remaining Gaps						
Number	48	11	16	10	63	148
Construction Cost (In billions)	7.2	1.7	3.0	1.0	8.0	21.0
Benefit/Cost Ratio	1.2-7.9	1.0-1.7	0.8-1.3	0.7-0.8	0.0-0.6	0.0-7.2
Internal Return (In percents)	12-80	10-76	9-12	5-7	-20-4	-20-80
Percent of Cost	35	8	14	5	38	100

SOURCE: Congressional Budget Office adapted from Skrotzki Associates.

NOTE: Dollars in billions in 1979 prices: benefit/cost ratio is the ratio of discounted benefits to discounted costs assuming 1980 construction; the internal return is the discount-rate which would equate the present value of costs and benefits over a 20 year life of the road segment; it represents the return on the investment. Date of construction priority is based on the year in which benefits would first cover annualized construction cost.

a. See text for definition.
b. Less than $50 million.

formance alone, compared with 43 percent of all gaps. In other words, the process of selecting candidates for withdrawal has sharpened the choices of which roads to complete to favor those roads with high traffic need.

But the withdrawals also include 28 percent, in dollar terms, for which traffic might have been expected to justify construction. These are the projects found to be overdue or due now. Still, this includes far fewer overdue gaps than there are in the network overall (15 percent compared with 39 percent) and around the same proportion in the group of roads that might otherwise have been constructed in the 1980s (13 percent compared with 14 percent). Moreover, it may have been the case that the locally-preferred projects had even higher rates of return than those withdrawals.

Allowing substitute choices from a wider range of projects has led to decisions to write off economically unjustifiable segments of the Interstate system. Moreover, cities may well have higher priorities for, say, projects dealing with general urban road improvements, wastewater treatment, or economic development, than for transit or other federally aided highway systems as substitutes for such segments. In view of the high proportion of overdue uncompleted Interstate segments, a city (or a state) might prefer to accelerate completion of its Interstate network by simultaneously cancelling unwanted parts and speeding up construction of extra overdue portions. The 57 percent of remaining gaps with strong traffic justification (those either overdue or due now), for example, could be completed with three to four years' authorizations at the current annual rate for Interstate construction of around $4 billion.

Conclusion

Thus both using performance rather than design specifications and widening the categories of activities eligible for aid result in wider searches for efficient infrastructure projects. In these examples, consideration of a wide range of options for achieving program goals was encouraged by the infrastructure management system. The switch to innovative and alternative technologies for wastewater treatment occurred as states gradually assumed responsibility for managing the program and setting project priorities among different communities claims. Comparisons of different ways to improve mobility were encouraged by relaxing federal rules in favor of guidelines that recognize differences among communities and that encourage a wider scope in local choices for improvements. Appropriate incentives have encouraged communities to cancel construction plans for unneeded highway segments, in favor of other projects.

CHAPTER III

EVALUATING OPTIONS: MEASURING VALUE

Once a public infrastructure management system identifies an array of relevant program and project options, it must measure their relative value. An evaluation system must assess the values of competing but dissimilar options, and must do so in comparable terms. Options must then be ranked according to merit so that those making the greatest contribution to program goals are more likely to be selected. Together, the evaluation and ranking processes must provide consistent information about the consequences of choices involving different types of actions, different effects over time, different risks and uncertainties, and in competition with other programs.

But many federal programs now fail to consider the costs and benefits of their program options over the lives of the facilities in question, and others fail to do so using comparable measures of costs and benefits. This chapter deals with three of the common difficulties found in the current system of evaluating and ranking infrastructure options:

- The failure to use comparable measures of value for projects with different types of effects or for projects that occur over different time spans,
- The failure to compare projects with different lives, and
- The use of "hurdle values" for determining which projects are to be approved.

COMPARABLE MEASURES OF VALUE

To be rational, an evaluation system needs comparable measures of value to bridge differences in projects' engineering and technical aspects, as well as variations in the effects and the purposes they are to serve. Navigation projects intended to allow passage of larger vessels, for example, can entail either raising bridge decks or dredging deeper harbor channels and basins. A

proposed navigation project should withstand competition from projects to improve other harbors or channels. Moreover, the evaluation of these projects must incorporate indirect effects that convey real costs--raising a bridge deck may appear cheaper than dredging a channel until the costs of traffic delay caused by the deck construction are considered. Finally, to gain a budget position, all navigation projects should be comparable to projects with as diverse purposes as, say, dam construction.

Uncertainties and risks further complicate evaluations. Degrees of difficulty in arriving at comparable values vary. Planners may be more confident of, say, estimates of construction and operating costs than of responses of users to improvements in service or changes in price. Moreover, underlying assumptions may be uncertain. In other cases, evidence of how people value certain effects must be assembled from behavioral studies--what travelers spend to save time or avoid accidents, for instance, or what houseowners pay to avoid aircraft noise near airports.

Assessing Risks

Analyzing the risks and uncertainties surrounding a project's design can do much more than answer "what if..." questions. If undertaken systematically, a risk analysis can uncover those features of a project's design and those aspects of its implementation requiring management attention.

Few programs recognize that risks or uncertainties affect the viability of capital investments. Feasibility studies for high-speed intercity rail systems in Florida, California, and New Mexico, for example, confidently predicted large potential passenger markets. The Office of Technology Assessment's (OTA) review of high-speed rail potential in the United States, on the other hand, shows that population density in the proposed U.S. corridors is, at best, around one-half that in European high-speed corridors, and less than one-third those in Japan. 1/ Such findings call the initial confidence into question. The OTA review concludes that "... any U.S. corridor with totally new high-speed rail service would have difficulty generating sufficient revenues to pay entirely for operating and capital costs." As with feasibility studies, few Environmental Impact Statements or Alternatives Analyses pay sufficient attention to uncertainties to include an assessment under a range of prospects. Furthermore, uncertainties surround not only projected use of new facilities but also other projections about

1. See Office of Technology Assessment, *U.S. Passenger Rail Technologies*, December 1983.

performance. The following example, using CBO's 1983 study of the National Airspace System plan, shows that realistic projections of cost savings are critical to the project's success. 2/

Managing Risks: Modernizing Air Traffic Control. In 1982, the Congress authorized the Federal Aviation Administration's eight-year plan to modernize the air traffic control system. The FAA's plan has two key elements. First, through automation, the plan is to increase the system's capacity, reduce risks of aircraft collisions and other hazards, and shorten flight times for airliners. Second, by consolidating facilities, the FAA should be able to provide these improved services at lower cost; this is to be done by reducing staff and saving on maintenance. In formulating its plan, the FAA made three key assumptions: that consolidations of facilities would occur on schedule despite past opposition to closing towers from labor and aviation groups and the Congress; that air traffic would continue to increase at annual rates of 4 percent for airlines and 3 percent for general aviation; and that tax collections paid to the Airport and Airway Trust Fund would be enough to provide the $7.6 billion in federal finance.

To test the value of the plan and the risks in implementing it, CBO analyzed it under different assumptions. The suppositions included lower-than-projected air traffic, that tower closings would be delayed or prohibited, that traffic would level off rather than continue to grow rapidly, and that declining airfares, together with slower traffic growth, would mean that Trust Fund revenues would be insufficient to complete the plan. CBO also considered the possibility that owners of private general aviation planes might find too little financial incentive to warrant their investing in the sophisticated equipment needed to receive signals from the proposed microwave landing system, so that the effective use of this part of the plan could be reduced below the FAA's estimates.

This risk analysis disclosed three important findings. First, modernizing the traffic control system was found to be a sound economic investment, but only if the consolidations of facilities proceeded as forecast. If the efficiency gains from consolidation were to be delayed by as little as five years, the economic worth of the plan would be approximately halved; if only half of the productivity increase were ultimately gained, the plan would be of only minor economic value. Maintaining the pace of consolidation was therefore critical to the plan's success. Second, the FAA has a poor fore-

2. See Congressional Budget Office, *Improving the Air Traffic Congrol System: An Assessment of the National Airspace System Plan* (August 1983).

casting record, with consistently wide differences between actual traffic and the projected volume. While CBO found poor forecasting to have little effect on the economic value of the plan--which derives from gains in productivity rather than from expanding traffic needs--lower demand and declining airfares, if continued, might mean that at current tax rates the Trust Fund would be insufficient to finance the modernization. Though a decision to implement the plan rests on its economic value, managers are thus alerted to a possible need to raise taxes or seek federal fund appropriations. An alternative to either of these courses would be to trim the plan. A candidate for trimming would be the plan's least worthwhile component, the microwave landing systems. Indeed, CBO's third major finding was that this sub-project was, at best, of marginal value, thereby suggesting the option of making selective conversions to the microwave system, if the costs to aircraft of carrying both conventional and modernized avionics could be covered.

In other words, the kind of risk analysis that CBO's study of the airspace plan represents not only looks at what can happen if circumstances are less favorable than planners hope, it can also reveal ways to improve a plan's chances of success.

Dealing with Intangibles and Uncertainties

Uneven information about costs and benefits has prompted improvements in some measuring systems. During the 1970s, for example, several techniques were proposed for measuring the health benefits of air pollution abatement to assist comparisons of complex programs in terms of costs for control devices and production output forgone (see Chapter II). For some project features, however, particularly those involving environmental or social values, no evaluation method has been commonly agreed on. Nevertheless, in reaching a decision on which course of action to adopt, program managers are in fact evaluating those intangibles. By choosing to limit traffic at airports to mitigate noise nuisance, for example, managers are actually assessing the nuisance that would have been generated by additional flights as more costly to the community than is the traffic to be diverted or suppressed. As much comparable information as possible must therefore be assembled to validate those evaluations.

In practice, the best measurement systems for comparing options is a mix of the best techniques in each area in question. Typically, managers are presented with evaluated differences among costed items, measured differ-

ences in certain other fields (perhaps smoke or noise emissions), and broad assessments of areas of greater uncertainty. A combination such as this narrows the range of uncertainty on the values of unquantified effects by providing thresholds they must meet in order to sway the decision. Comparative, rather than absolute, value guides the selections. Thus, intangibles affecting all options equally can be disregarded. But to reach a decision on others, a program manager must judge whether differences in unquantified effects are valued at more or less than the measured differences among options.

Uncertainties, too, affect measurement. Estimating life-cycle costs and benefits depends on various forecasts of future events: demand levels, prices, equipment availability, maintenance cycles, deterioration rates, and so on. An evaluation system should indicate the extent of these uncertainties and their effects on project rankings. Projects that propose new technologies or major changes in program emphasis are inherently more risky than continuing current operations. Sensitivity to uncertainty, therefore, is an important intangible affecting evaluation of all options.

Comprehensive Measurement

Though federal studies today are wide ranging in the effects they seek to consider (including unquantified intangibles and environmental factors), these systems fail to apply comprehensive measurement to assist in selecting among quantitatively and qualitatively different options. A common failure is that evaluations of projects financed with federal aid typically look at costs and benefits from a strictly local, and therefore narrow, perspective. In 1983, for example, cities provided only 5 percent of the finance for capital improvements on their transit systems from general revenues, while transit agencies and cities together contributed 70 percent of the operating funds needed. Cities' preferences in evaluating options for transit improvements, not surprisingly, tend to pay more attention to reducing local subsidy needs or to attracting other local benefits (such as job creation or commercial development), and rather less to the efficient use of the capital to be invested. In evaluating options to improve Sacramento's transit system, for example, the economic efficiency of the possible investments was listed as eighth in order of priority.[3/] Experience in the

3. See U.S. Department of Transportation Urban Mass Transportation Administration, *Alternatives Analysis/Environment Impact Statement/Environmental Impact Report on Prospective Interstate Substitution Transportation Improvements in North-East Sacramento,* California, unpublished paper (June 1981).

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wastewater treatment program (discussed in the following example) shows that attention to investment efficiency improves when all of the costs are considered.

Disregarding Costs and Benefits: Wastewater Treatment. A common fault in infrastructure management is to make choices on the basis of subsidized prices rather than the national costs of the resources used. A recent CBO study of wastewater construction projects found a clear relationship between higher local cost shares and improved investment efficiency. 4/ After accounting for the relatively smaller unit costs of larger plants, the analysis demonstrated that reducing the federal share of grants from 75 percent to 55 percent would lead to more efficient investment decisions by local authorities: on average, capital costs for secondary wastewater treatment plants could be reduced by about 30 percent. For example, in the case of a city of 50,000 constructing a secondary treatment plant under the EPA program with 100 percent reserve capacity, a 10 percent increase in local cost share would lead to a 7 percent decrease in lifetime unit costs, a 14 percent decrease in unit capital costs, and a 25 percent increase in unit operating costs. 5/

The CBO study analyzed the relationships between the varying cost shares paid by local communities and the investment efficiency of the projects they undertook. Looking at 68 plants constructed since 1974, with local cost shares varying from 5 percent to 100 percent, the study indicates that such cost savings do not arise evenly across all projects. Rather, they are likely to accrue from very large savings in some projects arising when local choices account more closely for national or total costs. When costs are properly considered, savings are found in five ways: by substituting simpler treatment technology, by exercising rigorous local cost control through local project management, by limiting construction of excess capacity, by focusing on regional planning or regionalized treatment where feasible, and by speeding construction. Clearly, better project management practices are used when costs are properly accounted.

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4. See Congressional Budget Office, *Efficient Investments in Wastewater Treatment Plants* (June 1985). In that study, local cost shares were computed on discounted lifetime costs for construction and maintenance excluding state and federal contributions.

5. This also supports the finding, later in this chapter, that capital bias in federal-aid programs is not manifested in neglect of maintenance. In wastewater treatment, capital bias stemming from the high federal capital match led to local choices that minimized local maintenance expenditures at the expense of increasing federal capital aid.

ACCOUNTING FOR DIFFERENCES IN TIME

A separate set of issues concerns evaluating options that have different effects over time. The costs and benefits of different projects occur over different time profiles. Thus, to make projects comparable, future costs and benefits must somehow be discounted. There is, then, the choice of an appropriate discount rate itself. A discount rate that is too low promotes projects with distant benefits, while a discount rate that is too high penalizes the same projects.

The Use of Discount Rates

Making the effects of projects comparable requires converting the dollar estimates of future effects into equivalent current values. From today's vantage point, future receipts and payments are worth less than the same amounts due or payable now, not simply because of inflation, but because in current resources they require less than their face value. For example, at a 10 percent interest rate, $2 seven years into the future is worth only $1 today, simply because a dollar invested at a 10 percent interest rate will double in value in seven years. Discounting techniques--which translate future receipts and payments into an amount that, if set aside now at expected long-term interest rates, would cumulate to the future amounts--allow all costs and benefits to be considered in terms of current opportunities. 6/ That is, discounted present values reflect current oppor-

6. Although the choice of the rate itself is contentious. See Kenneth Arrow and Robert Lind, "Uncertainty and the Evaluation of Public Investment Decisions," *American Economic Review, 60,* (June 1970), pp. 364-378. Arrow and Lind argue that the risk of investing in public goods is so broadly spread among taxpayers that the value of unanticipated gains or losses to the individual is zero. Therefore, the social discount rate only need incorporate time preference. A criticism of this approach focuses on the issue of dividing and assigning the profits of a public good, which in its purest sense is indivisible and cannot have its profits assigned; see Kenneth A. Shepsle, "Risk and the Discount Rate of Investment Yielding Public Goods: The Arrow Lind Theorem Reconsidered," in Gordon Tullock and Richard Washer, eds., *Policy Analysis and Deductive Reasoning* (Lexington, Massachusetts: Lexington Books, 1982), pp. 167-178. The high discount rate position argues for the inclusion of a risk factor in the public discount rate so that there is not overinvestment in public goods relative to private goods. See Jack Hirschleifer, "Investment Decision Under Uncertainty: Application of the State Preference Approach, " *Quarterly Journal of Economics, 80* (May 1966), pp. 252-277.

tunities forgone in undertaking to pay future costs and current resources made available by future benefits. In business, these more sophisticated practices already prevail in analyzing investment opportunities. By the early 1970s, firms that were regularly making large investments had generally adopted appraisal methods that compare discounted costs and revenues. 7/ In the federal sector, however, use of these is rare.

The discounting techniques used so routinely to assess business investment opportunities are not usually applied in federal programs. The cost-effectiveness index the Urban Mass Transit Administration proposed for comparing new transit projects, for example, used single-year comparisons that distort both the size and direction of a project's cost effect and the relative ranking of competing projects. 8/ In the water resources programs, which have relatively comprehensive evaluation systems, evaluation results are distorted by the use of outdated discount rates.

The Failure to Discount: New Transit Starts. The cost-effectiveness tests that UMTA proposed for assessing for new transit projects rely on the snapshot data collected for the Alternatives Analysis or Environmental Impact Statement prepared for each proposal. These effectiveness measures combine capital and operating costs at the mid-life of the proposed project by annualizing capital costs over the life of the facilities to be constructed. This looks at the projects from the point of view of a city which has already constructed them. It disregards the reality that capital costs must all be expended over a relatively short construction period at the start of a project, while returns on the investment are recouped slowly throughout the assets' useful lives, and therefore must be discounted.

Basing the cost-effectiveness index on the discounted total for capital and operating costs and user benefits would give a more realistic measure of the value to each city of undertaking its project. (*Table 2 compares such measures with UMTA's 1984 ratings of new start proposals.*) Besides new

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7. See Thomas Klammer, "Empirical Evidence of the Adoption of Sophisticated Capital Budgeting Techniques," *The Journal of Business*, vol. 45, no. 3 (July 1972).

8. Urban Mass Transportation Administration, *A Detailed Description of UMTA's System for Rating Proposed Major Transit Investments*, U.S. Department of Transportation, (May 1984).

TABLE 2. COST-EFFECTIVENESS MEASURE FOR NEW TRANSIT STARTS, 1984

UMTA Cost-Effectiveness Ranking a/			Discounted Cost Ranking b/		
Rank	Project	Index (In dollars) c/	Rank	Project	Discounted Cost (In millions of dollars)
1	St. Louis Bus	d/	1	St. Louis Bus d/	-17
2	Seattle Bus Tunnel	-0.9 per Rider	2	Houston, Northwest Bus	80
3	Los Angeles Rail	+1.46 per Rider	3	Houston, Southwest Bus	125
4	Houston, Northwest bus	+2.59 per Rider	4	Seattle, Bus Tunnel	132
5	Houston, Southwest Bus	+4.09 per Rider	5	St. Louis Rail	147
6	Detroit Rail	Disqualified	6	Detroit Rail	848
7	St. Louis Rail	Disqualified	7	Los Angeles Rail	1,303

SOURCE: Congressional Budget Office and data provided by the Urban Mass Transportation Administration.

a. Based on annualized capital costs and mid-life operating costs, and user time savings.

b. Based on discounted capital and operating costs, and time savings.

c. Cost indexes are measured from a baseline of improved traffic management under the existing transit arrangements. Thus a plus sign indicates the project would increase the cities' overall cost; a minus sign projects an overall cost saving.

d. Not included in UMTA ratings, but alternatives analysis showed this to be a superior option. UMTA's disqualification of the rail project in St. Louis is based on its attracting fewer riders than the bus option.

starts rated by UMTA, Table 2 includes a St. Louis bus option; this is not a new start but an option that emerged in the planning for the St. Louis rail project and that was found to have the potential to attract more riders at about one-sixth the cost. Apart from this option, none of the proposed projects listed would retain its suggested place in the UMTA cost-effectiveness ranking if evaluated according to discounted costs taking proper account of the expected future flows of costs and benefits. The Seattle bus tunnel, rated most cost effective under the UMTA procedure, drops to mid place; the Los Angeles rail project, found by UMTA to warrant second place, actually is the least economical of all.

Perhaps more important, ignoring a project's profile of future costs has apparently converted a cost into a benefit. According to UMTA's calculation, the Seattle project appears to save around 90 cents for each new rider it attracts. This is an illusion, however, caused by the artifical spreading of capital costs over the structure's long life, rather than over its projected four-year construction schedule. The discounted cost analysis shows that Seattle actually faces committing a net additional $132 million to the transit system over the first 20 years of the project's operation. Only in the case of the St. Louis bus project are costs forecast by project planners to be less than benefits.

Using Outdated Discount Rates--Water Resources. Though water resources programs have well documented systems for evaluating projects, they apply the procedures in ways that distort choices. Current procedures do not apply consistent tests of economic worth to projects making current claims for funding. Often, local preferences are allowed to dictate the options considered, and project effects that attract development at the expense of other areas and groups are counted as project benefits. Of greater current concern, however, is the practice of using historical rather than expected borrowing rates in evaluating the priority of approved projects for continued funding. Budget requests for water resources projects are based on evaluations using discount rates ranging between 3 percent and 9 percent.

At a 3 percent discount rate, benefits accruing after 30 years are counted as valuable today as benefits accruing eight to nine years hence when discounted at rates around 10 percent. All projects showing benefits greater than costs are classified as "active" and qualify for financing. The low rates thus attract current budget resources to projects with low and slow payoffs, mostly benefiting future generations. Projects authorized far exceed the resources budgeted for completion, but the evaluation procedure fails to give clear guidance on which projects should be completed first. Annual appropriations for the Corps of Engineers have been averaging about