Planning Priorities for Replacement of Transit Assets

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Increasing retrenchment in governmental budgets at all levels has heightened interest in exploring new ways to ensure that transit capital assets are replaced efficiently. Too frequently, current capital budgeting and priority-setting techniques practiced by transit agencies are short term, ad hoc, and reactive, and may have little connection with the actual economic benefits and costs of competing projects. Many transit agencies lack adequate detailed inventories of the actual size, value, and complexity of the capital assets. Consequently, they may have little or no base from which to judge the value of competing capital requirements. These limitations to effective capital planning are particularly apparent in the routine, unglamorous, but vital area of planning and programming for replacement of major facilities and equipment. For many managers and capital planners, the question of replacement capital planning needs as much research as expansion of capital assets.

CURRENT CHALLENGE IN TRANSIT CAPITAL REPLACEMENT

The climate for undertaking a rationally planned program of transit capital asset replacement has never been more difficult. Among the many challenges to be faced are

1. An aging capital plant,
2. Increased competition for funds,
3. Unpredictable annual funding,
4. Wide variations in transit market share,
5. Cost pressures, and
6. New federal requirements.

These issues will be defined more precisely.

Aging Capital Plant

Some older urban systems have facilities dating back to the early part of the century. Most systems have assets acquired during the period of expanding federal support for transit capital projects (1960s to early 1980s) that are now due for replacement.

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Increased Competition for Funds

Competition for funds results from the general reductions in governmental expenditures, from tax and expenditure limitations passed by legislatures or citizen initiatives, and from general resistance to new taxes. The competition exists on several levels:

1. *Between transit and other public expenditures*: In the 1988–1989 federal budget debates, for example, transit competes in the U.S. Department of Transportation budget with such worthy programs as the war on drugs (the Coast Guard's drug interdiction efforts) and air traffic safety. In state and local budgets, transit competes with education and all other public services.
2. *Between types of transit services*: Within state and federal transit budgets, budget choices must be made between urban or rural, rail or bus.
3. *Between types of projects*: Within a transit agency, choices must be made between expansion and maintenance projects, among competing departments, and among competing demands of constituents for services.

Unpredictable Annual Funding

Federal funding of 75–80 percent of project costs has been critical for transit capital replacement and has often been the principal source of such funds. Despite increasing levels of federal budget authorizations for transit, actual grants rely on annual appropriations debates, which recently have been dominated by concerns over the federal deficit. Federal transit expenditures have been, and apparently will continue to be, reduced substantially below both previous appropriations and authorized levels, confounding consistent multiyear capital planning.

Wide Variations in Market Share

The priority of capital replacement varies with local transit market conditions. For areas with a stable or shrinking transit share of the travel market, timely capital replacement is vital to retaining current patrons and attracting new ones. At the same time, critics may use the reduced market share as an argument for not investing further capital in transit. In areas with growing

transit markets, resources may be focused on expanding services to meet demands at the expense of maintaining the existing plant. In both cases, asset replacement must compete.

Cost Pressures

Overall budget pressures place great burdens on transit management to economize in every area. The result can sometimes be that maintenance to extend asset life or replacement of deteriorated assets is deferred, leading to increased maintenance costs. Continuing cost pressures coupled with the lack of a comprehensive asset replacement strategy can result in decisions that ultimately only make matters worse.

New Federal Requirements

In 1987 UMTA held training workshops on financial capacity assessment. The requirement that grantees demonstrate the capacity to maintain and operate assets purchased with federal funds was not new. The new emphasis was on more formally and rigorously documenting the grantee's position. This requirement will put even more of a responsibility on transit management to fully justify their capital programs.

Even if these transit-specific conditions are not present, there are a host of other factors that complicate investment decision making. Brevard (*1*, p. 44) has described a complex environment for public facilities investment decisions, shown in Figure 1. "Rational analysis," that is, application of rigorous economic criteria, is but one of many influences, competing with organizational values and traditions, organizational style and reward structure, and perceived marketing or image factors. As to how all these factors interact to produce decisions, Brevard observes (*1*, p. 42):

> It is worth noting that, in real organizations, and particularly large ones, decisions are ponderous, sometimes bewildering, and often unexciting events. Not only are they arrived at in inexplicable ways, but it is frequently unclear at just what point a decision has been reached and who has participated in the process of reaching it.

FIGURE 1 Decision environment.

The transit manager and planner should at least be aware that all these forces are work, even (and perhaps especially) those forces beyond their control. The result of these pressures is to place increasing demands on investment decision-making techniques and to ask the question, How can we be sure that we are spending scarce resources on the right things at the right times? The current challenge is to ensure that transit managers have appropriate tools to make these critical decisions with confidence.

PROBLEMS WITH CURRENT METHODS

On the basis of purely anecdotal evidence, a common approach to transit replacement planning appears to consist of four steps:

1. Ask the department heads what they want,
2. Add it all up,
3. Guess at available local and federal resources, and
4. Make cuts to fit constraints (proportional across-the-board cuts, project deferral, or stretching out the timing of expenditures are the most common responses).

This exaggerated caricature of the approach should be contrasted with the classic rational or analytic model of decisions (Figure 2). In this model, a linear series of analytic steps leads to a deterministic optimal solution: develop asset classification, determine standards, inventory assets, assess condition, and identify assets for replacement. The touchstone of this approach, the Golden Rule for capital planners, is simply stated: invest to maximize the net present value of all future benefits.

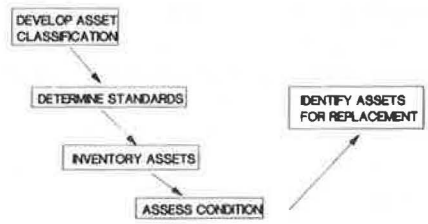

FIGURE 2 The classic approach to capital programming.

The intent of this criterion may be contained in a variety of related economic techniques: cost-benefit analysis, internal rate of return, return on investment, payback period, and so on. Of course, neither approach gives an accurate picture of how transit capital replacement planning occurs in practice. Still, even the best-trained and most well-intentioned capital planners who believe that the classic approach is the right way to do things find their path strewn with traps. Although they are trying to do the best they can, these planners typically stumble on common problems. The main problems in practical application are incomplete and imperfect data on which to conduct analysis in the first place and the limited technical background of the analysts and their audiences (managers, policy boards, and the public) to deal with methodological complexity.

The problems include the following trade-offs:

1. *Quantitative versus qualitative*: Not all costs and benefits of investment decisions can be measured in dollars and cents, either conceptually or practically.
2. *Public versus private*: Techniques oriented to private-sector "bottom-line" thinking may be inappropriate to the public sector's service orientation.
3. *Subjective versus objective*: The selection of evaluation criteria (quantitative or qualitative), their scoring, and their weighting rarely hinge on rigidly set objective standards.

When rigorous techniques cannot be used (or even attempted) in the face of such problems, ad hoc approaches are

relied on to make the necessary decisions. These techniques may be prompted by an immediate crisis, emotionalism, or simple expediency, but they always compromise technical rigor for short-term needs. At worst, ad hoc methods are subject to the varying influences of claims to equity ("fair share," "my turn") and the personal writing, speaking, and political skills of project advocates. Ad hoc methods have the further problem of producing uncertainty about results. With little consistent structure behind decisions, it is often difficult to rationalize the resulting investment priorities as the best that should be made at this time.

BLUEPRINT FOR AN IDEAL PROCESS

It is easy enough to take potshots at inadequacies in the current evaluation systems of many transit organizations, but what should a transit capital planning process ideally contain? In the research that produced the papers in this Record and in other documents produced in recent years, several parameters have been discovered. Foremost is that there should be an agency focus on the problem, from the top down. Without a meaningful commitment of staff and management attention to improving capital replacement planning, little progress can be expected.

The classic approach demands a complete and accurate asset inventory, but it can be argued that even ad hoc approaches need this basis for decisions. The problem has been that such complete inventories either do not exist or are conducted only rarely for special studies. To be effective, such inventories must be kept up to date. Substantial effort may be needed to set up such an inventory system, and it may be difficult to convince managers that significant resources should be spent on such a "housekeeping" function. Attention is specifically drawn to the paper by Peskin elsewhere in this Record.

Complete maintenance cost data on major asset classes is essential for determining the optimal timing for asset replacement. Maintenance costs appear to follow a bathtub-shaped (inverse bell) curve, starting out high when new assets are being broken in and new maintenance procedures are being learned, leveling out for a long period of routine maintenance, and then increasing as age, deterioration, and needs for outdated parts compound costs (Figure 3). The ideal time to replace assets is just as the curve starts to swing up again. Only a good database on maintenance costs can help catch or anticipate that point on the curve.

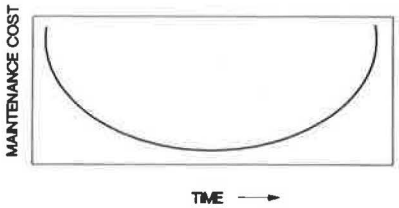

FIGURE 3 The bathtub curve.

The two critical components to an ideal program are evaluating the condition of the assets and assessing the impact of investment choices. The evaluation of asset condition could be based on any combination of methods. Three of the most common would be

1. Arbitrary replacement age based on experience,
2. Engineering ratings based on established performance standards (e.g., mean time between failures, maintenance costs per unit output, or physical measurements of wear), and
3. Subjective assessment of condition when more rigorous methods would be too costly or infeasible.

Once all assets have been inventoried, their condition has been determined, and candidate assets have been identified for replacement, there remains the central function of setting priorities for investment (assuming that there are resource limitations that preclude replacement of all identified assets). An option is explored in Guillot's analysis of various scenarios for Seattle elsewhere in this Record. The evaluation of priorities amounts to impact assessment: what is the effect of replacing or not replacing this asset at this time? These questions should be asked:

1. Will this investment improve system operational efficiency? How much and in what way?
2. Will this investment produce tangible benefits for current or prospective system riders? How many would be affected and in what markets?
3. Will this investment solve significant identified system problems (safety, reliability, attractiveness to riders, political support)?
4. Will this investment help the system toward its strategic, long-term goals?

Such evaluations do not simply fall automatically out of economic analyses. The problems of comparison of different types of projects are immense. These issues are explored elsewhere in this Record by Schaevitz in relation to a railcar rebuild-or-replace decision by the Port Authority Trans-Hudson (PATH).

Older systems may have many assets projects that are meritorious because they are so far behind a replacement schedule that is ideal or even capable of preserving the basic asset. It is not so much a matter of separating the winners from the losers, but rather of deciding which winners have to wait longer, as discussed by Bennett elsewhere in this Record.

Other systems may have the problem of needing to modernize by replacing equipment that is not yet functionally worn out. They also have the problem of funding future capital replacements. One approach is a funded depreciation reserve similar to that discussed elsewhere in this Record by Larwin and McCalley of San Diego's Metropolitan Transit Development Board.

Fitting these projects into a common scale is not simple. It is not enough to complain that apples cannot be compared with oranges, for indeed they can once one decides on the criteria and standards for choice (fiber, calories, sugar content, taste, texture, etc.). Within this ideal system, analysis would not simply lead to a straightforward "keep or replace" dichotomy, but to a range of prioritized choices. Wohl and Hendrickson (2, pp. 318–319) list six categories of investment options:

1. Replacement without changing function,
2. Restoration or rehabilitation to original condition,
3. Improvement with new capabilities,
4. Expansion of capacity,

5. Downsizing to lower capacity, or
6. Abandonment of the asset.

Within the context of this discussion, however, these six options can be narrowed to three choices that exist along a cost continuum (*3*, p. 2.2):

1. *Refurbishment*: "Restoration of substandard equipment and facilities to adequate standards of performance,"
2. *Rehabilitation*: Replacement of worn elements of a system with new elements having essentially the same characteristics of the original equipment, and
3. *Modernization*: Replacement with "new elements to achieve higher performance standards than the original."

Charles River Associates, in a report for Chicago's Regional Transportation Authority (*4*, p. 5), points out that the private sector often works within an investment hierarchy in which the evaluation criteria vary for each level: mandated projects, maintenance (or cost reduction) of existing production capacity, modernization to improve product quality, capacity expansion in existing product lines, and investment for new products.

Both of these categorizations of investment choice may be useful for transit replacement choices, and the ideal analysis should support them.

RESEARCH AGENDA FOR TRANSIT CAPITAL REPLACEMENT

Future research to aid the transit capital replacement decision must focus on three areas.

Realistic Information and Computational Requirements

Overly complex mathematical models may only confuse, rather than enlighten, decision makers. As was once said of travel demand and land use models, the "black box" approach must yield to a "glass box." Unless decision makers have some degree of understanding and confidence in the underlying analysis, they will not be willing to advocate the best analytical recommendations. The challenge is to balance the technically "best" approach against the "keep it simple" desires of decision makers. There must be a real market for better information to justify the costs of a more complex process.

Practical Investment Decision Making

Techniques must be not only theoretically elegant and correct but useful. Public policy goals, including what different people expect of transit, have been characterized as multiple, vague, and conflicting. Analytical techniques must be able to handle uncertainty and risk, and to compensate in priority setting for projects of vastly different scale, nature, and impact.

Tools for Continuous Use

One-shot inventories and needs statements devised for legislative advocacy are not adequate for the long-term needs of the transit capital plant. Tools must be suitable for continuous use by operating agencies and within the technical abilities of staff to accomplish and managers to interpret.

NATIONAL PROGRAM

A national program needs to be coordinated to bring together much work that is already under way, including good work within operating agencies that has not been given adequate distribution. Three tasks should be accomplished:

1. Survey existing practices both to document typical models and their faults and to locate innovative examples,
2. Evaluate and document the best of practice so that knowledge can be effectively transferred to others, and
3. Disseminate this information to practitioners in the operating agencies, not just to other researchers.

If these ambitious goals can be achieved, significant progress can be made to ensure that the nation's investment in public transportation will be continuously renewed.

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