Applying Program Budgeting to Highways: An Illustrative Example

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•PROGRAM budgeting[1] may well be one of the least understood terms of our time. Because of its relatively brief history and the fact that the Chief Executive personally prescribed its extension to federal civilian programs, program budgeting has acquired a mystique. Its practitioners have contributed to the aura of mystery by quickly supplying a program budgeting jargon and have perhaps overemphasized the new features of the technique.

Yet, when the basic principles of program budgeting are uncovered and examined, it is found to be a powerful tool for planning and managing public programs. The technique appears to be especially adaptable to highway program analysis.

The purpose of this paper is to project a simplified, uncluttered view of how program budgeting fits into the highway program development process at the federal level. Possible extensions to state and local level investment decisions should be apparent.

SUMMARY OF THE PROCESS

A short definition of program budgeting might be "A systematic process through which decisions on the scope or size of future public investments are made with reference to their impact on the goals or objectives of the particular public agency." This definition, while legible and fairly complete, hardly serves our purpose of simplifying the program budgeting process. A more suitable way to define program budgeting is to identify it as a logical 7-step process. Each individual step is briefly described in the following and will be illustrated in later sections of this paper, using a hypothetical but completely realistic example program area.

1. Identify objectives—By this we mean that the basic reason or reasons for the existence of the public program activity need to be clearly identified. This is by no means a simple process, especially when dealing with existing programs whose original objectives may well have changed over the years.
2. Develop measures—This step involves the establishment of quantifiable measurement units by which progress toward or away from program objectives can be gauged. Not all objectives, of course, lend themselves to easy quantification (reflect, for instance, on some of the newer social-oriented programs).
3. Identify needs—The next step is to forecast how the current situation would change if no program activity were undertaken. In other words, what undesirable future situation will the programs try to alleviate?
4. Set targets—Next, the agency must establish short-range (2 to 5 years) targets for the program activity. Should we try to cure 100 percent of the future ills, or 10 percent, or some intermediate figure?
5. Develop program structure—In this step the public agency identifies the alternative program activities (existing or new proposals) through which it may attack the identified problem. These program activities constitute the alternatives, which are then tested.

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[1]Throughout this paper "program budgeting" is used interchangeably with "planning-programming-budgeting system" (PPBS). Although not precisely correct, this is an acceptable simplification.

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6. Make analyses—This is the program testing, evaluation, or analysis procedure. The analysis involves estimating for each proposed program the probable beneficial returns at various levels of annual program cost. If program costs and anticipated benefits are both expressed in dollar terms the analysis is known as a cost-benefit analysis. If, as is more often the case, benefits can be identified but not valued in dollars, the procedure is known as cost-effectiveness analysis.

7. Select program size and mix—In this final step the program budgeting analyst recommends to his administrator the group and level of program activities that will for the future year result in either (a) the desired short-range performance report being achieved at lowest combined program cost, or (b) the greatest beneficial results being returned for the known amount of available funds.

It is hoped the 7-step procedure outlined has more adequately defined the program budgeting process. Even so, to this point we have dealt in abstractions. For greater clarity, the step-by-step logic involved in the annual program budgeting cycle is further detailed in the following sections, using as a hypothetical (but completely realistic) illustration the group of safety-oriented highway improvement programs administered by the Federal Highway Administration, Bureau of Public Roads.

IDENTIFICATION OF PROGRAM OBJECTIVES

We are assuming that our area of concern is highway improvement for added safety. Here the establishment of program objectives is relatively easy. Obviously, our program objective is to increase safety on the nation's highways. We may express it in those terms or we may say that our objective is to reduce existing or future highway accident rates.

MEASURES OF PROGRAM EFFECTIVENESS

The selection of proper units of program measurement is an important step in the establishment of a workable and useful planning-programming-budgeting operation. The proper unit (or units) can have several identifiable features:

1. The unit will be a real descriptor of the objective being considered;
2. Agency program activity will have an influence on the magnitude of the unit;
3. The unit may be expressed as some physical element, or, if possible, may be stated in terms of dollar value; and
4. The unit may be a measure of agency program output or may be completely unrelated to output.

To illustrate the final point, which may be significant, the obvious measure of highway program output is the number of lane-miles of facilities opened to traffic in a year. Without knowing how much traffic is using the new facilities, or how safely and swiftly the traffic is being carried, however, we have no real idea of the impact of these new facilities on the objectives of the program.

Keeping these points in mind, we can quickly think of several potential measures of effectiveness of safety-oriented highway improvement programs. For instance, we may use the annual number of casualties (fatalities and injuries combined) resulting from highway accidents. Another possibility would be the annual dollar cost of highway accidents. These measures are shown in Figure 1. Other potential measurement units could be illustrated, such as annual fatalities; accident, casualty, or fatality rate per unit of exposure; and cost per accident.

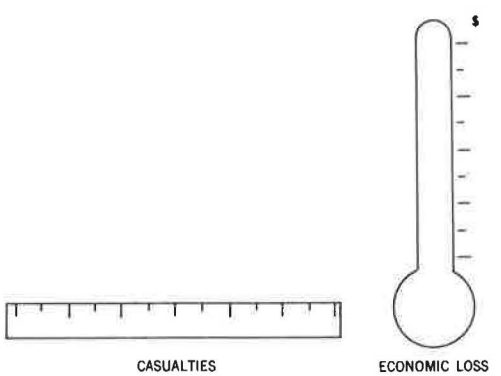

Figure 1. Highway safety quantitative measures.

NEED FOR PROGRAM ACTIVITY

The next step in preparing a program budget submission for an agency is to determine the warrants, if any, for future program activity. The word "future" is important. Program budgeting is for the most part a tool for program planning (as opposed to day-to-day program management or control operations). Therefore, the decisions made today will be translated into program activity taking place two to seven years in the future. We therefore need to identify not today's problem, but future problems. In many program areas this can be done by studying recent trends and predicting how certain features would change if no new program activity were proposed.

For instance, in our example, we know the number of annual casualties and the estimated annual dollar loss due to traffic accidents over a historical period. By assuring a continuation of current safety improvement program activity (or, as an alternate, by assuming no activity at all), we can predict what the future annual casualty and/or economic loss values will be. These figures, shown in Figure 2, represent "the need to do something."

SETTING SHORT-RANGE PROGRAM ACHIEVEMENT TARGETS

The next step in the program budgeting process involves an evaluation of the previously identified future situation. Let us suppose that the forecast is that by 1975 the projected growth of traffic and traffic accidents will result in an annual expectation of casualties (injuries and fatalities combined) on the nation's highways. We appraise this figure and find it completely intolerable. As a result, we would establish as the numerical desired result of our 5-year program activity the reduction of the estimated annual casualty total by, let us say, 100,000. This desired reduction is known as the short-range achievement target of the safety-oriented highway improvement programs. The establishment of numerical targets is shown in Figure 3.

DEVELOPMENT OF ALTERNATIVE PROGRAMS

We now know the type of return we desire from our programs and how much of an effect we want the program dollars to have over the next few years. Our next step is to itemize the various programs that may singly or jointly contribute to achieving the established short-range targets. In PPB jargon this step is known as developing the program structure.

Imagination is one of the principal ingredients in this step. Remember, we are considering a time period of several years, a period long enough to develop and apply new or completely modified program tools to the solution of our problem. There is no need to limit the program structure to existing activities.

For our current example, we can identify several existing and proposed types of capital improvements designed to increase highway safety. It is important to remember

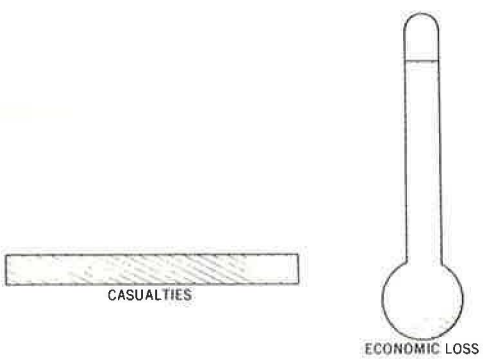

Figure 2. Needs if no action is taken.

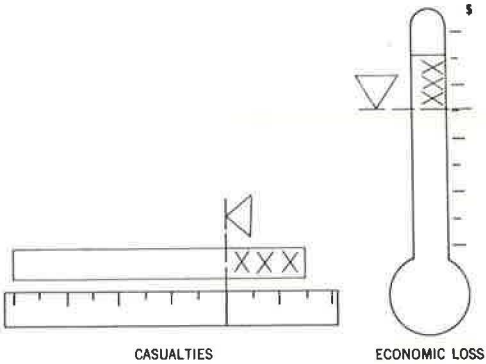

Figure 3. Highway safety targets.

that we are at this point restricted to considering only those activities that improve the highway; the driver-oriented and vehicle-oriented programs administered by the National Highway Safety Bureau are evaluated in a later step. Therefore, the safety-related program structure for the Bureau of Public Roads includes the following activities:

1. The Interstate Program—The end product of this activity is a nationwide network of highways which, in addition to increasing the efficiency of highway transportation, are also much safer than other highways. Therefore, we must for completeness estimate the safety gains attributable to the annual Interstate program activity, and evaluate these against the estimate of Interstate dollars that are buying added safety each year.
2. The Primary, Secondary, and Urban (ABC) Programs—These programs also contribute to highway safety and to other objectives. Costs and safety gains must also be estimated for these activities.
3. The Traffic Operations Program to Increase Capacity and Safety (TOPICS)—The title of this new program indicates that highway safety is one of its principal benefits.
4. The Spot Safety Improvement Program—Here again safety is a prime objective of this program activity.
5. The Railway-Highway Grade Crossing Improvement Program—A program designed to improve safety by causing reductions in the incidence of a specific class of accidents.
6. The Roadside Hazard Reduction Program—This program, involving conformance with the provisions of the AASHO "yellow-book", is another example of a special-purpose safety improvement program.
7. Conformance with the Manual of Uniform Traffic Control Devices (MUTCD)—Here the reason for wanting uniform traffic control devices is an estimated desirable impact on highway safety.
8. Research and Development Activities—In developing and comparing alternative future program activities it is most important that the comparison not be limited to existing or committed programs. For instance, if the analysis period runs through 1975, there may be some current research or development activities that would reach operational status in the near future. In the area of highway safety improvements, we may want to consider the estimated costs and benefits of the Passing Aid System, the Electronic Route Guidance System, and the Merging Control System, to name only a few efforts.

COST-EFFECTIVENESS ANALYSIS OF ALTERNATIVES

After the full group of programs having potential impact on stated goals has been identified there remains the task of evaluating the relative desirability of each program. The evaluation is accomplished through a process known as cost-effectiveness analysis. This process may be extremely complex or may be largely intuitive, depending on the extent to which the program objective can be quantified, the amount of historical program performance data available, and several other important determinants.

Cost-effectiveness, in an oversimplified view, is an estimate of the anticipated amount of returns at several assumed annual program cost levels. If enough information is known about a program, its cost-effectiveness characteristics may be expressed as a mathematical relationship, or alternately may be graphically displayed as in Figure 4.

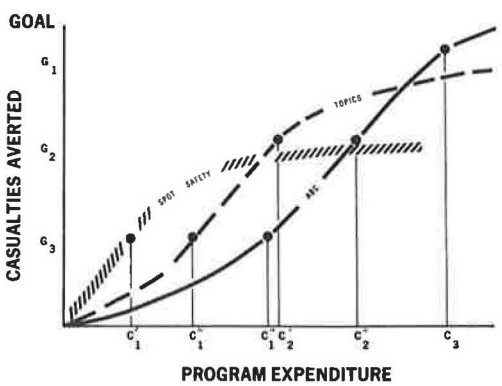

Figure 4. Example of cost-effectiveness analysis.

Figure 7 purports to show the relative cost-effectiveness of three highway improvement programs identified as poten-

tial contributors to the goals of reducing the annual traffic accident toll. Annual program costs are measured along the abscissa, while the ordinate shows the estimated number of annual casualties reduced by each program. It should be noted that further analytic study will be needed before the actual points on each curve can be specified, although the general shape and relative position of the three program functions is probably quite realistic.

The figure implies that the Spot Safety program, being composed of relatively minor improvements, will have high payoff at low cost, but will quickly approach a maximum number of casualties that could possibly be averted without more extensive new or rebuilt facilities. Similarly, returns from the TOPICS program will be higher than ABC results at small annual costs, but tend to "peak out" at a level lower than the maximum ABC returns.

In similar fashion the cost-effectiveness of each individual program, including R & D expenditures, should be investigated and incorporated into a comparative framework.

SELECTION OF MOST EFFECTIVE PROGRAM MIX

The final analytical step involves the identification of the group of future programs and the proper size of each that will lead to the most desirable results. "Most desirable" means the mix of program activities that either (a) achieves the desired annual results at lowest total cost, or (b) maximizes the returns at the known amount of funds available.

To illustrate the "low-cost" solution, let us turn again to Figure 4. If we presume that our specified target is to reduce annual casualties by G_1, it is evident that we would recommend the Spot Safety program which gives G_1 return at a cost lower than that of TOPICS or the ABC programs. It follows that with a target of G_2, we would select TOPICS, and at G_3, the ABC program would be selected.

This obviously oversimplifies the program selection process. The real problem is to select the mix of programs that yields the low-cost solution. For instance, to achieve G_2 at low cost, we should obviously include some elements of the Spot Safety program. The actual process involves a simultaneous investigation of incremental costs and returns of all programs, a process that sounds formidable, but is less of a problem than the necessary prior step of identifying individual program effectiveness.

In many instances a government agency operates under conditions of budgetary constraint—that is, the amount of potential increase in future program size is limited. In other words, a known limited amount of money is available for the planning year. In this situation the solution of the cost-effectiveness analysis is the maximization of desired returns within the limits of known program funds. The solution principle is as discussed in the previous paragraph, namely, simultaneous investigation of marginal costs and returns.

One final clarification concerns the relationship between cost-effectiveness analysis and the more widely known cost-benefit analysis. Cost-benefit analysis normally presumes the ability to express benefits in terms of their dollar value so that the analysis is solved in terms of, say, the ratio of benefits to costs or the expression of net present value of benefits minus costs. Cost-effectiveness, however, can be carried out whenever the desirable returns can be quantified, and may be quite useful in program selection. For instance, if program A results in a reduction of one highway traffic fatality for each $500 of cost it is obviously preferable to program B, wherein $1200 is needed to reduce fatalities by one.

USE OF ANALYSIS FINDINGS

We now have traced the repetitive cycle of program budgeting analysis. For the sake of expositional ease no mention has been made of complicating factors such as periodic feedback throughout the process. The inventory of needs may lead to a reappraisal of agency objectives. The target establishment step may uncover more meaningful measures of program effectiveness. So, too, results of the program analysis undertaking can cause reexamination of any of the earlier stages.

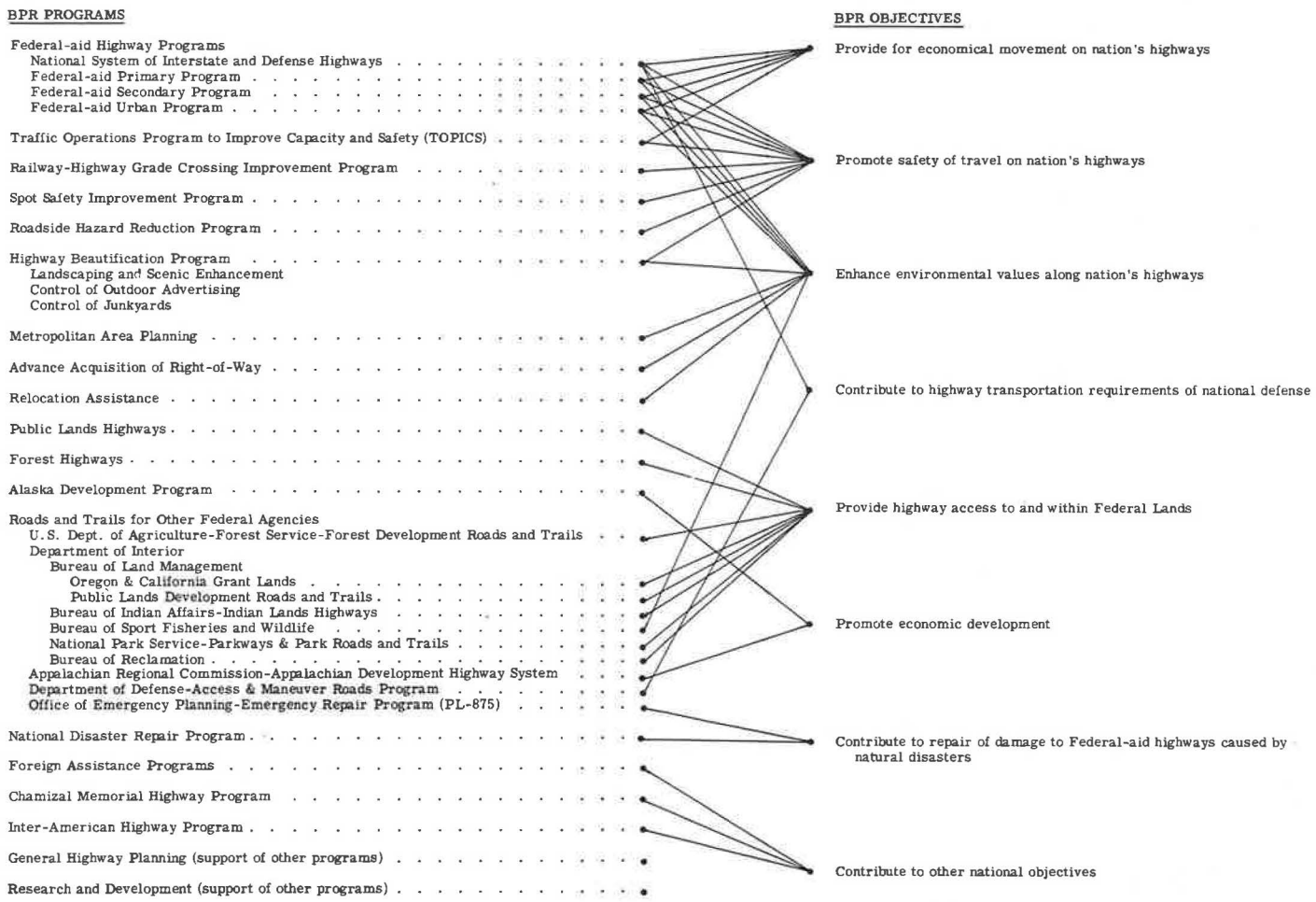

Figure 5. Relationship of programs and objectives.

To return to the results of the program budgeting process described, however, let us briefly trace the next series of tasks. We must remember that our end result has been a recommendation to the agency head of those programs that appear most justified from a cost-effectiveness standpoint. The agency head must also consider many other potentially competing influences, such as:

1. Legislative and political constraints;
2. Organizational capabilities—federal, state, and local;
3. Existing commitments; and
4. Advice from program managers.

When these factors have been evaluated, the annual Bureau of Public Roads program budget submission is ready for transmittal to the Federal Highway Administrator. At this next level the BPR safety-oriented program costs and accomplishments are considered jointly with National Highway Safety Bureau and Bureau of Motor Carrier Safety data and proposals. The FHWA material forwarded to the Department of Transportation sets forth the most desirable grouping of all highway safety programs.

At the Departmental level highway safety activities are evaluated with safety program recommendations covering other transportation modes. A coordinated recommendation is then sent to the Bureau of the Budget and, after review at this level, is incorporated eventually into the proposed budget for all federal activities advanced by the President in January of each year.

HIGHLIGHTS OF BPR PROGRAM BUDGETING ACTIVITY

This paper has described the makeup of the PPBS process in the Bureau of Public Roads by using as a hypothetical example the treatment of highway safety-oriented improvement programs. What of the full set of BPR program activities? Several highlights of the Bureau-wide process would seem to be applicable at the state or local level.

There appears to be substantial agreement on the best way to state the several objectives of highway improvement programs. The principal highway program objectives are as follows:

1. To provide efficient, economical, low-cost highway transportation, attempting to increase such user benefits as traffic service, convenience, capacity, and operating speed;
2. To provide safer highways, minimizing loss of life, human suffering, and property losses stemming from highway traffic accidents;
3. To preserve environmental values, enhancing the benefits of highway facilities accruing primarily to non-users;
4. To provide highway access to areas of federal interest, such as national parks and national forests;
5. To promote increased economic development in designated regions or areas.

Figure 5 illustrates how the most important programs of the Bureau of Public Roads contribute to the achievement of these objectives. Note how many programs (such as the Interstate) simultaneously impact upon two or more objective areas.

As a final illustration, the Appendix illustrates the way in which the various BPR programs are displayed within the program structure developed for fiscal year 1970 programs by the Department of Transportation.

Appendix

BPR PROGRAM STRUCTURE (1968)

Program Category I:

Urban Transportation (SMSA)

1. Interstate system
   a. Efficiency features
   b. Safety features
   c. Aesthetic, environmental and social features
   d. National defense features

2. Other primary
   a. Efficiency features
   b. Safety features
   c. Aesthetic, environmental and social features

3. Secondary system
   a. Efficiency features
   b. Safety features
   c. Aesthetic, environmental and social features

4. Urban extensions
   a. Efficiency features
   b. Safety features
   c. Aesthetic, environmental and social features

5. TOPICS
   a. Efficiency features
   b. Safety features

6. Railway-highway grade crossings program

7. Spot safety program

8. Roadside hazard reduction program

9. Fringe area parking

10. Roadside beautification program

11. Billboard and junkyard regulation

12. Metropolitan area planning

13. Advance acquisition of right-of-way

14. Relocation assistance

Program Category II:

Inter-Urban Transportation

1. Interstate system
   a. Efficiency features
   b. Safety features
   c. Aesthetic, environmental and social features
   d. National defense features

2. Other primary
   a. Efficiency features
   b. Safety features
   c. Aesthetic, environmental and social features

3. Secondary system
   a. Efficiency features
   b. Safety features
   c. Aesthetic, environmental and social features

4. Urban extensions (in areas 5,000-50,000 population)
   a. Efficiency features
   b. Safety features
   c. Aesthetic, environmental and social features

5. TOPICS (in areas 5,000-50,000 population)
   a. Efficiency features
   b. Safety features

6. Spot improvement program

7. Railway-highway grade crossings program

8. Roadside hazard reduction program

9. Billboard and junkyard regulation

10. Roadside beautification program

11. Advance acquisition of right-of-way

12. Relocation assistance

Program Category III:

International Transportation

1. Inter-American highway

Program Category IV:

Other National Interest

1. Natural disaster repair

2. Access to Federal lands
   a. Public lands highways
   b. Forest highways

3. Alaska development

4. Chamizal Memorial Highway program

Program Category V:

General Support

1. Research and Development
   a. Traffic operations
   b. Social and economic impact
   c. Structural

2. General highway planning

3. Administration