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A SIGNS FABLE

**ROLE OF ECONOMIC ANALYSIS
IN PLAN SELECTION**

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**FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE
Washington, D.C. 20013**

A SIGNS FABLE

Wes Ostheller



*Mystic Forest Signs Coordinator
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Once upon a time in a Forest far, far away, the Mystic Signs Coordinator (hereinafter and forevermore to be called Mystic) was informed by the equally far, far away Minor King (O&M Leader) that each Forest must follow all rules, decrees, and edicts set forth in the scrolls of the Kingdom (RO)--including those requiring ye olde sign programme. Mystic sent a message to the Minor King by the fastest horse available (Rumor) that the Forest truly had a magnificent sign plan. Rumor traveled fast; by sunset, Mystic received a message bearing the seal of the Great Regional Emperor: "Ye have not a sign plan, but--in fact--an inventory." ALAS!

'Twas about this time it came to pass that the Forest was blessed with a new Grand Ruler (Supervisor), who had a strange habit of coming in late each night from his daily rounds of the Forest land. Everyone thought, "How nice! Truly, he loveth the Forest."

One bright day, Mystic was summoned before the Grand Ruler. OH, WOE! Sitting on his mighty throne, he said, "Mystic--dost thou value thy head?" "Verily, mighty Ruler," said Mystic. Then, in a roar to be heard throughout the land, the Grand Ruler spake, "If I get lost just one time more on an unsigned road, thy ox is boxed!" (Using a similar phamiliar phrase).

"But sire," said Mystic, "we have the finest sign inventory in the land; truly, all the royal roads are marked. Each and every one dost have its wee, tiny number. As thou canst see on this parchment, the royal maps do truly show the royal roads, even though they are somewhat old. And when, if ever, new maps are made, roads thereon shown will also truly have a number."

"Fine," said the Grand Ruler, "but numbers help me not! If thou desireth to live and prosper, put up signs that have some real words--words that tell in which of the seven rings of Hades I might be!"



To the Emperor word was sent: "A Sign Plan we do truly need! When shall be the soonest we can meet?" The Emperor replied, "I am so happy I could cry. Four hours hence, the Duke (Regional Sign Coordinator) and I shall be upon thy lands."

Then it came to pass, throughout all the Forest, the Grand Ruler's word was heard: "A Sign Plan!" Cried the District Knights, "Oh, no! Oh, please--not now." But the Grand Ruler's final word was: "Yea, verily--a plan--now; we'll all be truly proud when 'tis done."

Posthaste, all the Knights and Knaves assembled. Each District Knight on the Forest was truly involved. Plans were laid and all did meet and meet again--the Emperor, the Duke, the Knights, the Knaves--and Mystic too. The meetings long did last, and after many weeks had passed, lo! there was

 A SIGN PLAN

These last words the Emperor did say: "Try Ojo Caliente.... and signs at Condon ye are not to make."

And, in due time, it came to pass that the royal roads were royally signed and well.

Now, Mystic of Flathead Forest tenders homage and paeans of thanks to the Emperor, and the Duke, and Ojo Caliente for all the help they rendered in ye olde sign programme. And, acknowledging the salubrious benefices to be derived therefrom, calls upon our brethren and sistern Forests whose names begin with "F" to perform in a like manner.

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ROLE OF ECONOMIC ANALYSIS IN PLAN SELECTION*

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INTRODUCTION

The purpose of this paper is to describe the impact of changes in the planning process on the role of economic analysis, to describe the economic tools that are available for application to transportation planning, and to analyze the use of these tools in the planning process. An understanding of the capabilities and limitations of the economic analysis techniques in the context of the overall planning process should assist in the selection of the appropriate techniques to satisfy specific planning objectives. It should also be of value for insuring that the tools are applied in a manner consistent with the function for which they were intended.

Concern is being expressed by many professionals about the use of economic analysis tools in the process of plan selection. Articles in technical journals (1,2,3) have covered the application of various economic analysis techniques to the evaluation of proposed plans, the setting of priorities, or the analysis of alternative plans. There is a great deal of controversy and disagreement about the proper application and significance of economic analysis in the plan selection process. Several sessions and committee conferences at the 1977 Transportation Research Board meetings were dedicated to these topics. At one of these sessions, it was suggested by Robley Winfrey, an accepted authority and author of many articles and books (7,8) on engineering economy, that the profession was actually regressing in its understanding of economic analysis and its role in the decision-making process.

The controversies and misunderstandings regarding the role and proper application of economic analysis techniques appear to be an outgrowth of changes that have occurred in the purpose and scope of the planning process itself. The need to address social and environmental issues as well as transportation related concerns in the

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development and selection of transportation plans has had a profound influence on the type and quantity of information required. The need to involve the public in the decision-making process has created a requirement for mechanisms through which the opinions, desires, and concerns of the public can influence the decisions. These changes in the purpose and scope of the planning process have resulted in a search for new analytical tools or new ways of applying old techniques, that are responsive to the expanded scope and objectives of the process.

Before beginning to examine the topic of concern in this paper, it may be well to describe what the paper does not consider. The paper is not concerned with the economic or market behavioral models usually used to predict travel behavior and the travel related impacts. Nor is it concerned with the means of obtaining, or the sources of, funds required to implement the selected plans. Both of these topics are important to the process of plan selection, and in some instances they may be of greater importance than the results of economic analyses to the decision makers.

This paper is concerned with the analytical tools required to answer three basic questions relevant to plan selection. First, is a particular plan a wise investment of public funds, or should the resources necessary to implement the plan be spent elsewhere or not spent at all? Secondly, which plan of a group of alternatives is economically better to accomplish some set of objectives? Finally, what priority should be placed on each element of a selected plan from an economic point of view?

EVOLUTION OF ECONOMIC ANALYSIS TECHNIQUES FOR TRANSPORTATION PLANNING

Economic analysis of transportation plans had its roots in the engineering economy which has been and remains an important aspect of an engineers' education. The purpose of teaching engineering economy is to provide the engineer with a methodology capable of evaluating the tradeoffs that exist among alternatives with different initial costs, operating and maintenance costs, and life spans. The application of these principles to the analysis of transportation plans was a natural step when the major issue of relevance in the plan selection process was the economic justification of the proposed expenditure.

In the initial phases of governmental involvement in the financing of transportation facilities, the goal of providing improved roadways to aid and foster business, commerce, and national defense was clear. Few questioned the advisability of the investment to provide for these needs. When the basic needs had been satisfied, however, the investment decisions became more difficult. Many state highway departments and other groups charged with the planning, programming, and implementation of transportation improvements used

principles of engineering economy as a basis for determining which projects would be built and in which order.

There are several techniques that were used to assist in determining which projects were wise investment decisions and in deciding the order of implementation to achieve the greatest public benefit. Benefit/Cost analysis is perhaps the most famous, or infamous, of the techniques, although Equivalent Uniform Annual Cost, Net Present Cost, Rate of Return, and other techniques were also used. One or more of these tools was capable of defining a "best" alternative or a priority ranking of projects when all relevant concerns could be readily measured in dollar values.

With the expansion of concerns to include user impacts other than those directly measurable in dollars came efforts to incorporate these concerns into the existing analytical tools. Many studies were conducted to define the dollar value of time saved in travel. Others have been concerned with the value of injuries and deaths that result from highway improvements, and others have dealt with the conversion of user comfort indices into dollar values to be incorporated in the economic analysis.

The need to consider nontravel related impacts has also resulted in the development of mechanisms to estimate the dollar values of air pollution and noise impacts, of the changes in property values and the real estate tax base, and of changes in employment resulting from transportation improvements. Each additional concern has increased the strain on the analytical tools by increasing the number of assumptions and value judgments that must be accepted by a decision maker before the result of the analysis can be considered valid. Since it becomes nearly impossible to obtain agreement from any group of decision makers on the appropriate assumptions to use in such an analysis, and because the results of the analysis can be materially affected by changes in these basic assumptions, the single index economic analysis tools have fallen into disfavor.

The search for new techniques that are better suited to the problem of evaluating alternatives, selecting plans, and establishing priorities among plan elements in the context of present planning requirements and procedures has resulted in the development of a group of goals achievement analysis techniques and in the concept of Cost Effectiveness. These techniques have the flexibility to address a broader range of issues without the need to convert the impacts into dollar values. They can also facilitate the incorporation of citizen participation and other public involvement into the decision-making process. They do not, however, eliminate the need for sound economic analysis nor render the basic engineering economic analysis tools obsolete.

The prudent expenditure of public funds to achieve desired conditions is still an important consideration in the assessment of alternative plans. Economic analysis can provide valuable information to the decision maker that will help him or her to assess the prudence of alternative investment decisions. Ultimately, the selection of a plan is made by the decision maker based on his or her evaluation of the information provided. The task of the engineer has been, and remains, to select the analytical tools that will provide the information relevant to the decision maker in a manner that facilitates an understanding of options available and clarifies the consequences of the alternative plans.

BASIC ECONOMIC TOOLS

For the purposes of this presentation, the various types of economic analysis techniques have been placed into one of the following five categories: (1) Net Present Cost; (2) Equivalent Uniform Annual Cost; (3) Rate of Return; (4) Benefit/Cost Ratio; or (5) Cost Effectiveness. Different sources have used different terminology for these techniques. Some authors (5,7) distinguish between cases where annual revenues or measurable benefits are anticipated and those where no such revenues or benefits are anticipated in the Net Present Cost and Equivalent Uniform Annual Cost categories. However, the grouping provided in the preceding is convenient for the purposes of this presentation.

Before considering the techniques and their applications, it is appropriate to examine three elements of economic analysis that are common to each technique. These elements are: (1) The period of analysis; (2) the inflation rate; and (3) the discount rate. The choice of values for each of these elements can have a significant effect on the results of the economic analysis and their meaning.

Period of Analysis

The period of analysis is the time over which costs and benefits associated with a particular plan are assumed to accrue. The selection of an appropriate period of analysis is dependent upon the nature and purpose of the analysis. Periods of between 30 and 50 years are frequently used for the analysis of transportation plans.

In general, the period of analysis should be consistent with the length of time over which a nonrecurring cost will produce revenues or benefits. Since different components of transportation systems have different useful lives, the life of the longest lived components are usually used. These components are the rights-of-way and the fixed facilities. Although these components may last longer than 30 to 50 years, the discounted costs and benefits are usually insignificant beyond that time. In addition, the reliability of estimates of costs and revenues or benefits decreases with increasing time horizons.

Shorter periods of analysis could be used for transportation plan evaluation if it were possible to estimate the salvage value of the plan elements prior to the end of useful life. The salvage value could be considered as a revenue to be derived from selling the assets of the system at the end of the analysis period. Since such assets are seldom if ever sold, the salvage value is probably more difficult to estimate than the longer range operating and maintenance costs and benefits. Using a life of 30 to 50 years renders the estimate of a salvage value insignificant and therefore it can be ignored.

The important point about selecting a period of analysis is that all alternative plans to be examined should use the same period of analysis, unless salvage values can be accurately estimated for all unused capital facilities at the end of the periods of analysis to be employed. The choice of the period of analysis, therefore, depends on the judgment of the engineer regarding the accuracy of estimating the future costs, revenues, or benefits, actual useful life spans of system elements, and salvage values of the various system components. For most long-range transportation plan comparisons, a single 30 to 50 year period of analysis is selected and potential salvage values are ignored.

Inflation Rate

The inflation rate is an assumed rate of change in the value of the dollar with time. That is, it is the rate of change of the consumer price index or any portion of that index that is relevant to the escalation in costs of transportation goods and services. The rate of inflation is used to determine actual cash outlays or revenues, or the dollar value of benefits at sometime in the future based on the estimated costs, revenues, and benefits in current dollars.

Trends in the application of economic analysis techniques at present are to ignore the effects of inflation as a separate consideration and to account for inflation in the selection of a net discount rate. The assumption implicit in this process is that costs, revenues, and benefits will all be subject to the same rate of inflation. If the engineer has reason to assume that the inflation rates will be different for different components of the costs, revenues, or benefits, (as has been the case for energy costs compared to other items in the consumer price index in the past few years), separate inflation rates should be used for each component. In general, however, the use of present dollar values in conjunction with a net discount rate is an acceptable practice.

Discount Rate

The discount rate is a measurement of the time value of money. In general, a person would rather have \$1.00 today than \$1.00 1 year from today. If he had \$1.00 today, he could invest it in an interest bearing account at 5% (6%, 7%, etc.) and have \$1.05 (\$1.06,

\$1.07, etc.) at the end of 1 year. The rate of interest that induces a person to forgo an expenditure today to have more to spend at some future point in time is a measure of the discount rate for that person. People also borrow money to purchase homes, cars, and other commodities and agree to pay back the amount borrowed plus an interest charge for the use of the money. The rate of interest that a person pays to borrow money is also a measure of the discount rate.

Both of the measures of discount rate described in the preceding are estimates of the gross discount rate. That is, the effects of inflation (or the change in the value of the dollar) are included in the measure of the discount rate. They are measures of the market time value of money and inflation is present in the market place. The net discount rate would be obtained by subtracting the inflation rate from the observed discount rate.

There have been, and continue to be, debates about the appropriate discount rate to use when evaluating public works projects. In general, low net discount rates favor plans that require large capital investments and have low annual operating costs, while high discount rates, favor projects with small capital costs and large annual operating costs. This occurs because the higher the discount rate, the less impact future costs and benefits have on the results. Some have advocated the use of an artificially high discount rate as a measure of the risk involved in the investment while others have suggested that high discount rates are necessary to account for the alternative uses of public funds. For now, suffice to say that the choice of a discount rate, either a gross discount rate in conjunction with an inflation rate, or a net discount rate, is an important feature of the analysis that should not be glossed over. It is hoped that the following examination of the applicability of the various techniques and their use in the plan selection process will assist the engineer in the selection of appropriate discount and inflation rates.

Net Present Cost

The Net Present Cost technique is a measure of the value of all costs associated with a plan throughout the period of analysis. Execution of the technique begins with a time period by time period (usually year by year) accounting of all expenditures required to implement, operate, and maintain the facilities or services, or both, throughout the period of analysis. Revenues, if any are anticipated, can be subtracted from costs to obtain the net cost by time period. The expenditures can be in inflated values if the analysis is to use inflated costs and a gross discount rate, or in current dollars if a net discount rate is to be used. The sum of expenditures for each time period is then discounted using the present worth factors appropriate for the selected discount rate and the number of time periods before the expenditure is expected. The sum of the present and future discounted expenditures is the Net

Present Cost. It represents the total amount of money that would have to be on hand today to meet all project costs; present costs are paid directly and future costs are paid using the principal and the interest that would accrue from the investment of the remaining sum at the selected discount rate.

The Net Present Cost technique is helpful when there are two or more alternatives for achieving the same goal involving tradeoffs in terms of differences in the expected useful life of components or tradeoffs between high initial cost--low recurring cost and low initial cost--high recurring cost options. The plan with the lowest present cost is the most economical method of achieving the desired result given that the appropriate discount and inflation rates have been selected. It would be appropriate to conduct sensitivity tests using different inflation and discount rates to determine how the result is affected by different assumptions.

Equivalent Uniform Annual Cost

The Equivalent Uniform Annual Cost is a measure of the average annual cost associated with the implementation, operation, and maintenance of a plan throughout the period of analysis. As with the net Present Cost technique, all expenditures associated with the plan must be accounted for by time period. Revenues can be subtracted if appropriate. The sum of expenditures for each time period is converted into its present cost using the appropriate discount rate. Then the annual capital recovery amount for the period of analysis and the appropriate discount rate is computed. The Equivalent Uniform Annual Cost is the sum of all such annual capital recovery amounts. It represents the average annual income that would be required to meet all expenditures associated with the plan for the period of analysis.

The Equivalent Uniform Annual Cost and the Net Present Cost techniques differ only in that the Equivalent Uniform Annual Cost is the Net Present Cost times the capital recovery factor for the appropriate period of analysis and discount rate. Both are useful for examining alternative methods of achieving a desired condition when the alternatives differ in the time sequence of payments. The Net Present Cost might be a more meaningful analysis if the decision maker is accustomed to considering the amount of a bond issue that would have to be floated to pay all project costs for period of analysis. The Equivalent Uniform Annual Cost might be more useful if the decision maker is accustomed to thinking in terms of annual budgets.

Rate of Return

The Rate of Return technique was developed as a guide to investment options when a revenue is expected from the implementation of a plan. As with the Net Cost techniques (i.e., Net Present Cost and

Equivalent Uniform Annual Cost), expenditures are accounted for by time period and either discounted to the present cost or converted to the annual cost. Revenues are similarly enumerated by time period and reduced to the same base. The difference between the revenue and the cost is the return on the investment. And the return divided by the cost is the Rate of Return.

It can be seen that this technique can be applied to evaluate alternative investment strategies that do not necessarily achieve a common goal. The Net Cost techniques require that each alternative provide the same function because there is no measurement of the degree of achievement in the computational form. The Rate of Return technique measures achievement in terms of the revenue generated. The alternative that provides the highest Rate of Return is the most economical and is the best at generating revenue per dollar spent.

An extension of the Rate of Return involves the substitution of benefits for revenues. For example, the construction of a particular highway might result in a savings in vehicle operating costs and in travel time. Even though no toll will be charged, the operating cost savings and the travel time savings converted into equivalent dollars can be considered as the price the public would be willing to pay to use the new facility. In this instance, the Rate of Return is a measure of the return received by the public for an investment of public funds. Note that the computation of savings in time and money requires that a base condition be established against which all alternatives must be measured.

Benefit/Cost Ratio

The Benefit/Cost Ratio is similar in concept to the Rate of Return except that the numerator of the fraction is the total benefit (revenue) and not the difference between benefits (revenues) and costs. Application of the technique requires an accounting of cost by time period as with the other techniques. These costs can either be discounted to their present value or converted to an average annual cost. The benefits must also be accounted for by time period and their value in dollar amounts discounted to their present value or converted to the average annual value. The benefits divided by the costs is the Benefit/Cost Ratio.

Application of Benefit/Cost Ratio to the analysis of alternative plans requires that a base condition be established. The costs used in the denominator are the increases in the costs of implementing, operating, and maintaining an alternative over the base condition and the benefits are the differences in costs incurred by the public as a result of the expenditure as compared to the base condition. Other benefits that may accrue to the public include a reduction in travel time, a decrease in automobile accidents and deaths, an increase in accessibility, and perhaps others. The

important point is that these benefits must be converted into dollar values if they are to be included in the Benefit/Cost Ratio. The Benefit/Cost Ratio is a measure of the value or benefit, as measured in dollar amounts, achieved from the dollar spent. The alternative with the highest Benefit/Cost Ratio provides the most benefit for the dollar.

The Benefit/Cost Ratio was used as the standard form of economic analysis for public works projects for many years. The results provided a simple, understandable estimate of the economic value of a proposed plan. As concerns over the consequences of such projects expanded to include environmental impacts, social impacts, and land-use impacts, attempts were made to force the analytical technique to include these concerns. The inclusion of all of the factors of concern served to obscure the meaning of the result, particularly when certain impacts were considered positive by some and negative by others and when some impacts of concern are simply different measures of benefits already counted. Benefit/Cost Ratios can provide valuable information regarding the economic consequences of alternative decisions if applied to measurable benefits. However, other techniques are required to evaluate the performance of alternatives with respect to items of concern that cannot be readily converted into equivalent dollar benefits.

Cost Effectiveness

Cost-Effectiveness analysis was developed to permit the examination of the economic performance of alternatives with respect to objectives that did not lend themselves to conversion into equivalent dollar benefits. The process requires that all costs be reduced to a Net Present Cost or an Equivalent Uniform Annual Cost. These costs are then divided by the measure of effectiveness, or the degree to which an objective is achieved. In cases where two or more plans achieve the desired objective to the same degree, the Net Cost techniques themselves are Cost-Effectiveness measures. When different plans provide different degrees of achievement, the lowest cost per unit of effectiveness is usually the most desirable. Care must be exercised in the application of the technique, however, because an alternative with twice the effectiveness may not be "worth" twice the cost although both alternatives have the same Cost Effectiveness.

Cost-Effectiveness analysis can assist a decision maker by providing information regarding the relative economic efficiency of alternative plans for achieving some objective or a set of objectives. It has the advantage over Benefit/Cost techniques in that tradeoffs regarding the achievement of different objectives by different alternatives are clearly indicated rather than obscured in the computational form of the technique. Cost Effectiveness cannot, however, provide information relative to the economic justification of any of the alternatives nor can it provide for the analysis of alternatives that are designed to accomplish different objectives.

Summary of Basic Economic Tools

Five basic types of economic analysis tools are available to assist in describing the consequences of selecting alternative plans. Each technique requires that a complete accounting of the costs of implementing, operating, and maintaining alternative plans be prepared by time period for the period of analysis. When revenues or benefits are to be estimated, these two must be accounted for by time period throughout the project life. The tools also require that a period of analysis, an inflation rate, and a discount rate be selected. Care should be exercised in the selection of the analysis period, discount rate, and inflation rate to insure that the results provide meaningful information to the decision maker.

The Net Cost techniques are applicable to the evaluation of the economics of two or more plans for achieving the same objective or objectives. The Rate of Return and Benefit/Cost Ratio techniques are useful for examining the economic justification of a group of alternatives with respect to measurable public benefits. In this case the alternatives do not have to satisfy the same objective or set of objectives and may, in fact, be completely unrelated. Cost-Effectiveness analysis is valuable for examining the performance of different alternatives with respect to a set of objectives which do not lend themselves to measurement in terms of dollar benefits. The selection of an economic analysis technique for use in the evaluation of transportation plans depends upon the nature of the decision required and the nature of the decision maker.

PLAN SELECTION PROCESS

The process of developing or selecting a plan for implementation, or both, can be thought of as a five step process: (1) define the problem; (2) identify the constraints; (3) formulate alternative plans; (4) evaluate alternative plans; and (5) select a plan for implementation. The process, or modifications of it, may be quite formal in structure or so informal that neither engineer nor decision maker is aware of it. Recent trends (4) have been towards a more formalized approach as a means of structuring citizen participation and providing a mechanism for addressing environmental, social, and land-use issues.

The problem definition step is perhaps the most critical step in the process. The plans that are formulated as alternatives are designed to solve the problems as understood by the engineer. The information developed by the engineer to assist the decision maker addresses the performance of the alternative plans with respect to their ability to solve the problems as defined. The analytical tools, both economic and other, selected for use in the decision process are chosen to clarify the consequences of alternative plans. If the decision maker has a different perception of the problems to

be addressed by the planning process, the techniques selected for the analysis and the information provided by them will not be useful for selecting a plan. Despite this rather obvious conclusion, the problem definition task is frequently not given the attention it deserves.

The identification and proper treatment of constraints is also an important step. A plan that is "best" for solving a problem but fails to satisfy minimum standards of acceptability is of no value. However, an otherwise acceptable plan can be adversely affected because it satisfies assumed constraints that increase costs or otherwise affect its feasibility. Care must be exercised in the application of constraints to insure that minimum standards of acceptability are met without unduly imposing constraints that may adversely affect plan selection.

The formulation of alternatives involves the judicious application of different concepts to the solution of stated problems. Here, the engineer uses experience and judgment to develop each concept into an implementable plan. Alternatives should represent the range of feasible options available so that the selection process will not exclude potentially acceptable plans.

The evaluation of alternatives has already received a great deal of attention in this paper. The function of this step is to perform all such analyses as are relevant to the selection of a plan. It is in this step that the economic analysis tools are applied along with other analyses of the performance of the alternative plans with respect to the issues of concern.

When the analyses are completed, the engineer, planner, or analyst has the responsibility to make a recommendation regarding the selection of a plan. The recommendation should be based on the results of the analyses performed and supported by them. The recommendation, however, is not the decision. The decision must be made by the decision maker based on his or her own interpretation of the analytical results. It is important to note that the results of the analytical process do not constitute a decision, but should identify the consequences of selecting alternative plans.

Integration of Economic Analysis into Plan Selection Process

The process of selecting a transportation plan for implementation and the implementation of that plan will involve the expenditure of public funds. The decision maker in these instances is acting as an agent or representative of the people. In this position, the decision maker is pledged to the judicious use of public funds for the public welfare. In order to discharge this responsibility, the decision maker should be concerned with information regarding the prudence of the investment required to implement the alternative plans. The function of economic analysis is to provide this information.

The economic analysis technique or techniques selected to provide information relative to the economic advisability of alternative plans is dependent upon the nature of the problem. If there is a well-defined objective that either is or is not achieved, the Net Cost techniques will provide a basis for examining the economic consequences of alternative plans. If, however, the objective or objectives are such that different plans will provide different degrees of achievement, the Rate of Return, Benefit/Cost Ratio, or Cost-Effectiveness techniques should be applied. The Rate of Return and Benefit/Cost Ratio are valuable for determining if the return or benefits exceed the costs, and if so by how much. The Cost-Effectiveness analyses are valuable for defining the cost per unit of achievement of some objective or set of objectives.

The tools selected for a particular situation should be those that will best define the economic consequences of alternative plans for the decision maker. The problem definition task should be designed to identify the function of the plan as viewed by the decision maker and the issues relevant to the selection. Only then can an effective evaluation process be defined.

The constraints within which plans are developed can have significant impacts on their economic consequences. It might be assumed, for example, that all plans must meet interstate standards. Design to less rigid standards might produce a much less expensive solution which is only slightly less desirable than the plans that satisfy the constraints. Failure to consider the less expensive alternative may result in a rejection of all plans or in the selection of a plan that is more costly than necessary to accomplish the desired objectives.

The engineer should examine each constraint carefully to insure that adherence to constraints does not preclude the consideration of the "best" plan. When appropriate, the costs of satisfying constraints should be provided so that the decision maker understands their economic implications. In some instances, alternative methods of satisfying the intent of a constraint should be proposed for consideration. The economic implications of satisfying various constraints can have a significant influence on the plan selection process.

The purpose of developing alternatives is to insure that each concept that represents a potentially feasible solution is given every opportunity to be selected as the "best" plan. In this phase of the analysis the engineer must apply each concept, taking advantage of the unique features of the concept for the development of a solution to the defined problems. Economic evaluation of components or elements of a particular concept may be necessary to insure that the most economical application of that concept is achieved.

The evaluation of alternative plans requires that the relevant consequences of the alternatives be described. In general, only the differences in the performance of alternatives are relevant. It is

worth noting a second time that the purpose of the evaluation analyses is to describe the performance of the alternatives with respect to the issues of importance as stated in the problem definition task.

In order to define the economic consequences of alternative investment decisions, it is necessary to examine the costs of a project in light of the anticipated impacts. The costs used in the analysis should reflect the costs that would actually be incurred to implement, operate, and maintain the plan, not only for purposes of economic evaluation, but also for subsequent financial planning and budgeting. This means that the costs should reflect current market prices and should either be stated in current dollars or inflated dollars using the best estimate or range of estimates of the rate of inflation that will be experienced over the course of the period of analysis.

For the comparison of alternatives that involve different distributions of expenditures over time, costs must be converted to the present cost or to an annualized cost using either a net or market discount rate. In order to accurately portray the present or annualized cost, the best estimate or range of estimates of the discount rate that will be experienced during the period of analysis should be used. If artificially high or low rates are used for either inflating or discounting costs, the meaning of the results of the analysis will be difficult to explain to decision makers and will not be useful for evaluating the relative market value of alternative investment strategies.

When different degrees of achievement are obtained by different plans, the return, benefit, or effectiveness of each plan must also be estimated. Measures of effectiveness are usually directly available from information regarding the performance of alternatives. The most cost effective plan is the one with the lowest Cost-Effectiveness value. Although this form of analysis can be of assistance in the selection of an alternative plan, it does not provide information relevant to the prudent expenditure of public funds.

In order to determine if any plan is a wise investment, it is necessary to determine if the dollar value of benefits which accrue to the public as a result of the expenditure of public funds exceeds the cost. Much has been written regarding those consequences of transportation investments that constitute benefits and how those benefits should be valued. As a general rule, however, a benefit should represent an actual savings in cost to the public or a savings in an economic good for which there is an established market value. A consequence that has no established market value is not an economic good, although it may represent a matter of concern in the decision process. Artificial pricing of such consequences does not provide information relevant to the prudence of the proposed investment.

Care must also be exercised in the calculation of benefits to avoid double counting. One of the reasons that Benefit/Cost Ratios have been viewed with suspicion is that benefits have been double counted in some applications. Double counting generally occurs when attempts are made to expand the list of benefits to include all or most items of concern in the evaluation. If the analysis concentrates on the measurement of economic consequences, the results will be easier to understand, more useful, and less likely to contain double counts and other anomalies.

It is important to notice that economic analysis techniques do not address all issues of concern in the plan selection process. Economic analysis techniques are not, in general, useful for measuring the desirability of alternative plans with respect to social, environmental, and land-use goals. They do provide a mechanism for comparing the costs of alternatives that involve different distributions of expenditures throughout the period of analysis. They can be used to evaluate the advisability of an investment by comparing the market value of benefits that accrue to the public with the costs to be incurred. Economic analysis can also be useful for establishing priorities among plans or among elements of a plan.

CONCLUSION

The role of economic analysis in the plan selection process is to provide information regarding the economic consequences of alternative plans. In particular, economic analysis is concerned with the comparison of the costs for implementation, operation, and maintenance of alternative plans. In some instances, these costs are examined in light of the returns or benefits that accrue to the public as a result of incurring these costs throughout some period of analysis. The costs and benefits are measures of the expenditures of economic goods required to carry out travel, the basic activity for which the plan is being considered.

There are many important consequences of alternative choices that are not addressed by economic analysis. The social, environmental, and land-use impacts are relevant to the decision, and information regarding these consequences should be provided to the decision maker. All of these consequences should be presented in a fashion that will assist in defining the choices available. Neither the economic analysis nor the complementary analysis of noneconomic impacts, however, is a decision. It may represent a recommendation of the technical evaluation, but the decision is the responsibility of the decision maker.

The responsibility of the engineer is to select the economic analysis tools and other methods of analysis that will provide the decision maker with the most useful information regarding the differences among alternatives. The basic tools available for economic

analyses can be categorized as the Net Present Cost, Equivalent Uniform Annual Cost, Rate of Return, Benefit/Cost Ratio, and Cost-Effectiveness techniques. The judicious application of one or more of these techniques will provide valuable information that will help the decision maker to understand the economic consequences of alternative investment strategies. This information, coupled with information regarding other relevant consequences of alternative plans, should form the basis for selecting an alternative for implementation.

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WASHINGTON OFFICE NEWS

CONSULTATION AND STANDARDS

*Walter E. Furen
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The new Forest Transportation Terminology Handbook (FSH 7709.16) was distributed in June. This handbook was developed in response to a recommendation from the FR&T Transportation Investment Decision Policies and Analysis (June 1977).

The authors of the study report found that policy changes had created new terms that were misunderstood, and that existing terms caused communication difficulties. They proposed to the Chief that an "official" transportation glossary be developed, and FSH 7709.16 is the result.

Initially, the list included all terms in the directives system and other applicable publications. Two reviews by the Regions and the WO Staffs reduced the list appreciably, and refined the definitions. Final selection of the terms was based on four criteria:

1. Retain those terms defined by law or regulations;
2. Retain those terms that are unique to the Forest Service, including common terms that have been modified for Forest Service use;
3. Retain those terms for which several definitions exist and the Forest Service definition is advisable to avoid confusion; and
4. Avoid adding or redefining terms that affect new policy.

To be effective the handbook must be correct and current, and the manual, other handbooks, and publications must be in agreement. We are now making revisions to the latter documents. We welcome comments, recommendations, and corrections.

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