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Publication of this paper sponsored by Committee on Taxation, Finance, and Pricing.

Concepts, Principles, and Objectives of Economic Analysis Applicable to Traffic Accidents

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In the many years that cost-benefit analysis has been used as a management tool for decision making between different alternatives for highway improvements, a penetrating study has never been made of the factors of personal injury and fatality accidents as they relate to economy of transportation. Specifically, the economic gains and losses related to wage and salary incomes foregone because of lost work time (including death) have never been determined. This paper sets forth concepts, theories, and principles that can serve as guides in the search for dollar amounts to represent consequences of highway improvements that impinge on traffic accidents. Descriptions of 32 main consequences are given that indicate the role of each and how it could be priced for input to the cost-benefit analysis. It is proposed that these factors and others should be studied in depth by professionals from the several disciplines involved.

PREFACE

In past discussions, I have had difficulty in getting others to understand my position. It may be difficult for some persons to distinguish between making an analysis of the transportation economy of alternative investments in highway improvements and in pricing traffic accidents for other purposes or for viewpoints other than that of the economic community as a whole. In the evaluation of this paper, the differences in these two concepts must be kept in mind.

This paper takes the position that the analysis for the economy of highway transportation investments should (a) evaluate all economic factors in market dollars; (b) include all economic consequences that can be market priced and exclude economic factors that cannot be market priced; (c) exclude all factors that are not related to the conservation of resources; and (d) price highway costs, motor-vehicle costs, and accident costs in economic cost dollars and not in value dollars.

The ultimate decision maker can accord such weight to the humanitarian factors as he or she believes just and right. For calculating a benefit-cost ratio or a rate of return, however, that includes highway and motor-vehicle costs, traffic-accident costs must likewise be expressed in market price dollars that relate to economic conservation of resources.

SETTING AND SITUATION

It is encouraging to find increased use of economic analysis, or cost-benefit analysis, as a means of calculating the relative index to the transportation economy that exists between any pair of alternatives for the investment of capital in a highway improvement (whether for construction, reconstruction, or alteration of the highway structure) and traffic facilities.

There is agreement that the procedure of analysis should involve the economic costs of fatal traffic accidents; in fact, some new highway and motor-vehicle investments have had as their major objective the reduction in the number, cost, and rate of accidents that result in human death. The factor of accidents has brought new discussions, new literature, and new analysis to bear on the dollar cost of a traffic fatality. However, some of the dollar sums arrived at as costs are actually values that have been calculated without proper attention to the principles of economic analysis, the application of the results, or the role of economic analysis in the decision process.

The capital-investment analysis of any proposed highway improvement that involves the factor of fatal traffic accidents is, in reality, no different than the analysis of a proposed project that does not involve consideration of traffic fatalities. But many persons consider such a proposal to be different because of the human, emotional, and social implications. Although a fatal accident is different from a nonfatal accident because of these human and social factors, it remains equally true that the concept, principles, and theories of economic analysis do not differ. A change in concept can be injected into the analysis without changing the basic set of principles. The one significant change needed is that of separating the emotional and social factors from the highway costs, the motor-vehicle costs, and nonfatal accidents. In substance, this concept restricts the main cost-benefit analysis to strictly market-based economic-resource factors and sets aside the social and human factors for a cost-effectiveness analysis, or no analysis at all other than to be considered by the decision maker along with the other irreducible factors.

Some current writers have gotten away from the concept of placing a value on the life of a traffic fatality, which change in thinking is progress in the right direction. On the other hand, the procedures often used point to a value calculation, rather than to an economic cost calculation. Agreement is rather widespread now that there should be no attempt to actually value human life as life or a person as a living being or as a social member of society. The alternatives that remain, then, must lie in determining a person's economic productivity within the social and economic system, or in determining his or her economic role as a consumer, or by using a combination of the two.

For purposes of a cost-benefit analysis, the finding of a dollar sum to measure a person's worth to economic society must be directed toward an economic base and away from a humanistic, humanitarian, or benevolent base. The cost-benefit concept and calculations are traditionally and correctly geared to the economic base--toward the conservation of resources through the reduction of economic consumption for a given amount of transportation. This concept leads to the question, What is the economic difference to society in going ahead with the living person for the number of future years to the normal death year and going ahead the same number of years after the death of that person because of a traffic accident (or any cause of death)? When this net difference in economic consequences between being living and being dead is found, the dollar factor in cost-benefit analysis that measures the role of decreasing traffic fatalities in the economy of proposed highway investments can be calculated.

For investment economy analyses, the human and social factors of a traffic death should be dealt with separately, reported separately, and used by the decision maker as separate factors. Therefore, this paper does not recommend pricing pain, suffering, bereavement, family love, social entities, and the value of life as life as opposed to death, except as a firm economic market price may be found. This position does not infer, or at least it is not intended to infer, that I believe that these human factors are not important to people and to society in general. My position is simply that these factors are not direct economic factors, they cannot be priced on the market, and there is no procedure by which dollar amounts can be found for them except by the wide-open path of personal opinion. It is this lack of a market basis that has resulted in the past in a wide range of dollars, perhaps from $25 000 to $500 000/fatality, that have been applied in economic analysis.

Before a generally acceptable and conceptually sound procedure can be developed for the treatment of traffic fatalities and bodily injuries in cost-benefit analysis, two tasks must be accomplished. First, the scope of the total system should be defined with respect to objectives, concepts, theories, principles, and applications. Second, representatives from the various disciplines and working groups concerned with the analysis should exchange views and come to an agreement on the overall features and procedures of analysis. These disciplines include subjects that lie within the professional competences of highway engineers, economists, sociologists, planners, political scientists, comptrollers, and public works officials.

One of the objectives of this paper is to show the need for consistently priced traffic-accident costs and how to solve that problem by putting all dollars on a common base--a base directly related to economic market prices. The same kind of market dollars are customarily used for costs of highway construction and maintenance, motor-vehicle operation, and traffic accidents (exclusive of fatal ones). Proper procedure, however, requires the fatality dollar to be market priced also and not determined from opinions, willingness-to-pay valuations, and worth of a life as a life valuations.

This paper outlines the process of analysis, discusses the factors in the entire system involved, determines the role of each factor, and then indicates how each includable factor should be quantified and priced. No attempt is made to price any factor in specific dollar amounts.

VIEWPOINT--FROM WHOSE EYES

When traffic accident costs and their inclusion in an economic analysis of a proposed highway-improvement investments are being considered, the viewpoint should be specifically kept in mind. Consider a human death from a traffic accident. Possible viewpoints are those of the insurance company; the highway engineer; the vehicle driver or owner; the estate of the person killed; the family of the person killed; the friends of the person killed; the social community; and, lastly, the total economic society that may be affected.

The economic analyses of proposed new investments in highways are made for the purpose of informing the decision maker about the calculated transportation economy that will probably result over a period of future years from each alternative considered. Because the economic forces to be considered are general and widespread, they must include all types of people and a wide geographical area. Therefore, the viewpoint of the economic analysis and the input data and consequences must be the last cited above--the total economic community.

A person is both a producer and a consumer. Production and consumption are both economic activities, but adding them together would be double counting. A choice of viewpoint--production or consumption--should be made at the outset of a cost-benefit analysis of a proposed highway improvement. Traditionally, and correctly, in concept, this viewpoint has been taken as the conservation of consumption of resources. Engineering economy has always been based on the conservation of resources, one aspect of which is striving for the minimum consumption of resources to achieve an objective.

CONCEPTS AND OBJECTIVES OF ECONOMIC ANALYSIS

An understanding of the concepts and objectives of economic analysis is an essential beginning to a study aimed at finding a dollar sum by which to represent a traffic fatality in an economic analysis of the choice of highway-improvement investments. The economic analysis attempts to answer the question, "Of a pair of alternatives, which one, within a selected future period, will consume the minimum or lesser amount of resources?" Another way to frame the question is to ask, "Which alternative will maximize the return on the investment?"

In public works types of construction investments, as contrasted to private business and industry, there is usually not a cash sales income against which to measure the profitability of the investment. Therefore, in public works (highways), the net return is measured in terms of a cost reduction in the ownership and operation of the facility. Additional capital is invested in the existing highway network in the expectation that vehicle running costs, travel times, and accident costs will be reduced. These reductions in transportation cost are the dollar return against which the economy of the proposed dollar investment is measured.

The analysis is carried out on a discounted cash-

flow basis. This means that all cash flows are combined into equivalent sums as of a common date. The concept also requires that dollars must be of the same price level; that is, the pricing of all factors must be as of a common date.

The cash flows include the costs of such items as planning, design, construction, maintenance, and operation of the highway facility combined with the costs of operating motor vehicles over the facility. Traffic accident costs are a part of motor-vehicle use.

In this concept of economic analysis, a fatal traffic accident should be represented by a cash flow based on market pricing. If this is not the case, then the pricing of the fatality is not in the same dollars as are the items of highway cost and motor vehicle use. A fatal traffic accident should be priced to include all the known or determinable direct economic costs and gains of the accident, including property damage, medical service, and other direct economic consequences that are market priceable and that represent consumption of resources. The decision maker wants to know that the economic analysis is based wholly on true consumption of resources.

These concepts and objectives set the stage for the economic analysis. But, in the execution of the analysis (data gathering and their arrangement, included), there is need for guidelines. These guidelines, constraints, or criteria are discussed below.

PRINCIPLES OF ECONOMIC ANALYSIS

Although this paper is primarily addressed to the single factor of traffic accidents, the concepts described above and the principles to be discussed below apply to economic analysis (cost-benefit analysis) for all applications--public works and private works. The nine principles presented here do not embrace all principles, but are those especially applicable to the analysis of traffic injuries and fatalities.

1. The analyst must exercise complete objectivity. There is no room in economic analysis for an analyst who tries to get a chosen answer. Every factor within an alternative must be included, whether favorable or unfavorable to that alternative, and each factor must be priced according to the same standards. Unfortunately, there have been analyses of traffic fatalities wherein there seems to have been an attempt to arrive at the highest possible total net cost of a fatality. This attempt is characterized by the finding of high costs, not discounting the future costs, and the omission of factors of apparent gain to society.

2. At the outset, the viewpoint from which the analysis is to be made must be established. Possible viewpoints are the decedent, the family and relatives of the decedent, the community of the decedent, the social aspects of society at large, and the total economic society as partially represented by the system of highway transportation, including all road users. Our highway systems are constructed and operated by use of public funds, produced mainly from highway user taxes, from property taxes, and from (in new urban areas) the price of land and buildings served by the highways and streets. These highways are part of the public works systems and available for use by the public without restriction. Thus, the economy of highway transportation facilities should be determined on the basis of total economic costs and use, regardless of specific classes of users or financial supporters. Therefore, in an economic analysis of a proposed highway improvement, the viewpoint should be that of the people at large as highway users. There has been some tendency to treat traffic fatalities from the viewpoint of the decedent's family. In the concept of conservation of resources, the highway-user population shares, losses and gains. Thus, the viewpoint of the community as a whole should be adopted with respect to a fatal accident as well as for all other traffic accidents and all economic costs and gains.

3. All analyses must be conducted on the basis of alternatives based on the concepts of "with and without" or "to do or not to do." These two expressions relate basically to comparing an existing situation (the now-being-used facility) with another one as proposed. There are always two alternatives--that of doing something and that of doing nothing. In comparisons, however, of two alternatives of doing something the principle of "with and without" holds. The alternative that has the lower cost may be chosen as the base with which the higher cost alternative is compared. If traffic fatalities are at issue, this principle may be correctly interpreted as meaning with and without the death. In other words, What are the economic forces and factors to be evaluated had the fatality lived as compared with the economic forces and factors without his or her living? What are the economic impacts on society after death compared with the economic impacts had the person continued to live?

4. The differences between the two alternatives in the pair of alternatives being studied are the significant factors in decision making--not the magnitude of individual factors. In reality, this principle is a supportive statement to the "with and without" principle. It is the "with and without" comparison of a pair of alternatives that permits obtaining the difference between them. This principle is often violated by a failure of the analyst to compare each possible pair of alternatives by differences.

5. The analysis should include all consequences to whomsoever they may accrue--a form of system analysis. This principle includes both the priceable and nonpriceable consequences. Obviously, however, the nonpriceables cannot be included in the numerical calculations. They must be handled by separate descriptions or on a cost-effectiveness analysis basis. With respect to fatal accidents, this principle dictates the inclusion of all consequences to all people and to all activities. Naturally, there is a practical limit of how far afield the analyst may go in running down every consequence. But with certainty, the analyst should include every significant economic consequence and all those that are readily obtainable and easily and positively market priced.

6. All of the market factors included in the calculations of a benefit-cost ratio, a rate of return, or a net present worth should be dollar based in the marketplace. This principle is interpreted to admit dollar pricing on an estimated basis when the estimates result from normal pricing procedures. Included in this category are highway construction and maintenance costs, motor-vehicle running costs, medical costs, and the like. Many of the costs and gains are priced at current prices but estimated for a future period. This market-pricing principle excludes dollar pricing for those factors not quantifiable and not commonly and consistently exchanged on the open market.

7. All cash flows should be discounted to a common specific date. The date is usually chosen as the current date or the date the facility is to be opened to traffic. The logic of this principle is that the worth of money is tied to the time at which the money is available as income or expense.

8. The analyst must select a future time period over which to make the analysis. All plus and minus cash flows from the consequences occurring within this future span of years are accounted for on a discounted basis. Often, this time period is restricted to the period for which the traffic volume is estimated (such as a 20-year period).

9. The analysis is based on the net of costs and gains of all factors. The word "net" is an indication that there may be two types of cash flows, one positive and one negative, but in the analysis it is the net, or difference in the two flows, that is used. Examples of types of factors where a hunt for the net is advisable are the cost of food included in hospital costs less the cost of food that would have been purchased by the victim otherwise; a proper accounting between insurance premiums, damages and other payments received, and the cost of the accident; and the use of rental vehicles adjusted by the cost of using own vehicle had it not been damaged.

PAST PROPOSALS FOR PLACING A DOLLAR SUM ON A TRAFFIC FATALITY

The one significant item to be priced in determining the economic cost of traffic fatalities is the dollar amount to use in cost-benefit analyses to represent a fatality. Both social and economic concepts have been used. Some of the concepts and procedures are discussed here to point out more directly the importance of this controversial factor.

Many analysts speak in terms of the value of life, the value of living, the value of a person to society, and other value terms. Perhaps it would be preferable to consider the net economic production that is made by a person as the base dollar amount to use in economic analysis. This production can be measured in terms of one's net wage earnings as a surrogate for the real contributions to economic society. But even this measure of net production may be objected to on the grounds that, on the death of any productive person, his or her production is taken over by some living person, so that there is actually no reduction of production in the total community. Witness our ever growing economic production over the years, despite the deaths per year.

1. Present worth of earnings foregone less present worth of cost of maintaining earning capacity: For many years, analysts have used the total earnings foregone because of death, without a time discount, as the cost of a fatality. More recently, the calculation of the present worth of the earnings foregone by use of a time-discount factor has been used. At present, some analysts take the difference between the present worth of earnings foregone and the present worth of the yearly costs of maintaining the worker in an earning capacity. These sustaining costs are related to cost of living and working. Under the principle of including all consequences, the cost of maintaining a wage or salary earning must be considered equally with the amount of earnings. It is the net amount that is significant.

When a working person is removed from the work force for any reason, including as a traffic fatality, there is a presumption that his or her place is taken by another worker. The replacement worker comes from the unemployed, by transfer from another position, or from the age group just entering the labor force. When the vacancy is filled by transfer from within the working force, often with a promotion in wage, there may be a chain reaction that provides a promotion for two or more levels of employment.

These actions of changing the labor force and wage incomes are certainly consequences of the traffic fatality that should be considered. The process of simply taking the future expected earned income of the decedent as a measure of the cost of the fatality ignores completely the gain to society of the new employment or the increased wage or salary. If salary foregone is a cost, should not salary increases be a gain? Both actions are a part of the same economic system and are equally important.

If the earned income foregone is accepted as the measure of a person's productive contribution to society, then the next step is to find a measure of that person's consumptive contribution. The net of the two economic factors is what is desired for use in economic analyses.

The consumptive contributions that persons make to society are found in what is expended in their behalf that enables them to sustain their productivity. These expenditures are for such items as food, clothing, shelter, health, education and training, transportation, work expenses, entertainment, and recreation as they contribute to working capabilities.

The earned income foregone as a measure of productivity and the cost of living as a measure of economic consumption should both be calculated on a year-by-year basis with a present-worth factor for each of the years covering the death year to the year of probable death by other causes as determined from mortality tables in the life insurance industry.

Exception to the subtraction of the cost of maintaining the person in a working condition is sometimes based on the concept that the inclusion of the subtractive element of living consumptions takes away the benefit to society of this consumption. If a person is to be kept alive to consume some of his or her own earnings and increase economic consumption, why then are the reduction in consumption of motor fuel attained by better designed highways and the reduction in medical supplies obtained by reducing the number and severity of traffic accidents considered desirable goals? We justify highway improvements by reducing economic consumption and not by maintaining or increasing consumption of scarce resources. Conservation of resources is the guiding concept in economic analysis.

2. Lost work time at wage rate: Because the cost of lost work time for temporary disability is often measured in terms of the injured person's wage rate, the lost work time by death could also be measured the same way. Death is permanent lost work time over the period of remaining work-time expectance as compared to lost time from temporary injury. At least, as between these two types of accident severity, there should be consistency as to how work time is converted into an economic factor to use in cost-benefit analysis.

3. What society is willing to spend: The social point of view as measured by what society is willing to spend to reduce the number of traffic fatalities has been advanced as a measure of the dollar evaluation of human life. This approach is a value concept, rather than an economic cost approach. There exists no completely open forum from which to determine how much society is willing to spend. It is doubtful that enough persons in each economic class could be found who would have any particular basis of making a determination of how much the public should spend on highways to reduce fatalities. These same persons have little knowledge about the differences in human values and economic values in the concept of economic analysis.

If the willingness-to-pay concept is used for fatalities, why not also apply the same concept to pain and suffering and to reduction in gasoline consumption and tire wear?

4. Individual person's evaluation: Another method that relates to value of life is found in the proposal to ask people what they would take in current dollars to avoid death. In other words, How much are they willing to pay to remain alive? Few persons would be able to give any sensible answer to this question. There would be many factors not understood by the person answering the question. When would death take place? If not to be dead, how long would I live? The answer would be related to the

Table 1. Item consequences of traffic accidents by time periods.

Consequence	Includable in Cost-Benefit Analysis	Accident Period	Postaccident Recovery Period	After Recovery but With Permanent Disability	Death Period	Post-death Period[a]
Property damage to vehicles, highways, adjacent property, cargo, and personal effects	Yes	a				
Emergency crews and rescue vehicles	Yes	a				
Police and traffic officers	Yes	a				
Disruption of traffic flow—vehicle costs	Yes	a				
Traffic delay time and travel time at time of accident	Yes	a				
Travel expense of accident by concerned persons	Yes	a	a	a	a	a
Postaccident travel time	Yes	a	a	a	a	a
Rental of substitute vehicle	Yes	a	a	a	a	a
Accident investigation, reporting, and analysis	Yes	a	a	a	a	a
Hospital service charges	Yes		a	a	a	
Medical professional services	Yes		a	a	a	
Medical supplies	Yes		a	a	a	
Prosthetic devices and equipment	Yes		a	a		
Incidental hire	Yes		a	a	a	a
Legal services	Yes		a	a	a	a
Court expenses and witness fees	Yes		a	a	a	a
Flowers, gifts, telephone, postage, and such	Yes		a	a	a	
Funeral and associated expenses	Yes[b]				a	
Pain, suffering, grief, and remorse	No	a	a	a		
Induced illnesses and accidents	Yes-No[c]	a	a	a	a	
Community activities and labor and professional groups	No		a	a	a	a
School days missed and delayed promotions	Yes-No[c]		a	a		
Welfare payments by governments	Yes[b]			a[b]	a[b]	a
Tax levies by governments						
Income	No					
Sales	No					
Social security	No					
Inheritance	Yes[b]					a[b]
Insurance						
Motor vehicle	Yes[b]	a				
Workmen's compensation	Yes[b]	a[b]	a[b]	a[b]	a[b]	a[b]
Personal accident and disability income	Yes[b]	a[b]	a[b]	a[b]	a[b]	a[b]
Health and hospitalization	Yes[b]	a[b]	a[b]	a[b]		
Life	No					
Exchange of assets after death	No					a
Family services to the home	Yes		a	a	a	a
Services by neighbors and others without charge	No	a	a	a	a	
Training of job replacement	Yes[b]		a	a	a	a[b]
Cost of working and payroll burden	Yes[b]					
Nonproductive time of employee absence and position vacancy	Yes[b]		a	a	a	
Economic cost of death	Yes		a	a	a	a[b]

Note: a = applicable to time period whether or not includable.

[a]Coded on basis that death could occur at moment of accident or at some future time. [b]With restrictions and under certain conditions. [c]Includable but not practical to price.

economic status of the individual. But more important, it is unreasonable to assume that people at large in society would have any basis at all of offering sound, well-considered answers to such a question. But even if the approach were successful, the answers would not deliver the economic answer that is sought. This statement goes back to the concepts and principles discussed above. If one digresses from the economic concept and wishes to use a value concept, then to be consistent, the whole cost-benefit approach must be a value-benefit approach on all dollar evaluations. But such an approach does not lead to a measure of the economy of transportation alternatives--the objective that this whole effort is trying to reach.

5. Principal sums of life insurance policies: A procedure often suggested for the determination of the dollar value of human life is to sum up the principal amounts stated in life insurance policies and accident risk insurance. Insurance carried by a person is not specifically related by the insured to his or her evaluation of his or her life. It is determined more by ability to pay the premiums and who the beneficiaries of the policy are. Much short-term insurance (airplane travel, for instance) is not taken on the basis of the value of life, but as a gamble--risking a small sum for a small chance of a large gain. Again, the holders of life insurance policies are not a representative sample of the persons killed in traffic accidents. Finally, as in the concepts of willingness to pay and personal evaluation, there would be little direct relation between the dollar amounts gotten from insurance policies to the economic truths needed in cost-benefit analyses. This insurance concept is a value concept, not an economic cost concept.

6. Jury and court awards: Each year, the courts decide cases wherein specific dollar amounts are awarded on the death of persons as a result of responsibility for such death. These awards have no sound foundation to make them acceptable for economic analysis of death from traffic accidents. The amount of the award, in addition to being based on ability to pay, is influenced by the situation of the trial, the judge, the jury, and the attorneys. Finally, these awards are not acceptable because they are not representative of the individuals across the nation who meet death from traffic accidents; they have no relation to the economic factors of death.

ITEMS OF TRAFFIC ACCIDENT COST

Table 1 lists 32 consequences that are pertinent to compiling the costs of traffic accidents for use in cost-benefit analyses. This table is somewhat detailed in some instances and is rather gross in others. These 32 consequences are part of the total system picture. No claim is made as to the completeness of Table 1.

One of the purposes of Table 1 is to supply a listing by which to identify consequences that are contro-

versial or for which the handling in cost-benefit analyses is uncertain. Certain of the consequences will be discussed in depth in accordance with the above statements on concepts, principles, theories, and viewpoints.

The division in Table 1 of the listings into five columns by time periods, as related to traffic accidents, is to facilitate the selection of consequences for discussion and to show that some consequences are common to all time periods, starting with the accident itself and continuing into days or years thereafter. The costs of permanent bodily injury would continue for years after the accident and after direct medical attention ends. The same is true of death. In this analysis, the consequences of death need to be considered over a time period equal to the estimated life expectancy of the accident victim had the traffic death not occurred. But some of the consequences may be effective through many years thereafter.

1. Property damage: Traffic accidents cause property damage to motor vehicles, highway structures, private property adjacent to the roadside, cargo in commercial vehicles, and personal effects of drivers and passengers. Costs are based on repairing the damage, including both labor and materials. If the property is not economically repairable, the cost would be the current market value of the property in its preaccident condition less its scrap price.

2. Emergency crews and rescue vehicles: At the site of the accident, tow trucks, paramedic crews, and ambulances may be needed. The costs of these vehicles and their crews are usually priced on the basis of the trip or per hour, including wages, vehicle operations, and travel times. All such incremental expenses are wholly chargeable to the accident, as part of the on-site costs.

3. Police and traffic officers: When police or traffic officers are called to the site of the accident, their personal time and vehicle use is chargeable to the accident. This charge is determined on the basis of wage and salary rates plus vehicle operation on an hour or distance basis. Police and traffic officers are on a public payroll, without direct charge to the owners of the vehicles in the accident, but there is still an incremental economic cost involved. Without the accident, these officers would be available for other assignments and, if accidents could be reduced sufficiently, the number of officers on the force could be reduced.

4. Disruption of traffic flow--vehicle costs: Even minor accidents can disrupt traffic flow. Vehicles are slowed in speed, stopped, and detoured around accident vehicles in either one-way traffic or over other routes. The result is added vehicle running costs resulting from changes in speed, idling engines, turning movements, and extra distance traveled. These extra running costs are wholly chargeable to the accident.

5. Traffic delay time and travel time at time of accident: The increases in traffic delay time and in travel time due to the accident are a chargeable expense. The rate of time charge should be that being used for normal travel as applied in cost-benefit analysis. (Consequences 4 and 5 apply only to the traffic and travel consequences caused directly and immediately by the accident.)

6. Travel expense of accident-concerned persons: The travel by all modes by relatives, neighbors, friends, and business associates that results from personal-injury traffic accidents is a chargeable expense to the extent that this travel would not otherwise have been made. The includable items are common-carrier fares, taxis, distance charges on personal vehicles, lodging, meals, and incidentals. Subtracted from this gross expense to get net expense are the normal expenses foregone such as home and restaurant meals, personal vehicle use, and the expense of other activities permanently canceled. These costs, however, should be incremented or at least discounted on the basis that the costs would be incurred later on death by another cause.

7. Postaccident travel time and its pricing: The pricing of travel time is still somewhat a controversial factor, primarily for two reasons. First, even for high daily traffic volume of vehicles, there is doubt that a few seconds or a minute or two not used in travel would be economically and productively used in other activities. A second factor relates to whether travel time is or can be expressed in terms of the market. For commercial vehicles, the market base can be used (1). For automobiles, the Stanford Research Institute (2) reports dollar expressions for travel time based on comparing nontoll and toll routings. On this basis, it is concluded that the travel time of personal vehicles and occupants has been priced on a market base.

As shown in Table 1, travel time is a common factor in all time periods except the last. The postaccident travel is by accident victims, relatives, friends, associates, witnesses at court, and others when visiting accident victims, caring for business items and home items, for preparing and filing legal documents. Professionals associated with the accident who are working for a wage, salary, or fee (such as attorneys and medical personnel) normally include vehicle-operating or travel-time cost elements in their professional charges. Work time, travel time, and vehicle use by public employees (such as police, accident-associated employees, and volunteers) should be charged to the accident on an incremental basis.

8. Rental of substitute vehicle: Because of damage to vehicles at the accident, their owners may rent vehicles or use taxis for local transportation. This direct expense is a cost of the accident. But the net cost of this travel by hired vehicles would be this direct expense less what the owner would have incurred by using the owned vehicle had it been available. This procedure illustrates the principle of difference, the principle of net cost, and the principle of all consequences.

9. Accident investigation, reporting, and analysis: Official accident reports are normally required to be filed with a designated governmental agency for all accidents that cause property damage of more than a minimum total and every accident that causes personal injury needing professional attention. In addition to the reporting, many accidents are investigated on site at the time of accident or later. These investigations and reports require the use of vehicles and the time of field personnel, the accident victims, their associates, and witnesses. This total of both travel expense and time are chargeable to the accident on an incremental basis. For all but the official motor vehicles used by safety agencies and other public agencies, both travel expense and time of others could be included in consequences 6 and 7. Some of the costs, however, for collecting and analyzing the data are used in finding ways to reduce future accidents and, therefore, the net costs could be negative.

10. Hospital service charges: The net cost of hospital charge is the hospital billing less any reductions in expense that would have been incurred had the victim not been injured. A major item in this category is that of food. By going to the hospital, the cost of meals outside is reduced by at least the cost of the food not eaten at home or at restaurants.

In addition to meals at the hospital, other expenses avoided should be deducted. Among these other

expenses are such items as recreation, entertainment, the net of automobile use for all purposes, and social expenses. For privately operated hospitals, any profits above costs should be excluded as being transfer items.

11. Medical professional services: Medical professional services other than those included in the hospital billing include home calls, office calls, and hospital calls of private physicians, dentists, and nurses, and outside laboratory services. These services are usually billed on the basis of including all travel, overhead, and assistants. In addition, there will be medical supplies that are furnished through the professional in charge. These professional charges can continue over days, weeks, and months, until the injured is fully recovered or dies.

12. Medical supplies: Medical supplies, including prescriptions, are procured from three main sources: (a) through the hospital billing, (b) through the physician's billing, and (c) through direct purchase. Regardless of the source of supply and the process of billing, they all represent costs of the accident.

13. Prosthetic devices and equipment: Such items as canes, crutches, braces, artificial limbs, beds, and exercise machines may not be included as medical supplies. These items may be directly purchased and discarded or sold at the end of their use, or they may be rented. In either case, the net cost is chargeable to the accident.

14. Incidental hire: Because of the problems of time allocation and the absence from home of the injured, it may be necessary to hire help for jobs at home or in connection with business, managing the home, child care, or in getting errands and accident incidentals cared for. The cost of such hired help is a justified expense against the accident.

Without question, the cost of any hired help to care for the injured person at home would be a justifiable charge against the accident. But when such care is given by family members, there is some question whether it would be an economic charge. If a family member gave up gainful-employment cash income to care for the injured person, then the charge against the accident should be sustained.

15. Legal services: Legal services for all parties to the accident constitute a real cost and should be included. The legal services that are furnished through the motor vehicle insurance companies would be included in the insurance administration and overhead costs. But legal expense is optional with the individual, except when he or she is sued by another party. These optional costs are not community expense and do not involve conservation of resources. The personal-client type of legal expense would consist of services before, during, and after any court proceedings for all matters that were consequences of the accident. As with medical professional expenses, legal fees normally include travel, office assistants, and overhead of the professional service.

16. Court expenses and witness fees: All normal public expenses of official legal proceedings, whether by trial judge, jury trial, or by conference, should be a charge against the accident on an incremental basis. For jury and witness fees, there will be a direct cash outlay; but for the court in general (including judge, assistants, and administration expense), there will be some general incremental charge. Here again, these court costs are optional and not a community cost of the accident, except to the defendant.

17. Flowers, gifts, telephone, postage, and such: Throughout the period between the accident and the funeral, there is an accumulation of miscellaneous expenses on the part of relatives, friends, and associates who are concerned. These expenses, on the basis that they would not have been incurred had the accident not happened, are normal costs of the accident. Getting at their net total may prove a difficult fact-gathering task. Their total may not be significant relative to the grand total cost of the accident, but they should not be neglected. Even if they are not included, they should be recognized as being omitted from the total.

Two general restrictions should be observed. The expenses chargeable to the accident are the net of those that would not have occurred in the normal course of social and business actions. Any items associated with a funeral should be time discounted.

18. Funeral and associated expenses: Because every person will die someday, the expenses of a funeral are not unique to a traffic accident. For cost-benefit analysis, the funeral charges should be included on a discounted basis over the time between the date of the funeral and that future year when, according to life-expectancy tables, the individual would have an expectancy of death. The calculation of this present worth or discounted cost should be made for each death separately for the period of expectancy of life and not by an average expectancy for all deaths. The exponential character of the calculations precludes using the average expectancy.

19. Pain, suffering, grief, and remorse: Without doubt, the injured person sustains considerable pain and suffering because of bodily injury. In addition, relatives also suffer and grieve because of the injury. These physical and mental feelings are not economic gain or loss, although they may sometimes result in some loss of economic production and a change in consumption. Pain and suffering do not have a market base for pricing and probably do not have any trait of conservation of resources. In view of the governing concepts and principles, there is no sound basis for including a dollar sum in cost-benefit analysis for the combined item of pain and suffering.

For pricing this item and for compensation for death, whether or not for insurance settlement, some analysts have turned to awards by court juries or judges. This source of evidence of acceptable dollar amounts for either pain and suffering or for death does not furnish any reliable, soundly based, or generally acceptable results. The reaons for this rejection of jury and court awards for use in cost-benefit analysis lie in the following factors: First, the cases that reach the courts are the unusual ones, and the sample of awards that may be collected from court cases is not a good statistical sample. The cases from court records are neither chosen at random nor taken from a homogeneous population. Second, the judgments that are awarded are based on the ability to pay whether or not through an insurance company. Third, awards are only a matter of the personal opinion of the judge or the jury and have no factual basis or market base for setting the amount. Fourth, the awards made are customed to fit the specific case and should not be used as representative sums for the average accident. The influence of the attorneys, the judge, and the witnesses greatly affects the result.

Any weight to pain, suffering, and grief for the highway-improvement alternatives under study must rest on the decision maker's judgment for each proposal individually. No dollar amount for any pain, suffering, and grief should be included in the cost-benefit analysis. Pain and suffering as yet have not been related to conservation of resources.

Finally, if an analyst insists on considering court awards for a fatality or injury, the cases wherein the award was zero dollars should be included along with the dollar awards.

20. Induced illnesses and accidents: There are cases of record where such events as a serious traffic accident resulted in additional tragedy. The

shock of the accident may induce sickness or mental distress that leads to a stroke, heart failure, or another accident. Fortunately, these cases are relatively rare. They may be hard to identify. Therefore, the best procedure in cost-benefit analysis is to neglect them.

21. Community activities and labor and professional groups: On the death of a person or on confinement due to permanent disability, there follows a wide scope of social, business, and professional consequences, some favorable and some unfavorable, to the remaining population and its social, business, and economic actions. The highly organized population in the United States reaches all the way from local neighborhood groups to wider scope citizen associations, regional groups, county committees, state committees, and national committees. Conventions of associations, societies, unions, and institutes that represent social, religious, health, athletic, recreational, business, trade, labor, and professional persons continue, seemingly with no end.

These types of social, business, and professional groups undergo continuous changes in memberships and officers for many reasons. Any loss or gain by death is no different internally to these groups than any other change in membership or leadership. These groups and their activities will continue after the death of any member or officer in whatever way those in charge desire. What worthwhile economic contribution is made now to society that will not continue to be made after the death of the principal contributor? This is the critical question. If the economic contribution is not continued after the death and is important to society, then there is an economic loss; if some other person continues the contribution, then there is no loss (i.e., no change in the economic balance). For cost-benefit analysis of proposed investments in highway improvement, there is no need to explore the consequences of these social, business, and professional orders. It is doubtful that any positive net gain or net loss of a worthwhile magnitude would be found.

22. School days missed and delayed promotions: When students, in the range from primary school through college, are the victims of accidents other than death, there can be interference with the educational process. Many days or weeks in attendance may be lost. In case of a prolonged period of recovery or partial recovery, a grade promotion may be delayed and, in some instances, the formal education could be ended.

The consequences of a traffic accident to the educational progress of school-age persons are uncertain and difficult to measure in terms of economic gains and losses. Perhaps the best procedure is to admit these difficulties and uncertainties and exclude the item from the analysis. The total magnitude in dollars would be relatively small.

23. Welfare payments by governments: To the extent that persons who become traffic fatalities are being supported through government welfare payments or other public support, there is a gain to society as a whole in the ending of these payments at the time of the accident as opposed to ending them at some future date. Such a gain accrues to the public at large when the total of payments is reduced. In theory, all other factors being constant, the tax rate could be reduced by death of persons on the welfare rolls.

Should the fatality be supported by public welfare and engage in little or no productive employment, the net economic change would be the present worth of the reduction in consumption by the cost of living. The welfare payments would be stopped but, being paid from taxes, this cash flow can be considered to be a transfer of funds.

24. Tax levies by governments: This discussion applies to all forms of tax levies--income, sales, social security, and inheritance--there is little difference among these in relation to economic analysis. A closer examination of all taxes than is given here is appropriate, however, to determine the net effect on social and economic welfare factors as consequences of a traffic accident and a fatality.

Taxes are imposed by the people upon themselves for their common welfare. Most taxes can be considered as transfers within the accounts of the people (governments are agents of the people) and, therefore, tax payments and tax incomes are neutral in their effect with respect to production, consumption, and conservation of resources. By this logic, taxes can be omitted from calculations of the gains and losses due to traffic accidents in analyses of the economy of proposed highway investments.

Income taxes, sales taxes, and social security taxes are influenced at the locale of incidence by the costs and incomes from traffic accidents. Similarly, in the long run, accident costs and incomes therefrom affect the size of estates and resulting inheritance taxes. The effects are largely in the forces that cause redistribution of incomes, expenses, tax levies, and wealth. But it is within reason that, for economic analysis, taxes can be omitted without undue effect on identifying the investment alternative that has the greatest transportation economy.

When considering taxes in respect to cost-benefit analysis, the general practice is to focus on only the current or near future cash flows of taxes. This leads to total neglect of the fact that the current retail price of any commodity has buried in its price an accumulation of taxes of all sorts that are paid by all handlers of the commodity from raw materials to final sale to consumers.

25. Insurance: The five types of insurance listed in Table 1 are discussed here. In each type of insurance, the factors that relate to cost-benefit analyses, in connection with traffic-accident injuries and death, are the actual costs of accidents, premium payments by policy holders, claims paid to policy holders, and expenses of overhead, administration, and operation (simply called overhead hereafter). In any insurance company, the total of claims paid will not equal the total of premiums received because of the overhead expenses. Because of this, the cost of overhead becomes an item that varies with the number and character of the accidents that result in claims for reimbursement.

Risk insurance expenses, as may be affected by traffic accidents, must be carefully evaluated to arrive at the net cost as related to the traffic-accident cost. If the total of premiums was used in place of the net cost of the accident, it would be necessary to adjust this total for any overcost or undercost of the accident as compared with the claims paid. Thus, the direct method of using cost of accident plus insurance overhead is the preferred procedure.

In cost-benefit analysis, the procedure should be to determine the current costs of accidents and insurance overhead and use these in the base alternative. Then, on the basis of effecting through the proposed highway or vehicle improvement a reduction in the severity of accidents or the number of accidents or both the existing accident cost would be adjusted to the proposed conditions, together with a corresponding adjustment in the insurance overhead cost.

In theory, a reduction in the rate of traffic fatalities through improved safety measures should result in an increase in longevity and, therefore, a reduction in the life insurance premium for a given policy. Because of the millions of persons insured, the effects on policy premiums would be so small that

no real errors will result from ignoring this economic gain in cost-benefit analyses. Any determination of the true cost would require considerable research and calculations, and the effort would have doubtful utility.

A reasonable, practical, and technically acceptable method of handling all insurances that relate to traffic accidents is to determine the actual total cost of the accident and add to this amount the total overhead cost of the insurance policies in effect. The overheads should be based on their marginal cost, and the overhead cost should reduce as the number of accidents and their severity are reduced by improved highways.

26. Exchange of assets after death: A deceased person may have left an amount of worldly property to be distributed to heirs, friends, and others as directed by the will or by the court. There may be financial, business management, and legal affairs to be handled by the executor of the estate. This overall settlement requires many types of expenditures borne by the estate. Such expenses may properly be considered chargeable to the accidental death. Such costs, however, should be discounted by the time factor between the date of death and the date of probable future death from other causes. Whether the estate would increase or decrease in dollar amount in this time period would be difficult to determine. Unless there are specific evidences to the contrary, the estate at the date of death could be chosen for any necessary calculations.

One special item with respect to personal values of estate property concerns those goods that to the deceased and his or her household family or dependents provided considerable satisfaction to daily living. On death, these properties may be disposed of through estate settlement. These goods could be motor vehicles, furniture, recreational supplies, forms of arts and crafts, and heirlooms. The concept is that these goods would be sold after death and would bring an income considerably less than the value to the owner before death. Another concept involved is that, because the deceased's probable future earnings are to be included, it is logical also to include the effects of past earnings that at the time of death were in the form of non-income-earning assets.

There is no way to determine the economic value of these goods to the deceased, because there are certainly no records. Original cost or market value may be determinable, but personal value is not.

Selling such goods at market price does not result in any economic loss to society. The sale merely transfers the utility of the goods from one owner to another. There is no consumption of resources and no creation of resources. Values and satisfactions of ownership of the properties could be greater to others than to the deceased at time of death. This possibility is high with respect to relatives, which implies that, if consideration is to be given to such personal property, then equal attention must be given to gains as well as to losses.

As far as market prices are concerned, it must be presumed that the owner--the decedent--has already used up the service of these properties down to the level of market price at the time of death.

Thus, it is necessary to give serious attention to the differences between price, cost, and value. Highways cannot be built on the basis of values to owners of properties. The market price is the only sound base for such analyses. Cost-benefit calculations must be based on market prices and conservation of resources. What the decedent, before death, and the relatives and friends, after death, would pay in dollars for these personal goods is a biased value judgment that has no role in cost-benefit analysis of proposed highway-improvement investments.

27. Family services to the home: In case of the injury or death of a housewife or other family member, there may be economic loss to society when they cannot perform their normal duties in the home. Total duties in the home are such a miscellaneous and varied set of tasks that there is no market experience for the hire of a person to perform them. The normal hire of housemaids, cooks, and yard workers does not cover the range of duties of family members for their joint benefits. To include these contributions in the economic analysis, they could be considered as the equivalent of an employed worker at a wage prevailing for the type of work the housewife or other family member is qualified to handle.

Obviously, these family accomplishments have economic value to the family and allow part of the income from wages to be spent on other family needs and desires. But should they be included in the cost-benefit analysis for proposed highway improvements? There is no conservation of resources involved. The work simply enables the family to spend less on household operations and more on other items of choice; it is a reallocation of expenditures or savings. The economic society at large is not affected through production or consumption of resources; only the internal home is. Many of these accomplishments by family members could be priced at market rates but, in the end, there does not seem to be any justification for their use in the form of an economic cost reduction that could be used to support highway-investment improvements. In case of a fatality, the home will continue to accomplish the tasks as needed and will adjust to the absence of the deceased member. For major tasks, however, these household labors could be priced at market rates and the resulting dollars be added to earnings outside, if any, as commonly has been done in the past with reference to the housewife.

Perhaps the most important factor related to these home and household tasks by family members is that the activities do not end with the death of a family member. To the extent that the tasks are needed, they will be performed by one of the living family members. This family work performance is somewhat in the same category as the work done by any employed person, in that the work done will continue to be done after death of the current employee should there be economic reason why it should be continued.

28. Services by neighbors and others without charge: In times of distress, relatives, neighbors, and friends perform a wide variety of services for a family and do so at their own expense and on their own time. Although these services have economic cost and are an economic gain to the family, their identification and pricing is highly uncertain. The grand total would also be small in relation to the total economic cost of a traffic accident. These neighborly services are closely related to the home services performed by family members. The total analysis would be relatively unharmed by complete omission of these services, which are distinguished by their sudden initiation and short duration in time. They do consume the resource of time, but the time used probably does not interfere with other desirable accomplishments by the persons performing them.

29. Training of job replacement: In all employment types of activities, the list of employees is in a state of continuous change for many reasons--illness, retirement, resignation, labor-force reduction or expansion, discharge for cause, and death. Management is continuously faced with training newly hired employees or employees given changed assignments. The expense of this training is absorbed in labor productivity, supplies, and other forms of overhead when the training is not performed in an organized training department.

The death of an employed person often results in the expense of training a replacement employee. Such expense is justifiable in a cost-benefit analysis, provided that it is discounted over the years the employee would be expected to remain in the position.

30. Cost of working and payroll burden: There are many items of expense to the employee working for pay outside the home and to the employer that are associated with the activity of working. For the employee, these include such items as transportation, clothing (ordinary and special), tools and instruments (in the crafts especially), professional society memberships and union dues, travel and conventions, job-oriented literature, self-supported continuing education, and training.

For the employer, there are the fringe benefits, payroll taxes and insurance of all categories, and normal overheads that relate to employee affairs (e.g., payroll, statistical reporting, and compliance reports).

Which of these expenses are includable in a cost-benefit analysis of the economy of measures to reduce the cost and number of traffic accidents? If includable, just how are the items to be priced and calculated?

To begin, these items should be viewed in three ways: (a) for temporary off-duty accidents, (b) for permanent types of injury, and (c) for traffic-fatality accidents.

The points to look into are these, Is there a change in economic production or consumption of resources? Will there be, in the future, any change in the magnitude of the gain or loss related to these items in terms of the principle of with and without or in comparison of a pair of alternatives?

The personal working expense items of the employee would not be expended after death any more than would consumption of food, clothing, shelter, and other expenses of living. But if his or her position in employment is retained by the employer, the working expenses continue (although by and for another individual), so the societal economic costs and consumptions are not altered. To include these personal working cost items in the before-and-after data (with and without) in both of the alternatives would make no difference in the final calculated answer; thus, the item becomes neutral in its effect. However, if the concept chosen is that of finding the present worth of future estimated earnings less the present worth of the probable future expense of maintaining that income, the costs of working expense should be included in the interest of consistency. This inclusion applies only to permanent disability and death. For a few days or weeks of temporary absence from work, these items could be omitted in the interest of simplicity and because their total would be minor. However, those expense items not incurred after death become a gain and offset part of the cost of maintaining the worker.

The employer's expense of maintaining the employee in the position could be excluded in its entirety because it may be assumed that a replacement employee will incur the same support. The expense items then become continuous within the employment and do not alter the community economic production or consumption after the accident as compared with before the traffic accident. This conclusion applies to all three levels of severity of the accident.

31. Nonproductive time of employee absence and position vacancy: Because most employment is on a continuous basis, except strictly seasonal and sports job engagements, employers are concerned with how to keep production up to normal for those days employees are not at work. This includes situations of temporary disability, permanent disability, and death.

The general practice in economic analysis is to calculate wages lost at the dollar equivalent of the normal wage as a charge against a traffic accident that necessitates absence from work for a few hours, days, or even weeks. When the time reaches or goes beyond a few months, then other procedures are considered. First, look at the short-term absence from work. For economic analysis, the factor of importance is whether there is, in reality, any loss in production compared with payroll. Two factors are involved with respect to payroll. Is extra help provided at extra payroll expense, and does the pay of the absent employee continue under some form of employee agreement or employer policy? Does or does not the employee suffer a loss of income? Does or does not the employer suffer a loss of production? Is the work normally produced by the absent employee produced by fellow workers along with their own work? Is overtime work paid for or donated? Is the normal workload of the absent employee just held up? Is compensation in any way covered by insurance?

The answers to these questions provide the information on how to handle this temporary absence from work in determining the cost of an accident. Should there be no actual loss in production regardless of how or by whom the work is performed, then, in the sense of economic production, there can be no reduction. And likewise, there would be no change in consumption because the factors of economic consumption have not changed.

All forms of employment have daily absence from work for a variety of reasons--sickness, marriages, funerals, sports, family business, vacations, and social and business meetings. Business is geared to this and so successfully that, over the year, there is no particular lack of performance because of these absences from work. At least the performance is as expected and a few days of absence because of a traffic accident results in no positive, identifiable gain or loss to the employment, as compared with the accident not happening. On this basis, there is no real economic justification for including in the cost of a traffic accident an item for any decrease in economic production.

The payroll factors can be considered separately. If the employer continues the payment of wage, then the worker has lost no income. If the wage is continued through some form of insurance, then, economically speaking, there could be a justified charge in the cost of insurance overhead to maintain the wage income.

If the employer hires help or pays overtime to produce the work and, at the same time, continues the wage of the absent employee, this extra wage payment would be a charge against the accident. But if the absent employee is not paid in any form and additional hire is paid, then, although the absent employee does suffer a loss of wage, the wage is paid to others and there is no net loss to society, just a redistribution. But if the absent employee is not paid and the wage is not paid to others, this reduction in total wage could be a charge to the accident on the basis that the money available for consumptive spending has been reduced without a comparable reduction in economic production.

The concept of wages lost and its many factors is a situation that deserves a study in depth to determine the proper handling of the item in cost-benefit analysis. Under current practices, policies, and laws, the wages-lost item could be omitted without injustice to the results of the economic analysis. But if wages lost is an economic cost, why then is not wages earned an economic offsetting gain?

32. Economic cost of death: Throughout this paper, I have referred to the major decision of determining the dollar amount that should be used in economic analysis to represent the economic cost to

society of a traffic fatality. The past proposals need no further discussion, and neither do the basic principles and concepts. As is evident here, I reject all value-based concepts and accept concepts that are based on economic production and conservation of resources. But if proposed improvements in highway transportation systems are to be examined for the relative economy of alternatives, a dollar sum for fatalities is a factor that must be included.

CONCLUSION

This paper presents three main bodies of information: (a) objectives and main concepts of economic (cost-benefit) analysis, (b) principles and concepts on which the economic analysis should be based, and (c) identification of 32 main consequences of traffic accidents and discussion of their role in economic analysis.

The purpose of these three sections is to provide a base for a discussion of the factors involved in determining the economic cost of traffic accidents and their role in an economic analysis of the transportation economy of proposed highway-improvement investments.

The next phase will be to bring persons from all concerned disciplines to a study of just how the entire system of economic analysis should be handled, specifically including the role of traffic accidents. An important and complex phase will be to agree on which of the accident factors (and others not included here) should be included in the analysis and what pricing procedures should be used.

Finally, there will still remain the large task of data gathering. In this final phase, the process would have the advantage of knowing ahead of time just what to look for and how the findings would be used in the economic analysis.

Although I have taken rather definite positions on the factors in the economic analysis procedure, I have done so on the basis that this definite position will be more helpful to the workers in the next phases than would mere statements of problems. I do not infer that I am correct and others are wrong. I am seeking the best practical answers based on definite principles, theories, consistency, and proven economic consequences.

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Discussion

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Winfrey's paper provides an excellent listing and discussion of many of the costs associated with traffic accidents. Rather than criticizing this listing, we would like to question his basic approach to the evaluation of accident costs, specifically his contention that analysis for the economy of highway transportation investments should "exclude all factors that are not related to the conservation of resources." In addition, we would like to draw attention to economists' research on the value of life saving, much of which has been ignored in recent evaluations of traffic-accident costs.

Jones-Lee (3) and others (4,5) have reviewed different methods of evaluating the value of life that should be used in benefit-cost analyses. Based on his review, Jones-Lee concluded that an anticipated reduction in the mortality rate during some period of time affords any particular individual three major components of value: (a) a reduction in his or her share of the real resource costs occasioned by the death of others, (b) a reduction in his or her share of the loss of net output owing to the death of others, and (c) a reduction in the risk of his or her own death or the death of anyone cared about.

Similar comments apply to an anticipated reduction in the rate of nonfatal accidents (3, p. 147).

For the purposes of cost-benefit analysis, the appropriate value to place on the anticipated saving of one (anonymous) life during a particular time period is (in addition to avoidance of real resource costs and losses of net output) given by the average, over the relevant population, of the marginal value of a decrease in risk. Insofar as the concept of a value of life has any relevance in the analysis of safety improvement, this is the appropriate interpretation of such a concept. Other definitions of the value of life, such as the present value of anticipated future output per capita or court awards to the relatives of accident victims, are irrelevant for conventional cost-benefit analysis (3, pp. 149-150).

Jones-Lee also points out that, as far as the existing literature is concerned, the most neglected component of the value of life is the value of the reduction in the risk of the person's own death or the death of anyone he or she cares about. This neglect has also been pointed out by McFarland (6), who referred to this element as the "value of a person's life to himself." McFarland includes four items in his cost of a traffic fatality: (a) cost of lost resources (e.g., property damage and medical expenses); (b) present value of future gross production net of the deceased's consumption; (c) cost of other pain and suffering by the community, not accounted for by lost net output; and (d) value of the person's life to himself or herself. He also points out that "most individuals pay taxes which are used for public goods, and thus, by the nature of public goods, the person contributes more than he consumes since his consumption takes nothing from others." To the extent that the person's output supports true public goods, the benefits to society may be substantially more than this portion of his or her income, even though the opportunity cost of losing this support would be (roughly) the amount of taxes paid. Winfrey's paper, with its emphasis on evaluating only economic factors, economic consequences, and conservation of resources, does not adequately address Jones-Lee's problem of determining the value of life and thus is an incomplete statement of the problem. Although Winfrey does include a short discussion of the individual person's evaluation, he discusses this evaluation in terms of asking "people what they would take in current dollars to avoid death" and concludes that "even if the approach were successful, the answers would not deliver the economic answer that is sought." Winfrey distinguishes between what he calls economic concepts and value concepts. It perhaps should be pointed out, however, that this distinction, and the way that it is made, contradicts the use of these concepts by econo-

mists; for economists, the economic concept is the value concept.

Most states currently use one of three types of values in calculating accident costs.

1. Direct costs: Several state studies have developed the direct costs of traffic accidents; these direct costs basically include only one of the three items listed by Jones-Lee, the cost of lost resources.
2. National Safety Council (NSC) values: The NSC provides estimates of the costs of accidents of different severities; these costs include the cost of lost resources and, for fatal accidents, the discounted value of future production less consumption for the deceased. California uses a similar concept, and their costs have been reported extensively.
3. National Highway Traffic Safety Administration (NHTSA values): NHTSA values include direct costs and the discounted value of future production (not net of consumption as is the case with the NSC values).

The first method, based on only direct costs, provides values that are ridiculously low, usually less than $30 000 for fatal accidents, because no value of life to anyone is included. The NSC values can be interpreted as including the direct cost of lost resources plus a value that at least partially represents the value of the deceased to others, represented by his or her contribution to others as measured by net production. The NSC values do not include any value for the person's self worth. The NHTSA values do not subtract the deceased's consumption, and this part of their value can be interpreted as being a partial representation of self worth. Recent research, however, indicates that the present value of future consumption underestimates the value of a life; thus, even the NHTSA values underestimate the accident costs that should be used in benefit-cost analysis.

It may be concluded, therefore, that neither the NHTSA values nor the NSC values are appropriate for use in benefit-cost analysis. However, of the two, the NHTSA values are preferable because they include a measure of the value of the person's self worth (the present value of the person's expected earnings that he or she would be expected to devote to his or her own consumption expenditures). The NSC values, by subtracting out this measure, give clearly inadequate representations of the costs of accidents.

Values based on market approaches are preferable to the NHTSA values. Recent theoretical work has shown with certain reasonable assumptions that the amount a person will pay to reduce his or her probability of being killed is greater than the amount that would be calculated by multiplying that reduction in probability by the present value of expected future consumption. More specifically, Conley (7) concluded that, in general, the value of life saving is greater than the discounted lifetime labor income and, in early and middle adulthood, greater than the discounted lifetime consumption.

Although there are both methodological and empirical problems associated with market-oriented methods, recent research indicates that the theoretical problems are being solved. Also, recent empirical research indicates that market-oriented approaches can be used to calculate reasonable values. Among the recent studies that have calculated values for life are

1. Carlson--compensation to pilots for risky flying--$200 000 to $1 000 000 (8),
2. Jones-Lee--from questionnaires about airline choice--approximately $6 000 000 in 1975 dollars (3),
3. Thaler and Rosen--risk premium for working in risky occupations--about $260 000 in 1975 dollars (9),
4. Ghosh, Lees, and Seal--speed of travel on British motorways--about $260 000 in 1975 dollars (10),
5. Melinek--study of choices between crossing a road directly or using a safer but slower subway crossing--about $340 000 in 1975 dollars (11), and
6. Blomquist--study of motorists' decisions to use seat belts--$257 000 in 1975 dollars (12).

These studies, especially Blomquist's, which appears to be both the best and also the one that is most relevant to traffic accidents in the United States, indicate that a value of life that is acceptable for current use can be given. Although more research, both theoretical and empirical, is indicated, the evidence available at this time suggests that a value of about $257 000 in 1975 U.S. dollars would be appropriate for use as the value the average motorist places on the value of his or her own life to himself or herself. The U.S. consumer price index can be used to update this value to current dollars.

To derive total values of life saving to be used in benefit-cost studies, this value should be added to the value of lost resources (i.e., items such as the costs of medical expenses and property damages) and the value of the person's life to others [which, at this time, perhaps can best be estimated as the value of the person's future production less consumption (6)]. [However, it should perhaps be pointed out that recent research has given an indication of the value to relatives of a person whose life is at risk. By using the national age-sex distribution in Great Britain, Needleman (13) has calculated that the total estimated valuation of relatives is 45 percent of the valuation of the person himself or herself.]

Thus, the $257 000 (1975 dollars)/life saved should be added to the direct cost of the accident and the cost to others. For example, the NSC values and also the California (14) and Burke's (15) values, should have added to them $257 000/fatality. To derive costs per accident for different types of fatal accidents, the average number of fatalities per accident must be multiplied by the $257 000 (after updating).

The cost per fatal accident can thus be derived roughly as follows: (a) use the NSC cost per fatal accident of $113 500 in 1975 dollars as representing the costs of lost resources and of lost net output and (b) use the average of 1.17 fatalities/fatal accidents (14), together with a value for life, to the person whose life it is, of $257 000, to derive a cost for this item of about $300 700/accident. Adding $113 500 and $300 700 gives approximately $414 000 as the cost per fatal accident in 1975 dollars. Probably the best estimates to use with these costs for the costs of injury accidents and of property-damage-only accidents are those developed by NHTSA, which are $14 600 and $650 respectively in 1975 dollars.

Using 158.6 as the consumer price index for April 1975 (with the 1967 base of 100) and updating the above values to February 1978 (when the consumer price index was 188.3) gives the following approximate accident costs for 1978.

Type of Accident	Cost ($, 1978)
Fatal	491 000
Injury	17 300
Property damage only	770

Because NHTSA reports the loss of gross output rather than net output, the cost per fatal accident cannot as readily be derived from their values, but presumably this could be done given their basic data.

One difficulty in using the NSC and NHTSA accident-cost values should be emphasized. Neither of these sources gives costs by type of accident (such as head-on, rear-end, or angle collisions), nor do they give breakdowns by type of road (such as two-lane or four-lane undivided), nor by type of area (urban, suburban, or rural). Because of this lack of detail, persons using their costs often use the same cost for a fatal pedestrian accident as for a rural, head-on accident (only one person may be killed in the pedestrian accident but there are an average of 1.4 fatalities and 1.6 nonfatal injuries in rural head-on accidents). Thus, for evaluating accident countermeasures, it may be more desirable to update, by using values such as Blomquist's, accident-cost values such as those for California (14) and Texas (15), rather than trying to modify the NSC or NHTSA values. It should be pointed out, however, that the NHTSA approach for evaluating costs of injuries may be preferable to that used in the state studies and, ideally, the approaches could be combined or better methods could be developed of evaluating the injury costs associated with different types of accidents, taking into account that more severe injuries are associated with certain types of accidents.

Another point perhaps deserves mention; at the 1978 Transportation Research Board session on accident costs, the NSC representative defended the NSC values on the bases that they are conservative, have become widely accepted, and are practical from a political standpoint. However, these values, by subtracting out the individual's expected future consumption, omit any measure of the value of the potentially deceased's life to himself or herself. Although the NSC values reflected the state of the art at the time they were first published, recent research has shown that they no longer do so; neither does the approach reflected in Winfrey's paper. Use of these values can lead to a misallocation of resources (safety funds).

Although further research on the cost of lost resources (property damage, medical costs, and such) may be needed, a more immediate need is for research along the following lines:

1. Values for life, indicating the value of the person's life to himself or herself, should be added to appropriate values for the avoidance of real resource costs (direct accident costs) and losses of net output to derive traffic-accident costs that can be used to evaluate safety programs;
2. The market approach should be used to validate and extend to other situations the values developed to date; and
3. Costs of accidents should be developed that could be used for specific countermeasures; often, the same costs are used for widely varying types of accident countermeasures, even though different countermeasures are intended to affect accidents of different types that have significantly different expected numbers of fatalities and injuries per accident.

This research probably could be accomplished by using existing data and relatively modest funding. This is in marked contrast to the funding of $1 million or more that many people believe is currently justified for developing better estimates of the costs of such items as property damage and medical expenses. It is our contention that research should attempt to derive answers that are vaguely right, rather than precisely wrong.

ACKNOWLEDGMENT

The comments in this discussion are based on research performed for the U.S. Department of Transportation. We are indebted to Robert Lavell and the members of the project staff for their assistance in this research. The contents of the discussion, however, reflect our views only and do not necessarily reflect the views or policies of the Department of Transportation.

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Author's Closure

The discussion of my paper presented by McFarland and Rollins is most welcome. Even though I totally disagree with their concept and philosophy, its publication along with my paper offers the readers a ready comparison of the two approaches--the economist's value concept and the engineer's cost concept.

The economist can, by personal judgments, derive a value of human life if he or she wishes to do so. Such value has been rightly ignored in cost-benefit analyses because it is wrong to base the investment in highways on personal judgments of dollar values as compared with market-based dollars. McFarland and Rollins do not state any other application of the dollar value of a life. It is assumed that the value of life as determined is applicable to all of the 2 000 000 deaths in the United States per year.

McFarland and Rollins do not say why the cost concept is wrong because it involves the cost, market price, and conservation of resources. Nor do they say why their value concept is to be preferred to the cost concept. In fact, they do not recognize that there is a difference between cost and value--these words do not have the same meaning. An analyst should not commit the crime of adding personalized dollar values and marked-price dollars. Such arithmetic makes no more sense than adding U.S. dollars to Singapore dollars just because the two monies are called dollars. In cost-benefit analyses, highway construction dollars and motor-vehicle operating-cost dollars cannot be added to personalized dollar values of a life.

Publication of this paper sponsored by Committee on Application of Economic Analysis to Transportation Problems.