

# Evaluation of Highway Impact

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● THE SUBJECT of highway impact has received much attention from highway planners, engineers, and administrators. Certainly the subject deserves all the attention it can get. The authors' present concern with the subject is that of the planner, or more precisely of the engineer as he operates within the framework of the planning function. In selecting a highway location is "impact" something to be considered? What is impact, and what kinds of impact are there? If impact is something to be considered, how can it be identified and predicted? What should be done with these measurements or predictions? These are questions which unfortunately are more complicated than they sound. Hopefully, they are questions for which workable answers will soon appear. They are questions, however, to which the sort of answers needed are not now available. It is this last fact that is of principal concern.

Briefly, the authors not convinced that either the data on highway impact thus far collected or the uncertain conclusions advanced therefrom are of any real use in making decisions regarding the economics of a highway program. If these findings do have a use, it seems most logically to be in connection with traffic prediction (1), over-all land-use planning, or land acquisition, but not with the economic justification of location and design. This is notwithstanding the fact that some very complete studies of so-called "economic impact" have been made in recent years (2, 3).

It is important to note that the discontent with these findings is as engineers, not as social scientists, though perhaps the questions at issue are more properly within the realm of the social scientist than the engineer. However, engineers cannot escape the responsibility for bringing highway planning and location studies to some definite conclusion. The social scientist, who should long since have surpassed the engineer in his ability to render sound judgments on the very complex questions here at issue, has thus far shared very little in this responsibility. The fault, is largely the engineer's, not his. The engineer's concepts of such things as "economic impact" do not seem to do the job. Not only do the engineers need the economist, the sociologist and others; but they need to use them.

Sharing the responsibility does not, however, mean renouncing it altogether. This, highway engineers cannot do. They must still understand the problem as it relates to the engineering job, even though this may not require them to formulate the basic concepts. It is in this spirit that the authors have undertaken to review the subject of highway impact.

## WHAT IS IMPACT?

It is impossible to separate the question of whether impact should be considered in planning and location from the more basic question of what is meant by highway impact. In the ultimate sense, if it could be specified exactly what is meant by impact, all questions regarding its measurement and how it should be accounted for in decisions would be answered. It does not seem the matter can be disposed of so easily. In general, it can be agreed that when the "impact" of a highway is spoken of the effect of its construction and operation on the character of its total environment is brought to mind. Within this definition highway impact can still mean many things to many people. It can be and often is thought of solely in economic terms. It can be but is not so often thought of in social terms. It should be and fortunately is being thought of more and more in aesthetic terms. It is almost always thought of, though perhaps not by engineers, in political terms. Which frame of reference is the important one, then? Where does one begin?

Clearly all points of view are important. To say one is most important is probably not meaningful as a general statement. Yet it would seem possible to reduce the problem in some respects. One can logically suggest, for instance, that the aesthetic impact of a highway manifests itself in part as either an economic or a social impact. That is, the impact of a highway on the senses of those who use it or those who inhabit its environment has an ultimate effect on the way in which those people are impelled to order their economic and social activity and the degree of satisfaction which this produces for them. By similar reasoning one might also account for the political impact of a highway by specifying its economic and social impact.

One might go even further by explaining social impact in economic terms. If people have a discernible preference for one alternative social situation as compared to another, then presumably they will be willing to pay something for it. Inasmuch as anything for which a money market exists can be said to have economic value, the shift from a social to a strictly economic point of view is perfectly possible in theory. Yet the practical difficulties are too obvious to mention. In the present state of ignorance, moreover, the probability is that if such simplifications as these are made, the extremely complex set of relationships which are actually involved may be obscured. Thus, it seems not only necessary but desirable to consider the question of impact from at least these four points of view, economic, social, aesthetic, and political.

Of these four, economic impact has received the most attention in recent years, and for obvious reasons. There has been a profound restructuring of economic activity in the environs of many controlled-access highways immediately after their construction. This experience has raised the possibility of using highways as an instrument in a purposeful program of economic change. It has also suggested that to the extent the resulting changes are desirable one might find in them a further economic justification for the building of highways. These possibilities appeal greatly to highway administrators and to engineers. The interest in economic impact is, therefore, logical.

This paper is primarily concerned with economic impact largely because this puts both the reader and the authors on somewhat more familiar ground, and not because of any intention to minimize the importance of the other types of impact mentioned. It is the authors' conviction, in fact, that the social impact of highways will in the long run be the more important problem.

#### WHAT IS ECONOMIC IMPACT?

"Impact" has been defined as the effect of a highway improvement on its total environment. It seems logical that to the extent this effect manifests itself in an economic form it can be spoken of as "economic impact". Again, one should not confuse this economic impact with the value which may be attributed to, say, the aesthetic benefit of an improvement. To put it another way, if impact is what happens to the environment of a highway, economic impact is what happens to the economy of the environment. As such it has little necessary connection with aesthetics or with social and political structure.

Each of the many economic impact studies seems to have redefined, either explicitly or implicitly, the term "economic impact". Most commonly, however, these studies incline to the view that the non-user (non-vehicular) economic benefits (or changes) resulting from an improvement constitute its economic impact (4, p. 20). This point of view is not entirely consistent with the more general definition suggested previously. It does, nonetheless, serve as a fairly good working definition. The distinction made between user and non-user benefits (which may also be referred to as vehicular and non-vehicular, or as direct and indirect benefits) is one which facilitates the study of impact questions.

Excluding user benefits from economic impact does not obviate the need to include them in this discussion. It is necessary to understand the nature of user benefits to avoid confusing them with economic impact (4). User or vehicular benefits are a key, in fact, to an understanding of non-user benefits; that is, economic impact (1).

Basically user benefits take the form of: (a) vehicle operating cost savings; (b)

time savings; (c) a reduction in accident costs; and/or (d) an increase in "comfort and convenience." Where an existing highway has been improved, for example, the users of that highway presumably will receive benefits in one or more of these categories. Characteristically improved roads will do more than that, however, in that they will serve some (and perhaps many) users who either did not use the old road or who did not use any road before the improvement was made. There are three classes of users (5) then, that are of interest here:

1. Those who used the old road (if any);
2. Those who previously used another road; and
3. Those who previously did not use any road;
  - (a) More frequent trips between previously existing origins and destinations,
  - (b) Trips previously made by other modes of transportation, and
  - (c) Entirely new trips which the improved facility has now made "worthwhile".

Some comments on the benefits realized by the last two of these three classes of users are in order. In the case of a user who formerly took another route, the time and operating cost benefits on the new route may be negative. The comfort and convenience benefits may appear to be negative as well. One may be tempted to suggest that the user is therefore acting irrationally and to point out that it is impossible to predict irrational benefits on a rational basis. The answer to this apparent inconsistency is that if a user changes his route he does so because he is receiving a positive benefit as far as he is concerned. If he were not, he would not have made the change in route. If the values which engineers choose for time or comfort and convenience do not correspond with what the motorist actually does, then it is the engineer's values which are wrong. Whether one can consider the user's action rational or not is beside the point.

In the case of the entirely new trips using the improved road, a similar confusion may arise in that the operating and other user costs are necessarily greater than when no trips were being made. It would thus seem that these were negative benefits, but quite the opposite is true. The question of how large these benefits really are is discussed elsewhere (6, p. 40). It is important to point out, however, that this situation necessarily involves a diversion of consumer expenditures from other sectors of the economy. (When a highway attracts new trips in this fashion, the government has, in effect, set itself up in business to compete for more of the consumer's dollar. If the consumer sees fit to buy, moreover, it is an indication that the service offered is justified—assuming, that is, that he not only pays the full costs involved but realizes as well what he is paying.) As a result, the actions of this class of users may be of interest in connection with the total impact of the improvement on its environment. Unfortunately this shift of expenditures is generally so diffused as to be relatively unsusceptible to measurement.

There is one additional class of user benefits which deserves mention, if only because it is so generally ignored. These shall be called second-order user benefits to distinguish them from the benefits discussed previously (which can thus be thought of as first-order user benefits). Second-order user benefits are those accruing to the users of routes which have been partially abandoned by other users in favor of a new or improved route. These benefits will characteristically take the form of a reduction in congestion delay, and thus are clearly net benefits. Because they may in some cases be significant, they merit consideration in any complete economic analysis.

Highway improvements do not necessarily produce user benefits (or disbenefits) which are significant. In a case where they do not produce user benefits, it is doubtful that there can be any non-user benefits either. In the more likely case where there are direct user benefits (in detail if not in the aggregate), one might expect, however, to find some non-user benefits—that is, economic impact—as well. Before going on to discuss this possibility, exclude from consideration a type of benefit which really does not belong in this picture. This is the sort of benefit exemplified by an improvement to local drainage incident to the construction of a highway. This, it is true, may be an economic gain to the community and as such may justify part of the construction costs. It is, however, a tangible external economy that is more proper-

ly classed with user benefits than with the less tangible non-user benefits of interest here. For the time being, similarly exclude social, political, and aesthetic benefits, though for different reasons.

Can a highway produce anything other than transportation which has economic value in its own right? One notion of the transportation product would seem to suggest an entirely negative answer. This is the notion that almost no one wants transportation for any by itself. Everyone seems to want it only to get something else; to get to work, to see a movie or to get cargo to some place where it can be used. It is always what takes place at the end of the trip which has real value, not the trip itself. Thus, in most cases transportation is merely a means to an end, not the end itself.

In this sense improving the transportation system can only be a conservative process. That is, by improving highway facilities the best that can be hoped for is to conserve the total resources expended on transportation so as to make them available for some truly desired objective. This is possible, of course, only if more user costs are saved than expended on the highway plant. Thus, one returns to vehicular benefits.

What about an increase in land values? Highway improvements seem to have an effect in this respect. Yet, a highway cannot create land. It can only increase the relative accessibility of that land. Increased accessibility is just another way of saying that the difficulty of getting to the land in question has been reduced. That is, the cost of transportation to the user has been lowered. Increased land values, therefore, are merely a reflection of user benefits which have been realized or are anticipated. This is the sort of shift in benefit which Zettel has explained. An increase in real estate tax receipts, though clearly a benefit to the communities concerned, similarly has its origins in these same vehicular benefits.

What about improvements in a production process which stem from improvements in transportation? Economics of scale in production are often realized when better transportation permits a concentration of production activities. At first glance it might seem that economics of this sort are separate and apart from the savings in transportation costs. A closer look reveals that this is not so. In the first place, if an activity which formerly was performed at several locations is now to be performed at one, the total transportation requirements characteristically will increase. Thus, the transportation costs will tend to increase. The question is whether or not they will increase more than the rest of the costs of the activity decrease. If the transportation costs do increase more than other costs decrease, the concentration is not economically desirable. If they do not increase that much, the concentration is economically desirable.

If concentration of a certain production activity did not take place before the transportation facilities were improved, this would indicate that the unit cost of transportation to the producer was too high to make the concentration economically desirable. Lowering the unit cost of transportation by highway improvements could make it economical to concentrate, on the other hand, and to realize the benefits of lower production costs in the process. Notice here that a lowering of transportation (that is, user) costs is a necessary condition. Notice further that this reduction in total transportation costs under what they would have been had the new road not been built must be at least as large as the saving in production cost. It must, in fact, be larger, or there will be no net benefit to the economy. Yet if the benefits accruing to the three classes of users mentioned earlier are properly accounted for credit will already have been taken for all of this reorganization benefit in the form of user benefits. (Again the question of how one should properly account for these vehicular benefits will be left unanswered. It suffices to say that only part of this apparent benefit is actually realized.) Thus, even this type of non-user benefit seems largely imaginary.

The foregoing discussion leads, in any case, to the conclusion that the net economic benefits of highway improvement are all user benefits—that there are no net non-user benefits over and above the user benefits. Even so, the restructuring of economic activity which highway improvement so often catalyzes is of importance in highway planning. It definitely can produce benefits to some sectors of the environment; apparently it may, however, produce disbenefits to other sectors in the process. To

signify that these non-user benefits are a mere reflection of direct user benefits, they shall henceforth be referred to as secondary benefits.

### HOW MIGHT SECONDARY BENEFITS BE MEASURED?

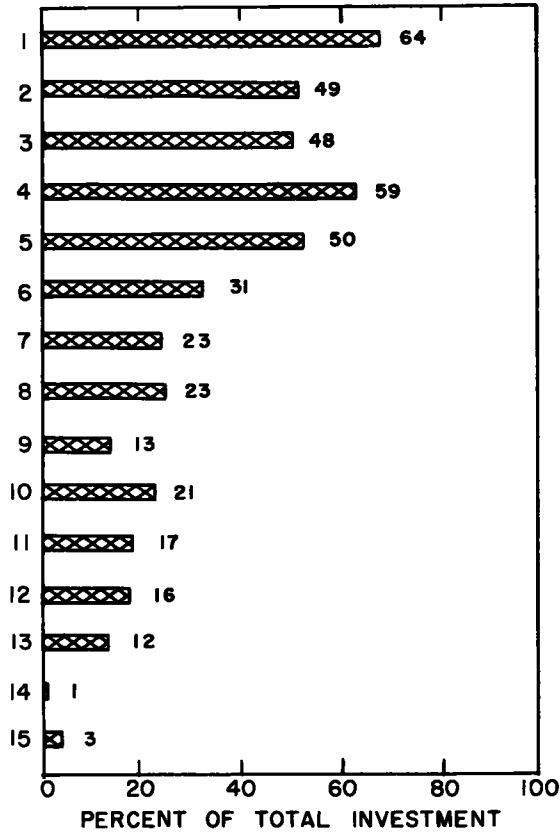
The process of identifying the changes in economic activity (including expansion, consolidation, and/or relocation) resulting from highway improvements is extremely complicated. Determining the magnitude of such changes is even more difficult. The relative accessibility of new and old locations—whether evaluated in terms of market size offered, or in commercial transportation costs—is but one of the variables which will affect the short- and long-run land-use changes taking place. For any economic activity there are also other considerations such as the relative importance of accessibility, space requirements, water supply, etc., to different types of activity; availability of land with varying degrees of accessibility; relative importance and magnitude of transportation costs (in terms of markets or movement of goods per se) as opposed to other production costs; tax structure of new and old locations; and marketability of the firm's existing plant.

At the outset some remarks regarding past economic impact studies are pertinent. First of all, these studies have dealt primarily with what the authors have called secondary benefits. Also, they have generally restricted their attention to measurement of changes in value of those properties (both improved and unimproved) abutting or within perhaps two miles of the highway. This is tantamount to saying that changes will take place only in this limited region. Some studies have reduced these value changes to the percentage increases which have followed the highway improvement; others have rated the increases relative to those of "control" zones or properties deemed unaffected by the facility. Where absolute values have been used and it has been implied that all these values were secondary benefits of the facility, some clarification is necessary. Certainly land value increases can and do result from user or primary benefits; they should, therefore, be classed as secondary benefits of the highway. On the other hand, it would not be correct to assume that all of the value of the improvement to that land was secondary benefit of the highway. This improvement value increase can be included only to the extent that accessibility (or other forms of direct highway benefit) played a role in the location and development decision.

In determining the extent of the highway's influence on relocation decisions, the results of one recent study of industrial development (2) may be of some aid in suggesting an approach. About 80 firms which relocated following the construction of Massachusetts Route 128 (a semi-circumferential route surrounding Boston on the western side) were interviewed and questioned regarding the major factors in their decision to move to Route 128. The replies were then tabulated under one or more of 15 factors or headings and each factor, if more than one was given, was "weighted" equally (Fig. 1). The investment represented by those companies indicating the factor of "Land for Expansion", for example, was then added up. This sub-total divided by the total investment of all 80 firms interviewed is the "Percent of Total Investment", or an index of importance, attached to the "Land for Expansion" factor. These percentages or indices are thus a measure of the relative importance of these factors to the industries involved. How then might they be used to evaluate the extent of the highway's influence?

The sum of the percentages of all 15 factors is 430. Thus, the importance of any one factor (or group of factors) might be expressed as its percentage divided by the total percentage of 430. Assume, for example, that the only location factors which can be traced directly to the user benefits of the highway are:

<u>No.</u>	<u>Site Location Factor</u>	<u>Percentage</u>	
2	Labor market	49	
3	Employee accessibility	48	
4	Commercial accessibility	59	
6	Advertising	31	
10	City congestion	21	
12	Commercial market	16	
	Group sub-total	<u>224</u>	
			Grand total for all 15 factors 430



**FACTORS**

- |                             |                     |                              |
|-----------------------------|---------------------|------------------------------|
| 1. Land for Expansion       | 6. Advertising      | 11. Lower Taxes              |
| 2. Labor Market             | 7. Parking          | 12. Commercial Market        |
| 3. Employee Accessibility   | 8. Land Cost        | 13. Railroad Facilities      |
| 4. Commercial Accessibility | 9. "Package Deal"   | 14. Other                    |
| 5. Attractive Site          | 10. City Congestion | 15. Potential Value Increase |

Figure 1. Rating of major factors considered in site selection by industries interviewed on route 128—September 1957.

Inasmuch as the factors having a direct relation to the transportation service offered by the highway make up slightly over 50 percent (224/430 x 100) of the total decision, it might be concluded that 50 of any improvement value changes (of the area being studied) can be classified as secondary benefits of the highway.

Two other important aspects are worthy of consideration at this point. First, because property value increases can be a reflection of either first- or second-order user benefits, the area of consideration must not be limited solely to bands or zones within close proximity of the new highway. Development some 5 or 10 miles distant from the road may be affected to the same or greater extent than that adjacent to the highway, and, again, either by first- or second-order user benefits. Research must also be sufficiently accurate to identify whether these transportation benefits are in fact associated with the facility in question rather than with other transportation improvements which occurred elsewhere at approximately the same time (or a combination of these events). Secondly, if the development being considered is one of relocation, the losses or decreases in value at the former locations must be taken into account.

The foregoing remarks also apply to new development taking place following highway improvement. For example, assume a highway is constructed which provides sizeable tracts of vacant land with good accessibility to large consumer markets where previously the transportation service was inadequate. That is, the unit cost and/or total cost of transportation prior to the improvement was high enough to discourage travel between other land uses and the vacant land. As a result of the improvement, realtors, developers and retailers combine interests and construct a large-scale shopping center on a portion of the vacant land. Certainly the added value can properly be considered as a positive secondary benefit of the new highway to this area. However, it would seem that at the same time disbenefits will accrue to other parts of the community where this new investment is not being made. These disbenefits should be balanced against the gains. In this case, as a result of the change in retail attractive forces (that is, there are now two centers of attraction, one for example, at the downtown core and the other adjacent to the highway) and the change in relative accessibility of these centers to their employee and consumer markets, the attractive force of the former retail center has been reduced. It thus stands to lose business and profits. This is another way of saying that the property values at the old center may decrease in the long run, at least with respect to what they would have been without the highway. Should not these disbenefits be balanced against the gains realized at the new shopping center?

"Reorganization benefit" is another secondary effect, resulting from reorganization or relocation of activity following a highway improvement (4). This reorganization may be required to take advantage of a shift in markets (that is, a change in relative accessibility) and may represent gains to an individual firm. These gains may be measured in terms of more profit for the industry, a lower unit price of the product (or service) to the consumer, more production (which might follow the previous gain), and/or an expansion of the company. This type of secondary benefit must be measured and included in any comprehensive secondary benefit study.

It is also of interest to ask what is known about measuring these benefits at the present time. Thus far the tendency has been to conduct research only on those highways which have had an obvious impact, and then only in so-called "zones" of influence. Research this narrow in scope can only yield information that is biased. In other words, the "sample" on which present thinking must be based is not representative. Any generalizations made can be applied only to impact that takes place adjacent to a road, only to industries of certain types, only to areas abutting certain types of roads, etc.

If more general questions with regard to secondary benefit are to be answered, investigations in both scope and depth must necessarily be extended. The entire community or region in which the highway improvement takes place must be studied before, during and after construction. Perhaps a region can be cross-sectioned in much the same fashion as that used for some of the more recent transportation studies. In general, it must be known what kinds of secondary benefit take place as a result of highway improvement, how much benefit there is, and where it occurs. Listing all the information which must be collected and analyzed to answer these questions to the satisfaction of all concerned is a research study in itself. Nevertheless, it is not impossible to identify some of the major areas of inquiry which a study of secondary benefit might include:

1. Investment in land and improvements.
2. Production costs (by amount and percent in labor, rents, raw material, and transportation).
3. Market characteristics.
4. Accessibility (7).
5. Land prices and quality.
6. Other site location factors (such as listed in Figure 1).
7. Incidence of highway costs.
8. Local economic conditions.

Each of these factors should probably be evaluated in both absolute and relative terms, before and after the highway improvement. Each factor should also be evaluated by industry or activity type.

Although one is led to the conclusion that non-user benefit is more properly a secondary effect of highway user benefit and thus of itself provides no net economic impact, it must be recognized that this conclusion remains to be proved by field experiment. (It must also be realized that no study to date has proved the converse, that non-user benefit does in fact provide some net benefit.) It is the authors' feeling that research of the nature suggested here could not only establish more definitive relationships between highway improvement and its secondary effects but also allow engineers and planners to test the hypothesis that the net non-user benefits (over and above the user benefits) of a highway are zero. If the sum total of these non-user effects exceeds that of user benefits, then obviously the conclusions would be incorrect.

### THE IMPORTANCE OF SOCIAL IMPACT

It was suggested earlier that the economic impact of highways might in any case be less significant than their social impact. Unfortunately this is a subject to which highway planners and engineers have devoted only the most meager attention in the past. Yet, the changes which highway transportation has wrought in the structure of society are everywhere so obvious that they scarcely need mention.

Hennes (8) has pointed out, in fact, that at one time highway construction was impelled largely by social, not economic motives. This was at a time when the absence of all-weather roads meant virtually that people living in the country could not get around at all. This is no longer the important problem. More recently the problem has been one of getting around more quickly and more economically. Another force has been at work, however, as more and more people have acquired their own automobiles and the time to use them. Universal mobility on a local, regional, and continental scale has been achieved. Though this certainly has much to do with the structuring of the economy, it seems even more significant as a social fact.

Why, then, have highway engineers and administrators made almost no attempt to evaluate this aspect of highway impact? Several reasons can be advanced. First, one could say, this is a problem for politicians, not highway administrators. Second, the change takes place rather gradually, at least on a national scale, so that the problems are more long-term than the average engineer or administrator can handle effectively. Third, no reliable techniques for identification and measurement of social impact are available. Fourth, there is not any clear-cut or even any not-so-clear-cut scale of social values against which to weigh decisions.

Yet, these objections fail to alter the facts of the case. Major changes in accessibility and personal mobility are producing profound changes in the structure of social life. Certainly what highways or a lack of them will do to the way of life in large cities is no longer an idle question. Rational planning of transportation systems can no longer be done in the absence of some consideration of the social structure one wants most to promote (9). Nor is it likely that one can ignore such questions on a regional or national scale either.

Highway administrators and engineers could, in fact, find a number of compelling arguments to refute these reasons for indifference to the problem. Why, for instance, are social impact questions left entirely in the hands of the political process, where they currently can be answered only with the utmost difficulty? Is it not because those responsible for highway improvement programs have failed to examine and report to the public on expected social impact? It seems entirely reasonable to suggest that highway planners are just as responsible for providing this sort of information as they are for providing an estimate of costs and economic benefit. This argument does not, of course, do away with the difficulties involved. Social change is something which takes place relatively slowly and it is difficult to measure. Yet the fact that one must speak in qualitative terms, and then with much uncertainty, does not mean that one should not try at all. Presumably the concern is with rational planning. The very word rational implies attention to the outcome of the planning process. Social change is an outcome of highway planning. (The authors do not mean to imply that no one has worked on these problems. Some excellent work is even now in progress. The important thing here is that those responsible for highway planning seem to pay little attention to what has been or is being done.)



The problem of establishing a scale of values is admittedly confusing. Certainly little is known about what social change is "worth" to people. As suggested earlier, an attempt to translate social gains into explicit money terms can do more to obscure the problem than to solve it. Yet much could be done if studies were undertaken to identify and evaluate even in qualitative terms the expressed preferences of people involved in the political (that is to say, ultimate) decisions relative to highway construction. Such studies might also identify the extent to which decision-makers at various levels are truly aware of the implications of highway improvement. This could, among other things lead to a better specification of the data which highway administrators should have and should furnish in connection with the total planning process.

In any case, there is much to be done on the question of social impact. Highway planning has long since passed the stage where it can proceed in a vacuum, social, economic, or otherwise.

### CONCLUSION

A number of suggestions have been advanced here. Foremost among these is the authors' conviction that there is no logical basis for assuming highway improvements can produce any net economic benefits over and above user benefits. Not only have the authors and other students of the problem argued this point of view, but the highway impact studies to date have failed to prove the contrary point of view. One important conclusion follows immediately from this; namely, that non-user benefits cannot be used as economic justification for improvements. This is not to say, however, that what the authors have called the secondary economic benefits of an improvement are of no importance in the planning process.

Secondary benefits such as increases in land values, increased industrial investment, and expansion of retail trade areas are obviously of importance in the over-all picture of land-use development. An ability to predict the nature and magnitude of such benefits is a prerequisite for the formulation and implementation of any effective land-use plan.

Secondary benefits are of even greater interest, perhaps, because of their effect on traffic generation. An estimate of the magnitude of this feedback effect is an essential part of the highway design process. It is, in fact, a problem which has received major attention in several urban transportation studies, though the term impact itself may not have been used. Insofar as these secondary benefits affect traffic, moreover, they affect total user benefits as well. (Where the change in accessibility which results from an improvement is large, the admissible benefits for vehicles making entirely new trips may be substantial. If the impact (that is, secondary benefits) of the improvement produces large volumes of such new traffic, the total vehicular benefit thus may be very large.) Inasmuch as user benefits are the basis for economic justification, secondary benefits can thus have an important, though indirect bearing on the economics of planning and design.

Unfortunately there is not enough understanding about the relationship between highway improvement and its secondary benefits to make reliable judgments in connection with both land-use planning and traffic estimation. Though some very interesting studies have been done, they have had some serious limitations. They have concerned themselves only with roads whose impact was clearly significant and, more than that, with roads whose benefits were apparently heavily on the plus side in the zones of influence studied. (It is possible that the study of the eastern end of the Connecticut Turnpike, for example, will yield a far less bouyant picture than have most of the earlier studies.) The restriction of the influence zones themselves has been another limitation. A third difficulty with these studies is that they have generally failed to distinguish that component of economic activity which depends in some way on transportation from that component which does not. The net result of all this is that the available findings probably have a heavy bias. More than that, though there is information on what has happened following highway improvements, there are not yet any really clear ideas of how to predict what will happen for highways still in the planning stage.

There is a good deal to be learned, then, about the economic impact problem. There

is even more to learn about other types of impact. There is reason to suspect that haste to justify highway improvements economically with a great array of non-user "benefits" may be a diversion to a relatively unimportant byway. The most important questions which highway planners will have to answer in the next few years may be social and not economic ones.

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#### *Discussion*

**SIDNEY GOLDSTEIN, Bureau of Public Roads**—The writer would like to state that there is almost complete agreement on the need for economic impact materials for various planning purposes. Professors Lang and Wohl do concern themselves mainly with the economics of location and design and the use of these materials for such a purpose. In the process, however, the authors make some statements which have broader implications, and it is to these that the writer directs his comments.

Highway impact has many facets. There is no doubt that in a sense the first order of any impact is through vehicle use. To separate vehicular from non-vehicular uses, however, so as to measure benefits derived in each of these categories is neither better nor worse than specifying these as first- and second-order benefits as is done by the authors.

Economic impact of a highway improvement can be approached in different ways. For instance, if one could measure economic activity fully and account for property values fully and all transfers not counted in the activity measures—and if these measures were supplemented by a means of allocating various items of highway influence, one would be able to trace the changes in activity occurring because of highway impact.

Rather than separating the economic impact into different kinds of benefits, the writer believes it might be more appropriate to look at types of consequences. Highway activity once identified finds its way through the market system and "triggers" other activity.

To say that economic impact is vehicular-derived and therefore that non-vehicular or second-order benefits may virtually be ignored in highway justification is like saying that because employment is derived from sales or demand—an axiom in textbook economics, there is no use to study employment, occupation, income, etc., but rather that one should study only demand or sales. The measurement and evaluation of economic activity through such a development as the reorganization engendered by a highway improvement is certainly an alternative approach to understanding the underpinnings of highway impact.

If the writer may draw another analogy—the fact that the national income accounts

collect information on expenditures is no reason to abstain from collecting income data from sources derived or factor payments. The two make a totality. Similarly, because benefits or effects are counted at the user level is no reason to ignore the rearrangement of resources (the non-user level). In a dynamic situation, the rearrangement of resources to achieve economies and more efficient allocation of resources may be only partially related to time-distance. There may be compelling socio-economic motives for rearrangements ranging from institutional prestige, parking facilities, labor supply, neighborhood, to cost determinants for investment. For these reasons, the origin and the incidence of economic activity are both equally and alternatively means of measuring "benefits" to the community or to the economy.

The economic impact studies, it is true, have been concerned with local effects adjacent to the highway. Although a measurement of this type doesn't show the effect upon the community as a whole it does provide a measure of the restructuring that takes place within proximity to a highway facility. The use of the "study" and "control" mechanism is at least some attempt to filter out influences which are attributable to the highway.

Transfers in economic activity are always occurring. In the most sophisticated analysis of national income, transfers are completely disregarded, although activity measures are included. To the extent that economic impact studies attempt to determine the influence on investment, land values, or property transfers, they provide information beyond the scope of the usual economic approach for the economic impact studies also provide information on such activity as employment, retail and wholesale sales, services, etc.

The fact that economic activity in one location might have occurred in another location if the highway had not been built, is like saying that national income analysis is faulty because consumers have substituted one industry for another in their demand for products. The interest is in how the highway improvement restructures economic activity and its physical organization. The assumption that business and labor saw fit to reorganize implies an economic advantage for them from the point of view of costs or utility.

The authors' familiarity with metropolitan area studies appears to bias them in the direction of desiring answers for an entire metropolitan area rather than the area adjacent to the facility. In some localities, of course, economic impact studies can arrive at net consequences through the normal study and control approach; in other communities, even in metropolitan areas, an approximation of the influence of the most sensitive areas are desired (adjacent to the highway).

As to whether the benefit to an entire community can be adequately evaluated in terms of net dollar value of property gains, net dollar value of economic activity and net dollar value of transfers implies a finer knowledge and development of local economic accounting than has been done thus far even in the more sophisticated transportation studies. This is not to say that the researchers are not aware of the needs for a framework of local accounting which can fit into a national accounting scheme and can provide this type of information.

To say, however, that these benefits are vehicular derived ignores the concepts of the restructuring of people, commerce and industry. These engender other advantages through the market process over and above transportation costs, and change the production cost structure because of the reorganization of the factors of production. The impact is no different from any other dose of investment in the economy with the attendant consequences.

Because a highway may be considered a technological improvement, an innovation, a dose of investment, it changes conditions from what they were. The influence may be traced through a community and the dollar effects and restructuring effects can be approximated.

Although it is conceded that these economic impact studies have considerable use in connection with traffic prediction, land-use planning and land acquisition, it is believed that to the extent that it has been possible to document occurrences and restructuring that occur, the economics of location and design should and many times do take these into effect in determining proper load factors, in determining relative use of the high-

way, and in considering the service of the highway. Location should not be separated from the other items. If the results of economic impact studies give some indication of different-order effects, it is only logical that they should be used. In fact, by the time the authors get to their conclusion, they are no longer as sure that such information cannot logically be used.

The authors say "if these findings do have a use, it seems most logically to be in connection with traffic prediction, over-all land-use planning, or land acquisition, but not with the economics of location and design. This is notwithstanding the fact that some very complete studies of so-called 'economic impact' have been made in recent years." Later they say: "Inasmuch as user benefits are the basis for economic justification, secondary benefits can thus have an important, though indirect bearing on the economics of planning and design."

They also state that "the engineer's concepts of such things as 'economic impact' do not seem to do the job." In all studies in the economic arena, it is acknowledgedly difficult to hold the environment constant. It is to the credit of highway engineers that they have attempted these studies and have progressed further than others in related public works fields. In other fields, impact studies, using perhaps only one or two criteria, have been made of the effects of various types of investment, public investments, raising minimum wages, etc.

The exact definition of impact is, of course, difficult because of its ramifications. But merely defining impact will not determine measurement. In fact, in some respects, defining measurement may be a prelude to defining impact. Researchers have given considerable thought to the subject of economic impact. In a number of studies of experimental design the Bureau of Public Roads has been directing its attention to determining a framework for measuring impact. A study at New Mexico State University is concerned with the use of accounting at the local level—to determine the effect on the economic base of the community; a study for the Boston Inner Loop has given thought to the use of economic impact data in highway location and planning; a Northwestern University project is concerned with the entire area of net non-user concepts; University of Washington studies, the University of Kentucky, and many others have grappled with these problems. There is no reason to expect that spatial relationships encountered here should not be given consideration in highway location (not strictly defined as return on highway investment).

The main theme that goes through the paper is "are there really any other non-vehicular economic benefits? Can a highway, for instance, produce something which has economic value in its own right?" All economic activity is a means to an end, the enjoyment of utility. Yet all persons who work do so to buy goods and leisure. This doesn't mean that there are no benefits from their activity. Our entire system benefits and we agree that it is derived from a combination of all factors. This is equally true of transportation. It provides utility which when combined with all other utilities furnish income and activity and goods.

The authors say "a highway cannot create land that is not already there. It can only increase the relative accessibility of that land." However, there appears to be a relationship of a complex of socio-economic factors rather than just accessibility. Much more research is needed on this question of accessibility and land values before one can accept the statement that the land values are the result of time shifts which lower costs of transportation. To the land buyer, is it simply user-savings that he evaluates in his purchase price or is it a complex of factors of which user-savings may even be minor although proximity as a convenience is important?

A highway cannot create land that is not there, but it can change the character and intensity of land use. To this extent, it can set into motion a "triggering" influence on other activity which results in community benefits. To say that land is there and cannot be increased ignores the fact that land's value in use can be changed by changing the use, and land's value in exchange or price may have different utility to various groups. It is like saying that one cannot create labor because persons are already there, but one can train labor, provide it with skill and capital improvements and make a different form of labor. So it is with land.

The reorganization benefit referred to by Garrison (4) is of course the purpose of

all activity in a dynamic society; namely, to obtain the best organization of resources to arrive at a least cost combination.

Lowering of transportation costs may not be as important in some locations, however, as lowering of labor costs or internal economies of scale. These are not always completely dependent on transportation costs. The authors state that "if the benefits accruing to the three classes of users mentioned earlier are properly accounted for, credit will already have been taken for all of this reorganization benefit in the form of user benefits." The benefits do not end at the user level, for other income and investment is generated as are transfers which generate income effects. This is all economic activity. Perhaps other matters to which economic research activities should be directed are such items as economies of storage and warehousing and their relation to economies of scale because of highway location.

The authors also state: "In the first place, if an activity formerly performed at several locations is now to be performed at one, the total transportation requirements characteristically will increase. Thus, the transportation costs will tend to increase. The question is whether or not they will increase more than the rest of the costs of the activity decrease. If the transportation costs do increase more than other costs decrease, the concentration is not economically desirable."

Concentration of decentralized activity in most cases means economic reorganization both internally and externally of which transportation cost is only one consideration.

New market and demand situations and new technical coefficients of production could conceivably swamp certain amounts of increased transportation costs.

Even though increased transportation requirements may bring about increased total transportation costs, this does not mean that marginal costs exceed marginal benefits derived as a direct result of an improved transportation facility.

Thus the writer suggests that cost is not the sole determinant for the feasibility of making an investment. The question must be decided in terms of net benefits capitalized through time.

Concern with development that occurs beyond the point of immediate highway contact has certainly intrigued researchers and this is being analyzed where it appears applicable to the problem at hand.

Many of the researches sponsored by the Bureau and State highway departments are experimenting with community studies rather than sections of the road. Although not implemented yet, discussions of economic impact have centered about tracing economic activity through local accounting, local input-output, local money flows, statistical isolation of factors, etc. What is significant from the point of view of the highway engineer is not the total of user or non-user benefits—but the identification of where these advantages and disadvantages occur so that they may be taken into account in planning location.

Finally, if benefits are looked at as total economic welfare added to a community by the improvement, it must be agreed that there are tangible and intangible factors that go to make up the increment in total welfare. In this respect welfare is a function of many items. For example,  $W = f(x, y, z)$ . Changes in welfare would be represented by  $dw = f_x dx + f_y dy + f_z dz$ . That is, incremental changes in  $x$ ,  $y$  and  $z$  will bring about incremental changes in total welfare in the community. To determine the economic impact of a highway  $I = f(x, y, z)$ , then total impact would be of the form  $dI = f_x dx + f_y dy + f_z dz$  where  $dI$  represents an incremental change in impact of a new highway over a previous highway or no highway. Therefore, theoretically, the impact of vehicular benefits can be determined by holding all other benefits invariant. But total impact must be determined by bringing all of the other direct and indirect benefits into consideration.

Uses of vehicles are functions of many other variables so that vehicular benefits fall short in themselves of explaining the economic impact of highway improvements. The vehicular benefits may be multi-valued. But there is no more reason to assume all other variables in a dynamic economy to be constant and then determining what happens to vehicular benefits and consider this a partial derivative than it is to assume vehicular benefits as constant while varying each of the other factors.

## Social Impact

The writer agrees with the authors that there is a need for work on the qualitative aspects of highway influence. The subject of social impact is something of which the Bureau of Public Roads is certainly aware. More and more, the Bureau's impact studies and instructions are suggesting the use of mobility information, and non-work associations in order to understand the meaning of a highway to the individual and to his community. The Bureau has sponsored studies on such varied subjects as public services, tax bases, public utilities, small community considerations, and wherever possible, in newer studies the Bureau has emphasized the aspects of personal relocation.

The Bureau has suggested the evaluation of social influences in both quantitative and qualitative terms. Of course income analysis at the local level, with its emphasis on the identification of various income receivers, is another dimension of a social impact study.

Despite all of these comments, the writer agrees with the authors' conclusions wholeheartedly. "There is a good deal to be learned, then, about the economic impact problem. There is even more to learn about other types of impact. The most important questions which highway planners will have to answer in the next few years may be social and not economic ones."

**A. S. LANG and MARTIN WOHL, Closure**—The authors have redefined vehicular and non-vehicular benefits or consequences as primary and secondary benefits, respectively, to reflect the fact that non-user benefits are merely transferred from user benefits and do not therefore represent any net gain to the economy. As such, it would be improper to include secondary or non-user consequences in an economic analysis for the justification of a highway. On the other hand, the authors did not say that secondary benefits should be ignored in an over-all highway justification analysis. They strongly emphasized that secondary benefits must be given consideration, but from the standpoint of the social structure of the community.

Again the authors emphasize the danger of restricting attention in economic impact studies on the local effects adjacent to the highway. First of all, use of the "influenced" and "control" zone technique does not in any sense identify the extent of the influence of the highway; it merely indicates relative value changes without reference to cause. Second, and perhaps more important, to measure the gains at the roadside without including losses elsewhere in the economy provides information which can be and often is used incorrectly in highway justification analyses. Inasmuch as highways typically are paid for by the community at large, highway planners and engineers are justified in constructing or improving them only to the extent that they represent a reasonable profit on the investment thus being made.

The authors must disagree with Mr. Goldstein with regard to his statements on highways "triggering other activity." Highways can only affect the economy to the extent that they alter highway operating costs, accident costs, and time-distance relationships. On the other hand, highway improvements cannot, as Mr. Goldstein suggests, "change production cost." Further, economies of scale which industry realizes because of relocation or consolidation cannot exceed the transportation cost savings, where these savings are the full difference between what transportation costs with the new highway and what it would have cost with the old highway.

It is worth repeating that the term "transportation costs" is meant to be all-inclusive. That is, these costs should include operating, time, accident, and comfort and convenience costs (real or apparent) to users of the transportation facility, whether they be commercial operators or private vehicle owners.

Mr. Goldstein quotes the authors correctly in saying that "if these findings (those of economic impact studies) do have a use, it seems most logically to be in connection with traffic prediction, over-all land-use planning, or land acquisition, but not with the economics of location and design. This is notwithstanding the fact that some very complete studies of so-called 'economic impact' have been made in recent years." He goes ahead to quote another section of our paper out of context, "Inasmuch as user benefits are the basis for economic justification, secondary benefits can thus have an

important, though indirect bearing on the economics of planning and design." His implication is that the authors have said that non-user benefits thus have a role in the economic analysis. This is, of course, incorrect. They merely tried to point out that to the extent that relocated industry, for example, generated new traffic or altered traffic patterns, this would affect user benefits and thus affect the project justification.

As for the question of whether highway engineers have done a good job with their economic studies, it is agreed that it is to their credit that they have tried to do this job. The authors do not feel this alters the facts of the case, however; namely, that so far highway engineers have not done too well. Nor does it alter our opinion that highway engineers have been slow to avail themselves of the help which economists and social scientists are now in a position to give.

With regard to Mr. Goldstein's remarks about incremental changes in welfare as a result of a highway improvement, the authors would suggest that his equations ought to look somewhat as follows:

$$W = f(x, y, z)$$

$$\Delta W = \frac{\partial f(x, y, z)}{\partial x} \Delta x + \frac{\partial f(x, y, z)}{\partial y} \Delta y + \frac{\partial f(x, y, z)}{\partial z} \Delta z$$

$$\Delta W = \left( \frac{\partial W}{\partial x} \right) \Delta x + \left( \frac{\partial W}{\partial y} \right) \Delta y + \left( \frac{\partial W}{\partial z} \right) \Delta z$$