

Desirability Rating and Route Selection

G. A. RIEDESEL, Consulting Highway Engineer; and
JOHN C. COOK, Washington State University

THIS PAPER REPORTS on an attempt to quantify the aesthetic, the social, and the neighborhood economic effects of a proposed highway on the area it serves, and to relate those effects to cost and service considerations so that rational, systematic comparisons of alternate routes can be made. The selection of a route and a design can then be based on a consideration of all effects—environmental as well as cost and service.

DESIRABILITY RATING

Environmental effects must be defined before they can be qualified or quantified. The scope of this paper does not allow a discussion of such defining.

Appearance Rating

Defining and rating methodology have been taken from a previous report (1). Aesthetic or appearance considerations are first rated in some manner such as that indicated in Figure 1. These considerations are very broad and are not limited to appearance. A proposed route is given a numerical rating for each of these considerations, and from these ratings a single desirability index for appearance is computed.

Figure 2 shows a summary of appearance ratings. The 8 considerations to be evaluated for any route represent the elements of desirability from an appearance approach. However, the word appearance as used here includes fitness, scale, consistency with the area, and all the other elements that go into an architect's concept of design. Items A-1 through A-4 are more localized in nature and can best be applied to specific sections. The mechanics of doing this should present no problem. Items A-5 through A-8 ordinarily apply to the route as a whole and should be rated for the entire route in one length. The basic ideas and philosophy of what is desirable and what is not desirable in appearance or architectural design are discussed and illustrated in the previous report (1). No one should attempt to use this rating scale

SCALE:	Is the type of freeway chosen dominant?	By width	
	How is it dominant?	By height	
		By support system	
	What action will be taken?	Isolation by distance	
		Isolation by objects, man-made or natural	
	Will a good scale relationship be achieved by the action taken?	Appropriate development of the character of the space by the road	Rating: _____
NOISE:	Is the noise from the freeway objectionable?		
	How is it objectionable?	Because the road is very close	
		Because of changes in grade	
	What action will be taken?	Isolation by distance	
		Isolation by a barrier	
	Will the noise be reduced to an acceptable level by the action taken?		Rating: _____
BARRIER:	Is a visual barrier created?		
	How is it created?	By the support system and the nature of the space under the road	
		By the width of the visible road surface	
	What action will be taken?	The selection of an appropriate support system	
		The development of a suitable pattern on the under side of an elevated freeway	
		The development of planes related to the support system	
		The provision of continuity of ground under elevated freeways	
		The creation of long controlled views through and over	
	Will the action taken reduce the barrier effect to the minimum?		Rating: _____
CHANGE:	Does the freeway create opportunity for constructive change?		
		As a neighborhood spine	
		In the development of well landscaped open space	
		In the development of space for activities	
		In other ways	
	Does the freeway create change of a negative kind?		Rating: _____
		By removing facilities	
		By changing the structure	

Figure 1. Appearance environmental rating.

ROUTE RATING FORM A—APPEARANCE CONSIDERATIONS

Route from Length	(1) Considerations	(2) 0-5 Yr. Period			(3) 6-25 Yr. Period			(4) 26-50 Yr. Period			(5) Combined 50-Year Weighted Rating
		Desirability Rating 1-10	Weight Factor	Weighted Rating	Desirability Rating 1-10	Weight Factor	Weighted Rating	Desirability Rating 1-10	Weight Factor	Weighted Rating	
		Local or Sectional:	8	4	32	8	2.5	20.0	—	0	
A-1 Scale Relationship	5	1	5	5	1.0	5.0	—	0	—	10.0	
A-2 Noise Factor	6	2	12	8	1.3	10.4	—	0	—	22.4	
A-3 Barrier Factor	8	3	24	8	2.2	17.6	—	0	—	41.6	
A-4 Changes in Area											
Route Total:											
A-5 City Planning	5	6	30	5	8	40	5	4	20	90.0	
A-6 Continuity & Fit to the Entire City	9	4	36	8	4	32	—	0	—	68.0	
A-7 Respect for Sacred Areas	8	5	40	8	5	40	—	0	—	80.0	
A-8 Driver's Experience of the City	9	2	18	9	2	18	—	0	—	36.0	
Total Section Rating										400.0	
Relative Section Rating	400/5.70									70	

Figure 2. Summary of appearance ratings.

until such ideas and philosophy are understood and appreciated. All ratings are on a basis of 10. The rating values shown in Figure 2 are for illustration only and do not apply to any particular route. The weight factors shown are considered to be typical for urban arterials, but they may be altered to reflect the goals and objectives of any specific route. The maximum possible rating for any route by this scale is 570. The relative section rating is obtained by dividing the total section rating by 5.7.

Sociological Rating

Conditions considered for their social or sociological effects are shown in Figure 3. To provide a basis for understanding the ratings, Van Blaaderen, a sociologist and one of the authors of the previous report (1), states:

The function of the scale is to measure the relative social impact of a highway on an urban area and also (1) to give a value of this impact and (2) to emphasize the relative value of the impact.

A problem in the construction of the rating scale is the level of sophistication of its users. As indicated in the first part of the report, a major problem is the type of rationalizations employed; for instance, a big gap exists between the appreciation of a situation (highways are "good") and the willingness to understand its consequences (but I don't want my house destroyed). For this scale a major effort was made to close the gap between the willingness of non-sociologists to use the scale in accordance with the approach presented in the report and the existence of advanced sociological theories and techniques of investigation.

Popularization of the subject matter on which the scale is based (or the scale itself) was avoided because simplification would tend to introduce those rationalizations which made previous attempts less viable. For instance, because the highways might be regarded as "good" for a state as a whole, or "bad" for a particular urban area, different interpretations can be given to the desirability of the resulting changes. One single solution cannot be recommended: only when the different impacts are clearly presented can further action be taken. Popularizations tend more often than not to be based on rationalizations which do not lead to assessment, but to vague statements favoring one (the state for instance) or another solution (the urban area). The only legitimate attitude possible is to favor neither, but weigh the influence of each.

Each of the major and minor impact elements discussed has been given a central value. The total of the central values is 100.0 and is to be regarded as a weighting of the social situation of

Social Highway Impact	Central Value	Desirable Impact	Undesirable Impact	Total Impact Value
	(1)	(2)	(3)	(4)
A. Inter-Metropolitan	26.4			
1. Wholesale Trade Area	(8.2)			
a. Volume Expand (2)	1.9			
Decrease (3)				
b. Trade Area Superordinate (2)	3.6			
Subordinate (3)				
c. Centralize Trade (2)	2.7			
Bypass Trade (3)				
2. Regional Dominance	(9.8)			
a. Cultural Dominance (2)	4.5			
Subservience (3)				
b. Functional Dominance (2)	2.7			
Subservience (3)				
c. Specialized Functions, Increase (2)	2.7			
Decrease (3)				
3. Communication and Transportation	(8.3)			
a. Major Economic Goods Increase (2)	1.9			
Decrease (3)				
b. Cultural Integrative Increase (2)	4.5			
Decrease (3)				
c. Administrative and Functional Headquarters Increase (2)	1.9			
Decrease (3)				
B. Intra-Metropolitan				
I. Metro Area	24.6			
1. Relationships Between Social Areas	(9.9)			
a. Style of Life Increase (2)	3.6			
Decrease (3)				
b. One Style of Life Diffuse (2)	3.6			
Only (3)				
c. Selective Avoidance No (2)	2.7			
Yes (3)				
2. One Social Area Only	(8.1)			
a. Deprivation No. (2)	2.7			
Yes (3)				
b. Low Resistance No (2)	2.7			
Yes (3)				
c. A Priori Rationalization No (2)	2.7			
Yes (3)				
3. Social Attributes of Metro Area	(6.6)			
a. Destruction No (2)	1.9			
Yes (3)				
b. Changing Balance Between Areas No (2)	2.8			
Yes (3)				
c. Eliminate Central Areas Information Functional No (2)	1.8			
Yes (3)				

Social Highway Impact	Central Value	Desirable Impact	Undesirable Impact	Total Impact Value
	(1)	(2)	(3)	(4)
II. Metro Community	24.3			
1. Change in Members	(13.5)			
a. Social Intimacy Increase (2)	4.5			
Decrease (3)				
b. Dislocation Very High (2)	4.5			
Very Low (3)				
c. Selected Communities Low (2)	4.5			
High (3)				
2. Community Attributes	(10.8)			
a. Functional for Social Intimacy Very High (2)	3.6			
Very Low (3)				
b. Day to Day Importance No (2)	2.7			
Yes (3)				
c. Integrative Focus No (2)	4.5			
Yes (3)				
III. Urban Man	24.7			
1. Semi-Permanent Settlement	(8.2)			
a. Individual and Family No (2)	3.6			
Yes (3)				
b. Interaction Patterns of Individual No (2)	2.7			
Yes (3)				
c. Style of Life No. (2)	1.9			
Yes (3)				
2. Individuals with Low Rates of Adjustment and Survival	(9.2)			
a. Eliminating Metro-community No (2)	4.5			
Yes (3)				
b. Decreasing Reestablishment Certain Types Metrocommunities No (2)	1.9			
Yes (3)				
c. Education to Successful Resistance No (2)	1.9			
Yes (3)				
3. Interaction Between Individuals	(8.2)			
a. Residential Segregation Decrease (2)	3.6			
Increase (3)				
b. Alternate Possibilities Style of Life No (2)	1.9			
Yes (3)				
c. Eliminating Successful Adjustment No (2)	2.7			
Yes (3)				

Figure 3. Sociological environmental rating.

an urban area as perceived prior to the social impact of a proposed or constructed highway. The social impact is then analyzed as follows. A social impact element is considered and the impact assessed.

Three additional columns have been added. Depending on the degree of sociological sophistication of the scale user and/or his knowledge of the actual situation, he evaluates the social impact in terms of their desirability and undesirability. Thus while the highway impact might be to increase the trade volume for one set of items, it could also decrease by the same amount in another. The sum of the desirable and undesirable impact we have called the total impact value. The important point is that however crude or sophisticated our measure of the social impact, the total impact value expresses or approximates the social changes which affect the urban area as a result of a proposed or constructed highway.

The total impact value of each item of the scale is limited to twice its central value—for instance, the complete disappearance of one set of wholesale activities carried out in an area previous to highway construction and the introduction of a completely new set of wholesale activities in such an area as a result of highway construction. The total impact value would indicate the total of the social changes which this proposed or constructed highway would engender in terms of the volume of the wholesale activities. A danger point is, however, reached when desirable and undesirable impacts affect aspects of the urban area differently. That is, a desirable impact does not need to be balanced by an undesirable impact. However, an undesirable impact has to be balanced by a desirable one if a satisfactory solution is wanted.

Figure 4 shows a summary of sociological ratings. The values given are for illustrative purposes and do not apply to any particular route. So that the evaluation and rating of any arterial route is simplified, the 11 sociological considerations each have a basis of 10. In Figure 3, Van Blaaderen suggests a range of basic rating values called central values. The ratings in Figure 4 when multiplied by the weight factors will be the same as the rating using the central value. The desirability rating for each consideration will be the answer to questions such as "To what extent will the highway impact affect the wholesale trade area?" and "To what extent will the highway impact interrupt a period of semipermanent settlement?" The weight factors in the 0- to 5-year period are double the ones in the 6- to 25-year period. In the 25- to 50-year period the weight factors may be considered to be zero or to have no significance in route selection.

ROUTE RATING FORM S—SOCIOLOGICAL CONSIDERATIONS											
		(2) 0-5 Yr. Period			(3) 6-25 Yr. Period			(4) 25-50 Yr. Period			(5)
		Desirability Rating 1-10	Weight Factor	Weighted Rating	Desirability Rating 1-10	Weight Factor	Weighted Rating	Desirability Rating 1-10	Weight Factor	Weighted Rating	Combined 50-Year Weighted Rating
Route from	Length	(1) Considerations									
		Inter-Metropolitan Effects									
		S- 1 Wholesale Trade Area	5	1.8	9.0	5	.9	4.5			13.5
		S- 2 Regional Dominance	5	2.2	11.0	5	1.1	5.5			16.5
		S- 3 Communication & Transportation	5	1.8	9.0	5	.9	4.5			13.5
		Intra-Metropolitan Effects									
		S- 4 Relationship Among Social Areas	6	2.2	13.2	8	1.1	8.8			22.0
		S- 5 One Social Area Only	7	1.8	12.6	8	.9	7.2			19.8
		S- 6 Social Attributes of Metro Area	6	1.4	8.4	8	.7	5.6			14.0
		Metro Community Effects									
		S- 7 Changes in Members	8	3.0	24.0	8	1.5	12.0			36.0
		S- 8 Community Attributes	7	2.4	16.8	7	1.2	8.4			25.2
		Effects on Urban Man									
		S- 9 Semi-Permanent Settlement	2	1.8	3.6	3	.9	2.7			6.3
		S-10 Rates of Adjustment & Survival	3	1.8	5.4	4	.9	3.6			9.0
		S-11 Interaction Among Individuals	3	1.8	5.4	4	.9	3.6			9.0
Section to	*	Total Section Rating									184.8
		Relative Section Rating 184.8/3.30									56

Figure 4. Summary of sociological rating.

The 26- to 50-year period is shown on all 3 summaries to keep the ratings consistent with the estimated 50-year life used by engineers. The maximum possible total section rating is 330. A relative section rating is determined by dividing the total section rating by 3.30. The 11 items are combined into a single desirability index for sociological effect. This form can be extended or expanded to include all the subtopics shown in Figure 3. The use of the scale will depend on the qualifications of the rater.

Economic Rating

Economic considerations are shown in Figure 5. The alternate routes selected for accomplishing the goal of moving traffic through an urban area between predetermined points are divided into shorter, manageable sections for rating considerations. The sections should be homogeneous as to present land use, e.g., residential, commercial, industrial, or other appropriate homogeneous classification. Each section is evaluated for each of the 10 items. A numerical desirability rating of 1 through 10 is applied to each item for each of the 3 time periods. Ratings for an item may differ considerably between time periods depending on anticipated future land use consistent with community development plans and forecasts.

A neutral or not applicable item for a section is evaluated with the numerical rating of 5. Numerical ratings less than 5 apply to evaluations progressively more undesirable. A numerical rating of 4 is only slightly undesirable. A rating of 1 is most undesirable. Numerical ratings greater than 5 apply to desirable effects of the item in re-

Route		Section	From	to		
Item Code	Item Affected	Desirability Rating (1-10) (1)	Relative Importance Weighting (Base 10.0) (2)	Desirability Weighted By Importance (Col. 1 x 2) (3)	Time-Period Weighting (Base 10.0) (4)	Combined Desirability Importance Time-Period Weighted-Rating (5)
0 - 5 Year Time Period						
E - 1	Residential Property Values	6	1.0	6.0	6.0	36.0
E - 2	Residential Relocation	4	0.7	2.8	6.0	16.8
E - 3	Business Property Values	7	1.6	11.2	6.0	67.2
E - 4	Business Site Development	7	1.8	12.6	6.0	75.6
E - 5	Commercial Relocation	5	1.1	5.5	6.0	33.0
E - 6	Opening New Markets	5	1.3	6.5	6.0	39.0
E - 7	Service to Employment Centers	6	0.5	0.0	6.0	18.0
E - 8	Service to Shopping Centers	6	0.5	3.0	6.0	18.0
E - 9	Service to: Churches, Clubs, Recreation and Community Services	7	0.7	4.9	6.0	29.4
E - 10	Relocation of Churches, Clubs, Recreation and Community Services	5	0.8	4.0	6.0	24.0
Total		58	10.0	59.5	6.0	357.0
6 - 25 Year Time Period						
E - 1	Residential Property Values	7	1.2	8.4	3.2	26.9
E - 2	Residential Relocation	5	0.3	1.5	3.2	4.8
E - 3	Business Property Values	8	1.7	13.6	3.2	43.5
E - 4	Business Site Development	8	1.9	15.2	3.2	48.7
E - 5	Commercial Relocation	5	0.7	3.5	3.2	11.2
E - 6	Opening New Markets	5	1.6	7.5	3.2	24.0
E - 7	Service to Employment Centers	7	0.7	4.9	3.2	15.7
E - 8	Service to Shopping Centers	7	0.6	4.2	3.2	13.4
E - 9	Service to: Churches, Clubs, Recreation and Community Services	8	0.9	7.2	3.2	23.0
E - 10	Relocation of Churches, Clubs, Recreation and Community Services	5	0.5	2.5	3.2	8.0
Total		65	10.0	66.5	3.2	210.2
25 - 50 Year Time Period						
F - 1	Residential Property Values	8	1.4	11.2	0.8	9.0
E - 2	Residential Relocation	5	0.1	0.5	0.8	0.4
E - 3	Business Property Values	8	1.9	15.2	0.8	12.2
E - 4	Business Site Development	9	2.0	18.0	0.8	14.4
E - 5	Commercial Relocation	5	0.1	0.5	0.8	0.4
E - 6	Opening New Markets	5	1.6	8.0	0.8	6.4
E - 7	Service to Employment Centers	8	0.8	6.4	0.8	5.1
E - 8	Service to Shopping Centers	8	0.8	6.4	0.8	5.1
E - 9	Service to: Churches, Clubs, Recreation and Community Services	8	1.2	9.6	0.8	7.7
E - 10	Relocation of Churches, Clubs, Recreation and Community Services	5	0.1	0.5	0.8	0.4
Total		69	10.0	76.3	0.8	61.1
Section Total (3 Time Periods)		192	---	204.3	10.0	637.3*
* Equals Section Weighted Score						

Figure 5. Economic environmental rating.

lation to the impact anticipated from a highway route. A numerical rating of 6 is slightly desirable, a rating of 10 is most desirable. Numerical ratings from 4 through 1 and 6 through 10 are applied to value judgments between the extremes of slightly and most. Summing the scores for each item for a section results in the desirability score for the section. If the section score is less than 5 times the number of items, e. g., $5 \times 10 = 50$, the section is undesirable. If the section score is greater than 5 times the number of items scored, the section is desirable.

In the evaluation of socioeconomic phenomena, it often happens that the whole is greater than the sum of the parts. For some items the entire route, rather than a section, should be rated because the effects stem from the entire route and not from any one section alone. For such items the rating for the route, derived from the summation of the rating of its sections, should be adjusted with consideration given to the impact of the total route on neighborhood economic considerations.

The items rated will have different degrees of importance, and the relative importance will differ from section to section. Each item should be given a weight to indicate its importance relative to the other items. The total weighting for the several rating items for one section and for one time period is based on 10. The summation of the weights equals 10. In some sections the entire weighting of 10 may be applied to one item, in which case all other items would be weighted 0. The desirability rating of each item is then multiplied by the relative importance weighting for that item to obtain an importance weighted desirability rating. These weighted ratings are then summed for a section for each time period to obtain the section importance weighted desirability rating for each time period.

In addition to difference in importance of the items rated, there is also a difference in the present value of the time periods. Again, a base of 10 is used for the total value, and each of the 3 time periods is weighted. Assuming that the midyear of each time period represents the value of the period, we can discount the value of that year to its present worth. For long-term periods, interest rates are higher than for shorter periods. We arbitrarily select rates for the 3 periods and compute their weightings.

Figure 6 shows identical items in a simplified form. The rating for each item is on a basis of 10. The relative weights for importance and for time periods have been combined into one numerical multiplier. All 3 time periods have been included in one

		ROUTE RATING FORM E—NEIGHBORHOOD ECONOMIC CONSIDERATIONS										
		(2) 0-5 Yr. Period			(3) 5-25 Yr. Period			(4) 26-50 Yr. Period			(5)	
		Desirability Rating 1-10	Weight Factor	Weighted Rating	Desirability Rating 1-10	Weight Factor	Weighted Rating	Desirability Rating 1-10	Weight Factor	Weighted Rating	Combined 50-Year Weighted Rating	
Route #	Section #	(1) Considerations										
		E- 1 Residential Property Values	6	6.0	36.0	7	3.84	26.9	8	1.12	9.0	71.9
		E- 2 Residential Relocation	4	4.2	16.8	5	.96	4.8	5	.08	0.4	22.0
		E- 3 Business Property Values	7	9.6	67.2	8	5.44	43.5	8	1.52	12.2	122.9
		E- 4 Business Site Development	7	10.8	75.6	8	6.08	48.7	8	1.60	14.4	138.7
		E- 5 Commercial Relocation	5	6.6	33.0	5	2.24	11.2	5	.08	0.4	44.6
		E- 6 Opening New Markets	5	7.8	39.0	5	4.80	24.0	5	1.28	6.4	69.4
		E- 7 Service to Employment Centers	6	3.0	18.0	7	2.24	15.7	8	.64	5.1	38.8
		E- 8 Service to Shopping Centers	6	3.0	18.0	7	1.92	13.4	8	.64	5.1	36.5
		E- 9 Service to: Churches, Clubs, Recreation and Community Services	7	4.2	29.4	8	2.88	23.0	8	.96	7.7	60.1
		E-10 Relocation of Churches, Clubs, Recreation and Community Services	5	4.8	24.0	5	1.60	8.0	5	.08	0.4	32.4
		Total Section Rating										637.3
		Relative Section Rating	837.3/10									84

Figure 6. Summary of economic rating.

tabulation. The maximum possible section rating of a route is 1,000. A relative section rating is determined by dividing the total section rating by 10. The desirability ratings shown are only for illustrating the procedure. They do not apply to any route. These 10 items deal with the effects of the highway on the residents of the community. They do not consider the economics of traffic operation. They are combined into a single desirability index for neighborhood economics. All of the foregoing considerations take into account the long-range effects of a proposed facility as well as the immediate ones.

ROUTE SELECTION

The details of making the foregoing ratings are discussed at length in the previously published report (1). In this paper, we have purposely used the notations and identifications of the published report so that the reader can identify the information in the manuscript with the material in the published report. We found no simple mechanical or mathematical procedure for arriving at the numerical values. In fact, team members from various disciplines used varying approaches. At best they are relative. In most instances, a value of 10 is given to the most desirable condition and a value of 0 to the most objectionable. The relative importance of specific effects in each case must be decided by interested, knowledgeable people in and out of highway departments. There will be differences in judgment. However, a close analytical scrutiny of each item does ensure that no important effect has been overlooked. Figure 7 shows the form devised for tabulating the 3 desirability ratings of an entire route for further calculations.

There may be important or governing considerations that cannot be adequately treated in this procedure, such as building a freeway through Forest Lawn Memorial Park or over Niagara Falls, but these are strictly prohibiting conditions. In other instances, highly undesirable effects can be minimized by special designs.

From the foregoing ratings the environmental desirability of alternate route locations and various designs on any one location are determined. The real objective is to somehow present all pertinent considerations in a rational, well-organized manner so that a logical solution that takes everything into account can be made.

RATING CALCULATION FORM C, ROUTE _____

For Appearance Rating			
Section	Length of Section as % of Route Length	Relative Section Appearance Rating	Length Times Rating

Total Route Appearance Rating

For Sociological Rating			
Section	Length of Section as % of Route Length	Relative Section Sociological Rating	Length Times Rating

Total Route Sociological Rating

For Neighborhood Economic Rating			
Section	Length of Section as % of Route Length	Relative Section Neighborhood Economic Rating	Length Times Rating

Total Route Neighborhood Economic Rating

Route Comparison

There seems to be an opinion held by some individuals that desirability from an environmental approach and desirability from a benefit-cost approach cannot be reconciled into one analysis. However, these are all elements in the selection of a route, and they must of necessity all be considered in making an analysis and a decision.

We have, therefore, devised a form for route comparison (Fig. 8). For lack of better or conventional terms, we classified all considerations under 3 headings: fixed value, monetary, and desirability. The 3 fixed value considerations are administrative considerations that may or may not influence the selection or design. They are more apt to influence the decision as to whether any facility will be built. The monetary considerations are the usual engineering determinations for all highway projects and include the benefit-cost ratio.

Figure 7. Section and route summary.

When this form has been completed, the decision as to the best choice of route may be apparent. However, there may be conflicting opinions and interests, and further quantification in terms of a composite rating may be desirable. For that, we developed a desirability-cost ratio.

Desirability-Cost Ratio

Intangible considerations of alternate or associated items can be compared for study or for decision-making by having numerical values assigned to them and such numbers then combined into a single final number or index. For example, a particular highway project is selected from others for immediate programming on the basis of a priority index, which may represent alignment, pavement condition, traffic accidents, and other considerations. This index is a composite value derived from quantified considerations or conditions. Or a highway location may be selected from several alternates on the basis of points assigned for the different desirable and undesirable features. These may include construction costs, service advantages, and predicted environmental consequences.

These all involve quantification of an assortment of elements and their manipulation into a final figure. They can be used only to the extent that the quantification and manipulation are accepted. They should be used only as a manipulation and organization of figures, for there is nothing sacred or infallible about the results of such a process. There is nothing authentic or authoritative about a written number, *per se*.

Putting a dollar value on costs and benefits as used in a benefit-cost ratio does not necessarily make them more valid than if they are expressed as points. All devices of this nature used by the administrator, planner, economist, or statistician are subject to errors in estimating and forecasting and to fluctuations in concepts of costs and values. Any use of rating indexes or other intangible quantification is subject to the same errors of estimating and evaluating.

The form shown in Figure 8 presents the information available to the highway administrator for making a selection or arriving at a decision. His success in using the information for making the decision and having it accepted by his constituents will depend on how effectively he uses that information. We suggest a desire-cost ratio and a feasibility ratio (or selection number) as devices for using information and presenting it in an organized manner for comparison purposes, but not for exalting it above its original validity. If the information in Figure 8 does not in itself indicate a solution that is acceptable, further manipulation of that information may be desirable. Such manipulation, however, does not give any additional enhancement or authority to the information.

The desire-cost ratio is a numerical expression of the relationship between the rated desirabilities of proposed routes and their annual cost just as the benefit-cost ratio expresses the relationship between monetary benefits and cost. The cost consideration in the desire-cost ratio is introduced because in the final route selection process we must answer the question, "How much are we willing to pay for desirability to get the enjoyment and the social benefits we want?" In many instances a single route may have different degrees of desirability, depending on design, whether depressed, elevated, or

ROUTE COMPARISON FORM R

Considerations	Alternate Routes		
	A	B	Basic Condition
Fixed Value Considerations:			
R- 1 Funds Available			
R- 2 Completion Date			
R- 3 Legality			
Monetary Considerations:			
R- 4 Construction Cost			
R- 5 Annual Maintenance Cost			
R- 6 Annual Vehicle Operating Cost			
R- 7 Travel Time Cost			
R- 8 Accident Costs			
R- 9 Vehicle Mile Cost			
R-10 Benefit-Cost Ratio			
Desirability Considerations:			
R-11 Appearance Rating			
R-12 Sociological Rating			
R-13 Neighborhood Economic Rating			
R-14 Institutions or Prohibitions	DNA PC DTM	DNA PC DTM	DNA
Explanation:			
DNA = Does not apply			
PC = Prohibitive consideration			
DTM = Design to Minimize			

Figure 8. Comparative route summary.

at grade, and covering a wide range of costs. The relative desirability of a proposed route is expressed in the forms shown in Figures 7 and 8. The costs from the engineer's studies are shown in Figure 9.

Figure 9 shows how estimated costs and desirability ratings are tabulated to compute a desire-cost ratio. The desire-cost ratio may be used as a comparison of alternate routes or treatment of the same route as a percentage of a common total cost figure. It should be emphasized that the D-C ratio has only relative significance and is limited to the specific routes being rated. It cannot be compared with the D-C values of other studies or applications. If a route has a very low desirability rating because of an institution or other practically prohibitive situation, its rating could be raised and the objectionable aspects removed by more costly design and construction. Both changes—the greater desirability and the increased cost—would be reflected in a new D-C ratio. The D-C ratio is a management tool, not a straitjacket. It has its limitations and possibilities for improvement. It provides a starting place for more detailed research in the decision-making process.

Neither the benefit-cost ratio nor the desire-cost ratio by itself expresses a complete picture. Both must be considered. In so doing, we recognize all 3 important phases: costs, benefits, and social impact. If further comparison is desired, a weighted B-C ratio and a weighted D-C ratio can be combined by simple addition into one value (which we have labeled feasibility ratio). In our illustrative calculations we have given

FORM D DESIRE/COST RATIO

	2	3		4		5		6	
		Route A		Route B		Route C		Combined	
Costs (In thousands)	Rel. Wgt.	Numerical Value	Percentage	Numerical Value	Percentage	Numerical Value	Percentage	Numerical Value	Percentage
1. Annual Construction	xx	494	xxx	406	xxx	0	xxx	900	xxx
2. Annual Maintenance and Operation	xx	25	xxx	21	xxx	58	xxx	104	xxx
3. Totals	xx	519	51.7	427	42.6	58	5.7	1004	100.0
Desirability Ratings									
4. Appearance	1	69	xxx	60	xxx	10	xxx	139	xxx
5. Sociological	1	88	xxx	70	xxx	90	xxx	248	xxx
6. Neighborhood Economic	1	69	xxx	75	xxx	50	xxx	194	xxx
7. Totals	xx	226	38.9	205	35.3	150	25.8	581	100.0
8. Desire/Cost Ratio	xx	xxx	.752	xxx	.828	xxx	4.526	xxx	xxx
9. D/C Ratio Weighted	1	xxx	.752	xxx	.828	xxx	4.526	xxx	xxx
10. Benefit/Cost Ratio	xx	xxx	1.250	xxx	1.600	xxx	1.000	xxx	xxx
11. B/C Ratio Weighted	1	xxx	1.250	xxx	1.600	xxx	1.000	xxx	xxx
12. Feasibility Ratio	xx	xxx	2.002	xxx	2.428	xxx	5.526	xxx	xxx

Under costs, in Column 1, on lines 1 and 2, enter the annual construction cost and the annual maintenance and operating costs for each of the routes as determined by the engineers. Route C will normally be the basic condition or existing facility without capital investment or improvement. These costs are highway or street department costs and do not include user costs or savings by traffic.

In Column 2, on lines 4, 5, and 6, enter the relative weight to be accorded to the Appearance Consideration, the Sociological Consideration, and the Neighborhood Economic Consideration, respectively.

In Column 2, lines 9 and 11, enter the relative weight to be accorded to the Desire/Cost Ratio and the Benefit/Cost Ratio respectively. These relative weights must be determined from the goals of the community and the objectives of the proposed highway.

For illustrative purposes in this report, a weight of "one" has been used which gives the

items to be considered equal significance in the results.

Under desirability ratings of Column 1, lines 4 and 6 inclusive, enter the desirability ratings from Form R for each of the routes being considered, multiplied by the respective weight factor in Column 2. Lines 3 and 7 will show the numerical totals for the three other values on each line. In lines 3 and 7 the last box in each column shows what percentage the numerical route total is of the combined total.

For line 8 divide the percentage value of line 7 by the percentage value of line 3 for each of the three routes. This is the Desire/Cost Ratio.

Line 10 on Form D can be used for entering the B/C ratio and Line 12 for the sum, or combination of B/C and D/C. Here, too, further study may be appropriate.

Figure 9. Final route selection summary.

them equal weight. The feasibility ratio, obtained by adding arithmetically the desire-cost ratio and the benefit-cost ratio for any one of a set of alternate routes or designs, is the end product of the chain of calculations suggested by this study and will indicate which of the alternatives should be built.

Throughout an evaluation of desirability there is always a question of weighting various considerations. For example, the noise factor may be considered more important than the appearance factor, or the benefit-cost ratio may be more important than the desirability-cost ratio. These are matters of policy or of opinion and must be decided separately for each proposed project. Our proposed calculations allow for the use of weighting, but we do not suggest what weight multipliers to use. The significance of weighting factors in the final result is, however, often negligible or at least over-emphasized.

SUMMARY

The procedure we have outlined will (a) give a numerical expression of desirability and feasibility; (b) ensure a thorough consideration of all desirability features and provide evidence of such considerations; and (c) invoke public involvement in the decision-making process because the evaluation of desirability requires public reaction, and this, of course, pays off in beneficial public relations that are reflected politically and during hearings. We hope also that this procedure will encourage further study of this kind of approach. Decision-making requires value judgment for which quantified input is required.

REFERENCE

1. Riedesel, G. A., et al. A Study of the Social, Economic and Environmental Impact of Highway Transportation Facilities on Urban Communities. Highway Research Section, Washington State Univ., Pullman, 1968.