Chapter 2

Introductory Concepts in Transportation Systems Evaluation
2.1 IMPACTS OF TRANSPORTATION SYSTEM CHANGES: IMPACT TYPES AND MODELS

2.1.1 Impact Types

In the evaluation of alternative transportation systems, it is vital that all relevant consequences be considered, as transportation system changes, namely, change in the physical structure, institutional policy, or regulation of transportation infrastructure usage, can have profound influence on various (sometimes conflicting) groups and interests. An example of a change in physical structure is the construction of a new road, or addition of new lanes. An example of institutional policy is truck weight restrictions, while regulation includes seat belt laws. Therefore, the various categories and types of impacts expected to occur in response to transportation system changes, need to be identified before a detailed analysis of the level of each impact. For instance construction of a new interstate highway in southern Indiana may affect road users (by decreasing their travel time), the Indianan DOT (by their need to mobilize resources to maintain the road), noise pollution to persons staying near the highway, changes in the origin-destination patterns of travelers on the network. Such impacts can be categorized broadly as follows (Manheim, 1979):

1. **User Impacts**: This refers to impacts on individuals and shippers of goods. Users may be differentiated by the trip purpose, vehicle class, socio-economic group, etc.
2. **Operator Impacts**: Operators of transportation facilities and services can also be impacted by changes in a transportation system. Operators may be differentiated by mode, link, and route. For example air carrier, trucker, state DOT, port authority, etc.
3. **Physical Impacts**: These are the physical impacts caused by the presence of transportation facilities, and affect both users and non-users of the transportation facility. Examples include families, jobs, and real estate displaces by new construction, neighbors affected by environmental degradation through air, noise and groundwater pollution arising from construction and use of the facility.
4. **Functional Impacts**: Changes in transportation systems cause changes in the way users use the system. Such changes in travel patterns can be differentiated by location within region and type. Examples include changes in retail sales in suburban shopping centers and central business districts, changes in logistic costs, and changes in land values.
5. **Governmental Impacts**: These are the impacts on the functioning of local, state or federal government arising from the change in a transportation system. For example, a new policy or regulation for the system may be accompanied by the establishment of an overseeing body to monitor the implementation of the new policy.
Besides such categorization of transportation system impacts, it is important to realize that some groups or interest may gain from a given system change, while another groups may lose from that same change. Therefore, social and cultural concerns need to be addressed in any impartial evaluation of the impacts of transportation systems.

2.1.2 Categorization of Models for Impact Evaluation

To predict the expected levels of each impact type, five types of models are needed (Manheim, 1979).

1. **Service Models**: These are needed to determine the levels of service that correspond to various flow volumes, for any specified set of options. Examples include a model to determine the travel time over a rail link as a function of train length, schedule. Another example is the link volume and travel time relationships typically used in traffic assignment.

2. **Resource Models**: These determine the level of resource consumption (or resource degradation) associated with changes in the transportation system. Examples are land, labor, capital, air and noise pollution, environmental and aesthetic impacts.

3. **Demand Models**: The volume of travel demanded, for each mode and user characteristic, at various levels of service, are determined using aggregate or disaggregate demand models.

4. **Equilibrium Models**: These are needed to predict the volumes that will actually flow in a transportation system for a particular set of service and demand functions (short-term equilibrium in the travel market).

5. **Activity-shift Models**: These estimate the long-term changes in the spatial distribution and structure of the activity system as a consequence of the short-run equilibrium patterns of flows, that is, the feedback effect of transportation on land use (activity system equilibrium).

These are the five basic components of any system of prediction models in transportation. The interrelationships among them are illustrated in Figure 2-1. This excludes models for predicting the changes in organizational and institutional behavior that result from changes in organizational policies.

![Figure 2-1: Basic Prediction Models (Manheim, 1979).](image-url)
2.2 TRANSPORTATION DEVELOPMENT PROCESS

Transportation development process may involve all levels of government, national, state or local. It includes four areas: systems planning, location planning, design, and construction and maintenance. Each of these areas is discussed briefly.

**Systems Planning:** It is a continuous process. It consists of the following steps:

Goals and Objectives of the Planning Unit

- Inventory of Travel and of Facilities
- Analysis and Forecast of Travel Data and Facility Needs
- Alternatives of Future Facility Components
- Evaluation and Selection of Network Level Alternatives

The actors in systems planning phase are primarily the federal, state and regional agencies, local governments, citizen groups, and various special interest groups may also get deeply involved. System planning provides a network level planning of facilities with system-wide needs in consideration.

**Location Planning:** It involves an individual portion of a system-wide plan. In this phase, a corridor or a specific link is studied in depth to develop project level information. It may take 3 to 5 years depending on the complexity of the project. It follows the steps shown below:

- Evaluation of Existing Facility
- Social, Economic and Environment Data
- Definition of Alternate Corridors
- Informal Meetings
- Study of Corridors – Draft Environmental Impact Report
- Location Hearings
- Final Report and Environmental Impact Statement Approval

**Design:** This phase involves preparation of detailed construction plans, acquisition of property, and letting the project to contract. It may take 2 to 5 years depending on specific projects. The steps would include the following:

- Design Study and Review
- Design Hearing
- Final Design
- Approval
- Development of Detailed Plans, Specifications, Estimates
• Preparation of Relocation and R-O-W Acquisition Plan
• Processing of Contract Documents
• Advertising for Bids and Letting the Contract

**Construction:** The actual constriction of a project may take 2 to 5 years. This phase is primarily the concern of private contractors. However, contracting agencies have the responsibilities of supervision and quality control.

**Maintenance:** Once a project is constructed, it needs continuous maintenance. Some are routine yearly maintenance and some are periodic maintenance. Maintenance information is returned to the systems planning phase to assist in improving the system for the future.

### 2.2.1 The Role of Evaluation

Each phase of the transportation development process discussed in Section 1.0 requires evaluation and decision-making regarding what specific actions to take to fulfill the needs of the phase. Although economic analysis remains to be the backbone of the evaluation approach, there are other factors that also need consideration.

With increasing concerns regarding energy, environment, social justice and economic development, investment of public funds must be made with a careful evaluation. Decision regarding a specific course of action must be made through a deliberate consideration of all alternatives and their consequences with respect to the identified measures of effectiveness.

The purpose of an evaluation process is not only to identify the best possible course of action under given constraints, but also to clarify issues of choice regarding the specific problem at hand. For projects involving conflicting interests, the purpose of the evaluation process is to assist in building consensus.

Any evaluation process, particularly at system or project planning level, must have a clear definition of goals and objectives in order to define the measure of effectiveness. The hierarchy of the system of goals and objectives can be represented as shown below (NCHRP 96):

*Objectives* are specific statements and they are outgrowths of a goal. For example, if societal goal is to provide equal opportunity, then an objective can be to improve public transportation accessibility for the residents of an urban area.

*Criteria* are specific definitions attached to objectives (measures, tests, or indicators). For example, a criterion can be to minimize walking time to public transportation access points.

*Standards* are fixed objectives. They define the lowest or highest level of performance and can be considered as cut-off points. For example, a standard of public transportation accessibility can be that bus routes must be within two blocks of all residential
2.2.2 Basic Elements of Evaluation

All rational decision-making involves some form of evaluation. It is the particular form and sophistication of the evaluation process that vary depending on: decision-maker, decision involved, and alternative course of actions involved. Evaluation serves two functions, sifting and sorting, and defining new alternatives. Identified alternatives are evaluated with respect to the pros and cons and in the process new alternatives are also generated. Evaluation can be defined as the relative and absolute assessment of the worthwhileness of a particular course of action or planned expenditure. This raises two questions:

1. How does one measure worthwhileness?
2. What units of measure?

The worthwhileness of a project may be different for different stakeholders. For example, a land developer may like to see a project that calls for a new interchange close to its land built but environmental groups may oppose such a project on the grounds that it will adversely affect the adjoining woodland. So, it is obvious there are different measures of worthwhileness and their units of measure are also different. The difficulty lies not only in articulating the various aspects of worthwhileness, but also in identifying the proper tradeoffs. For example, a road may improve the accessibility to a downtown, but it will also require some of the parkland to be taken. The question is how can one measure the tradeoff of parkland for downtown accessibility.

It is important to remember that in public project decision-making, what we try to select is the best possible alternative. This alternative can be considered a good choice, as opposed to optimal choice. That means it may not be possible to arrive at the optimal solution, because all conflicting interests may not be fully satisfied. However, the solution achieved can be a consensus solution representing a good balance of all possible concerns known at the time of decision-making. In broad terms, the evaluation framework can be represented by the following triangle:

![3-E Triangle](image)

**Efficiency**: indicates the relative value of the return from an alternative with respect to the required investment. By evaluating efficiency, we check if we are getting money's worth. So, efficiency involves economic analyses.
Effectiveness: represents the degree to which an alternative is expected to accomplish the tasks. Or, in other words, just how well it attains the objectives specified. A clear understanding of goals and objectives of the project is important to analyze the effectiveness.

Equity: can be measured in terms of both social and geographical equity in the distribution of both costs and benefits related to an alternative. Although the equity aspect can be incorporated within the effectiveness consideration, equity consideration is important enough to be separately identified.

2.2.3 Procedural Framework

Traditionally, evaluation procedure has evolved from highway economic analysis based on engineering economy, where the task is to analyze the economic efficiency of the proposed engineering work by comparing the net gains with net cost. The analysis procedure revolves around applying the principles of compound interest and cash flow over time.

The assumption involved in engineering economic approach is that evaluation factors are priceable. While it is recognized that non-market priced factors, such as social and environmental, are important in decision-making process, engineering economic approach does not have any direct mechanism to include these considerations. Where these factors play a dominant role, engineering economic approach may not be adequate. There we need a broader approach that can consider social costs and benefits in addition to direct costs and benefits.

The procedural framework of a transportation plan or project evaluation process starts with the identification of stakeholders or affected parties. As most transportation improvements are conducted by public agencies, agency costs are important items to consider. Next, we need to determine what groups or geographic areas are impacted and the extent of these impacts. The groups can be expected users or non-users of the transportation project being considered. They can also include non-users who would be affected by secondary impacts of the project. Also, impacts can be monetary or non-monetary. User impacts are generally monetary in terms of vehicle running cost, travel time or accident cost. Non-user impacts are air pollution, noise, water pollution and wetland depletion, and so on. The temporal distribution of impacts can be classified as pre-construction, during construction, or post-construction. Post-construction impacts can be construction, during construction, and post-construction short-term, long term, or both. Boundaries of these impacts are also different. They may be local, regional, statewide, corridor-wide or system-wide, depending upon the impact type and the specific project. For example, CO is a local problem. HC is a regional problem, while the emission of greenhouse houses is a global problem. All of these impacts are also long term impacts.

The approach to evaluation of a transportation plan or project should start with an economic analysis of both user and agency costs. If the life cycle user cost savings from a project are significantly greater than the life cycle agency costs, the project is economically viable and should be evaluated further with respect to secondary impacts of air pollution, noise, water pollution, and so on.
It is clear that transportation systems have multiple objectives and the decision is not clear-cut. This is particularly so in case of projects involving parties with conflicting interests. For example, for some people minutes of travel time saved are more important than a number of trees removed, while others feel the other way around. However, it is difficult to establish a common basis to compare tangible (time saved) and non-tangible (trees) impacts. Moreover, attempts to establish tradeoffs or weights to be assigned to the identified impacts are fraught with judgments and viewpoints of individuals conducting the evaluation. Our task is to remain as objective as possible and to minimize subjective biases. In the end what we end up with is a "satisfying" solution that provides a consensus among affected parties.

2.3 STRATEGIC CONSIDERATIONS IN EVALUATION

COMMUNITY GOALS & OBJECTIVES

- Mobility enhancement
- Congestion relief
- Environmental Improvement
- Economic Efficiency
- Financial Viability
- City Center vs. Suburban Concerns
- Improved Accessibility

2.3.1 Community Objectives and Goals

Good practice in sketch planning requires an understanding of the overall planning and design process. In this context, a clear understanding of community objectives and goals will provide an indication of the importance of various impacts and how the locality might react to them.

Documented metropolitan or sub-area goals and objectives should be reviewed. Inputs from decision-makers should be sought. Statements of goals and objectives are useful checklists to insure that important impacts are not omitted. They also help identify specific issues about which consensus has been reached; for example, whether growth is desirable, and where it is to be encouraged. Evaluation measures (such as aggregate
travel time savings or tons of pollutants reduced) then can be designed to compare alternatives in terms of how they help to achieve these goals and objectives.

2.3.2 Appropriate Measures of Effectiveness for Measuring Community Objectives

While assessment of economic value of investment must continue to remain an important criterion, a much broader perspective that includes other key impact measures is needed. This would require use of multiple measures of effectiveness (MOE) incorporating monetary, other quantitative but non-monetary, and qualitative measures to reflect achievement (of multiple objectives).

### MEASURES OF EFFECTIVENESS

- **Economic Value** (e.g., jobs within 30 minutes)
- **Mobility** (e.g., vehicle-hours of delay reduced)
- **Environmental Quality** (e.g., tons of hydrocarbon emitted)
- **Monetary Measures** (e.g., net present value)
- **Economic Development**
- **Overall and Distributional Measures**
- **Non-Monetary Measures**
- **Qualitative Measures**

### LEVELS OF ANALYSIS

- Regional/ Corridor /Project
- Possibly Different Methodology
- Possibly Different Emphasis on MOE
2.3.3 Levels of Analysis

Different emphasis might be appropriate depending on the level of analysis: regional or system-wide; corridor/sub-area; or project. Each may call for different emphasis in both the methodology and MOE considered. We are not likely to see many new rail transit investments or major highways on a regional scale, or even at the corridor/sub-area level. On the other hand, we are likely to see many TCM, pricing and other alternatives at all three levels of analysis. In terms of impacts, certain categories might not be critical at particular levels. For instance, project level investments are not likely to have significant impacts on air quality except in terms of “hot-spot” problems.

![Conceptual Framework For Evaluation](image)

**Figure 2-3: Conceptual Framework For Evaluation.**

2.3.4 Conceptual Framework for Evaluation and Good Practices

The figure above provides a conceptual framework for comprehensive evaluation of transportation alternatives and outlines key inputs to evaluation, important relationships between evaluation and other planning activities, and the basic components of evaluation itself. As shown, estimation of impacts is a key component of the evaluation process. Estimation of impacts depends upon clear definition of the characteristics of modal alternatives and the local context in terms of goals; concerns of decision-makers, and others; and legal and other administrative requirements.
Public involvement is desirable in all phases, including developing key inputs, design and refinement of alternatives and evaluation. The box labeled "Decision-Making" means making decisions about the combinations of alternatives to pursue including service levels, collateral mitigation measures, funding, and other relevant choices.

Good practice in impact estimation and evaluation recognizes several key principles shown on the following page. Products of the evaluation process are used by many individuals including federal, state and local officials and the public. The information required by these decision-makers cannot be reduced to a single measure or, in many instances, to a relatively small set of quantitative measures of alternatives and their consequences. Rather, decision-makers have to apply a series of tests—to alternatives, to their consequences, and to the process through which alternatives are developed and evaluated. The decision to select, or approve the selection of, an alternative is based on a satisfactory outcome to each of these several tests.

Comprehensive evaluations will call for impact measures relating to: overall economic worth; environmental implication; equity; financial feasibility; legal and administrative feasibility, and social acceptance. The sensitivity of findings to uncertainties and value based assumptions, and the adequacies of alternatives and impacts considered will also need to be considered. Questions that need to be answered in order to address these evaluation elements are presented in the Appendix of this module.

One key element of transportation decision-making is that many impact measures contain subjective judgments: values of time; safety; comfort, quality of life etc.

Recognition of the inherent subjectivity in evaluation has fostered a trend toward lengthy, detailed statements of the impacts of alternatives--forcing a decision-maker to organize and summarize this information. However, that approach requires decision-makers to read and digest a potentially overwhelming volume of information. If they do not have time, that approach can exacerbate the very problem it attempts to overcome, by failing to adequately focus attention on important aspects of alternatives. Hence, the written products of a comprehensive evaluation should include brief statements highlighting key findings regarding the overall merit of alternatives and detailed information on the incidence of impacts.
PRINCIPLES OF GOOD PRACTICE

- Cognizance of Decision Sequence
- Concerns and Valuations of Decision-Makers and Others
- Qualitative as well as Quantitative
- Uncertainties and Value-Based Assumptions Should be Well Recognized
- All Key Impacts

LEGAL AND ADMINISTRATIVE REQUIREMENTS

- Local Ordinances
- State Statutes
- Federal Program Requirements
- Environment
- Safety
- Equity
- Access
2.3.5 Legal and Administrative Requirements

Advancing a plan element from the conceptual or "needs" stage through implementation requires a series of decisions based on approvals, submissions of studies, and other administrative actions. Guidelines for these decisions are provided in a series of legal and administrative requirements. Some stem from local and State laws and procedures, and others from Federal program requirements.

Legal and administrative requirements can define both the type of information to be produced and those with authority to approve, review, comment upon, or otherwise influence decisions. Legal and administrative requirements might also affect the feasibility of alternatives. Good evaluation should provide documentation of the adequacy of procedures used to arrive at a screening decision.

Legal and administrative requirements for the types or scope of alternatives under consideration should be outlined at the outset of the planning process, including key decision points and the principal actors likely to be involved. This outline can be the basis for a rough schedule, indicating when evaluation information would be needed as well as the audience for that information.

Note, however, that decisions will seldom follow a neat and orderly pattern. Frequently, considerations that ideally would occur sequentially in fact occur simultaneously, complicating the role of the planner who provides evaluation information. Therefore, any attempt to outline the process should recognize that the outline may not hold. Its value lies in the identification of major steps and related considerations, not in the ability to portray an accurate decision sequence.

2.3.6 Public Participation

PUBLIC INVOLVEMENT SHOULD BE:

- Inclusive of All Affected Parties
- Proactive
- Early and Continuing

To identify issues that are important to different groups and determine the information needed to address them, it is often useful to ask the public early in planning. Public involvement is particularly important for major capital improvements that might have severe local impacts, and in cases where major disincentives to automobile use are contemplated as a means for managing transportation demand. The need for, type of, and timing of public participation should be determined in preparing the Evaluation Work Plan. The expectations of an agency seeking public input must be realistic.
One important function of citizen involvement is the assistance participation, and should actively seek participation. The important principle is actively encouraging and enthusiastically providing the opportunity for participation and being flexible when interest is finally aroused. It provides in the modification of alternatives to ameliorate negative impacts. Public involvement also solidifies the purpose and need for a project and identifies viable options to meet the need.

The development of alternatives frequently has to occur through a political process of negotiation. The trade-offs involved among goals for air quality, energy, mobility, and the economy, become known to decision-makers and the community only when they are faced with actual choices. In addition, the relative values of such goals may be different to different groups within the urban area.

In summary, the elements of effective public involvement are:

- Each interested person or group is offered a level of involvement and a type of interaction consistent with their desire for interaction. Levels of interaction should range from periodic mailing to detailed work sessions with the appropriate staffs.
- Each agency has an active, rather than reactive, program to inform the public and interest groups, and uses any available media or civic groups to disseminate information.
- Representatives of citizen's associations and interest groups are asked to advise on all issues.

### 2.3.7 Evaluation Work Plan

#### EVALUATION WORK PLAN

**Step 1: Identify Concerns to be Addressed by Evaluation**
- Purpose and Need for the Effort
- Alternatives
- Impacts
- Relationship to legal and administrative requirements
- Different decision-makers and interests and their key concerns
- Preferences of key interests and valuation implied

**Step 2: Determine Information Need to Address Concerns**
- Set of Impact Measures
- Relationship of Measures to Goals
- Level of Detail for each Measure
- Formats for summarizing impacts

**Step 3: Assumptions and Analysis Procedures**
- Relative Importance of Impacts
- Current knowledge about measures
- Procedures for reducing Uncertainty
- Possible Sensitivity Tests
- Making Trade-offs
Preparation of an Evaluation Work Plan can be of great value to planners in managing impact estimation and evaluation activities. The evaluation work-plan forms the basis for agreement between planners, decision-makers, on scope and purpose of evaluation and information to be produced. Steps in the preparation of an evaluation Work Plan will be identified.

The Evaluation Work Plan should identify, at the start, the impacts to be broken down in terms of their differential incidence on different groups, because the forecasting methodology will often be influenced in major ways by the required dis-aggregations of impact data. For example, user cost breakdowns by user class are fairly easy to do, if the breakdowns are established at the start of the travel forecasting process. Otherwise, it can be very difficult or impractical to do after the forecasts are made.

Of course, the level of dis-aggregation for particular impact measures must be tempered by data availability and by the ability of available technical tools to forecast accurately. The availability of various planning data should be specified in the Evaluation Work Plan. Also, representatives of various groups should be consulted to be sure critical data items are not overlooked.

The information needed to analyze the distribution of impacts will almost always be significantly greater than for overall investment analysis. At a minimum, it will usually be necessary to estimate all major costs and benefits to groups. This is not always necessary in an overall investment analysis where some items represent transfers among groups, e.g., transit fares paid by riders to the operating agency, tax impacts, and land value impacts.

One danger in preparing the Evaluation Work Plan is allowing the burden of generating disaggregated impact data to become too great. The costs of having to disaggregate each impact variable into several categories could cause a major increase in costs. Wherever possible, approximation or simplifications should be made. Normally groups that are affected are more concerned with clear identification of the nature of the impact, rather than precise measurement of the magnitude of the impact.
2.3.8 Relationship of Travel Forecasting to Evaluation

TRAVEL FORECASTING AND EVALUATION

- Coordination with Estimating Impacts
- Level of Aggregation
- System Sensitivity
  - Variability in population and Employment forecasts
  - Value of Travel Time
  - Fuel Prices
  - Parking Costs
  - Peak Spreading
  - Induced Travel
  - Equilibrium
  - Operating Policies (E.G., fares, HOV)

Projections of future travel patterns and the effects of alternatives on travel patterns are a major input to the evaluation process. Assessment of the economic viability of proposed transportation improvements can be very sensitive to forecasts of traffic or patronage levels. Many of the non-user impacts-on air quality and energy consumption-also are related directly to the differential effects of system alternatives on travel patterns. For these and other impacts, the accuracy of travel forecasts will be a major determinant of the quality of evaluation.

Because travel forecasts are an important input to many impact estimation procedures, the selection of a travel forecasting methodology should be coordinated with the selection of these other procedures. There is no single approach to travel forecasting which is generally applicable to all planning problems. The selection of travel forecasting procedures is governed by the information needed in a specific planning context and an examination of the accuracy and costs of alternate methods for producing this information.

More accurate estimates of impacts can be made from more disaggregated travel forecasts. For example, gasoline consumption and other operating costs are affected by highway type and operating conditions, and can be more accurately estimated if VMT forecasts are disaggregated to account for these factors. However, some refinements may not be cost-effective in improving the accuracy of the final product. For example, using a very detailed scheme to classify vehicle miles by type of highway in order to obtain more accurate estimates of reductions in highway user costs is inappropriate if the primarily purpose of system evaluation is to compare system-level impacts, or help decide whether or not to implement a new rail rapid transit system.
A key consideration in assessing the merit of a particular refinement to travel forecasting procedures is sensitivity whether it will provide more accurate estimates of differences between alternatives. These refinements are generally more valuable than refinements that are oriented toward more accurate forecasts of base conditions.

Issues regarding system sensitivity which arise frequently are: variability of forecasted population/employment, value of time, fuel price, parking costs, peak spreading, induced travel; equilibration; and operating policies.

2.4 DEVELOPMENT OF ALTERNATIVES

2.4.1 Development of Alternatives

**PRINCIPLES OF DEVELOPING ALTERNATIVES**

- Responsiveness to goals and Problems
- Range of Alternatives/trade-offs
- Open and Documented Development

Transportation alternatives should be developed through application of certain basic principles:

1. Transportation alternatives should respond directly to the local goals and needs (problems and causes).
2. A wide range of alternatives should be considered so as to illustrate the trade-offs to the decision-makers and should include different modes.
3. Alternatives should be developed in a collaborative process in clearly defined stages that are open to full review and participation by stakeholders and the general public.

2.4.2 Responsiveness to Local Goals and Needs

**RESPONSIVENESS TO GOALS AND PROBLEMS**

- Recognize overlap between markets and modes
- Mix of Modes
- Recognize Physical Characteristics
- Respond to the Context and Values
Evaluation of transportation alternatives should start with a clear statement of problems and well-conceived alternatives. While conventional wisdom suggests that different modes and operating policies address different kinds of markets, it should be recognized that there is much greater overlap of modes across markets and problems than what conventional wisdom implies. Also, the tendency in the past assessments was to focus on single-mode alternatives and to consider single physical facilities and operating strategies as alternatives. The new approach is to encourage consideration of possible mix of modes, physical facilities (e.g., access policies and location) and operating strategies. HOV occupancy requirements and express/local transit operations within an alternative. It should also be recognized at the start that each alternative will have to meet financial and emissions budget constraints.

2.4.3 Range of Alternatives

The range of alternatives developed should illustrate trade-offs across goals and objectives. The No-Build alternative is required by NEPA. The TSM alternative is required by MIS. TDM and Pricing alternatives are not formally required, but they offer a low-cost benchmark and should be considered as much as possible. The alternatives should anticipate the preferred alternative. Also, it is important to provide a Fall-Back alternative where feasibility is in question. Finally, the number of alternatives should be manageable (while the sketch planning is carved out just so that one can screen out alternatives and bring the number to be carried into MIS to a reasonable level, even in sketch planning one can only deal with so many).

**RANGE OF ALTERNATIVES**

- No-Build (NEPA)
- TSM (MIS Requirements)
- TDM Pricing
- All Reasonable Modes
- Address Different Goals and Objectives
- Anticipate Preferred Alternative
- Fall-back Alternative
- Manageable Number of Alternatives
2.4.4 Open and Documented Development

Each alternative will need to be defined by: mode (or mode combination); general alignment- overall operating policies; institutional setting; and financial strategy. Typically, there will be three stages in the development of alternatives: Conceptual development, where enough detail is provided to state intentions; Detailed development, where enough detail is developed to support analyses; Final development, where evaluations can take place and decisions can be documented. Each stage should be carried out in a collaborative process in clearly defined stages that are open to full review and participation by stakeholders and the general public.

EXERCISES

1) What are the various types of impacts of transportation system changes? Give one example of each.
2) What is the role of evaluation in the transportation development process?
3) What is the 3-E triangle? What are its elements and what do they represent?
4) List some of the common measures of effectiveness for measuring community objectives.
5) What are the different phases of the evaluation work-plan?
6) What are the basic principles of developing transportation alternatives?

REFERENCES
