The Scenario Analysis Process and Long-Range Transportation Planning

JOHN M. MORDECAI

ABSTRACT

An 18-month study of a prototype application of a scenario planning methodology for public planning is documented. The scenario technique is intended to address concerns about long-range planning in the light of uncertainties about the future by considering the interaction of a few key variables. By assigning values to each of the variables and considering their interaction, a panel of policy makers generates several hypothetical scenarios of the future that provide a context for considering directions for future public policy. The key variables were oil supply, economic activity, and technological change. The scenario process is described and a summary is given of the substantive findings. Also the value of scenario analysis as an adjunct to the ongoing, conventional transportation planning process is assessed.

It is fairly accurate to describe long-range transportation planning as a process that projects future conditions based on existing trends and implicit assumptions about the key interrelationships between transportation and other factors, such as land use or the economy. The projected future conditions describe a set of needs on which plans and programs are based. Of course, the problem with this conventional approach is that it breaks down when the future is not a neat extension of the present or when the assumed relationships are altered. This was illustrated by the energy supply disruptions of the 1970s, which created departures from expected trends in travel behavior and gave new importance to sets of interactions that had never before been given serious attention, such as the linkage between the demand for transportation and the ability of the government to finance transportation investments. The demonstration project conducted by the Baltimore, Maryland, Regional Planning Council from fall 1981 to spring 1982 was an effort to focus more attention on unexpected changes in energy and other conditions that have a significant bearing on transportation and to consider more fully the interactions among transportation, energy, and other matters of primary importance to the region.

The project used a planning technique called multiple scenario analysis, which has been used frequently by private industry and research groups to improve planning for an uncertain future. The process consists of examining the interaction of a limited number of key factors that are expected to have a fundamental influence on future needs. By assigning several plausible but widely differing values to the selected factors and combining them in different ways, several hypothetical pictures of the future can be derived. Individually, the alternative future conditions pose unique problems and demand individualized public responses; collectively, they are intended to encompass the full range of possible futures and assure that the planning process has addressed them.

In the Baltimore study, a group of officials from the public and private sectors examined four futures (called scenarios) that were typified by variations in (a) availability of energy for transportation, (b) economic conditions, and (c) commercialization of technology. The interactions of the key variables with regional conditions brought to light a number of transportation issues (some were already part of the conventional transportation planning process and some were new) that demanded consideration of new policy and program responses and suggested important linkages between transportation and other functional areas of the regional planning process. The intent of the study was to generate discussion of these new concerns and to consider public-policy options in response to them.

STUDY CONTEXT, THE BALTIMORE REGION

The Baltimore region lies in the lower portion of the northeast corridor, which includes Boston, New
York, Philadelphia, and Washington, D.C. The region is typical of these urban areas and shares the trends and problems commonly associated with them. Most notably:

- An older central urban core with surrounding suburban areas;
- Most trips oriented toward the city center but significant amounts of travel oriented to widespread suburban locations;
- A shifting of the employment base from heavy manufacturing to service and trade industries; and
- New growth directed toward suburban areas.

The Regional Planning Council (RPC) is an association of the governments of Baltimore City and the five surrounding counties. The planning community also includes the Maryland departments of Transportation (MDOT), Natural Resources, Health and Mental Hygiene, and Planning. The RPC staff conducts various federally mandated planning programs for the region in conjunction with MDOT and carries out programs in natural resources, land use, housing, and economic development.

**PROJECT RESULTS AND FINDINGS**

The primary intent of the project was to bring a new perspective to long-range transportation planning, particularly in relation to varying future conditions. The results of this concern were evidenced in several specific areas.

The Energy/Transportation Futures panel recommended a number of policies to the RPC and its committees for inclusion in the 1982 General Development Plan (GDP). Many of these policies were included; however, because the GDP must be approved by a wide range of public and private organizations, it is a conservative document, and some of the more innovative policies were not adopted. For example, the panel recognized that systematic reduction in maintenance of low-volume facilities might be necessary under certain conditions, but the GDP does not reflect that concept. Also, the panel suggested establishing a regional body to encourage new industry, which would be funded through tax-base sharing. This policy was not accepted for the GDP. These policies and others that were rejected were extremely controversial; however, they were considered in the formal deliberations and have been stated for further consideration in the conventional planning process and greater attention in the work programs of the RPC and other planning agencies.

The major findings of this study on energy use in the transportation sector did not center on conventional conservation themes. Instead, the interactions of the key factors—oil availability, economic activity, and technological innovation—emphasized fundamental relationships that pointed to more far-reaching problem areas. For example, it was clear that with adequate oil supplies and healthy economic growth, there would be pressure for suburban expansion, little inclination to reduce fuel consumption, and reduced market demand for technologies that could reduce travel or increase automobile mileage. It was determined that under these conditions, the success of public conservation programs would be minimal and that more pressing needs would center on augmenting conventional transit to serve expanding suburban areas and adapting the transportation network to the changing needs of a growing industrial base. Further, it was less clear that with a sustainable economy and chronic fuel shortages would automatically promote conservation, reduce fuel consumption, and sharply reduce the rate of suburban growth. This scenario would yield its own set of problems that would revolve around severe shortfalls in transportation revenue caused by reduced consumption, preclude adequate maintenance of the highway system, and make it impossible to meet growing demands on the transit system.

By establishing these long-term relationships among oil availability, economic conditions, development trends, and transportation revenues, the study provided a new perspective for long-range planning and a new context for the design of specific policies and programs to be developed through ongoing planning activities. It is impossible to predict the degree to which this one-time project will have lasting influence on transportation planning or public decision making. The issues that emerged as most significant in the course of the study receive little or no attention in existing work programs. Thus, for the issues initially voiced during the scenario exercise to receive continued attention and further development, significant changes will be required in the substance of the existing planning process.

**SCENARIO PROCESS**

The broad objective of the study was to reassess the future needs of the region, not in traditional terms of a single future scenario extrapolated from current conditions but by considering a number of alternative scenarios, each having its unique set of public and private responses. For the outcomes of the process to have the most lasting effect, it was vital that the government officials who participate in the decision making be involved. Thus, a panel of 17 officials from local governments, state agencies, and private organizations was recruited and became the group around which the project was structured. The exercise was divided into three meetings.

**First Panel Meeting**

The panel's main task in the first session was to agree on a limited number of key factors (called independent variables) that were beyond the control of the region and that would have the greatest influence on the region, especially with respect to transportation, land use, and economic development. The panel selected three variables and assigned them general values that might occur during the coming decade.

1. Availability of oil: plentiful, stable, and shortage;
2. Economic growth: vigorous, slow, and declining; and
3. Commercialization of technology: rapid and slow.

The first session also included initial discussions of how the key factors would interact and which future conditions would be most important in considering future regional needs and problems.

Before the second session, the staff arrayed the variables to form 18 cells (skeleton scenarios) and described the history of conditions in selected cells.

**Second Panel Meeting**

The major business for the second meeting was to select the cells to be studied in more detail. The scenarios agreed to by the panel are given in Table 1; they were
- Scenario 5, the Trend Scenario, was considered the most likely to occur.
- Scenarios 3 and 7, Decline and Growth, were selected to represent polar conditions that would demand extreme responses of public and private policy.
- Scenario 16 shifting to Scenario 10 in the middle of the planning period was designated Transition. This combined scenario was selected so that the panel could consider the actions necessary to respond to a major, prolonged interruption of fuel supply.

### Table 1 Comparison of Significant Trends from Each Scenario

<table>
<thead>
<tr>
<th>Scenario 3: Decline</th>
<th>Scenario 5: Trend</th>
<th>Scenario 7: Growth</th>
<th>Scenarios 16 and 10 Combined: Transition</th>
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</thead>
<tbody>
<tr>
<td><strong>Energy Use</strong></td>
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<tr>
<td>High prices and depressed economy reduce consumption.</td>
<td>Increased automobile efficiency reduces fuel consumption.</td>
<td>Stable prices and high levels of economic activity prevent significant reductions in consumption.</td>
<td>High levels of demand before interruption. Sharp reductions forced by shortfall.</td>
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<tr>
<td><strong>Economy</strong></td>
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<tr>
<td>All segments of industry operating at depressed levels. Unemployment is most severe for blue-collar and semiskilled work force.</td>
<td>Slow economic growth. Unemployment is most severe for blue-collar and semiskilled work force.</td>
<td>Infusion of medical and technical light industry; some revitalization of heavy industry through plant modernization. Unemployment for blue-collar and semiskilled work force is stable.</td>
<td>Comparable to conditions in Growth Scenario with no protracted change following the fuel interruption.</td>
</tr>
<tr>
<td><strong>Transportation</strong></td>
<td></td>
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<tr>
<td>Demand: Automobile travel decreases, transit and paratransit increase, coal and grain exports rise.</td>
<td>Demand: Automobile travel grows as a result of more nonwork trips, little change in transit and paratransit use, coal exports increase.</td>
<td>Demand: Automobile travel grows as a result of suburban growth and more nonwork trips, transit ridership declines with suburbanization, little change in paratransit, port tonnage and rail volumes decline as light industry assumes high portion of industrial output.</td>
<td>Before interruption: Similar to Growth Scenario. After interruption: Sharp rise in coal exports, reductions in nonwork trips, sharp, temporary increases in transit and paratransit.</td>
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<td>Supply: No expansion, investment in the highway system declines, transit service cutbacks.</td>
<td>Supply: Little expansion, investment in the highway system declines, transit cutbacks.</td>
<td>Supply: Competition for funds between expansion and maintenance of the highway system, transit cutbacks.</td>
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<tr>
<td><strong>Government Revenue</strong></td>
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<td>Sharp declines in MDOT revenue, further eroded by high inflation rates. Local government revenues decline. Reduced federal assistance.</td>
<td>Slow declines in MDOT revenue. Constant local government revenue. Reduced federal assistance.</td>
<td>Stable MDOT revenues. Modest increases in local government revenue. Reduced federal assistance.</td>
<td>Before interruption: Similar to Growth Scenario. After interruption: Sharp drops in MDOT revenues with slow recovery through the remainder of the period.</td>
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### Table 2 Major Scenario-Dependent Variable Interactions

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Impact on Dependent Variable</th>
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<tbody>
<tr>
<td></td>
<td>Primary</td>
</tr>
<tr>
<td>Oil availability and economic growth</td>
<td>More rapid suburbanization, increased travel</td>
</tr>
<tr>
<td>Shortage and slow</td>
<td>Slower suburbanization, reduced travel</td>
</tr>
<tr>
<td>Economic Growth Rapid</td>
<td>Increased share of growth industries (service, technical)</td>
</tr>
<tr>
<td>Public infrastructure needs in suburban locations</td>
<td>Declines in manufacturing</td>
</tr>
<tr>
<td>Slow</td>
<td>Increased need for public infrastructure to attract new industry</td>
</tr>
<tr>
<td>Technology Mini cars</td>
<td>Need for new highway configurations</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>Reduced travel</td>
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</tbody>
</table>
also indicated an interest in promoting alternative fuels and developing energy contingency planning.

Before the final meeting, the staff wrote detailed scenarios based on the previous panel sessions. Also included were suggested policies and their effects on the problems and needs posed by each scenario. The panel was asked to review this material before the final meeting. Figure 1 shows a comparison of the major elements of the scenarios.

Third Panel Meeting

The third session was devoted to identifying policies that would respond to future regional needs as represented by the scenarios. The staff proposals from the written scenarios served as a basis for the panel discussion. The panel generated a large number of different potential policies. The following policies received the most attention:

1. Transportation policies
   - Conventional public transit must be considered in relation to paratransit and privately sponsored transportation programs.
   - The port and airport are dependent on adequate landside distribution and delivery systems; therefore railroads and highways must be an integral part of port and airport planning.
   - A complete halt in construction of new transportation facilities is unacceptable under any set of future conditions.
   - A regional sales tax should be implemented to fund transportation improvements.

2. Energy policies: Further study of the use and conservation of energy is needed regardless of future conditions.

3. Land development policies: Promotion by the government of centralized development and residential areas located near work is desirable; but crime, quality of schools, and racial distributions are probably overriding factors in choosing a location.

4. Economic development
   - A regional agency should be formed to coordinate efforts to attract new industry.

Rapid Commercialization of New Technology

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<th>ECONOMIC GROWTH</th>
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<tr>
<td></td>
<td>Vigorous</td>
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<tr>
<td>Oil Availability</td>
<td>1</td>
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<tr>
<td>Stable Shortage</td>
<td>4</td>
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<tr>
<td>Plentiful</td>
<td>7</td>
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</tbody>
</table>

Scenario 3: 1974-1975 in terms of oil supply and economic growth only.
Scenario 5: 1976-1978 in terms of rapid advances in automotive technology.
Scenario 7: 1950s and 1960s.

Slow Commercialization of New Technology

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<th>ECONOMIC GROWTH</th>
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<tr>
<td></td>
<td>Vigorous</td>
</tr>
<tr>
<td>Oil Availability</td>
<td>10</td>
</tr>
<tr>
<td>Stable Shortage</td>
<td>13</td>
</tr>
<tr>
<td>Plentiful</td>
<td>16</td>
</tr>
</tbody>
</table>

Scenario 10: World War II in terms of non-military technological development and domestic fuel shortages.
Scenario 16: Late 1960s in that there were few gains made in transportation technology.
Scenario 17: 1935-1940.
Scenario 18: 1930-1934.

Scenarios selected for further development are shaded.

FIGURE 1 Scenario matrix.
Tax-base sharing is a potential means of pooling resources and sharing benefits of a regional approach to economic development. 

- Unskilled labor and unemployed youth will be a major problem under any set of regional conditions.
- In the coming decade a joint effort by government and the private sector will be required to retrain a labor force.

Following this session, the staff prepared revised policy statements that were mailed to the panel for final review. The panel was also asked to indicate which of the policies could be recommended for the 1982 General Development Plan and which should be the subject of further study.

The final policy recommendations were presented to appropriate subcommittees of the Regional Planning Council for approval before they were included in the General Development Plan.

THE STUDY AND ONGOING PLANNING ACTIVITIES

As was the intent, the scenario exercise delved into concepts and substantive issues that are not usually covered by conventional planning. The most important of these is that the future is not necessarily an extension of the present and that existing programs and policies may not be appropriate for the future.

Those concepts and the specific, substantive results of the study depart sharply from the current approach and substance of transportation planning.

Because the study concepts are innovative, they cannot be easily embraced by the conservative, well-established planning procedures and decision-making process. In practice such a change would require major changes in agency work programs that would allow a more flexible agency response to uncertain and constantly changing needs and in the attitude of decision makers to new and controversial policies.

The panel was largely comprised of individuals who will continue to be influential in policy and program development and can be expected to support the methodology and results of the futures project. Their support is essential to any substantial realignment of the planning process or change in transportation decision making. It remains to be seen whether the influence of this group will be sufficient to alter the firmly entrenched practices of the existing planning framework; therefore, the long-term benefits of scenario analysis in this context remain uncertain at this time.

Incorporation of Energy Analysis in the Transportation Improvement Program Process

NATHAN S. ERLBAUM and WILLIAM C. HOLTHOFF

ABSTRACT

The New York State Department of Transportation in cooperation with the Genesee Transportation Council (the metropolitan planning organization of Rochester, New York) studied ways to incorporate energy conservation in urban transportation planning and project decision making. The study evaluated the energy impact of 92 proposed transportation projects, described these findings to local officials, and examined the impact of this information on project selection.

In 1980 the transportation sector used approximately 56 percent of the nation's petroleum, and more than 97 percent of the energy used in transportation was petroleum based. Clearly, reductions in the use of energy by the transportation sector would help reduce the nation's use of petroleum and its dependence on foreign oil.

At the state and local level, limited progress has been made to incorporate concerns about energy into the urban transportation planning and project decision-making process. To investigate ways to increase concerns about energy at this level, the New York State Department of Transportation (NYSDOT) and the Genesee Transportation Council (GTC) (the metropolitan planning organization of Rochester, New York) jointly assessed the energy implications of the proposed 1983-1988 Rochester Transportation Improvement Program (TIP). (TIP is a federally mandated compilation of all transportation projects and expenditures planned for a region.) The purpose of the study was to

1. Determine the energy savings and energy costs (of construction) for all projects to be included in the 1983-1988 TIP.
2. Use these results at various points in the local area's process for setting project priorities.
3. Assess the effectiveness of the procedures, both technical and administrative.

To accomplish these goals, the study group (a) developed analysis tools for those projects for which