# USING SCENARIOS IN REGIONAL STRATEGIC TRANSPORTATION PLANNING: AN EVOLVING METHODOLOGY

by

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Submitted to the Department of Civil and Environmental Engineering in Partial Fulfillment of the Requirements for the Degrees of

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## ABSTRACT

This thesis explores the application of scenario planning to regional strategic transportation planning (RSTP). Like all strategic planning, RSTP takes place in the presence of uncertainty, requiring flexibility and systematic thinking. The work presented builds on that of Muñoz in his application of scenarios to Mendoza, Argentina and the Cooperative Mobility Program – ReS/SITE team's scenario-based analysis of Houston, Texas. While these examples demonstrated the usefulness and applicability of scenarios to the RSTP context, several methodological shortcomings have been identified. This thesis addresses some of these shortcomings.

There are four major components to this thesis. First, this thesis provides substantial background on the concept of scenarios and illustrates their application in regional strategic transportation planning. The history of scenarios as a planning tool, a framework for RSTP based on scenarios, a scenario development methodology, and several applications of scenarios are discussed in detail.

Second, it provides a framework for integrating scenarios into a region's ongoing regional strategic transportation planning process based on a four phase "strategic conversation" as defined by Peter Schwartz.

Third, it defines the concept of regional architecture and describes how it can be used to develop organizational strategies. Scenarios are important for informing these regional architecture choices and they provide a framework for evaluating different organizational strategies.

Fourth and finally, it proposes that regional strategic planning needs to be considered in a comprehensive manner. Transportation strategies are only a part of the puzzle a region must solve to ensure its competitive position in the global economy. The pieces of a region's competitive strategy are discussed and the concept of scalable scenarios is introduced as a way to approach regional strategic planning.

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## PREFACE

The research for this thesis was done within the framework of an MIT research project called ReS/SITE: Regional Strategies for the Sustainable Intermodal Transportation Enterprise. This project aspires to developing new frameworks for regional strategic transportation planning. It has identified various shortcomings in that process through analysis of current planning efforts, and has worked to establish a new process to overcoming these weaknesses. It builds broadly on the concepts of scenarios and regional architecture as fundamental to this new generation of regional strategic transportation plans.

# TABLE OF CONTENTS

## CHAPTER 8

# LIST OF FIGURES

# LIST OF TABLES

# 1

# INTRODUCTION AND OVERVIEW

This thesis proposes that the use of scenarios can strengthen the regional strategic transportation planning process. The application of scenarios to strategic planning has proven highly successful in the private sector and several researchers have suggested that the application of scenarios to regional strategic transportation planning (RSTP) is a significant improvement to the traditional process. The use of scenarios for RSTP is part of a framework developed by the Regional Strategies for the Intermodal Transportation Enterprise (ReS/SITE) group at the Massachusetts Institute of Technology. This framework relies on scenarios to frame the transportation planning process.

This chapter is divided into two sections. The first will summarize the objectives, content and motivation for this thesis. This first section introduces the Cooperative Mobility Program – ReS/SITE scenarios for Houston, Texas project, the foundation for this thesis. The second section will describe the ReS/SITE framework that describes how scenarios can frame the RSTP process.

## OBJECTIVES, MOTIVATION, AND CONTENTS

Scenarios can be a valuable tool for regional strategic transportation planning. This thesis proposes ways in which the application of scenarios to RSTP can be improved. This section

establishes the objectives of this thesis, describes its motivation and outlines its contents.

## Thesis Objectives

In the 1960s and 1970s a business-planning group at Royal Dutch Shell employed a scenario planning approach in the face of growing uncertainty. Pierre Wack writes that scenarios were a way of overcoming the limitations of forecasting future conditions, a key aspect of Shell's financial planning strategy. Based on Shell's relative success through the oil crises of the early 1970s, the scenario approach to strategic business planning spread through industry (CMP-ReS/SITE1 2). Today, many derivations of scenario planning are applied in different contexts. Scenario planning can be used for strategic planning, project planning, tactical planning, crisis management, team building and improving morale (van der Heijden, 1996).

This thesis explores the application of scenario planning in a strategic context, specifically in the regional strategic transportation planning (RSTP) context. RSTP, like all strategic planning takes place in the presence of uncertainty, requiring flexibility and systematic thinking (Muñoz 1998). The work presented builds on that of Muñoz in his application of scenarios to Mendoza, Argentina and the Cooperative Mobility Program – ReS/SITE team's scenario-based analysis of Houston, Texas. While the CMP-ReS/SITE project demonstrated the usefulness and applicability of scenarios to the RSTP context, several methodological shortcomings were identified. This thesis addresses some of these shortcomings.

There are several objectives of this thesis:

1. It will provide substantial background on the concept of scenarios and illustrate their application in regional strategic transportation planning. The history of scenarios as a planning tool, a framework for RSTP based on scenarios, a scenario development methodology, and several applications of scenarios are discussed.

2. It provides a framework for integrating scenarios into a region's ongoing regional strategic transportation planning process.

3. It defines the concept of regional architecture and describes how it can be used to develop organizational strategies. Scenarios are important for informing these regional architecture choices and they provide a framework for evaluating different organizational strategies.

4. Finally, it proposes that regional strategic planning needs to be considered in a comprehensive manner. Transportation strategies are only a part of the puzzle a region must solve to ensure its competitive position in the global economy. The pieces of a region's competitive strategy are discussed and the concept of scalable scenarios is introduced as a way to approach regional strategic planning.

## Motivation – Mobility Scenarios for Houston Project

This thesis is being prepared as a continuation of the Cooperative Mobility Program – ReS/SITE analysis of mobility scenarios for Houston. The Cooperative Mobility Program – ReS/SITE team has developed future scenarios of mobility in the Houston metropolitan region. These mobility scenarios are based on different socioeconomic, demographic, development, institutional, and technological futures for the region. The region's strategies for providing transportation services were then be examined in the light of the different scenarios developed.

There are several different types of transportation strategies the region can consider. It can pursue infrastructure strategies that involve capital investment in new facilities. It can develop new services that serve different transportation needs. It can institute policies and regulations intended to control different aspects of the transportation system. It can also consider institutional arrangements needed to provide transportation services and develop new organizational strategies. Regardless of which types of strategy the region decides to follow, they will have to be viable across a broad range of different possible futures. The actual analysis of Houston considered infrastructure, service and policy/regulatory strategies but did not contain any organizational strategies.

Houston has been chosen for a case study in this area for several reasons. First, the institutions

responsible for providing transportation services in Houston have demonstrated a high degree of cooperation over the past several years. The Transtar organization, responsible for ITS implementation and operation of the highway system, has fostered cooperation between METRO, the transit agency, TxDOT, Harris County, and the City of Houston.

Second, Houston is of a particular type of modern city. The geographic growth of the metropolitan area is largely unconstrained and this growth occurs quite rapidly. Land use is less regulated in Houston than most other parts of the United States and the developed world, yet the development patterns in Houston resemble those of many other cities with much more stringent development ordinances and controls. Environmental attitudes and constraints in Houston are also much more relaxed than in other regions of the developed world.

Third, Houston has also focused on providing transportation services in the form of the private vehicle and highways. Travel by private automobile is by far the most dominant form of travel in the region. The public transit service in the region is also highway focused. Bus service around the metropolitan area is accommodated on the area highways. Recent investment in public transit in the metropolitan area has focused on High Occupancy Vehicle (HOV) lanes to serve both express bus and carpool services.

Fourth, Houston is a major center of intermodal passenger and freight movements in the United States. In fact, the city is a transportation hub for the entire Gulf Coast region. Houston George Bush Intercontinental Airport is a hub for a major U.S. airline with significant service to domestic destinations, Europe, Central America and South America. Two major U.S. freight railroads, the Union Pacific and the Burlington Northern/Santa Fe have major operations in Houston. The Houston Ship Channel operated by the Port of Houston Authority is, by some measures, the busiest port in the country and, according to some sources, serves as the primary Gulf port for Mexico. Recently passenger cruise lines have opened operations in the port increasing the demand for air travel and intermodal transfers through the region.

Fifth, Houston is a major international business center with several corporate headquarters for global energy, transportation and engineering firms. International banking, finance and

insurance are also major activities in the region. Furthermore, the city hosts major universities and medical research centers as well as large convention centers hosting national and international trade shows and conventions.

All of these characteristics made Houston an attractive case for application of these scenarios.

## Contents

The remainder of **Chapter 1** will describe how scenarios can fit into regional strategic transportation planning by outlining the ReS/SITE framework.

**Chapter 2** will describe the history of scenario planning and develop some applications of the methodology in different contexts. Three different applications are considered in detail: business planning, national visioning, and public sector service planning. Chapter 2 will conclude by establishing the tie between scenarios and regional strategic transportation planning.

**Chapter 3** will describe the application of scenarios to regional strategic transportation planning in Mendoza, Argentina.

**Chapter 4** will outline the methodology used to develop mobility scenarios for Houston. The chapter will begin by describing the current RSTP for the region. Next, a scenario platform for RSTP will be proposed based on an eight-step process in which the scenarios are determined by different combinations of scenario drivers.

**Chapter 5** summarizes the application of this scenario platform to Houston.

**Chapter 6** describes how scenarios might be introduced into a region's ongoing transportation planning process. The chapter describes Schwartz's concept of a strategic conversation and proposed a four-phase strategic conversation for integrating scenarios into the RSTP process.

**Chapter 7** considers how regional architecture can be used as a tool for including

organizational strategies in the scenario platform. Regional architecture is defined and examples of different organizational strategies are developed. An evaluation framework for these strategies is introduced at the end of this chapter.

**Chapter 8** suggests extension of this methodology beyond regional strategic transportation planning to regional strategic planning. While regional strategic transportation planning focuses strictly on transportation and transportation institutions, regional strategic planning would include other important infrastructure and service systems and their related infrastructure and institutions.

**Chapter 9**, the final chapter in this thesis, summarizes the work described in the previous chapters, draws conclusions about the scenario methodology, and provides suggestions for further research.

## ReS/SITE RSTP Framework

The Regional Strategies for the Sustainable Intermodal Transportation Enterprise, (ReS/SITE) research group in MIT's Center for Transportation Studies has been investigating regional strategic transportation planning (RSTP) over the past several years. The group has proposed that scenarios are an important component of the RSTP process. Scenarios present different possible futures of the region in question and provide a framework for evaluating the feasibility and effectiveness of various regional strategies.

ReS/SITE proposes a new framework for regional strategic transportation planning. This framework has been developed based on reviews of many planning efforts in the U.S. and around the world and through participation in several different projects including planning efforts in Mendoza, Argentina; the State of Maryland; the Osaka/Kobe region in Japan and the Tren Urbano project in San Juan, Puerto Rico. The key additions to the transportation planning process proposed in the ReS/SITE methodology is the use of scenarios to frame the RSTP process and regional architectures to help the region consider the institutional relationships necessary to provide transportation services.

Strategic transportation planning at a regional scale has long been a focus of agencies around the world. These plans serve as guides in many regions attempting to chart their future, maintain or improve their competitive position in the world economy, and direct their investment in transportation infrastructure. Regional strategic transportation plans need to consider changes in many different factors including economic conditions, environmental constraints, demographic shifts, the ability to finance transportation strategies, and technological innovation. These changes are uncertain and scenarios are an important way to consider this uncertainty in a structured, coherent manner.

## Regional Strategic Transportation Planning - Current Practice

To understand the current transportation planning process, it is important to understand the history of transportation planning and the major developments that have shaped the state of the art over the years.

### *How did Transportation Planning Develop?*

Transportation planning has a history dating back to the Roman Empire when an expansive network of roads was planned and constructed throughout Europe, the Middle East and North Africa. These roads were used to move mail, troops and goods and served as the fabric that held the empire together.

Similar historical evidence of transportation planning in the United States dates back to the latter parts of the 18th century and the early 19th century when the United States government established a plan to build a "national road." At around the same time, the United States also established a scheme that allowed privately financed railroads to flourish across the expanse of the North American continent. Plans of the railroad era did not specifically prescribe what was to be constructed and where. Rather, these plans established a framework for the private sector to provide transportation infrastructure and services for both urban and intercity transportation. Streetcar company franchise procedures were established and a policy to use the railroads to

settle the vast spaces in the American West was developed. This early type of "framework" planning changed rapidly after the popularity of the motor car grew after the Great Depression and World War II.

The modern concept of transportation planning in the United States can be traced primarily to the early stages of Interstate highway construction in the 1950s. The planning process that developed during the Interstate Highway era differed significantly from earlier planning efforts. These plans were focused, for the most part, on constructing highways. Aside from modifications during the environmental movement of the late 1960s and the 1970s, this era of planning lasted largely undisturbed until the early 1990s. Major changes to this planning philosophy finally developed in 1991 with the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA). This act required that transportation planning activities take all modes of transportation into consideration and allocated significant financial resources to modes other than highway travel.

## ***What Is in the Transportation Plans of Today?***

Today's transportation plans in the United States consist of four basic components.

1. Transportation plans summarize the current state of the transportation system and identify trends that will shape the conditions under which the transportation system will operate in the future. The plan lists the strengths, weaknesses and demands on the transportation system and forecasts these trends into the future.

2. Transportation plans identify goals for the region. Often, these goals are stated in terms of mobility and accessibility improvements.

3. Transportation plans identify infrastructure improvements that will address the weaknesses identified in (1) and satisfy the goals of (2) above.

4. Transportation plans discuss how these infrastructure projects will be financed. In fact, this is a recent addition to the transportation planning process since before ISTEA funding

considerations were largely ignored in transportation plans that served more or less as "wish lists".

In the United States, these four components quite common around the nation.

## Shortcomings of Current Planning Practice

Before a new planning framework is proposed, one must consider the shortcomings of the current planning process? To this end, the ReS/SITE team conducted a review of strategic transportation plans conducted around the world. This review considered strategic plans in the State of Washington, Iowa, New Mexico, Florida, the Netherlands and many others. Based on this review, areas in which current regional strategic transportation planning needs improvement were identified. These areas are important concerns for developing a RSTP that adequately assesses the future needs of the transportation system in a region. These shortcomings are:

- **Intermodalism**. Intermodalism can be described as using different, interconnected modes of travel to complete a person trip or freight movement. The importance of intermodalism is often overlooked, as are intermodal connections and multi-modal solutions to problems. In practice, many plans can be characterized as a set of unimodal plans rather than an integrated intermodal plan.
- **Technology Scanning**. Technology scanning involves considering which technological developments will impact transportation systems and how. For example, one could examine new ITS technologies and vehicle developments to help determine what type of system management techniques may be available within the planning horizon that are not available today. Few regional strategic plans include such an element.
- **Freight**. Many transportation plans do not adequately address the needs of freight movement. Most transportation planning emphasizes passenger transportation; freight mobility is given less attention despite its criticality for regional economic development.

- **Private Sector Involvement.** Transportation planning today does not adequately involve private sector entities such as major employers, shippers and carriers in the transportation planning process. Public sector agencies and citizen activists largely dominate the process with little opportunity for input from the business community. While the ability of the private sector to deliver needed transportation infrastructure through creative public-private partnerships has been taking hold, the role of such partnerships in more process-related, regionally-scale planning has been limited.
- **Economic Integration.** Transportation and economic development are inherently linked. Most transportation plans do not adequately assess the importance of transportation investment in retaining or achieving a competitive advantage, especially in the context of the global economy. Also these plans sometimes fail to address the local economic development needs that can be spurred on by transportation investment.
- **National Information Infrastructure.** The transportation system is placing increasing demands on the National Information Infrastructure as ITS technologies continue to be employed around the world. Further, transportation infrastructure is often used as right-of-way for information infrastructure. The interdependence of these systems is rarely addressed in transportation plans.
- **Master Plan Perspective.** Many transportation plans are primarily focused on capital investment rather than the operation of the regional transportation system.. The plans often simply identify specific projects and their implementation requirements and timetable rather than considering the overall operation of the regional transportation system.
- **Human Resource Development.** Strategic plans rarely address the need to develop transportation professionals for the future. The plans fail to address the "human capital" needs of the transportation system.

## How Common Are These Shortcomings

Throughout the mid-1990's the U.S. Department of Transportation, through the Federal

Transit Administration Office of Planning and the Federal Highway Administration Office of Environment and Planning, conducted a review of transportation planning in 21 major metropolitan areas. These reviews, known as Enhanced Planning Reviews, or EPRs were performed by the U.S. Department of Transportation Research and Special Programs Administration Volpe National Transportation Systems Center located in Cambridge, Massachusetts. The motivation for conducting this review of metropolitan transportation planning was the enactment of the Intermodal Surface Transportation Act (ISTEA) and the Clean Air Act Amendments of 1990. These two laws enacted by the Federal government placed new demands on and required more rigorous efforts in regional planning. In this context, these reviews evaluated the effectiveness of transportation planning around the United States at the MPO level.

The ReS/SITE group conducted an extensive analysis of the EPRs. From this analysis, it appears that the ReS/SITE group's diagnosis of planning shortcomings is consistent with the findings of the EPR Program.

## ***EPR Program Background***

The FHWA and FTA conducted a series of reviews in response to the planning requirements set forth in the ISTEA and CAAA legislation. The reviews were conducted over a period of four years and included extensive meetings with the MPO and related agency staff. As described by the EPR project team,

> *The EPRs are intended to determine the impact of planning on transportation investment processes. The EPRs also private a technical assessment of the transportation planning and programming processes, including consideration of the sic focal points identified by the FHWA and FTA Administrators for certification... and the ISTEA fifteen planning factors...Additionally, EPRs will provide information for future long-term federal policy-making, including possible legislative and regulatory changes; identify national issues and trends; and document national case studies of best professional practice...*

The six specific focal points of the EPR process are listed below:

1. Financial Constraint and Financial Planning,
2. Major Investment Studies,
3. Congestion Management Systems,
4. The Planning Process,
5. Links to the Conformity Requirements of the Clean Air Act Amendments of 1990, and
6. The Public Involvement Process

The EPRs were performed in 21 different metropolitan areas listed below:

- Kansas City
- Chicago
- Pittsburg
- Houston
- Southern California
- Minneapolis-St.Paul
- Sacramento
- Denver
- Portland
- Honolulu
- Salt-Lake, Ogden
- New York City
- Miami
- Cleveland
- Seattle-Tacoma-Everett
- Philadelphia
- New Orleans
- St. Louis
- Dallas-Ft. Worth
- San Francisco
- Northern New Jersey

Each of these EPRs has been reviewed in the context of the common planning flaws independently identified by the MIT ReS/SITE research team. The results of this review are presented below.

## ***Intermodalism***

Of all of the weaknesses identified initially through the ReS/SITE research program, intermodalism is addressed well by the MPOs throughout the country. Of the 21 studies, fifteen were intermodally focused.

Several of these plans identify the "Metropolitan Transportation System" (MTS) concept involving consideration of all modes as part of an overall system for the entire region. Specifically, this concept is mentioned as a driving force or goal in Denver, St. Louis and San Francisco. The EPR identifies Miami's efforts in intermodal planning as noteworthy. The

remaining plans are criticized as being either modally focused, or in some cases, focused primarily on the automobile.

## *Technology Scanning*

Technology scanning was not in any way a consideration in the EPR process. As a result, no useful data about technology scanning at the MPO level can be gathered directly from the EPRs. However, informal discussions with the Volpe Center staff suggest that this is not an activity underway in any of the MPOs visited.

## *Freight*

There is significant variation in the level of freight consideration across the MPOs evaluated in the EPR process. Volpe Center staff has revealed that freight was emphasized more later in the EPR process, so the EPRs prepared early in the project may be somewhat misleading in their handling of freight planning. In total, ten of the EPRs mention freight planning efforts underway with most of the freight emphasis occurring in major port cities such as New York, Miami, Seattle, and San Francisco. Only in two cases is freight planning noted as deficient. The other twelve EPRs do not comment on freight integration

## *Private Sector Involvement*

Most of the discussion in the EPRs considers the "general" public's participation in the planning process but does not focus on firms and other private entities. For the most part, as required by federal law, the public involvement process in metropolitan areas around the country provide many opportunities for public participation in the planning process. Twelve of the metropolitan areas mentioned private sector involvement in the planning process. This involvement ranges from councils of business leaders, to real estate developers, to "privatization committees". Few of the EPRs mention any significant effort toward developing public private partnerships to provide needed transportation infrastructure and services to the region. Most of the partnerships mentioned are transit route contracting. The federal

government mandated that transit authorities investigate the potential of this action in the early 1990s, so it seems logical that this consideration should be mentioned in the EPRs

## *Economic Consideration*

Ten of the EPRs state the economic considerations drive the transportation planning process in their respective metropolitan regions. Some of these plans are focused on sustaining economic growth in the region whereas others seem focused on controlling growth to predefined boundaries. This second approach to integrating economic considerations is especially profound in the Pacific Northwest MPOs, Portland, Oregon and Seattle-Tacoma-Everett, Washington. The remaining plans, to varying degrees, do not explicitly consider the economic aspects of their planning activities. It is important to note that economic consideration may be unstated, underlying aspects of the planning process since transportation needs are inherently dependant upon economic considerations.

## *National Information Infrastructure*

The demands that the transportation infrastructure will place on the national information infrastructure, and the demands of the information infrastructure on the transportation infrastructure are largely ignored in most regional strategic transportation plans. As ITS becomes more important, operating an efficient transportation system will require more and more sophisticated communications and information processing systems. Likewise, as our society depends more and more on high tech communications, increasing demands will be placed on our transportation system to provide the necessary infrastructure for these systems (i.e. utility ROW., fiber-optic networks laid in highway ROW).

Information infrastructure was not considered in any of the metropolitan areas. This conclusion is supported by discussions with EPR program staff who state that this area never came up in any discussion with an MPO, nor was this a consideration of the EPR review process.

### ***Master Plan Perspective***

From a review of the EPRs it is clear that regional strategic transportation planning is focused on infrastructure delivery and that little attention is paid to operational concerns.

It is important to note that Federal regulations require that MPOs prepare "financially constrained" long range transportation plans. This requirement requires that the MPOs focus their limited resources on meeting their legal obligations. Identifying operational concerns is encouraged, but it is often infeasible for an MPO to undertake these efforts given their legal and financial obligations.

### ***Human Resources***

The development of future transportation professionals with the breadth and depth of skills to meet the requirements of an increasingly complex field is noted as a deficiency in the planning process by the ReS/SITE team. Rarely do transportation planning organizations plan for their employees professional development. In no case did human resource development appear in the EPRs. Key EPR program staff, however, noted that this topic was not a focus of their review, and that, in fact, many MPOs do have professional development key staff replacement programs in effect.

## Conclusions from the EPR Review

Based on our analysis of the EPRs, it appears that the ReS/SITE group's diagnosis of major planning shortcomings is generally in line with those identified in the EPRs. The Volpe Center staff consulted as part of this effort confirm that the ReS/SITE conclusions are complementary to their own ideas about regional strategic transportation planning. Some of the flaws identified are more common than others, however, all are important to emphasize.

## How Do We Develop a Better Framework for Regional Strategic Transportation Planning?

While it is clear that there are some weaknesses in the transportation planning practice currently employed around the United States and the World, improving upon this process is by no means an easy task. In order to improve the planning process, one must ask four fundamental questions. These questions are related to clearly defining the intent of preparing a regional strategic transportation plan and the answers to these questions will help to address the shortcomings identified above.

- What is the appropriate scale for strategic transportation planning?,
- What is the appropriate planning scope?
- For what activities are you planning?
- For what conditions should you prepare transportation plans?

Each of these questions is discussed in detail below with a focus of how the answers to these questions can help to define a better planning framework. Scenarios are particularly well geared toward answering the final question.

## What Is the Appropriate Scale for Strategic Transportation Planning

One of the first considerations in developing a new framework for transportation planning is considering the proper scale for conducting this activity. Should transportation planning be conducted on a national scale, on a community scale, or somewhere in between. The answer to this simple question turns out to be far more complex than one might imagine. Regional transportation issues and needs often traverse city, state, and even national boundaries. Before one begins preparing a regional transportation plan, one must first decide what are the appropriate limits of the region.

### *What is a Region?*

The term "region" is inherently nebulous. This term is used in various contexts with different

scale implications. People talk about the Asia-Pacific Region, Central America, South America, and Europe as regions. People also discuss New England and the Southeastern States as regions. On the other hand, people discuss the northern suburbs and the southern suburbs of Atlanta as different regions. These different uses of the term region require that we define what we mean be a region before we talk about regional planning.

Used here, the term region is defined as a functioning economic entity. A region is generally centered on a major city and comprises the metropolitan area and hinterlands serving the city. In many cases a region crosses political boundaries such as county, state and national boundaries. For example, the "Boston region" extends across three states, numerous counties and hundreds of municipalities. Also, the El Paso, Texas region includes portions of New Mexico, and Juarez, Mexico.

A region that overlaps political boundaries often creates complications for planners since they rarely have the authority to plan in different jurisdictions. The planner may be limited to planning for a specific geographic entity even though the region extends beyond those boundaries. Some examples of regions, as defined in this thesis include, the Tri-State area consisting of New York City, Northern New Jersey and Southwestern Connecticut, the Portland, Oregon metropolitan area that includes portions of Washington State, the Los Angeles metropolitan area that spans several cities and counties, the Province of Mendoza, Argentina, and many others.

New developments in Intelligent Transportation Systems (ITS) has enabled transportation system management and control on a regional scale. This suggests a rationale for planning at this scale as well. Up to recently and even now, transportation systems were managed from a local perspective. ITS has allowed the agencies responsible the transportation system to operate transportation infrastructure and services as an integrated system, rather than as isolated individual pieces. ITS enables the transmission and processing of data on a scale that was impossible just a few years ago. This data collection and processing capability has allowed the system planners and operators to view the system in a more integrated manner encouraging a

much broader geographical perspective.

In short, advancing technologies allow us to manage and control transportation systems at a regional scale that corresponds to a functioning economic entity. This suggests we should plan at this geographic scale as well.

## What is the Appropriate Planning Scope?

A second concern that must be addressed when considering a new framework for transportation planing is the appropriate scope for this activity. It seems clear that there are bounds to what should be considered in the regional transportation planning process. The process should focus on transportation and how it is provided. There are many political questions such as state boundaries and the like that are unquestionably beyond the scope of transportation planning. So the question is where do you draw the boundary around the planning process?

Traditional transportation planning focuses on the infrastructure needs of a region. The plans identify shortcomings in the current system and identify projects that attempt to address these shortcomings. In essence, these plans serve as infrastructure master plans. The plans tend to view the institutional structure and relationships of the government agencies responsible for providing transportation services as fixed and beyond the scope of transportation planning. The plans view the institutions as fixed and the infrastructure as variable. Is this the best way to approach transportation planning?

We argue that regional strategic transportation planning should go beyond the infrastructure needs of a region. The planning process should include consideration of the institutional structure of the transportation system as a key aspect of the ability of the system to provide transportation services. With the advent of new information and communication capabilities such as Intelligent Transportation Systems (ITS), institutional interactions are of particular importance. In fact, institutional redesign may well be appropriate, difficult as it may be to accomplish.

A way of capturing these institutional issues in the regional strategic planning process is "regional architectures" expanding the concept as used in ITS. Examining regional architectures can lead to new and innovative institutional approaches to the transportation problems facing the region. These approaches can be in addition to the infrastructure solutions commonly developed as part of the transportation planning process. The development of new institutional relations through a regional architecture can improve the operation of the transportation and make transportation infrastructure investments more effective.

## For What Activities are You Planning?

Historically, transportation planning has been conducted in a modal fashion. Transportation "planning" focused on walking and horse transportation for hundreds if not thousands of years; planning focused on rail transportation for 50 years; planning focused on the automobile for 50 years. Current transportation planning addresses many different modes, but often in isolation. Is this the way planning should be approached?

Regional strategic transportation planning should consider different modal solutions to transportation problems . If a region is facing congested highways, the transportation planning process should evaluate potential rail and transit solutions that address the congestion problem. Simply because the problem manifests itself on highways, does not imply that the solution must be a highway solution. Furthermore, the process should ensure that often neglected modes of water transportation, walking and bicycling are adequately addressed and that their contribution to the transportation system for the region is duly noted. These considerations are past of a multimodal approach to transportation planning.

Equally important is that the transportation planning process address intermodal concerns. Intermodalism refers to the connectivity of the transportation system for a region. How accessible are the transit facilities from the highway facilities? Can one ride a bicycle to a train station and then take the train to his or her destination? Are seaports connected to the railway and highway network in a way that ensures efficient transfer of goods between modes? These

questions are another facet of transportation planning that must be addressed in any new framework.

## For What Conditions Should You Prepare Transportation Plans?

Three of the fundamental planning questions have been answered. What is the appropriate scale for preparing transportation plans? What is the appropriate scope for preparing transportation plans? What activities are being planned? Another fundamental question remains. For what future(s) should you plan?

In the current planning process current conditions are forecast to a future horizon year. These forecasts are generally point forecasts that state what the future will be. In some cases "sensitivity" analyses are conducted that look at the impact of small changes in these future projections.

Scenario planning implies that a well-defined methodology will be used to develop different potential future outcomes. The process not simply produce a point projection of the future. Rather, trends and possible events are analyzed and different outcomes are traced. This process allows transportation strategies to be tested across many different possible logical future outcomes based on coherent strings of cause-effect relationships. The intent of this process is to assist in developing strategies that are robust across many possible future outcomes.

Also, and importantly, scenarios require planners to think through a vision for the region and the relationship of transportation strategies to that vision. That vision will have economic, environmental and quality-of-life aspects. Scenarios should reflect all of these and others of relevance to the region in question.

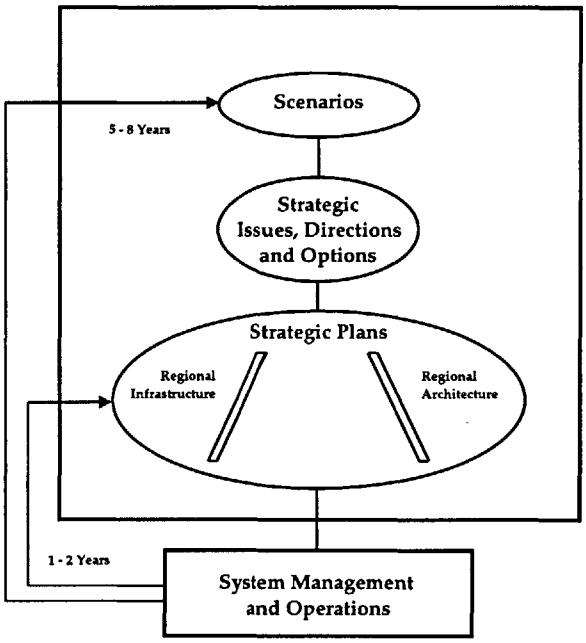
## The ReS/SITE Planning Process

In an effort to address the planning shortcomings discussed earlier and to address the scale and scope questions noted above, MIT has developed a new planning process that the research

team hopes will lead to a new generation of more effective, results-driven, comprehensive regional strategic transportation plans. This planning method is based on several major concepts that the MIT team has developed into the comprehensive planning process described in this section. The MIT planning process is graphically depicted in Figure 1. This planning process is based on the four following concepts described in more detail below:

- Scenarios
- Strategic Issues, Directions and Options
- Strategic Plans Including Transportation Infrastructure and Regional Architectures, and
- System Management and Operations.

**FIGURE 1-1**
**RES/SITE PLANNING PROCESS**




These components are described in detail in the following section.

## Scenario Development

One of the key components of the ReS/SITE planning paradigm is the development and use of scenarios. This term has been used in many ways in the professional literature. We note that some MPOs utilize a form of scenarios in their transportation planning efforts. Although the extent and complexity of the scenario development process are unknown from the EPR review, most of the scenarios are focused on land use and economic development. The scenarios predict the transportation demands caused by different land use patterns or develop predictions of transportation demand from and impact on economic development along major corridors. One of the MPOs, Minneapolis-St. Paul (The Council) employs multimodal scenarios in their planning efforts. For this paper, scenarios plot, in a structured approach, different ways in which the future may develop by exploring cause-effect relationships.

As discussed by Peter Schwartz in this work "The Art of the Long View," scenarios has been employed in corporate decision making since the 1970's when Royal Dutch Shell prepared its business plan using scenarios that included significant price increases and supply shortages in the world energy markets. Shell faired much better than its competitors through the oil crises that then occurred in the mid and late 1970's since its use of scenarios allowed it to develop a business plan which was robust across a large variety of potential future circumstances.

Scenarios can be a valuable tool in the regional strategic transportation planning process. Scenarios can be applied in a transportation context to develop transportation plans that account for different possible versions of the future. Currently, many transportation plans project a "future condition" that does not reflect the many factors affecting what the future will look like. As defined here, scenarios can rationalize this process for looking at the future and serve as a step toward the development of robust strategies. Scenarios allow decision-makers to examine different logical pictures of the future and develop new strategies that perform well across these different pictures. Scenarios also help identify events or trends that may indicate that a particular future is developing, allowing decision-makers to reevaluate the current strategies. Scenarios can also serve as a tool to facilitate organizational learning by providing a

framework for dealing with uncertainty that reduces decision-makers' risk of being wrong since they allow people to appreciate future views other than their own.

In this usage, developing scenarios is not simply guesswork. One does not simply suggest that "population will increase by 10 percent." Rather, developing scenarios is a complex and challenging process. Future events and trends must be evaluated based on their level of uncertainty and categorized as one of the following:

- Predetermined Elements
- Risks
- Structural or Critical Uncertainties
- Unknowables

Events and trends are then developed into scenarios based on a rational sequence of events related by a cause effect structure. These scenarios should reflect the central concerns and essential issues for the planning organization.

Research recently completed at MIT is focused on applying scenarios to the transportation system of the Province of Mendoza, Argentina including a trans-Andean connection to the Chilean port of Valparaiso. MIT actively participated in transportation planning for Mendoza in the last few years as part of their efforts to prepare for the possible construction of transportation infrastructure between Mendoza and Chile, which are separated by the Andes mountains. The scenarios developed as part of this effort include varying levels of economic activity worldwide, within Argentina, and within the Mercosur trade alliance region. Other potential scenarios could include varying levels of infrastructure development within Argentina, and whether or not other connections to the Pacific ports in Chile are constructed. Though the use of these scenarios, one could construct a set of robust strategies for this link and the rest of the transportation system given different possible views of the future. The application of scenarios to RSTP is developed extensively by Muñoz in his Master's Thesis, *Using Scenarios for Regional Strategic Transportation Planning: Framework, Methodology, and Application to Mendoza, Argentina.* This application is further advanced by the Mobility-ReS/SITE development of

scenarios for Houston as defined in this thesis.

## *Strategic Issues, Directions and Options*

Once scenarios have been developed, the next step in the ReS/SITE process is focused on determining the region's strategy given the results of the scenario process. This step is important in defining the strategic issues and directions that the region decides upon given its goals outlined at the beginning of the process. In this step, the decision-makers involved in the planning process evaluate the potential futures illustrated by the scenarios and decide on strategies to follow that are robust across all of the possible future conditions. This step of the process is focused on a direction-oriented decision-making process, rather than an implementation process. At this stage, decision-makers should decide, for example, that the region needs to improve its freight handling operations, not consider building specific terminals. At this stage of the process, we are looking at transportation needs and families of solutions rather than specific projects.

This activity includes setting goals for the region in terms of competitiveness in the global economic environment, regional and local needs, mobility, accessibility, safety, security, technological development, population changes, and many other factors.

## *Strategic Plans*

The above work informs the development of the "Strategic Plan" that concentrates on a long-term strategy with a 15 to 20 year planning horizon. We argue that the strategic plan is manifested in two major components, the Regional Infrastructure and a Regional Architecture. Each of these concepts is discussed below.

### Transportation Infrastructure and Architecture

For the most part, modern transportation planning adequately addresses the infrastructure needs of a region. Indeed, planning infrastructure investment has essentially been the focus of regional strategic transportation planning. It is undeniable that planning this investment is an

important component of the planning process. The region must ensure that it is allocating its resources to meet its transportation goals and objectives. Decisions about these investments in infrastructure need to be made with an appreciation that the future in uncertain. Most transportation plans developed today do not adequately consider this uncertainty.

The ReS/SITE process goes beyond infrastructure planning. It also includes the development of a regional architecture as a definition of transportation services, institutional relationships and responsibilities. The concept of regional architectures has its roots in the development of ITS technologies around the country. ITS has allowed the management of the transportation system at a level thought impossible just a few years ago. Advancements in communication and computing technologies have enabled and encouraged the collection and analysis of transportation data at a system-wide scale. These improvements have allowed the agencies responsible for managing the transportation system to respond much more quickly to incidents and changes in the operating state of the transportation system. Along with technologies that allow dissemination of information to use users of the system, improvements in system operations have been realized and more improvements are expected as systems mature. These advances have required that regions develop a plan along the lines of a regional architecture. These plans are necessary to define the responsibilities of different agencies and how they communicate to operate the transportation system.

The ReS/SITE process takes a broader view of regional architecture. The strategic planning process should result in a regional architecture that defines how the region manages transportation from an institutional point of view as well as from a communications and information perspective. The architecture should address what agencies are responsible for operating various components of the transportation system and how they should go about it. Furthermore, the architecture should define what information these agencies need to share and how to share it. In other words, as part of planning, the region should evaluate the institutional arrangements that govern the management of the transportation system through a regional architecture addressing the following questions:

- What institutions are responsible for planning and operating the transportation system in

the region?

- How do these institutions relate to each other and the underlying political environment?
- How can these current institutional arrangements be improved?
- How can the responsibilities and objectives of these institutions be better aligned with the transportation goals of the region?

### *System Management and Operations*

Closely related to the planning process, system management and operations is the short-term analog of Regional Strategic Transportation Planning. This activity ensures that the transportation system, in its current state operates as effectively as possible and works toward meeting the region's short and long range transportation and economic development goals. System management and operations has become an even more effective tool since the development of ITS. These new technologies have improved our ability to manage the transportation system more effectively than imagined a decade ago.

Any long-range plan must be complimented with a system management and operations component to ensure that the current system continues to operate well. Long range planning is not a useful exercise if the region fails to manage what it has today. These management measures include operation and maintenance plans, congestion management strategies and other measures focused on maintaining the integrity of the transportation system. A system management and operations plan should be focused on the same goals as any strategic transportation plan. However, these measures are generally focused on immediate and short-term items, within a 1 to 2 year time frame, whereas long-range measures are generally 5 to 20 years into the future.

## How Does the ReS/SITE Process Address the Shortcomings in the Strategic Planning Process?

Earlier in this section, four questions about the intent of the RSTP process were proposed.

- What is the appropriate scale for strategic transportation planning?,

- What is the appropriate planning scope?
- For what activities are you planning?
- For what conditions should you prepare transportation plans?

The answers to these questions define the ReS/SITE planning process. On first inspection, it may not be entirely clear how the ReS/SITE planning process addresses the planning shortcomings discussed earlier. The fundamental differences in the ReS/SITE process, as proposed here, include using scenarios as an input to the planning process, and developing a structured regional architecture as an output of the planning process. In some cases, the shortcomings discussed earlier are remedied directly in one or more of the ReS/SITE components. In others, these shortcomings must be addressed by specific consideration of the shortcoming in the planning process. This section will identify each of the planning shortcomings and how it is addressed in the ReS/SITE process.

- **Intermodalism.** The ReS/SITE process is inherently intermodal in nature. Intermodal planning is enhanced by the Regional Architecture output of the planning process. This regional architecture defines how agencies with different modal responsibilities should cooperate in providing transportation services. The process encourages considering different modal solutions to problems the region is facing.

- **Technology Scan.** A technology scan is an important component of the planning process. The planning agency should apply the scenario development process outlined earlier to consider the impacts of technology. The agency can then consider what new technologies may have an impact on the future requirements and operation of the transportation system and prepare the plan to accommodate these future developments.

  Further, the regional architecture, with its ITS roots and an emphasis on information technology and communications, is responsive to new technological approaches to solving transportation problems.

- **Freight Integration.** Freight services providers should be included in the regional architecture. These entities such as railroads and motor carriers have the explicit

responsibility of operating a service. The relationships between these operators and the providers of the infrastructure they use should be explicitly addressed in the development of a regional architecture.

Freight mobility is an important service provided by the transportation system and essential to maintaining the economic health of a region. The freight sector including shippers and carriers should be involved throughout the planning process. These entities should participate in goal setting, determining needed infrastructure improvements, outlining the regional architecture and implementing transportation system management measures important to freight mobility.

- **Private Sector Involvement.** Similarly, private sector entities such as major employers, manufacturers and service providers in the region should be involved in the regional architecture. It is important that the needs of the local business community are addressed in the products of the ReS/SITE planning process. The role of the business community in the regional architecture and the private sector's ability to deliver new infrastructure should be outlined in the plan.

  The private sector can also be included in the planning process through scenario development in which their perspectives on the future can be explicitly reflected. Further, the private sector can contribute scenario building expertise to the planning agency.

- **Human Resource Development.** Scenarios, viewed as a mechanism to broaden the perspectives of planners inherently have a human resource development aspect. Although scenarios can help to define the future human resource needs of a region, it is important that the planning agency address these human capital issues independently as part of their planning process. The human resource requirements of operating the transportation system should be identified and a plan for developing these resources should be outlined.

- **Integrated Economic Consideration.** This shortcoming is addressed through the development of scenarios. Different economic effects can be explicitly reflected in the planning process. Furthermore, the scenario development process can assist the region in

developing a plan that is robust across varying degrees of economic vitality.

- **National Information Infrastructure.** The NII should be an important component of the regional architecture in that it enables high levels of interaction between different institutions. Further, it is appropriate to consider how changes in the NII may affect the transportation system through the scenario development process in addition to developing an independent assessment of the interactions between these two systems. The planning process should outline the communication requirements of operating the transportation system both in terms of the institutions involved and the infrastructure needed.
- **Master Planning Perspective.** The ReS/SITE process through developing a regional architecture focused on information sharing is not focused solely on infrastructure delivery. Rather, the ReS/SITE process is focused on meeting the transportation needs of the region through operations as well as investment.

## CHAPTER SUMMARY

This chapter introduces the objectives, motivation and contents of this thesis. It then describes how scenarios can frame the entire RSTP by allowing the planners and decision-makers to develop different possible views of the region's future. These different views each provide a different outcome for the regional infrastructure and regional architecture strategies under consideration. With different views of the future, the decision-maker can make judgements about the feasibility and effectiveness of various infrastructure, policy, and institutional strategies and select a set of strategies that perform well across a wide range of scenarios. Another important contribution of the scenario methodology is that the process of building scenarios can identify leading indicators for various scenarios that allow a decision-maker to adjust to the unfolding future. The concept of scenarios is central to improving region strategic transportation planning and is the focus of the rest of this thesis. We now proceed to Chapter 2 which outlines the history of scenarios as a planning tool.

# 2

# SCENARIO PLANNING HISTORY AND APPLICATION

This chapter will briefly describe what the term "scenario" means as it relates to strategic planning. Once the meaning of this term is clear, the chapter will outline the history of this methodology following its development since the 1970s. Next, several applications of scenarios will be summarized to provide a sense of the various contexts in which this methodology has been employed. Finally, this chapter will describe potential applications of scenarios to transportation.

## THE SCENARIOS BUILDING PROCESS

While not a new term, in the context of strategic thinking, "scenarios" has a very specific meaning. In many cases, scenarios are thought of as outcomes different than those forecasted. In this light, one thinks of a primary estimate of the future based on some sort of projection. Scenarios are variations from this projection. In this context, contingency plans, different from the "real" plan are often developed to deal with scenarios. The application of scenarios discussed in this thesis is NOT based on the above logic.

Rather, here, scenarios refer to a structured, organized approach to strategic thinking that recognizes

that forecasts and single-point estimates of the future are usually wrong. Scenarios are tracing out different plausible futures that are based on logical cause-effect relationships of trends and events that may develop.

There is a lot of "management" literature focusing on the application of scenarios to business management and strategic planning. The majority of these sources define scenario planning as a process where one looks at the current situation and develops an idea about what "predetermined elements" and "critical uncertainties" exist. Predetermined elements are those current or recent events that will have a recognizable and definitive outcome in the future. Critical uncertainties on the other hand, are those future events and trends whose likelihood and impact are not determined.

If one were deciding whether to invest in a satellite television business, a predetermined element might be that satellite television services can effectively compete with cable-TV systems on the basis of cost and service. Current examples such as DSS and Primestar show that this is a true statement. A critical uncertainty might be the effects the Internet might have on demand for television systems, regardless of the mode of delivery. Will the Internet replace television as an entertainment medium, eliminating the market for these systems entirely?

These categories are not as neat as these definitions would indicate. Some items thought of as predetermined elements in some plans might be thought of as critical uncertainties in others. The combination of predetermined elements and critical uncertainties is often a function of the time horizon being considered. If a planner is preparing a scenario with a one-year time horizon, there are likely to be many predetermined elements and only a few critical uncertainties. Likewise if one is examining a scenario with a 50-year horizon, there are likely to be few predetermined elements and many critical uncertainties. In terms of longer range strategic planning, one may question the value of considering predetermined elements at all. However, as many noted authors have commented, it is important to ground the scenarios, or establish them in the events and trends of today. Predetermined elements are important in establishing the validity of these scenarios, grounding the scenarios, in the mind of decision-makers.

Critical uncertainties are due to many different factors; environmental, political, economic, social,

technological and so on. These various uncertainties can all be attributed to the nature of complex systems, both natural and manmade. Donald Michael, the noted author of *On Learning to Plan – and Planning to Learn*, comments on this uncertainty in a recent interview with BusinessTech. He states,

> *...We do know very well that complex systems – especially if they involve human beings...never work perfectly. There are always glitches, because we don't fully understand the complexity that we create.*

One distills the list of critical uncertainties into "drivers," or the major forces that will define different scenarios. From these drivers, different rationally constructed, logical narratives outline the development of the current situation to different future states by developing the predetermined elements and different drivers. These future states represent cases for studying the impact of different possible strategies, the primary purpose of the scenario exercise.

The literature often states that the particular scenarios developed are not the important product of the process; rather the institutional learning aspects of preparing and considering scenarios are more valuable. Institutional learning is fostered through two primary mechanisms. First, scenarios stretch the mind of decision-makers to make them aware of different world views other than their own, and second, the development of scenarios can identify leading indicators of different possible outcomes allowing adjustment of the particular strategies chosen.

Donald Michael comments on the concepts of uncertainty, error-embracing and boundary spanning. His comments highlight why scenarios are particularly effective planning tools when he discusses why learning is really a much more difficult activity than most writers imply.

> *Learning and becoming a learner are treated as reasonable activities that any rational, reasonable person will do – that an organization will naturally arrange itself to be a learning organization, given the opportunity.*
>
> *The psychological fact of the matter, the cultural anthropoligical fact, is that those habits of behavior that have successfully gotten us to where we are, are now our substitutes for instinct. To give up those learned ways, to learn some other way that has no guarantee of being safe and rewarding, is a very high-risk activity for most people and so there's resistance to it.*

> *People want to know what is expected of them; they want to be able, consciously and unconsciously, to convey messages to others about what their role is and others want to be able to reliably depend on those roles*
>
> *So it's a high personal-risk situation to acknowledge the kind of world we're talking about and unless there's support – most people are not going to do it. (Michael 1998)*

Scenarios provide the kind of support Michael is talking about. They imply a structured, reasonable construct for dealing with uncertainty and they foster the kind of institutional learning that Michael suggests is so difficult.

## Application of Scenarios

Strategic planning can apply scenarios very effectively. Strategic planning necessarily takes place with a high degree of uncertainty. With planning horizons of 5 to 50 years, world events can change visions of the future dramatically. This high level of uncertainty makes point estimates appear foolish and implies that a method accounting for this variability is needed. The types of decisions made in a strategic planning context are often long range and adaptable as the future develops making the scenario methodology quite useful in this context.

One can also use scenarios to plan a particular project. This type of planning generally has a much shorter horizon and with more definitive and immediate action required. When planning a particular project, one can develop scenarios and test the performance of different designs in the case of infrastructure projects, or applications in the case of policy and organizational projects. The design or application can then be adapted to perform well across a wide range of possible futures.

Tactical planning and crisis management applications of scenario methodologies have even shorter time horizons that the previous cases. These applications develop scenarios of different possible situations and develop response plans suited to each of the outcomes. One could imagine a workforce planning tactical application of scenarios in which a particular scenario outlines that a certain segment of the workforce will be unavailable due to an illness, service failure or other situation. The management can then turn to a tactical plan developed for such a situation. Similarly,

in the arena of crisis planning, a disaster relief or civil defense agency can develop different models of crises and develop contingency plans for these possibilities.

Building scenarios can help an organization foster teamwork and build morale. The process of building scenarios is a creative, cooperative exercise that requires the input of many different individuals. In the case of team and morale building, the planning outcome of the scenario process is less important than the cooperation and interaction that the process fosters. Having an entire team involved in the scenario planning process can foster "buy-in" to the plan at the end of the process.

# A Brief History of Scenarios

Scenarios have developed as a strategic planning tool over the past 50 years. Scenarios first developed as a military planning tool to deal with the inherent uncertainty of war and turns that a particular campaign make take. Peter Schwartz, a noted futurist and proponent of the scenario methodology cites the U.S. Air Force's use of combat scenarios to develop different strategies as a modern application of scenarios to military planning (Schwartz 7). Development of scenarios as a strategic planning tool in the business environment and industrial setting grew out of these military applications. Once the success of this methodology was demonstrated in the private sector, efforts have been made to extend the methodology to public sector decision-making as well.

## Military Application

The use of scenarios as a planning tool has a long history in military organizations. Scenarios can be applied as a planning tool both during combat and peacetime. These two activities are different in the time scale considered, but both are well suited to the application of scenarios. During combat, military planners can develop tactical plans allowing for different responses of the enemy. In this case, an overall plan of attack can be developed for different opposition maneuvers. This is a classical application of scenario planning. The military planner is faced with an uncertain, uncontrollable future situation. The actions of the opposition are never certain. In this light,

military planners can develop different plans for different actions by the opposition. The planners will attempt to envision all of the possible actions of the opposing party and develop an appropriate response for each.

While military planning activities during combat require tactical scenarios, peacetime efforts are likely require strategic scenarios. Military planners are likely to look at current world events projected several years into the future and develop scenarios of different types of conflict that may develop. This activity was far simpler during the Cold War era when the enemy and type of threat was well known. Today, faced with many different types of conflict in many different parts of the world, scenarios can be useful in determining investment in military technology and in developing strategic response plans for different types of conflict. Scenarios, in this context, are intended to ensure the military's readiness to meet the uncertain challenges that may develop in the future.

Gill Ringland, in her work *Scenario Planning – Managing for the Future* comments that World War II had a profound impact on strategic planning processes both in the public and private sector. She mentions that the war effort "mobilized large numbers of academics into government, researchers to new areas, and provided the crucible for a number of breakthroughs" including atomic and nuclear energy, radar and the computer (Ringland 11). She proposes the idea that the developing of these new technologies and managing the complexities of a large-scale war effort required a new kind of systems thinking that furthered developments in strategic planning.

## Movement into the Business Community

Schwartz attributes the movement of scenario planning to the business setting to Herman Kahn, part of the Air Force effort and one of "America's top futurists in the 1960s (Schwartz 7). Herman Kahn was employed by the newly formed RAND Corporation, established to research new weapons technology (Ringland 12). Schwartz, van der Heijden and Ringland credit RAND and Kahn's Hudson Institute with developing convincing stories about the future, most notably Kahn's book *The Year 2000* published in 1967 (van der Heijden 17).

Most authors discuss how the concept of scenarios as a planning tool took off rapidly in the late

1960s and 1970s. Two different groups are credited with advancing the methodology during the early days, Kahn's Hudson Institute with corporate sponsors such as Shell, Corning, IBM and GM (Ringland 12) and Stanford University's The Stanford Research Institute (SRI). SRI was founded "to offer long range planning for business incorporating operations research, economics and political strategy alongside hard science and military consulting" (Ringland 12). One of the most prominent business applications of scenario planning is that of Royal Dutch Shell, a sponsor of the Hudson Institute (Ringland 12), from the 1970s through today.

## Public Sector Application

The application of scenarios as a planning tool in the public sector developed after the virtues of the methodology were extolled in the business literature. Strategic planning in public sector organizations can be more challenging than in the private sector because the vision and purpose of a public entity is often less clear than in a corresponding private sector organization. Different individuals within the organization may have different ideas of the agency's goals and objectives. In a business, the profit motivation is a consistent, guiding goal for the organization, making the strategic planning process more focused.

Public sector organizations are also faced with a whole realm of political constraints not present in the private sector. Public sector organizations must compete for government funding, serve many diverse constituencies and face other political challenges that businesses do not commonly face. In some cases, these organizations are required by law to conduct their planning in a certain way further limiting their ability to think in novel and strategic ways. These additional constraints make strategic planning in this context more complicated and may explain why scenarios have been slower to be applied in the public sector.

There are some examples of scenario planning in the public sector. There are several examples of visioning for nations including Columbia, Japan and South Africa. Scenario exercises also examine the British healthcare system (Ringland 357) and the United States education system.

# SCENARIO APPLICATIONS

Scenarios have been applied in many different industries and for many different purposes. This section will outline several of the purposes scenarios can serve in an organization and several examples of scenario applications.

## Application Contexts

Fahey and Randall develop several different contexts for the application of scenarios in their book *Learning from the Future: Competitive Foresight Scenarios.* This work describes scenarios intended to develop visions of industry futures, evaluate competitors, technology investments, product development, economic conditions, public policy formulation, and national futures. These contexts for scenario development are intended to demonstrate the many goals different authors have proposed that scenarios can accomplish.

The principal thinkers about scenarios agree that they are a useful way to make decisions in the face of uncertainty. Many also suggest that scenarios are useful in testing different strategies, developing new strategies, building consensus around issues, fostering institutional learning, creativity and teambuilding, developing ideas about what events may indicate for the future, and fostering flexibility in organizations.

All of these contexts are arenas for strategic planning, a popular activity over the last several decades. Henry Mintzberg, a noted critic of strategic planning in his book *The Rise and Fall of Strategic Planning* proposes that, along with several other flaws, rigidity is a serious flaw in planning. Once the plan is set, deviation from it is seen as some sort of failure (Mintzberg1 176). Mintzberg also makes a case that planning is flawed in that it proposes only incremental changes from the current situation (Mintzberg1 177), stifles real creativity (Mintzberg1 180), and operates in too short a time horizon (Mintzberg1 182). Mintzberg suggests that scenarios may provide an answer to some of these planning flaws, but that "This is no simple business" (Mintzberg1 248). Mintzberg is certainly right in noting the complicated nature of employing scenarios; however, many authors believe that scenarios provide a useful mechanism for addressing these shortcomings Mintzberg has identified.

## Application Examples

Scenarios have been applied in many different contexts and for many different purposes. This section will summarize some of these applications. The section will begin with a discussion of the Royal Dutch Shell scenario program, perhaps the most notable. Second, industry case studies developed by Ringland will be summarized. The section will then outline some of the initiatives undertaken by the Global Business Network (GBN) in the past couple years. The first of these examples will be developed in much greater detail given its seminal role in scenario planning. The second two groups will be developed in less detail, and are presented mainly to highlight some of the varied contexts in which scenarios are currently being employed.

### ***Royal Dutch Shell***

The scenario planning activities of Royal Dutch Shell are well documented. These activities are best summarized by two of the participants, Pierre Wack and Kees van der Heijden. Wack published two articles in the Harvard Business Review entitled "Scenarios: Uncharted Waters Ahead" and "Scenarios: Shooting the Rapids" summarizing Royal Dutch Shell's scenario activities surrounding the oil crises of 1973 and the changeable business environment lasting through the mid-1980s.

After World War II, Shell concentrated on capital planning, building new facilities. In the mid-1950s their emphasis shifted to financial planning and Shell introduced the "Unified Planning Machinery" (UPM) system to coordinate all of their planning activity (Wack1 74). The planning process relied on forecasts of future conditions extrapolated from current patterns, a major weakness in the process given the growing uncertainty of the times. Based on Wack's work at Shell Francaise, scenario planning was implemented at the corporate level in 1972 (Wack1 77). Four scenarios depicting events concerned with oil supply and demand were developed. These scenarios depicted four different states of the future for an oil producer, but were lacking a detailed logical structure for decision-making (Wack1 77).

As a result, the scenario team rethought the process and looked more closely at the "critical uncertainties" associated with the problem. The team developed two different families of scenarios.

One family was based on political (or no) solutions to an oil shortage; the other was based on demand reductions to meet the lower oil supplies. World events in the coming year made it evident that the first of the two families of scenarios was impossible so the next round focused on the oil supply shortfall scenarios. These new scenarios made decision-makers aware of the changing characteristics of the international oil market and led Shell to change its investment strategies leaving Shell in a better position than its competitors who continued to invest heavily in transportation and refining infrastructure.

The next round of scenarios prepared by Shell examined the turbulent economic times following the 1973 oil crisis. The scenarios outlined two different scenarios, a boom and bust scenario, and a constrained growth scenario. These scenarios allowed the management of Shell to watch evolving trends and develop a strategy suited to the unfolding scenario (Wack2 1985).

**Lessons Learned**

Wack and van der Heijden draw several lessons from the Shell experience. Shell's scenario exercises, the motivation for the interest in this subject throughout the business community highlights two important aspects of the methodology. First, scenarios allowed corporate decision-makers to recognize that the world was not unfolding according to their preconceived notions of the future. Second, trends and events that were leading to a particular outcome were highlighted, and third, new strategies became apparent as the scenarios were developed.

*Importance of Rooting the Scenarios*

Wack emphasizes the importance of "rooting" the scenario (Wack2 6). Wack mentions that rooting the scenarios is important to give life to the scenarios in the managers' minds. He states,

> *"We call this process 'rooting' because scenarios on their own – that is, as mere description of alternative courses of events – would be effective and alive in the minds of managers as long as a tree without roots. I have seen many scenarios suffer this fate" (Wack2 6).*

According to Wack, rooting the scenario is accomplished through including a detailed study of the current environment and outlining the course of predetermined elements, those characteristics of

the scenario which are certain. Predetermined elements can be though of as the results of events in the current environment or very recent past. For example, Wack discusses the onset of severe inflation in mid 1970s as a predetermined element caused by the large oil price increases in 1973. The managers knew that oil prices skyrocketed in that year and that inflationary pressure was likely. The managers can read this statement in the scenario and realize that it is beginning at a common point with their own experience. The managers are them more likely to accept and appreciate the unfolding events predicted in the scenarios which follow.

*Risk Awareness/ Robust Decision Making*

One of the main purposes of preparing scenarios is to inform decision-makers about possible future risks on the horizon (Wack2 9). Development of scenarios identify impending events, the predetermined elements, and critical uncertainties. These critical uncertainties highlight the risks faced by the organization in the near term. Different outcomes of the critical uncertainties expressed in different scenarios have different implications for different strategic options. Take, for example, the decision about whether or not to invest in a new bridge across a contested international border. A critical uncertainty could be the relationship between the two countries. It would be foolish to build the bridge if the relationship turns sour. Scenarios can highlight the ways in which the relationship between the two countries may evolve and help the decision-maker better understand the risk.

Van der Heijden characterizes risk awareness slightly differently. He characterizes the value of scenarios as allowing for informed decision-making given a wide range of possible future outcomes. He states that scenarios allow for "robust decision making" in that scenarios result in a "generation of projects and decisions that are more robust under a variety of alternative futures" (van der Heijden 17).

*Strategy Formulation*

The other principle purpose for using scenarios is to highlight new strategies. Wack refers to this purpose as the "entrepreneurial" aspect of scenarios and van der Heijden characterizes this purpose as "stretching mental models leads to discoveries" (van der Heijden 17). Again, consider at the example of a city located on an international border. The developed area in Country A is preparing a

transportation plan. Currently the neighboring country is primarily agrarian with little trade and travel between the two; however, several scenarios indicate that the neighboring country will develop rapidly over the next ten years. These scenarios lead to the understanding that constructing a highway link between the two might be an effective strategy to meet the region's goals. The scenarios served an entrepreneurial objective; they highlighted strategies that the regional decision-makers had not considered previously. Although the term entrepreneurial might seem odd in the case of transportation planning it is entirely fitting. One can imagine that a private firm might have been searching for a new project and that this bridge may serve as a wise investment.

*Formulating Strategic Vision*

Wack indicates that scenarios require that there be a clear, structured view of what the organization would like to see in the future. In the case of regional strategic transportation planning, the region should develop a clear regional vision. While scenarios are useful in determining strategy, slightly different applications can help to define vision. Scenarios propose different views of the future based on the current state of affairs (predetermined elements) and critical uncertainties. From these different views of the future, a region can decide upon a view that matches its regional hopes and desires and pursue strategies that lead toward that particular goal.

*Changing Decision-Makers Microcosm*

One of the key benefits of scenarios cited by Wack is their ability to change decision-maker's view of the world. Often, failures are the result of a failed perception of the world rather than a flawed strategy. As he states,

> *These decision makers' strategies made sense and indeed were sometimes brilliant – within the context of their limited worldview.*
>
> *In times of rapid changes, a crisis of perception (that is, the inability to see an emerging novel reality by being locked inside obsolete assumptions) often causes strategic failure, particularly in large, well run companies. Opportunities missed because managers did not recognize them in time are clearly more important than failures, which are visible to all. As Peter Drucker said, "The greatest danger in times of turbulence is not the turbulence; it is to act with yesterday's logic" (Wack2 11)*

He continues by describing how the decision-maker's construct of reality is the key to good decision-making. Scenarios can effectively adapt this construct to a changeable future. As characterized by van der Heijden, scenarios "enhance the corporate perception" (van der Heijden 18).

*Leadership Development*

Another advantage of scenarios noted by van der Heijden is that scenarios can be used by top management to "provide leadership to the organization" (van der Heijden 21). By developing and establishing scenarios as an evaluation tool, management can communicate goals and direction effectively to others in the organization. By focusing on scenarios in strategy development, it becomes "a way of thinking which penetrates the institutional mind and eventually affects all activity" (van der Heijden 22).

## *Industry Scenario Applications*

Gill Ringland highlights the application of scenarios to several different industry applications. The first of these described below is in the transportation industry at British Airways, followed by market scenarios developed by United Distillers.

### British Airways

British Airways, a firm involved in the highly competitive and volatile air transportation industry developed scenarios to "highlight a number of issues within the company [and] to provide a forum in which the various divisions which need to be aligned could discuss market changes (Ringland 259).

The scenarios involved interviews to determine the official view of the future, workgroups to develop scenarios, and workshops.

> *The purpose of the workshops was to provide an opportunity for participants to hear and discuss the sceanrios, and to provide a structured framework for development new strategies and test existing ones (Ringland 267)*

The British Airways application developed two scenarios based on the driving forces of technology, education, world trade and world finance. These two scenarios were entitled "Wild Gardens" and "New Structures" in one case, the world becomes more chaotic and in the other "growth occurs in manageable way" (Ringland 266). From these scenarios, market implications for the airline industry are developed resulting in two very different views of the future of the industry.

**United Distillers**

United Distillers "Scenarios for India" illustrates a classic case of a firm employing scenarios. This summary is adapted from that developed by Ringland. With the growing popularity of Scotch whiskey in India, United Distillers developed scenarios to determine whether or not to enter the historically difficult Indian market. Interviews were conducted with members of many segments in Indian society and with United Distillers management to get their views and perceptions of the country's direction. From these interviews, four scenarios of India's future were developed:

- **In the Foothills**: Continued muddling through and little decisive action to allow real economic growth.
- **Grasping the Nettle**: A strong liberalization movement drawing India closer to the western world and spurring economic development
- **India IS Different**: A mixed picture of economic success in India with a weakening of the central government.
- **The Korean Model**: Liberalization to meet specific objectives, strict government controls and growing nationalism, susceptible to international pressures (Ringland 311)

Ringland states that these scenarios were useful in heightening the awareness of issues among middle level management; unfortunately, he does not comment on what these scenarios led to in terms of business decisions for United Distillers. The company clearly thought the methodology provided valuable insights however since they performed similar exercises in South Africa and Turkey. Ringland summarizes the scenarios results,

> *One of the key benefits of scenario planning that [United Distillers] found is that scenarios have helped people involved in business begin to understand that investment decisions are not just about submitting numbers and justifying budgets, but need to be set in a wider context of what might happen. (Ringland 316)*

## *National Visioning*

A series of scenarios depicting the future of certain nations has been undertaken by the Global Business Network (GBN), a scenario think tank headed by Schwartz. These national scenarios were prepared for South Africa, Japan and Columbia. These scenarios present different issues, or drivers facing each nation and possible reactions to them. For the most part the scenarios are intended to frame a strategic conversation for each country. Each of these is briefly summarized below.

### The Mont Fleur Scenarios (South Africa)

The Mont Fleur scenarios project, undertaken in 1992 to outline possible directions for the nation to follow during the very uncertain times surrounding the transition from the apartheid system. The scenarios were developed by a team including "political office bearers, academics, trade unionists, and business people" (le Roux 1). These scenarios were then presented to a broad spectrum of groups in South Africa and distributed to the populace through newspaper supplements. The scenarios were intended to frame a national understanding of the possible futures and challenges facing South Africa. The main lesson learned from this scenario exercise is that the scenario process had popular appeal, in that the debate about the country's future was often framed in terms of the scenarios. Unlike the other scenarios discussed previously, the strategies and decisions are implied in the actual scenarios rather than the scenarios being independent evaluative tools.

Four different scenarios were developed as part of this exercise, each named for a particular type of bird, whose characteristics match the outcome of the scenario.

- **The Ostrich**. The Ostrich scenario, reflecting the myth that ostriches bury their heads in the sand in the face of danger, represents a South African government unwilling to face the necessity

of change. The resulting picture is one of political discord, military activity, reduced economic activity and social disorder.

- **Lame Duck**. The Lame Duck scenario envisions a long transition from the current government to a new representative one. The current government remains in control over a slow change to a new government incorporating all of South Africa's people. There is a system of long time-lines and checks and balances as the government transitions. The scenario concludes that this long transition will lead to a period of ineffective government and poor policies. Economic improvements for the populace do not result and social crises are not averted. The scenario mentions that the idea of a long, formalized transition process is to protect against "incapacitation" of the government and disruption to the social and economic fabric of the country. The results are ironic in that the long transition creates just the situation it is intended to prevent.

- **Icarus**. The Icarus figure of Greek mythology takes flight only to crash to the earth when the heat from the sun melts its wings. In this scenario, the government embarks on a program of excessive spending on social programs to address the social inequities past years. While the program takes off with popular support and success in the beginning, just like Icarus, it crashes to the ground as the government runs into financial problems. The results of this scenario are a necessary international bail-out, or fall of the government most likely resulting in an authoritarian regime. The summary document also concludes that this scenario suffers from "unintended consequences" (le Roux 9). Policies intended to improve social welfare and appease the disenfranchised population result in economic crises and political turmoil.

- **The Flight of the Flamingos**. The final scenario describes a smooth transition to a new government followed by slow and sustained economic growth, much like the take-off of flamingos. The scenario implies that the government develops successful social programs, adequately and responsibly financed. The international community maintains its trade and interest in South Africa as well. The results of the scenario are political consensus and economic growth (le Roux 10).

**Scenarios for the Future of Japan (Nakamae International Economic Research)**

Nakamae International Economic Research and the Global Business Network prepared scenarios similar to the Mont Fleur Scenarios outlining different futures for Japan. The intent of the exercise was to help the people of Japan to help guide the countries strategic thinking and planning. Three different scenarios of Japan in the Year 2020 are depicted. These scenarios are narratives that have the flavor of independent short stories. The stories are quite compelling and convincing, illustrating the critical uncertainties of the banking situation in Japan, China's development and the U.S. commitment to the region.

- **The Long Hollowing**. This scenario is developed through an imaginary interview of a successful Japanese-American businesswoman at a dinner party in San Francisco, California. The long hollowing describes a reaction to the ongoing and impending banking crisis culminating in a supposedly "successful" bailout of the Japanese banking system in the year 2000. The scenario describes how the bailout looked successful from the outside, but that it actually masks "an unwillingness to undertake real reforms of a deeply flawed economic structure." The scenario discusses how lending policies to large corporations remained loose, strengthening foreign interest in China, both as a major military power and economic power decreased the importance of Japan, environmental problems began to plague the nation, and the enormous elderly population began to drain the resources of the nation. These factors coupled with an unchanged education system strictly based on testing caused an exodus of young, talented people from the country further compounding the problems facing the nation as the entrepreneurial spirit for which Japan is known fades further. The scenario describes Japan as a weak, marginalized country in the global scene facing profound economic, demographic and financial challenges which it is unwilling to face.

- **Crash and Rebirth**. This scenario predicts a more prosperous picture of Japan than either of the other two and is developed through a television commentary recalling the days since the banking collapse of 1999. In this scenario, the banking collapse results in real reforms fostered by a shift in political will resulting from the financial crises. While the people of Japan suffer more losses in the short term than in "The Long Hollowing" the reforms allow the economy to rebuild

on a solid foundation. Social reforms including increased participation of women in the workforce and an increase in the retirement age improved labor force participation. Education and environmental reforms were also undertaken. Japan was also instrumental in U.S. policy regarding China maintaining its prominence as a potent political force in the world scene. This scenario concludes with a picture of Japan as a strong political and economic player in the world scene.

- **Hercules Departs.** The third scenario is focused on the effects of an U.S. withdrawal from its World War II commitment to provide Japan's military defense. The scenario is framed as an interview with a retired politician and policy maker in Japan on the eve of a national election to determine the Japan's defense strategy. In this scenario, the U.S. withdraws its forces from the Asia-Pacific region following a high-speed remote deployment strategy. This policy increases China's influence over affairs in the region creating economic turmoil and security concerns for Japan. The United States refuses to intercede in China's meddling with free trade in the region citing fears of damaging relations with China, the other world superpower. With this situation, no one in Asia was sure how far the U.S. would allow China to go before intervening. This situation has placed Japan in the position of considering reforms to its constitution at the time of the interview given the weak economic and political stature of Japan in the world scene.

  One faction favors a reinvigorated relationship with the U.S. through strengthening of the U.S. defense commitment in the region with full financial support from Japan. Another wants Japan to pursue diplomatic resolutions to its security concerns and opposes any military force in the country, domestic or foreign. A Nationalist party resents U.S. involvement in the country and wishes to see Japan build its own defense structure. Yet another point of view is that Japan should drive for a Asian defense organization either including or not including China, depending on one's view of China as a threat to regional security.

### Destino Colombia (Global Business Network)

Much like the Mont Fleur scenarios, the Colombian scenarios were presented to the populace of the country as a way of framing a discussion of the country's vision and future. The Global Business

Network authors specifically state that this scenario exercise presents a methodological advance from the South African exercise. Four scenarios are presented.

- **When the Sun Rises We'll See.** This first scenario presents a picture of inaction. Continued political and economic turmoil results leaving the country severely weakened as the rest of Latin America advances. There are armed skirmishes between government and guerilla forces, illegal activity including that of drug dealers grows and violence is commonplace.

- **A Bird in the Hand is Worth Two in the Bush.** This scenario outlines a negotiated settlement between the various factions in the country. These negotiations are spurred by a fear of the country declining into further violence and economic decline. While the solution is not perfect, the society ends up better off as a result of the mere settlement raging disputes between different factions.

- **Forward March.** This scenario presents the actions of a strong government with the will to solve the conflicts facing the country. The picture presented is that of an oppressive military regime resulting in a decline in social services and some degree of international isolation. These negative outcomes are seen as necessary temporary conditions to restore order and rebuild the nation.

- **In Unity Lies Strength.** The final scenario presents a picture of unity of vision throughout the nation. In this scenario a grassroots movement to build the strength of their institutions and made efforts to meet their immediate needs. This movement decreased the political and military struggles in the region and slowly changed political life. A new stability developed resulting in decreased crime, improved social services and economy.

## *Government Services*

While there are some examples of its application to national visioning application of scenarios, as described above, to decision-making in specific government entities has been slower to develop. While decision-making in government entities can be seen as analogous to this activity in business,

there are some important differences. First, government entities are faced with more complex objectives than businesses. A business is primarily guided by a profit motivation, rarely the case for a government organization faced with social welfare, regulatory and other considerations.

Also, the constituency of a government agency is much more complex than that of a business organization. While a business must simply satisfy its customers and stockholders with financial gain, a government agency must please those that it serves while considering the constraints imposed by both executive and legislative bodies of government. These added complexities along with some regulatory mandates for planning processes have slowed the application of scenarios in the public sector; however a few examples exist. One of these known as the Hemingford Scenarios were developed for the United Kingdom's public healthcare system and another was developed depicting the future of the United States public education system. These scenarios are considered below.

**United Kingdom National Health Service (NHS)**

Four different scenarios of the future of the NHS are developed.

- The Renewed Welfare Order: The NHS Delivers
- Health is Wealth: Private Provision Works
- Science Makes the Big Push: High Cost High Gain Health Services
- Well Being As You Like It: State Sponsored Feel Good Services (Ringland 357).

These four scenarios are based on the following drivers: national vs. international provision of services, state centralized vs. regulated provision of service, disease vs. well being oriented services. These drivers play out in the following categories of key factors: clinical practice, public values, the socio-political context of healthcare, demography, and disease trends. Different departments and authorities in their planning and decision-making activities use these scenarios. One particular authority used these scenarios to develop strategies intended to meet its goals of having primary care lead the NHS, ensuring appropriate health and health care and fostering public involvement. Different strategies were developed for each scenario and robust strategies were developed based on an overall analysis.

**United States Public Education (National Education Association)**

The National Education Association (NEA) through the Global Business Network prepared scenarios for the "the future delivery of public education in the U.S. Four scenarios are prepared based on two dimensions of uncertainty (drivers) related to the nation's sense of community. The first of driving forces is the choice along a dimension bounded by a hierarchical approach and a participatory approach. These second driving force is an inclusive or exclusive approach to education. These two axes of driving forces lead to four scenarios, Orthodoxies, Orthodoxy, Wired for Learning, and Learning Society. The orthodoxy scenario presents a view of "education becoming indoctrination" with a formalized, universal view of the process. The Orthodoxies scenario presents a picture of cultural fragmentation, the illusion of choice and extreme pluralism. Wired for Learning explores the application of information technology to education and a wide range of uncertainties associated with this application. The Learning Society is similar in some ways to the Wired for Learning scenario except that technology is not central to education focused on inclusive community values.

These scenarios present different visions of the future of public education and offer insight into the events leading to each outcome. One of these scenarios, The Learning Society, is clearly the preferred vision of the future and conclusions to the exercise outline some possible strategies to achieve this outcome (NEA).

## Transportation Applications

There are both private sector and public sector potential applications of scenario methodologies to the transportation enterprise since both the public and private sector are heavily involved in this activity. This section of the chapter outlines some of these possibilities.

### *Vehicle Manufacturers*

Vehicle manufacturers face many strategic decisions in the development of their businesses. They must consider product development, capital investment and production strategies, and market strategies, decisions that scenarios could certainly inform. Some vehicle manufacturers already

employ scenarios as a way of looking at these decisions.

**Product Development**

Product development is one of the key strategic decisions vehicle manufacturers face. Manufacturers of all types of transportation vehicles must decide what types of vehicles the market will demand, a decision based in uncertainty. Consumer demand is a function of the economy, regulation, environmental constraints, tastes and preferences, and demographic constraints. All of these factors change with time and these changes are in uncertain. Scenarios can be used to develop some possible outcomes and help vehicle manufacturers to be aware of trends and developments such as the growing popularity of car-sharing organizations that will affect the quantity and type of vehicles demanded.

Not only must vehicle manufacturers decide what types of vehicles will be demanded, they must also consider the propulsion systems and vehicle features even if the physical design of the vehicles is stable.

Scenarios can inform these design decisions by allowing manufacturers to look at different events and trends to develop a vehicle mix that will meet the possible outcomes of futures.

**Capital Investment**

One of the biggest decisions a vehicle manufacturer makes is whether or not to construct an new manufacturing facility and where to site it. The risk associated with developing a new capital facility is large with the cost of these facilities in the in the range of multiple hundreds of millions and billions of dollars. Scenarios such as those conducted for South Africa, Japan and Brazil can inform vehicle manufacturers about different types of facilities and different locations that may be appropriate.

**Market Strategy**

What countries (markets) should a vehicle manufacturer consider entering? This decision is linked

to a strategic plan the incorporates all of the conditions for entering a market. Often, a region requires that these manufacturers site a facility in the country as a condition of entering the market and scenarios must consider all the implications of this decision. The risks associated with entering a particular market are lower than those of siting a major capital facility. Entering a particular market requires establishing a distribution and maintenance network in a particular location. These assets are far less costly than manufacturing capacity and can sometimes use existing competency in a region. Scenarios like those described above for South Africa, Japan and Columbia could inform decisions about entering the market. These scenarios can also help to define what mix of products is appropriate and how these products might be marketed to the population by defining some of the events on the minds of the people.

## ***Passenger and Freight Transportation Providers***

Much like the product development decisions vehicle manufacturers face, passenger transportation providers, both public and private sector including transit agencies, airlines, railroads and water transport organizations must make strategic decisions about what services to provide. These organizations must decide what origin and destinations to serve, what type of service they demand (either direct or connecting), how much service to provide, and what type of vehicle to use. Essentially, these organizations must employ a strategic service planning process. Scenarios can inform this process by describing different levels of activity and demand in different locations under different future conditions.

Scenarios can also be used at a more tactical level by these organizations, more similar to the methods employed by military organizations that those business applications described above. These organizations could use scenarios to consider different disruptions to service such as weather problems, vehicle failures and crew problems to develop contingency plans for a set of likely problems. These contingency plans could be used to help maintain a high quality of service and ensure customer satisfaction and safety.

Freight transportation providers face many of the same decisions, only in terms of goods movement rather than passenger movement. In some cases, freight transportation providers face more

complicated decisions than passenger transportation providers. Consider a comparison of a package service to that of a airline. Both face the same issues of what markets to serve and what type of service to provide. The airline's decision is much simpler than the package carrier's, however.

A hypothetical example, United Mail Service (UMS) and Everywhere Airlines are considering whether to provide service to Des Moines, Iowa. Both have similar long-haul networks serving similar markets. Everywhere must simply decide to deploy an aircraft to Des Moines from its hub, flying to an existing airport. UMS must make the same decision; they must, however also deploy a fleet of vehicles in Des Moines to deliver packages to various addresses and must likely invest in distribution center. Everywhere can easily reverse its decision by reassigning the aircraft. UMS cannot leave the market as easily. UMS and Everywhere are likely to use scenarios in very different ways in making this decision. UMS would need to consider scenarios picturing the details of transportation and the spatial distribution of demand in Des Moines while Everywhere would simply need to evaluate the macro-forces affecting Des Moines.

## *Fuel and Energy Providers*

Transportation is an energy-intensive enterprise. All vehicles require energy of some type for propulsion; some use electricity while most are propelled by oil-based fuels. Energy companies, much like the experience of Royal Dutch Shell could employ scenarios to develop different views of what the future energy requirements of transportation sector, a large portion of their business. Decisions by vehicle manufacturers and transportation providers are likely to alter the amount and type of fuel required. These companies could employ scenarios of different oil supply situations, economic, demographic and other affects driving demand for transportation and vehicle technology affects driving the fuel consumption of vehicles. These scenarios could help these oil companies deploy resources to exploration, processing and transportation and highlight important choices in product mix and market entry.

## *Research Agencies*

There are examples of research agencies using scenarios to help define their research programs.

One such example is the European Centre for Research into Computing (ECRC) (Ringland 281). The ECRC was trying to determine the future of the European IT industry in the next century to better formulate its research program. Ringland cites five different driving forces affecting the industry:

1. Geopolitical and economic constraints,
2. Autonomous/determinant technological factors,
3. Market sales trends,
4. Information/communication technology infrastructure investment, and
5. The strategy/game of the actors.

Based on variations in the five driving forces, different scenarios were developed and research decisions made.

A similar example is the Research and Technology Coordinating Committee (RTCC) of the U.S. Federal Highway Administration (FHWA). This second example is of particular interest in that it applies directly to transportation. Further expansion of the scenario methodology through the transportation research community including private sector providers, government and academia could help to develop a well-directed comprehensive strategic research program.

## *Regional Strategic Transportation Planning*

One of the most important applications of the scenario methodology to the transportation enterprise is the case of regional strategic transportation planning, the focus of the remainder of this document. Regional strategic transportation planning (RSTP) is primarily within the domain of government, either local, regional, state (or provincial), or national depending upon the particular regional context although we will argue that there is a potential role for the private sector. RSTP is particularly suited to scenarios for several reasons described below.

### Long Planning Horizon

As discussed early in this chapter, longer planning horizons imply more uncertainty. It is easier and more accurate to forecast the future months or even several years into the future. Most regional

strategic transportation plans project conditions at least 20 years into the future. One is hard-pressed to identify many predetermined elements with time horizons this long. The long-term nature of these plans bemoans the inadequacy of point projections for making investment decisions and is well suited to scenarios.

**Expensive/Irreversible Decisions**

This second factor addresses the risk associated with the investments recommended in RSTP's. While institutional, organizational, and operational considerations are important components of a RSTP, most of the plans today feature infrastructure investment programs as their primary product. Investing in transportation infrastructure is analogous to the capital investment decisions vehicle manufacturers face in that they are costly and not easily reversed. One need not search long to find examples of misguided investment in transportation facilities fostered by narrow-minded plans. Although the demand for transportation facilities is rarely underestimated the political will and popular support needed for these facilities is often lacking. One can see examples of these failings in the Boston metropolitan area with its uncompleted urban highways, in San Francisco with the detested Embarcadero Freeway recently demolished and in Atlanta, Georgia with the continuing debate of the merits of a second beltway. Examples of demand forecast failures can be seen in the toll road system in Mexico, and the longer than anticipated timeframe of development of the corridor between Washington, D.C. and Dulles Airport. These investments are costly and long-lived. It is quite hard to reverse construction of facilities and once constructed, they require maintenance regardless of the level of use.

**Different Futures Require Different Strategies**

Different futures require different strategies. Appropriate strategies and investments in some scenarios are costly mistakes in others. Some futures may project high growth in travel demand; some may project low ones. Some futures may project dense development patterns, some may project dispersed development, and so on. While a certain strategy is effective under one future, it may not be under others.

**Derived Demand, Diverse Constituencies, Many Influences**

Transportation demand is derived. Very little transportation activity occurs for the sole purpose of travel. Transportation demands are driven by demands for goods and services and the need to move people between home, work, shopping and recreation, and the need to move goods from manufacturing site to distribution center to point of sale. These demands are a function of demography, economic conditions, land use patterns, culture, and preferences. All of these items contain some degree of uncertainty and are therefore useful bases for scenario development.

Transportation systems also have many different constituencies. Transportation systems must serve the traveler or shipper; transportation must fall within environmental constraints; transportation systems must meet the profit objectives of private firms providing services; and transportation systems must meet the political objectives of decision-makers in government. These different groups, with different objectives are difficult to serve and their objectives are uncertain over the course of time. Scenarios can be constructed considering the evolution of these constituencies.

Transportation systems are influenced by many other factors. The motorization rate, spatial distribution of activity, cultural patterns, family responsibilities and many other social and economic factors outside the economic realm influence personal travel within a region.

**Strategic Nature**

Finally, RSTP, by definition, is *strategic.* In most cases, improving mobility and accessibility in a region is only a part of the overall goals of a RSTP. These plans are often directed toward achieving other social and economic goals as well with transportation strategies seen as a mechanism for achieving other objectives. The transportation measures recommended are strategies for achieving economic development, social equity, environmental rehabilitation, real estate investment, private development, or other regional objectives.

Regional strategic transportation planning is perfectly suited for the application of scenarios; it is of a long-term nature, goal driven, and occurs in a complex and uncertain environment. Scenarios provide a useful way of overcoming the inadequacy of current planning practice, point forecasts and

sensitivity analyses to develop these plans.

## CHAPTER SUMMARY

Scenarios define the application of a rigorous methodology to a planning problem that explicitly incorporates the concept of uncertainty. Rather than basing strategic decisions on point estimates of the future, the process develops different pictures of what the future may look like based on logical developments from the known current state to the planning horizon. These different futures are used to evaluate different strategies in addition to accomplishing other objectives.

Scenarios originally were developed as military tools and moved into business planning in the post World War II era. The best known application of scenarios to business planning is that of Royal Dutch Shell beginning in the early 1970s and continuing through the current day. Other examples of the application of scenarios to business planning abound.

Scenarios have also been employed in a national visioning context to frame a discussion of the different future possibilities facing a nation. Examples of this activity include the Mont Fleur Scenarios for South Africa, scenarios for the future of Japan, and Destino Columbia.

The application of scenarios in the public sector has been slower to develop due to the added complexity of the planning environment the public sector institutions face. However, one can find examples of its application in the National Health System of the United Kingdom and the public education system for the United States.

The transportation enterprise provides a fertile ground for the application of scenario planning. There are many different possible applications of scenarios within the context of transportation. Vehicle manufacturers can employ scenarios as a tool to help with many different strategic decisions. Scenarios can also prove useful for service providers, both passenger and freight and transportation industry suppliers such as the petroleum industry. Scenarios can also be employed by government, private sector and academic institutions to formulate their research programs to meet the needs of the transportation industry in the coming years.

Regional strategic transportation planning is ideally suited for the application of scenarios. RSTP is a long term planning process in which very few elements are predetermined. The future these plans are developed in is a highly uncertain environment in which scenarios are particularly useful. Further, the strategies these plans develop are most commonly, but not necessarily appropriately, infrastructure investments. These investments are risky in terms of popular support, political backing, financing, and in some cases, even demand. Furthermore, these investments are not easily reversible or adaptable to changing conditions. These strategies are also influenced by many evolving social and economic factors, not easily captured in a single forecast. Finally, regional strategic transportation plans are in and of themselves a strategy toward achieving other regional economic, social and environmental goals so they need to be evaluated through different future economic, social and environmental situations.

The following chapters of this thesis will describe the development of scenarios as a tool for regional strategic transportation planning.

# 3

# SCENARIOS APPLIED TO TRANSPORTATION IN MENDOZA, ARGENTINA

The previous chapter outlined some reasons why regional strategic transportation planning (RSTP) is particularly well suited for the application of a scenario-based planning methodology. These reasons include:

- RSTP usually has a long planning horizon
- RSTP often considers expensive/irreversible decisions requiring long lead times
- Different futures imply different strategies
- Transportation demand is derived from other activities with uncertain futures
- RSTP occurs in an environment with diverse constituencies and with many influences
- RSTP has a strategic nature, usually guided by broader regional goals.

While RSTP is an activity well suited to the application of scenarios, few examples of its application can be found. One possible explanation for this is the fact that RSTP is often the responsibility of regional, state or local government. These planning agencies are often bound to certain planning

methods by statutory and regulatory constraints. While these constraints do not forbid these planning entities from exploring new methodologies, they often do not have the financial and technical resources available to pursue activities other than those required by law or statute. These legal and financial constraints added to the more complex planning environment present in the public sector and the relative newness of the scenario approach illustrate some of the reasons why scenarios as defined in this thesis have slow to be applied in the RSTP field.

Two examples of the application of scenarios to RSTP have been developed through research at MIT. One example draws on Abel Muñoz's analysis of scenarios for Mendoza, Argentina in his Master's Thesis *Using Scenarios for Regional Strategic Transportation Planning: Framework, Methodology and Application to Mendoza, Argentina* which considers the development of a bi-oceanic corridor across South America. The second is the Mobility-ReS/SITE development of scenarios for Houston, Texas.

This chapter summarizes Muñoz's analysis of scenarios for Mendoza and Chapters 4 and 5 present the Mobility-ReS/SITE scenarios for Houston.

## SCENARIOS FOR MENDOZA, ARGENTINA

Muñoz begins his analysis of scenarios for RSTP by describing the logic for his selection of a particular scenario methodology for his application. Then, his analysis continues by presenting a description of the Province of Mendoza and its transportation system. Once the methodology is selected and fully defined, and the context developed, Muñoz develops four different scenarios of Mendoza's future, and looks at several strategic options using this framework.

### Methodology Selection

Some possible approaches considered are the Intuitive Logics approach attributed to the Stanford Research Institute (SRI), the Trend-Impact Analysis approach, and the Cross-Impact Analysis (Muñoz 144). The specifics of these different approaches are not central to this thesis, but it is important to recognize that there are many possible approaches to the activity of "scenario

building." Suffice it to say that the two latter approaches are based on extrapolation of trends, impacting events, probabilistic estimations and computer simulations. The former uses an intuitive approach based on "driving forces." Muñoz settles on an the intuitive logics based approach. He summarizes the reasons why.

> *The exchange of ideas when building scenarios and the discussion of their implications generate a proper environment for performing strategic thinking in organizations.*
>
> *The identification of forces driving the future and the sound cause-effect requirement between events are useful tools to reshape decision-makers' perspectives. In this way, intuitive logics scenarios provide a direct link to the strategic direction...of the planning process.*
>
> *It does not intend to play a forecasting role, which would limit the ability of scenario to uncover the entire range of possibilities posed by the future.*
>
> *AND*
>
> *The intense intellectual interaction between participants can become the common ground to initiate or advance planning efforts involving public and private stakeholders (Muñoz 149).*

Within the intuitive logics framework, Muñoz identifies three different possible methods formalized by van der Heijden.

- An inductive method relying on available data to create a list of illustrative events classified as either predetermined or uncertain with the uncertain events creating the framework for individual scenarios.

- A deductive method that relies on driving forces as the logic behind the data. These driving forces are intended to be both uncertain and important in determining the future. In this method, the driving forces distinguish each scenario.

- An incremental method based on "challenge" scenarios used to identify flaws and weaknesses in the projections underlying the "official future."

Muñoz chooses to follow the deductive method for developing scenarios as the most appropriate

given the scale and context of his analysis.

## Regional Context

Mendoza is located in the western portion of Argentina, bordered by the Andes Mountains and Chile. There are approximately 1.4 million residents of Mendoza in an area approximately 150,000 square kilometers (Muñoz 159). Mendoza has a traditionally agricultural economy with a limited role for export of goods to other portions of Argentina and South America. Development of the Mercosur trade alliance, consisting of Argentina, Brazil, Chile, Uruguay, Paraguay, and Bolivia is changing Mendoza's trade position as regional and inter-regional trade increases (Muñoz 166).

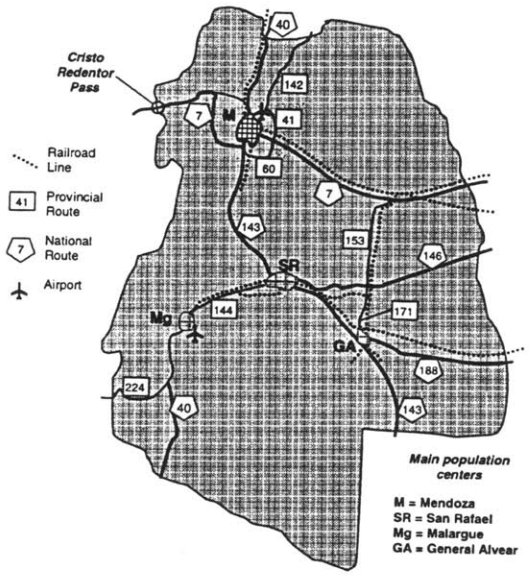
**FIGURE 3-1**
**MENDOZA'S STRATEGIC POSITION IN SOUTH AMERICA**
(From Muñoz Figure 7.4)


Mendoza is strategically located on one of the most favorable bi-oceanic corridor routes linking the Pacific ports of Chile to the Atlantic ports of Argentina, Uruguay and Brazil. The province is linked to Chile via several high passes over the Andes mountains, the Cristo Redentor pass being the most significant of these. The capacity of the links over the Andes is sufficient to meet current demand, but the limits of the most important pass are beginning to be tested. One possible strategy to alleviate congestion on the Cristo Redentor pass is the construction of a low-altitude tunnel at a cost ranging between US $1.0 and $4.2 billion (Muñoz 182). The regional context of Mendoza is shown

in Figure 3-1.

The regional transportation system, shown in Figure 3-2, relies largely on a national and provincial highway system including 6 major national roads and 6 primary intercity provincial roads. This highway system is complimented by over 1,600 kilometers of railroad linking the major cities to the rest of Argentina. A private concessionaire operates these railroad links. A multimodal freight terminal serves the area around the Provincial capital of Mendoza, also served by an airport able to accommodate some of the largest planes in service (Muñoz 175).

**FIGURE 3-2**
**MENDOZA'S TRANSPORT NETWORK**
(Muñoz Figure 7.5)




## Scenario Development

Muñoz applies a scenario methodology similar to that outlined by Schwartz to consider transportation strategies in Mendoza. The analysis consists of eight distinct but connected steps. These eight steps are:

- Step 1: Identify the Focal Issue or Decision
- Step 2: Identify Key Decision Factors of Success
- Step 3: Driving Forces
- Step 4: Rank Key Decision Factors and Driving Forces by Importance and Uncertainty
- Step 5: Select the Logic of Scenarios
- Step 6: Fleshing-out the Scenarios
- Step 7: Implications (Testing the Strategic Choices)
- Step 8: Choose Indicators for Each Scenario.

The details of each of each of these steps are summarized below.

**Step 1: Identify the Focal Issue or Decision**

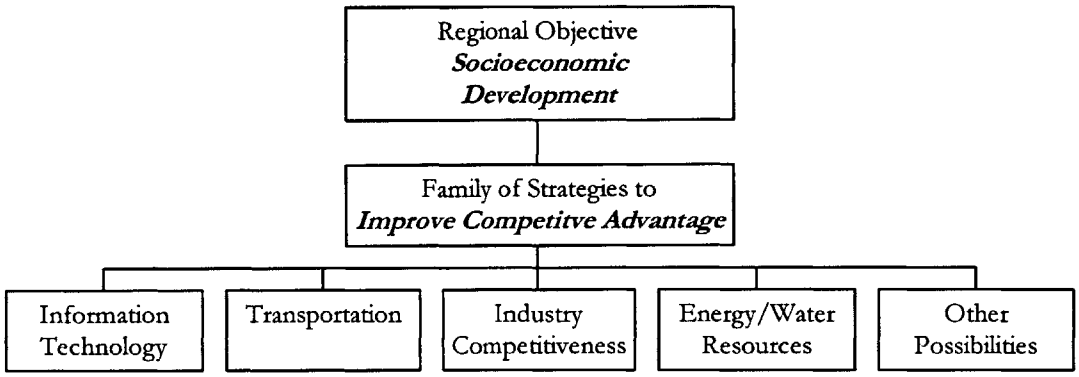
Muñoz correctly notes that transportation investment should be part of an overall regional strategy. He states that "transport systems are closely related to society's needs and functions, and that transportation can be thought of as a tool to support a region's economic activity" (Muñoz 186). This realization leads Muñoz to a discussion of the regional strategies for Mendoza and its competitive niches.

Muñoz summaries the region's overall objective as fostering the "generation of sustainable economic development that improves the living conditions of the population" (Muñoz 187). Working toward this overall goal is development of competitive advantage created through for different "strategic subsystems" (Muñoz 187). These strategic subsystems are Information Technology, Transportation, Industry Competitiveness, and Energy/Water Resources (Muñoz 188). These various strategies are depicted in Figure 3-3 below.

It is significant to note that while transportation strategies are the focus of the analysis, they are only a part of an overall strategy for the region. Muñoz notes, that some of the potential strategies under consideration do not fit well together. For example, some of the energy/water resources strategies have negative impacts on potential transportation strategies and that industry competitiveness improvement strategies may have a negative impact on the traditional agrarian-based economy.

Muñoz indicates that resolving these conflicts between different strategies is an important problem for the region to address. If the some decision-makers in the region decide to pursue some strategies that are in conflict with other strategies chosen by others, the results are likely to be a situation worse that the current one.

**FIGURE 3-3:**
**MENDOZA STRATEGIC OPTIONS**
(based on Muñoz Figure 8.1)




*Transportation Strategies*

The development of an international link through the Andes to Chile is only part of the transportation strategy available to Mendoza. While development of the bi-oceanic corridor is the primary strategy under consideration in Muñoz's analysis, he summarizes several other concerns for the provincial transportation system (Martland). These concerns include:

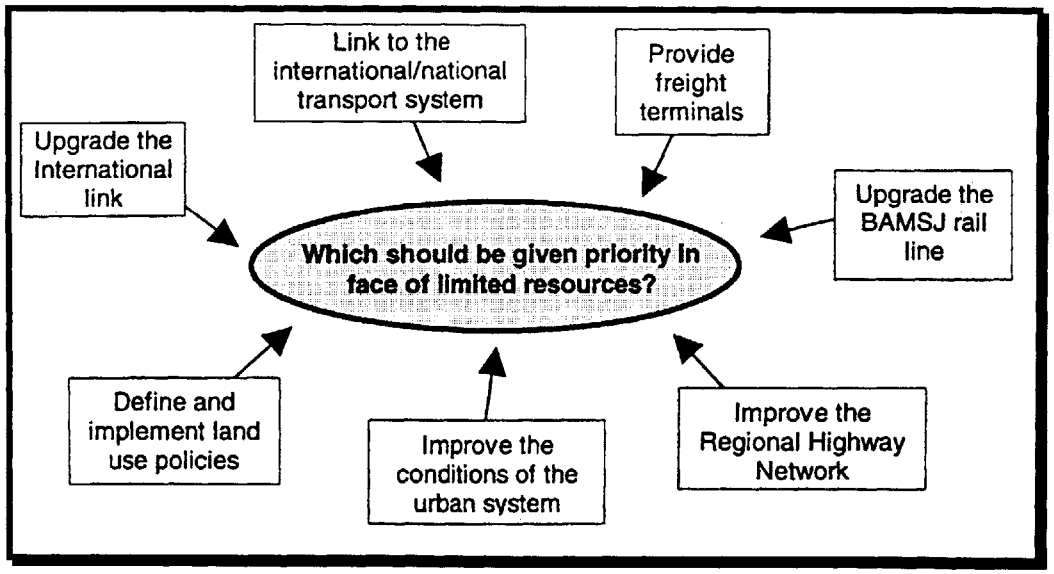
- The need for a multimodal connection between the provincial routes and the international freight transportation system,
- The need for accessible and efficient freight terminals for the transportation modes involved,
- The state of the provincial highway network,
- The need to upgrade the railroad serving Mendoza,
- Land use planning that supports and takes advantage of efficient freight movements, and
- The state of the urban transportation infrastructure and facilities in the city of Mendoza.

Each of these strategic areas leads to alternative investments in the provincial transportation system, shown in Figure 3-4, both complimenting and competing with the trans-Andean tunnel. From these concerns and the primary strategy, Muñoz develops the focal issue for the analysis,

> *Which of these seven strategies should be given priority in the face of limited resources?*
> *(Muñoz 194)*

Robustness and flexibility of strategies drive this decision. In the context of Mendoza, most of these seven investments will require many years to deploy indicating that there is little possibility of reversing the decision without incurring substantial costs. Faced with an uncertain future, one concludes that the decision about which strategy to follow must be made today and the strategies that should be chosen are those that appear *robust.* Strategies are robust when they provide a high level of performance under the widest range of reasonable future conditions. Scenarios are the tool used to measure this robustness and the first step in developing these scenarios is to identify the key decision factors of success.

**FIGURE 3-4:**
**MENDOZA STRATEGIC OPTIONS**
(From Muñoz Figure 8.3)



**Step 2: Identify Key Decision Factors of Success**

Step 1 is concerned with the refinement of the purpose of the analysis, "What decision are we trying to make?" Step 2 begins this decision-making process. Muñoz describes this step as "focusing on the provincial environment: How do we define success or failure of the decision from the viewpoint of the province?" (Muñoz 195). These factors represent the manifestation of local and global factors that affect the outcome of the various strategies. Three different "factors of success are identified:

> *a) The demand for transportation through the Andes*
>
> *b) The regional economic development and competitive economic advantage resulting from the transportation investment, and*
>
> *c) The competition posed by other regions/modes providing transportation services (Muñoz 196.)*

These three factors are those local issues that will have a profound impact on the success or failure of any of the seven strategic options considered. Muñoz further develops each of these key factors.

*The Demand for Transportation*

Transportation demand must be appropriately scaled to whatever strategy is considered. Muñoz states that a volume of about 10,000 vehicles per day is necessary to make the tunnel a viable option, although the basis of this level is forecasts laden with all of the problems projections normally bring. Muñoz does not suggest what demand levels are necessary for the other six possible strategies.

*Economic Development and Competitive Advantage Resulting from the Investment*

Different strategies have different level of impact on the province. The characteristics of each strategy and the particular designs proposed may have varying degrees of impact on the province depending on how they are connected to the major activity centers. Muñoz summarizes the following impacts that transportation investments can have on a region:

- Corridor effects, the new infrastructure bridges the region with little local economic impact,

- Crossroads effects, the new infrastructure brings economic development to the region servicing the intraregional trade, and
- Regional productivity improvement, where the investment spurs productive growth within the region.

Muñoz also cites two other factors affecting the economic development and competitive advantage resulting from the various strategies.

- First, competition between bi-oceanic corridors will impact the success of the link. The particular competitors he identifies are other land routes through South America, and the Panama Canal.
- Second, the world agricultural market that may provide a major opportunity for economic growth for Mendoza as industrialization continues and agricultural land and production becomes more valuable (Muñoz 214). Projections show that the demand for agricultural products is growing worldwide and that many countries will have deficits of grains in the coming years.

**Step 3: Driving Forces; Step 4 Ranking; and Step 5 Selecting the Scenario Logic**

According to the Schwartz methodology employed by Muñoz, the next step is to identify the driving forces that affect the key local factors outlined above. These driving forces are the predetermined elements and critical uncertainties that will affect the outcome of the scenarios. Muñoz begins by listing 21 different "relevant issues" that he clusters into 10 different groups. These 10 groups are then plotted in an influence diagram used to depict how the various "relevant issues" impact the key factors. The result is a list of 12 driving forces that are ranked in terms of importance and uncertainty in order to develop a list of two or three driving forces that are most relevant to the key factors. This analysis results in three key driving forces.

- Mercosur's development and performance
- Trends of global economic integration and free trade, and
- The level of affluence in developing countries.

**Selecting the Scenario Logic**

Muñoz depicts combinations of these three drivers as a "Scenario Space" (Muñoz 237) as shown in Figure 3-5 below. The figure indicates that there are many different possible futures to consider based on different states of the three drivers. The scenario logics define how these driving forces, key factors for success, and strategies relate to each other. The drivers describe the direction of the scenario. This direction plays out in the framework of the key factors, developing a different contexts for evaluation of the strategic options.

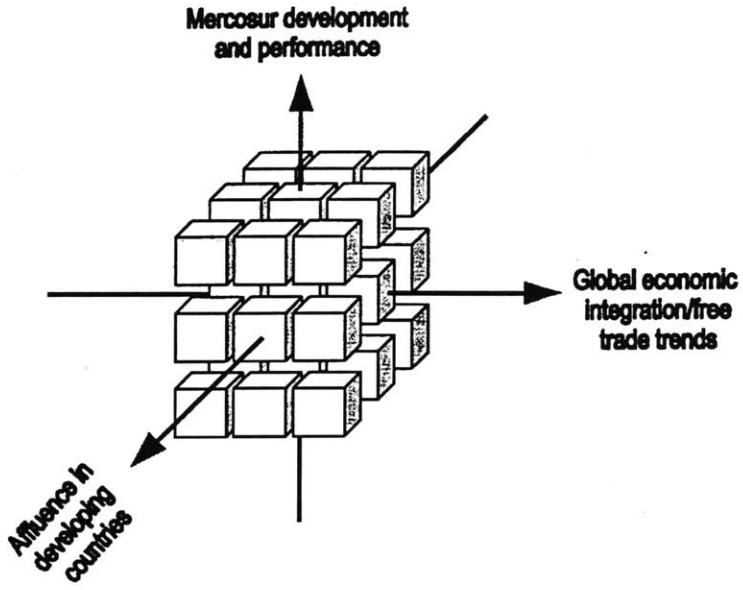
These different futures may each represent an interesting analysis; however, it is also possible that some of the combinations are not internally consistent, meaning that one driver state precludes another. Furthermore, it is not necessary to conduct an analysis of all of the realistic possible futures. The point of the scenario methodology is not to develop a comprehensive set of forecasts of the future. To do so would be an extremely time-consuming and costly endeavor; rather, the intent is to highlight different possibilities and develop an appreciation for the uncertainties and factors affecting the viability of the different options.

As shown in the figure, three different states of each of the primary driving forces, also referred to as critical uncertainties by Muñoz are considered. These three driving forces are:

1. Mercosur development and performance,
2. Global economic integration/free trade trends, and
3. Affluence in developing countries.

## FIGURE 3-5:
## MENDOZA DRIVING FORCES AND SCENARIO SPACE

(From Muñoz Figure 8.19)




Four different combinations of these driver states are selected for development into scenarios; these scenarios are:

1. "Extended Road" characterized by modest growth in Mercosur countries, an open global trade environment and selective improvement in the affluence of developing countries,

2. "Global Flight" characterized by a boom in the Mercosur countries, an open global trade environment and generalized improvement in the affluence of developing countries,

3. "Mercosur Trail" characterized by modest growth in the Mercosur countries, a closed, regionalized world trade environment and selective improvement in the affluence of developing countries, and

4. "Pothole" characterized by a slow-down in the Mercosur economies, a closed, regionalized world trade environment and a generalized deterioration in the affluence of developing

countries.

**Step 6: Fleshing Out the Scenarios.**

Muñoz develops short narratives depicting the chains of events leading to these different outcomes. The first of these scenarios, "Extended Road" describes a world of unified global trade. Despite this global environment, many countries still exhibit a wide variation in affluence among their populations since all do not share in this new prosperity. This disparity of wealth keeps the Mercosur countries from maintaining high levels of growth; however, they do continue to grow at a moderate pace. The prices of agricultural goods increases more modestly than expected with the majority of these products destined for other South American countries. Environmental consciousness increases as global warming is recognized as a reality resulting in higher energy prices. The Panama Canal has reached its capacity despite significant investments, but a northern bi-oceanic corridor passing through Brazil and Bolivia that more closely matches the original transport route handles most of the excess.

The second scenario, "Global Flight" depicts large growth in global trade with a fast growing Chinese economy. Mercosur invests in education, social services, and critical infrastructure vastly improving the state of its poorest citizens and there is a strong international demand for agricultural products. Much like the previous scenario, energy prices increase as environmental concern grows. The Pamana Canal operates at capacity, a northern bi-oceanic corridor is developed, and there is still a large market for the central corridor passing through Mendoza.

The third scenario, "Mercosur Trail" has lower levels of trade globalization than the first two. "Inequality in income growth and wealth distribution is the rule in developing countries (Muñoz 245) and food prices grow at a modest rate with the majority of Argentina's exports are destined for other Mercosur countries. Environmental concerns are growing as in the previous two cases, but there is no coordinated worldwide effort to address these issues. The capacity of the Panama Canal remains adequate to meet the needs of interregional trade.

The fourth and final scenario, "Pothole" is one of closed international trade, currency crises and a

global economic slowdown. Population and food demand grows slower than anticipated and inequity in income distribution remains a persistent, ubiquitous problem in developing nations. Low cost energy sources continue to be available and the Panama Canal operates well below capacity.

**Step 7: Implications**

Muñoz defines the implications of the scenarios on the strategic options under consideration and uses this logic to evaluate the various options. He employs a scheme that ranks the impact of each of the different strategies on the "socioeconomic development" of the region given the good performance of the option. In this step, Muñoz is essentially ranking the significance in terms of impact of each of the options. He then proceeds to evaluate each option's performance in each scenario. Each strategy is assigned a score from 1 to 5 with 1 indicating a low level of performance. These scores are then summed across all scenarios and multiplied by the impact factor to derive and overall score and ranking of options. The ranking of the strategic options is shown in Table 3-1 below.

The table shows some interesting results. One interesting outcome of this analysis is that upgrading the international link between Argentina and Chile, the fundamental motivation for developing the scenario analysis, is in the bottom half of the possibilities in terms of overall performance and impact. Several of the more mundane options like upgrading the provincial highway network and rail lines outperform the "big bang" option in the overall analysis. The conclusions of the analysis are that improving the link to the international and national transport systems and improving the provincial highway system are the most robust strategies while improving the conditions of the urban system and defining land use policies are the least robust. It is important to note that the analysis is based on the subjective judgements of the author; analysis by a wider range of stakeholders might yield different results.

## TABLE 3-1:
## MENDOZA STRATEGIC OPTION EVALUATION
(From Muñoz Table 8.13)

| Strategies | Perceived Impact (I) | Performance of Strategy 1 Extended Road | 2 Global Flight | 3 Mercosur Trail | 4 Pothole | Total Perform. (TP) | I*TP |
|---|---|---|---|---|---|---|---|
| *Upgrade the International Link* | 5 | 3 | 5 | 2 | 1 | 11 | **55** |
| *Link to the international & national transport systems* | 5 | 5 | 5 | 5 | 5 | 20 | **100** |
| *Improve the provincial highway network* | 5 | 5 | 5 | 5 | 5 | 20 | **100** |
| *Provide freight terminals* | 4 | 4 | 5 | 5 | 3 | 17 | **68** |
| *Upgrade the BAMSJ rail line* | 4 | 4 | 5 | 4 | 2 | 15 | **60** |
| *Define and implement land use policies* | 3 | 5 | 5 | 4 | 2 | 16 | **48** |
| *Improve the conditions of the urban system* | 2 | 3 | 3 | 2 | 2 | 10 | **20** |

**Step 8: Choosing Indicators for Each Scenario**

The final step in Muñoz's evaluation of scenarios for Mendoza is selecting signals to indicate the unfolding of the different scenarios. These indicators are the "events and trends affecting:

- The development and performance of Mercosur
- The behavior of the economic globalization and free trade trends, focusing on Mercosur efforts to reach out to other economic blocks
- The issue of the financial markets and their role in the possible future economic crises
- The development of the world food trade, and
- The operation of the Panama Canal" (Muñoz 253).

## Lessons Learned for the Mendoza Application

There are several major lessons to be learned from the application of scenarios in Mendoza. First, the scenario exercise demonstrates the importance of establishing regional goals and objectives at the outset of the analysis. One must remember that the process is strategic and that it is intended to help a region choose strategies that help it reach its goals. Muñoz uses the goal of "socioeconomic development" (Muñoz 187) to frame his analysis of transportation strategies. He notes that the link between the development of transportation networks and economic development is well established. Transportation investment acts as a sustainer, retainer, attractor of economic activity by providing a links between local, national, and global economies (Muñoz 191). While transportation is important, he also notes that it is part of an overall strategy involving investment and strategic options focusing on many other regional issues fostering competitive advantage (Muñoz 187).

Second, Muñoz demonstrates that a rigorous application of a scenario process to RSTP is indeed a viable endeavor. He develops the fundamental pieces of the analysis, key decision factors for success and driving forces, both predetermined and uncertain. He selects an analysis timeframe consistent with the deployment time of the strategic options, develops scenario narratives, evaluates the consequences of each scenario on the potential strategies, and, finally, identifies leading indicators of different scenarios.

Specifically, his analysis highlights several methodological concepts. First, influence diagrams, showing cause and effect relationships between key factors and different potential driving forces can be used to select the most pertinent driving forces. These influence diagrams illustrate a useful tool for refining the drivers to a manageable set. Second, Muñoz ranks the key factors and driving forces in terms of importance and uncertainty further aiding in the refinement of important driving forces. Third, the concept of a "scenario space" is an important construct for organizational learning. The scenario space depicts the range of uncertainty associated with a particular decision and helps to illustrate that the scenarios chosen for analysis are not a comprehensive picture of the future; rather that they illustrate specific snapshots of possible future outcomes.

In terms of analyzing different strategies, Muñoz uses an approach that highlights the most robust

strategies in terms of performance and impact. Including the concept of impact is an important one in that it clarifies the distinction between the performance of an option in the theoretical case and in each scenario. His analysis, however, lacks any measure of feasibility. Not all strategies are feasible in all possible futures and the analysis of these options should consider this factor as well. Other shortcomings of the process illustrated by Muñoz 's analysis include the difficulty of effectively evaluating strategic options without a great familiarity with the region's characteristics and a wide range of perspectives. Finally his analysis does not suggest any new strategic options, one of the primary objectives of this type of analysis.

Overall, Muñoz 's analysis of scenarios for Mendoza, Argentina provides an informative and valuable example of this methodology's application to regional strategic transportation planning. This work in large part inspired the application of scenarios to Houston, Texas introduced in the remainder of this chapter and further developed in Chapter 4.

## CHAPTER SUMMARY

Regional Strategic Transportation Planning is an activity well suited to a scenario-based methodology; however few examples of RSTP using scenarios can be found. Many regions talk about scenarios in their planning process, but these discussions are usually about different point projections of population, land use and other trip creating factors. Rarely, if ever, do these discussions relate to a consistent methodological framework for dealing with uncertainty.

Muñoz 's analysis of scenarios for Mendoza, Argentina provides a useful illustration of the application of scenarios to RSTP. The analysis is driven by the region's goals of socioeconomic development and the consideration of a "big bang" strategy, the construction of a low-altitude tunnel link between Mendoza and Chile through the Andes Mountains. The analysis of scenarios for Mendoza is thorough, interesting and inspired the Cooperative Mobility Program – ReS/SITE team to develop mobility scenarios including both a region independent scenario platform and specific application in the case of Houston. These efforts are discussed in more detail in the following two chapters.

# 4

# A SCENARIO PLATFORM FOR TRANSPORTATION PLANNING

The Mobility-ReS/SITE team developed scenarios of mobility in Houston, Texas. The scenario building process took approximately nine months including developing a methodology, building scenarios, analyzing data, and evaluating strategic options. The team's objective was to demonstrate that a scenario-based methodology could be effectively applied to regional strategic transportation planning with no "big bang" options like in Mendoza.

This chapter will describe the development of the "scenario platform" used in this analysis and the scenarios resulting from application of this platform. The chapter is drawn almost entirely from two reports by the Cooperative Mobility Program-ReS/SITE group presented at the 1998 MIT Cooperative Mobility Program Sponsors Meeting:

- *A Scenario Platform for Regional Strategic Transportation Planning*, and
- *Mobility Scenarios for Houston in the Year 2020.*

This chapter begins by describing the current planning environment in Houston including those institutions involved in the planning process and the products of this process. The next section outlines the methodology employed by the Cooperative Mobility Program – ReS/SITE team.

## HOUSTON PLANNING CONTEXT: THE OFFICIAL FUTURE

Regional strategic transportation planning in Houston is undertaken by the region's metropolitan planning organization (MPO), the Houston-Galveston Area Council or H-GAC. The H-GAC performs transportation and other planning functions for an area of over 7,700 square miles encompassing eight counties. Their planning efforts also include several other agencies and transportation providers in the region. In addition to the county governments, the council involves:

- Local Municipalities such as the City of Houston,
- METRO, the transit agency for the Houston Metropolitan Area,
- Brazos Transit Systems (Brazoria County),
- Texas Department of Transportation(TxDOT),
- Port of Houston Authority,
- Harris County Toll Road Authority, and
- TranStar, the regional transportation systems management (TSM) organization.

There are two primary products of this planning activity, the regional strategic transportation plan, *Vision 2020* and the Transportation Improvement Plan, or TIP. *Vision 2020* is a strategic plan that is focused on a regional vision and regional goals looking 20 years into the future. The TIP is a short-range planning document, essentially a tactical plan for deployment of projects. The strategic plan sets out the direction for the region, establishes future demands, outlines anticipated resources, identifies needed projects and establishes an implementation timeline. The TIP is the implementation tool of the strategic plan. It sets out the infrastructure development program for the region in two-year increments. The long range, strategic plan is periodically updated, at least every three years. The TIP is updated every two years.

### *What Is "Vision 2020"*

*Vision 2020* is the "official future" for the region. Many of the scenario "experts" discuss the concept of the official future as that which is based on traditional forecasting methods. The contents and purpose of the Vision 2020, known as the Metropolitan Transportation Plan (MTP)

are summarized below:

> *The MTP is a long-range transportation planning document that provides a twenty-year framework for addressing the region's transportation needs. It affords an overview of the existing system, identifies existing needs, forecasts future needs, and defines strategies to help the region meet those needs. In addition, the MTP ensures that the transportation system does not contribute to worsening the region's air quality. Furthermore, the system must meet established financial constraints, which is to say that the cost of implementing the solutions has to be realistic and cannot exceed the expected financial resources....It includes the projects and programs that will be programmed and implemented in future TIPs...(H-GAC 6).*

Vision 2020 contains an introduction (Chapter 1) and six subsequent chapters (Chapters 2 through 6) outlining this regional future. Each of the substantive chapters is summarized below.

**Regional Trends**

Chapter 2, Regional Trends describes projections of population growth, employment growth and spatial distribution used to develop a forecast of travel demand in the Year 2020. These projections develop a point estimate used as the basis for the plan's recommendations. This forecast does not account for uncertainty or other changing conditions and, in that sense, is typical of the current practice. The analysis of trends and projections contained within this chapter is a primary enhancement offered by a scenario-based methodology.

***Vision 2020* Framework**

Chapter 3, "*Vision 2020* Framework" describes the vision and goals of the plan as the basis for evaluating potential strategies to meet the region's mobility needs. The vision for the region's transportation systems is summarized:

> *The Houston-Galveston regional Metropolitan Transportation Plan will enhance mobility by providing an efficient, affordable, and environmentally responsible transportation system for both people and goods (H-GAC 19).*

To achieve this vision, the plan establishes several goals presented in no particular order. The region establishes the following as goals for the Metropolitan Transportation Plan (MTP):

- A multimodal transportation system,
- Enhancement and maintenance of existing infrastructure,
- Coordinated land use and transportation development,
- Seamless connections,
- Efficient movement of people and goods,
- An environmentally responsible system,
- Active citizen involvement, and
- A cost-effective and affordable transportation system.

**Regional Issues**

The next chapter, "Chapter 4," describes "an analysis of the issues involved in development of the future transportation system" (H-GAC 22). The chapter presents four major categories of issues, maintenance and preservation of the existing system, goods movement, transportation system safety and environmental considerations.

Maintaining the roadway system is a large financial burden for the region to meet. The plan presents an analysis of different levels of investment in system maintenance with varying degrees of system deterioration from its current state. In order to preserve the system, the plan indicates that the region will have to invest around $108 million annually in maintenance.

Providing for the freight requirements through the region and accessing the 66 intermodal terminals in the Houston-Galveston area is a major challenge to planning for the future transportation system of the region. The needs of the freight system often are complicated by the passenger transportation needs of the region since they use many of the same facilities, "a source of efficiency and inefficiency" (H-GAC 25). The restrictions on meeting the goods movement needs of the

region are compounded by the fact that facilities "in many areas cannot expand or be reconfigured because of competition with other land uses" (H-GAC 25).

"Safety is one of the fundamental requirements of any successful transportation system" (H-GAC 25) and is one of the primary issues in developing the future transportation system for the region. The plan considers safety in two sections:

- roadway safety - traffic accidents, railroad crossings and emergency evacuation planning; and
- transit safety including security concerns, downtown pedestrian safety and HOV lane safety.

"Environmental factors can have a major impact on regional development patterns and the resulting transportation system" (H-GAC 29). The plan summarizes wildlife and vegetation, and water resources as the two primary areas of concern. Interestingly, air quality is not listed as a consideration.

**System Management**

Chapter 5 describes one of the region's primary strategies for improving mobility and reducing congestion (H-GAC 33). The MTP describes a congestion management system (CMS), "an ongoing process that is designed to systematically evaluate, select, and implement cost-effective strategies to manage new and existing transportation facilities" (H-GAC 33). These systems include both transportation system management (TSM) techniques and travel demand management (TDM) measures. Some examples of TSM techniques include:

- Incident detection and response programs
- Courtesy patrol, motorist assistant programs,
- Changeable message signs,
- Traffic operations centers,
- Motorist information centers,
- Traffic signal timing and coordination improvements,
- Automated traffic management systems, and
- Computerized traffic management systems.

TSM techniques are intended to maximize the capacity, or throughput of transportation facilities under real-time operating conditions. TDM measures, on the other hand, are intended to control the demand on system. These two techniques combined have the effect of increasing supply and decreasing demand resulting in better system operation. Some examples of TDM measures include:

- Regional vanpool programs,
- Transportation management organizations,
- Home-based telecommuting, and
- Peak spreading measures.

Major investment studies (MIS) are also seen as an important system management tool. MIS are long-term planning tools for a particular area of concern within a region. These studies look at the transportation situation in a particular area, usually a corridor and attempt to identify the most efficient and reasonable solutions to a mobility program. The MIS is a tool currently being used in the region to find solutions to several transportation system problems.

**Financial Analysis**

A necessary part of any planning effort is to match a region's financial resources to its needs and potential strategies. Chapter 6 defines the region's financial situation. The region projects that nearly $2 billion will need to be invested annually in the regional transportation system over the 22-year period between 1998 and 2020. The plan identifies these needs as exceeding resources by $257 million per year. The overall result is a budget shortfall of nearly $6 billion over the 22-year period. The MTP proposed five strategies to bring the region's needs in line with its resources. These strategies include:

- A toll-financing policy for new freeway projects,
- Reduction of diversion of state transportation funds from non-transportation activities,
- Increasing Houston's share of state transportation funds,
- Increasing Texas's share of federal transportation funds, and
- Deferment of projects resulting in an annual savings of $55 million.

**Strategies and Performance**

The final section of the MTP defines some of the strategies and projects recommended for the region. This section begins by defining enhancements to the regional transit system. The plan recommends increasing transit service to high growth areas, implementing advanced technologies such as a regional computerized traffic signal system, intelligent transportation systems, automatic vehicle location, automatic passenger counters and congestion pricing programs. The plan also recommends capital programs including construction of new HOV lanes and high-capacity transit in the Astrodome to Downtown corridor.

The plan also recommends that the region construct nearly 13,000 miles of new roadway resulting in an additional 50,000 lane miles in the region. These additional miles of roadway are conjunction with intersection improvements and other operational measures. These roadway improvements along with the transit system initiatives are expected to significantly reduce congestion in the region.

As a sidelight, the plan recommends construction of an additional 357 miles of pedestrian and bike facilities as "viable alternatives for many local trips" (H-GAC 68).

Based on the figures presented, it appears as though the recommended package of strategies will have a profound impact on the levels of congestion in the region. In fact, the future condition has fewer areas of congestion than the existing case presented.

One might ask at this point, "What's wrong with this plan?" The answer is simple. In the light of the planning requirements placed on H-GAC and the customary way of preparing these plans, nothing. However, in reality, we have little idea what the actual travel demands, financial resources, environmental constraints, or technological choices will be in the year 2020. Planning in the context of uncertainty requires more than a point estimate of these important future variables.

## ***How does Vision 2020 Inform the Scenario Building Process***

The *Vision 2020* plan provides a valuable starting point for performing a scenario analysis of mobility in Houston. It, in effect, is a scenario. The narrative of the scenario for the *Vision 2020*

projections and evaluations could read as follows:

> *Everything continued as expected for the 22 years between 1998 and 2020. The growth trends between 1998 and 2020 were the same as those between 1990 and 1998. Environmental constraints on development in the region still remained minimal. There were no significant technological innovations in the last 20 years that required us to think differently about the transportation system, and the region continued to receive adequate financial resources to maintain the system and fund improvement projects.*

This is one reasonable view of what the future may hold. Furthermore, *Vision 2020* is effective in defining the current conditions in the region and the important issues that it will face. The MTP also gives the scenario exercise valuable insight into the vision of the region and the goals that it wishes its transportation system to meet. The remaining question is how can we achieve the vision and meet the goals established in the MTP given an uncertain future; this is the focus of the following sections.

## OUTLINE OF METHODOLOGY

The Cooperative Mobility Program – ReS/SITE team developed a scenario platform for regional strategic transportation planning in order to look at mobility in Houston. This platform is intended to be a coherent, general, logical methodology that can be applied to the case of any region for the purpose of regional strategic transportation planning. The framework is depicted graphically in Figure 4-1 below.

Scenarios are well suited to thinking strategically about transportation planning. Scenarios allow the planner to account for uncertainty about the future. By looking at events and trends that may occur, different visions of the future can be developed. If this process is done effectively, these different visions of the future will span a range that includes the actual future that is likely to develop. This approach to transportation planning is quite different than the traditional planning process that extrapolates current trends into the future to develop a point estimate of what the future will be.

There are four principal advantages to using scenarios for regional strategic transportation planning.

1. Scenarios allow planners to look at different future possibilities and consider strategic options that are well suited to each.

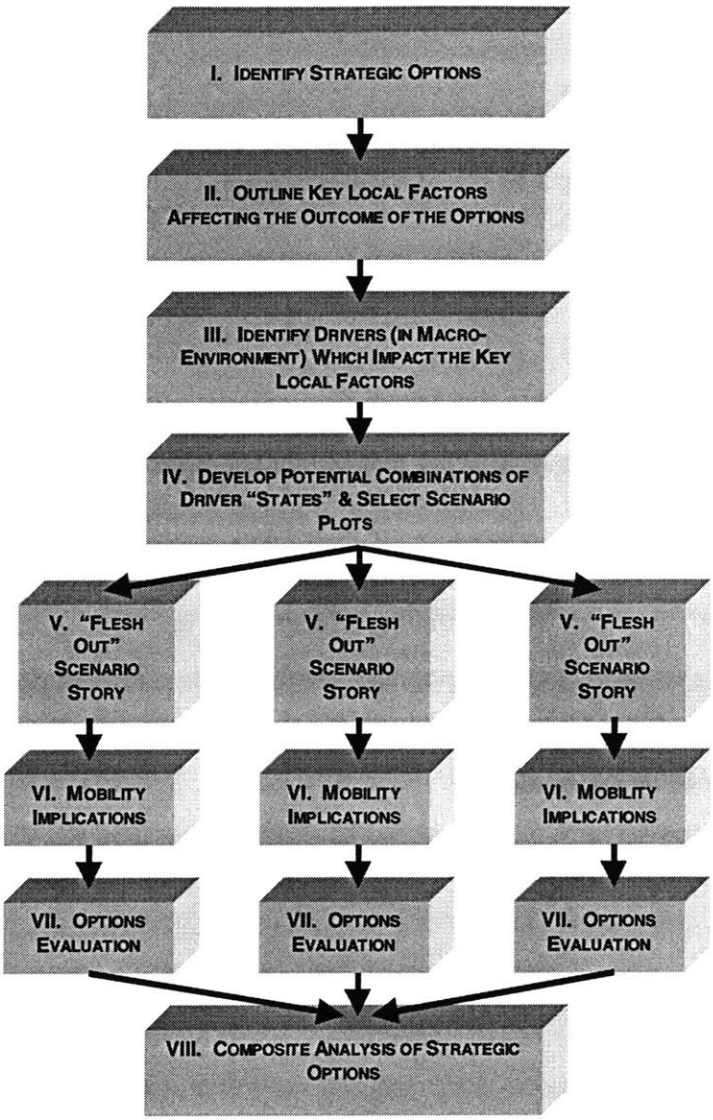
2. Scenarios allow planners to develop sets of strategic options that perform well across a wide range of possible futures.

3. Scenarios can help identify events and trends that may indicate that a particular future is developing, allowing adjustment of the regional strategies.

4. Scenarios can facilitate organizational learning by allowing decision-makers to stretch their minds.

One might think that applying a scenario methodology to transportation is simple However, the actual application of these methodologies in a new context is more complicated than one might suppose. Developing a methodological framework, consistent with the purpose and motivation for scenario analyses; considering the nature of transportation systems as derived activities; and incorporating each team members' understanding of scenarios, individual goals, objectives, and professional experience was a very challenging task involving the efforts of eight researchers over a nine-month period. The following section describes this methodology and the following chapter summarizes the results of its application.

**FIGURE 4-1: SCENARIO FRAMEWORK FOR REGIONAL STRATEGIC TRANSPORTATION PLANNING**
(ADAPTED FROM CMP-RES/SITE PAPERS)




## Define the Scope

The first step in a scenario analysis of any strategic situation is to establish the purpose of the exercise. Strategies are central to using scenarios for RSTP. The underlying purpose of the scenario exercise is to develop strategies that will help the region attain its goals and vision.

Different scenarios are developed to test strategic options the region is considering. Using this framework, the region can identify strategies that are robust across a wide range of possible futures.

## Identify the Strategic Options

Once the scope of the analysis was determined we move into the flowchart shown in Figure 4-1. The first step in applying scenarios as a RSTP tool is to identify to strategic options the region is considering for implementation. These strategic options fall into three different categories, shown in Figure 4-2. All of these categories are related to the philosophical direction the region wishes to pursue. In some cases, for some regions, a philosophy focusing on infrastructure investment is most appropriate while in others, focusing on transportation demand and control are most appropriate. In still other cases, a region can focus on its institutional structures for managing the transportation system.

1. **Capital Investments**. This first category is the traditional output of RSTP, infrastructure projects. This category includes the development of new facilities, rehabilitation of existing facilities, expansion of facilities, and investments in operational controls. Capital investments are new roadways, intersection/interchange improvements, new airports and airport upgrades, port improvements, public transit improvements and the entire range of transportation facility and service deployments.

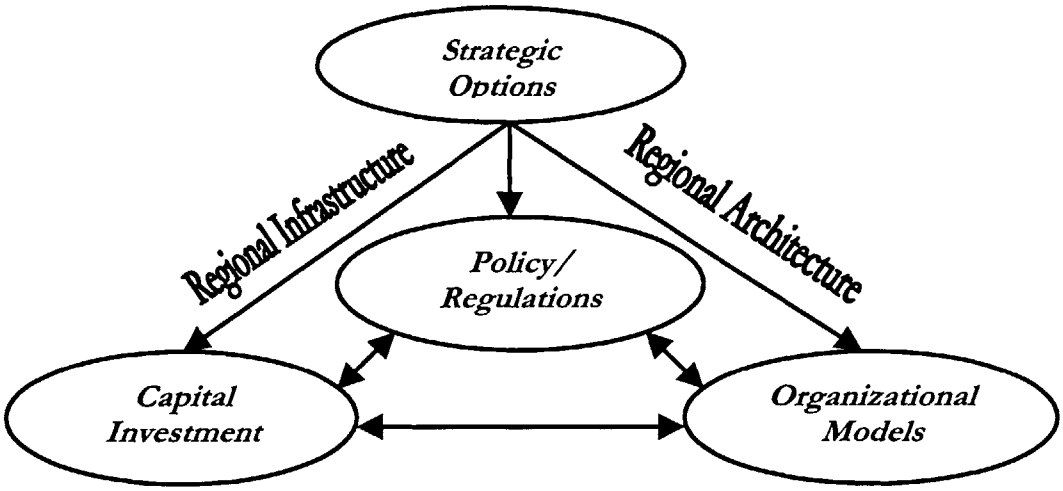
2. **Policy/Regulatory**. Scenarios can serve as both a project evaluation tool and policy analysis tool. Policies and regulations are transportation control measures that can affect the demand for transportation or its impact on other activities. These strategies include improved transportation system and demand management tools, land development controls, efficiency programs, and environmental impact controls. Examples of these policy/regulatory strategies include emissions controls for vehicles, parking freezes, and congestion pricing. These policies are as important in shaping the future transportation system needs of the region as any possible investment in infrastructure. In fact, capital investment and policy implementation are very closely linked in that different policy directions favor different capital investment and vice versa.

3. **Regional Organizations.** The final type of strategy available to the region is that of organizational structures. The region can pursue different organizational strategies to meet its transportation needs. There are many different control strategies that a region can pursue to manage the transportation enterprise. Just as an example, the region can focus on controlling land use, can focus on operational control, or can focus on controlling infrastructure development as tools for managing the transportation system.

   Other questions also fall into this category of strategic options. These questions are concerned with the bureaucratic arrangement of the public sector organizations providing transportation services in a region, funding mechanisms, and questions of private sector provision of transportation services. These questions are all quite complex in and of themselves, even outside of the strategic planning context. Scenarios provide a valuable evaluative tool for considering these questions as part of an integrated regional transportation planning process.

Figure 4-2 shows how these different categories of strategic options relate to one another and how they fit into the RSTP methodology described in Chapter 1 of this report. You will recall that the ReS/SITE methodology recommends that RSTPs result in "Regional Infrastructure" and "Regional Architecture." This figure shows how these two constructs fall into the three categories of strategic options. Capital Investment is related to the "Regional Infrastructure." Organizational Models fall into the construct of "Regional Architecture." There are two sets of arrows linking all of the possible strategies. The longer arrows between "Strategic Options," "Capital Investment," "Policy Implementation," and "Organizational Models" represent direct products of the strategic planning process while the short arrows represent the feedbacks these various strategies.

**FIGURE 4-2**
**STRATEGIC OPTIONS**




## Identify Key Local Factors Affecting the Strategic Options

As mentioned in Chapter 2, transportation demand is derived from the demand for other activities. Transportation demand is a function of economic activity, employment patterns, residential patterns, demand for goods and services, geographic distributions, industry, environmental constraints, social patterns, and political constructs. This step of the scenario methodology for RSTP is concerned with identifying those factors in the local context that will affect the supply of transportation services, the demand for these services and the various strategies being considered to meet the future needs of the region.

The word "local" is important in defining what is meant by these factors. There are many factors affecting the transportation system that are not local: oil pricing, prices of automobiles, the world economic environment, global environmental constraints, etc. These factors, outside the control of the region, are better classified as scenario drivers, described in the following section. Key local factors are the manifestation of the scenario drivers, those global forces, in the local environment. These are the political, economic, environmental and demographic attributes of the region and are in

many cases influenced by local-decision making. These local factors can be broadly described in five major categories.

- Health of the local economy,
- Shifts in environmental attitudes and policies,
- Demographics,
- Federal and State investments and control, and
- Local politics.

The Mobility-ReS/SITE team suggests that these categories of key local factors are universal in preparing an RSTP for any region. These local factors appear to be just as relevant for transportation planning in Bombay, India, as they are in Boston, Massachusetts. Certainly, this proposition will need to be tested by applying this planning framework to a diverse set of metropolitan areas.

While the categories appear to be universal, the precise local factors are likely to vary significantly from region to region. The local economy in Bombay, India is likely to be comprised of a very different mix of industries and services than that of Houston, Texas, and influenced by different scenario drivers. Similar variation is certain in the other four categories as well. These key local factors influence the success or failure of particular strategies and help to define the evaluative context for each scenario.

## Identify the Scenario Drivers

The scenario drivers are the determinants of the scenarios. These are the events in the global or national environment that affects the local region. One of the key distinctions between the key local factors and the scenario drivers is that the scenario drivers are considered to be beyond the control and influence of local decision-makers. While people in the region can manipulate the key local factors to some extent, the drivers represent changes at a much larger scale and degree of complexity. The scenario drivers are defined below.

> ***State of the Economy*** *– global and regional economic integration, trade, capital flows, competition and wage levels;*
>
> ***Finance*** *– availability of infrastructure funding, user charging mechanisms, private sector participation in infrastructure [development and management]*
>
> ***Technology*** *– intelligent transportation systems (ITS), telecommunications, vehicle technologies, fuel extraction technologies, high speed rail technologies, shipping advances; and,*
>
> ***Environment*** *– local air pollutants, climate change, endangered species, water pollution, "sprawl" (CMP-ReS/SITE1 – 16)*

The environment scenario driver is, in reality, more complex than suggested in the above definition. While the local effects indicated are important, this driving force is intended to capture the constraint placed on the local transportation system by environmental action at the national and global level.

For each of these scenario drivers, 1) a positive, and 2) a stagnant or decreasing state was assumed.

- Economy: increasing or decreasing global economic activity
- Environment: limited or strict regulation compared with today's expectations.
- Technology: advancing or stable development of technological solutions to transportation constraints.
- Finance: increasing or decreasing willingness of federal government, state government, and the private sector to finance strategies.

The scenario drivers are the key to the scenario stories. The narratives describe the scenario driver states, outline the logical chain of events leading to that state of the driving forces, describe the local impact and describe the effect on the various strategies.

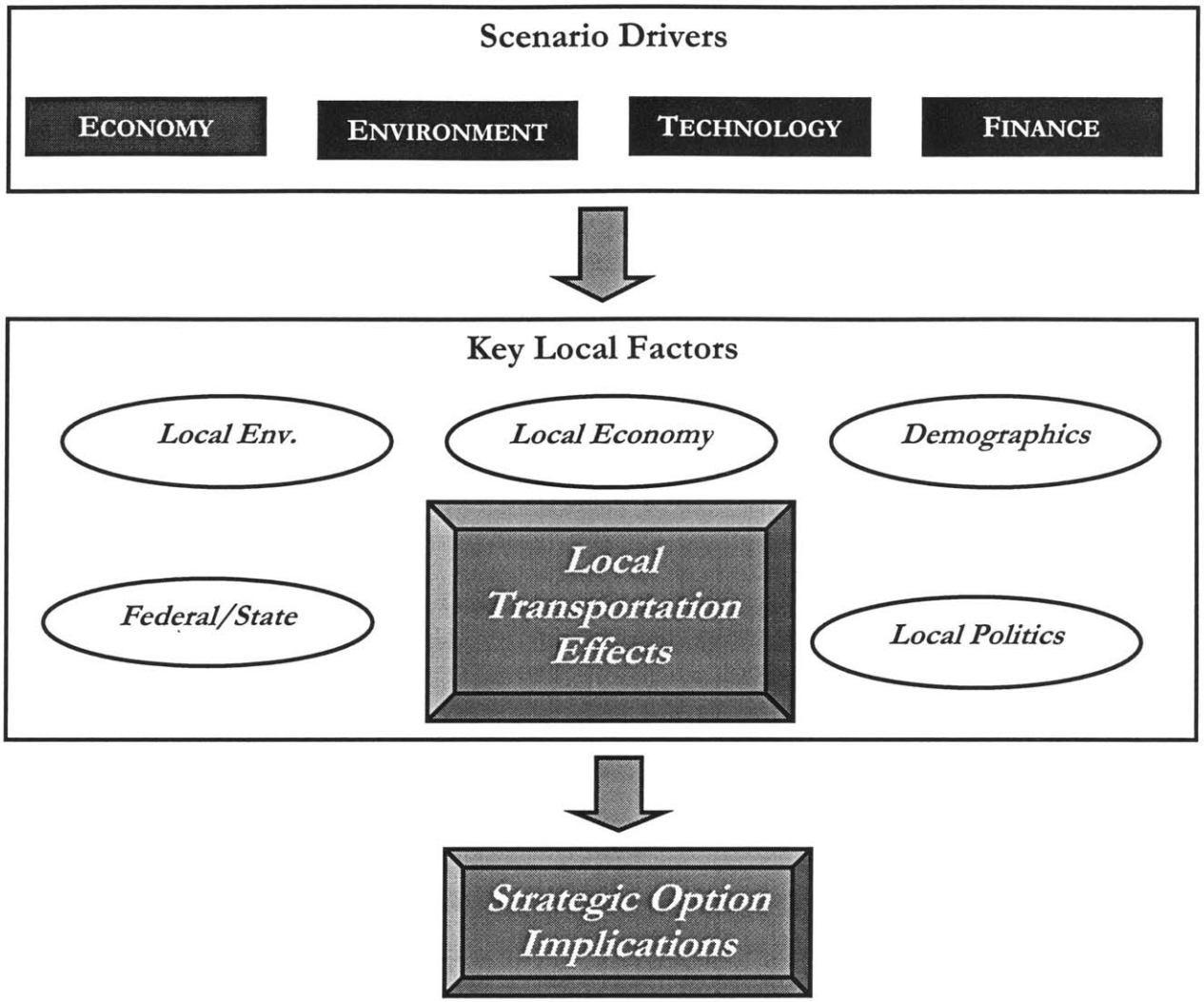
Many of the scenario drivers have analogs in the key local factors. For example, the environment driver, intended to capture changes in national and international environmental concern and policy directly impacts the local environment key factor, representing the attitudes of the local population and their response to changes in the global environment. The economy scenario driver is analogous

to the local economy key factor. The finance scenario driver is related to the federal and state investment and control key local factor. Finance intends to define the market for private finance in addition to federal and state willingness to invest in local transportation facilities. The federal and state investment and control key local factor describes the region's ability to capture these federal and state and private resources in competition with other regions of the nation and world.

The technology driver does not have an analog in the key local factors. It is expected that technological developments will be broader in geographic application than the specific region under consideration and therefore no local component of technology is explicitly considered. One must note, however, that the technology driver does impact the local economy key factor in that some local industries will either benefit from, or be harmed by these technological developments.

The logic of these scenario interactions is depicted graphically in Figure 4-3 below. This figure depicts how the scenario drivers impact the key local factors and how these effects impact the transportation system and thus impact the performance of the strategic options.

**FIGURE 4-3**
**TRANSPORTATION SCENARIO LOGIC**




## Combining Driver States and Selecting Scenario Plots

As mentioned above, this analysis assumed two possible states for each of the scenario drivers. One could also construct scenarios with three or more states of scenario drivers. To develop three scenario driver states one would include a neutral state in addition to good/bad polar states. Four or more scenario driver states would result in combinations of moderated good/bad states. For

example, you could have a very bad, bad, good, very good list of possible driver states. As the number of driver states increases, the number of possible scenarios increases dramatically with little added value. More scenario states makes choosing particular scenarios to fully develop more complicated and little insight is added by creating these additional states. The purpose of a scenario analysis is to highlight the important directions the future can take and to make decision-makers aware of this uncertainty. Adding complexity in the number of driver states does not make these differences more apparent since the new states are likely to lie somewhere in the range established by having polar good/bad scenario driver states. Sixteen possible scenario driver combinations considered for this analysis

## Fleshing-Out the Scenarios

Perhaps the most fulfilling and informative part of preparing the scenarios is fleshing them out. Selecting the scenario plots informs what conditions you are describing in the future, but does little to explain why that particular future is plausible. The first important step in fleshing-out the scenario stories is to root them in the events of today and those events that are certain in the near future. If the economy is currently booming and employment in a particular part of the city is skyrocketing, the scenario must present the reasoning behind a change in this activity. Rooting follows any existing conditions and predetermined elements to their logical conclusion before departing on new possibilities for the critical uncertainties. "Rooting" the scenarios allow the decision-makers to follow the logic from the very beginning, rather than expecting a "leap-of-faith" to some future condition. In the RSTP context, predetermined elements normally only affect the first several years of a planning horizon, so adequately rooting the scenarios does not over-constrain scenario development.

Once the scenarios are established in the current environment, the logical development of each of the scenario stories begins. The events leading to the various driver states are outlined. The effect of these events on the key factors in the local environment is described and the implications for the transportation system are outlined, as presented previously in Figure 4-3.

## Mobility Implications of the Scenarios

Each of the scenarios has different implications for the transportation system in the region. Some scenarios are likely to project growth in demand for freight flows, while others may describe a rapid decentralization of the employment in a region. The scenarios describe effects on both personal travel and goods movement through the region as a result of the different driver states. The scenarios can affect the transportation system in two primary ways.

1. Changing the magnitude of activity in the region, and

2. Changing the spatial distribution of activity in the region.

These effects can either be opposing each other or complimentary. For example, if the magnitude of activity is decreasing as the spatial distribution of activity is spreading, the aggregate level of transportation activity in the region may remain unchanged, an example of opposing effects. If the magnitude of activity is increasing and the spatial distribution of activity is spreading, the aggregate level of transportation in the region will be greater, an example of complimentary effects.

At this point in the analysis, one may want to apply quantitative models to the analysis in order to project possible traffic flows on the region's network. A simple, manually adjusted model was used in the case of the Houston analysis to give the team an idea of what the differences between the various scenarios were. Conducting some type of quantitative analysis is useful at this point to inform the evaluation of strategic options.

## Options Evaluation

Once the transportation implications of the scenarios are identified, we proceed to evaluate the strategic options in the context of each scenario independently. This step allows the decision-maker to see what the package of options well-suited to a particular scenario looks like. As stated before, different scenarios have different implications for the transportation system and different strategies are better matched with different scenarios. This first evaluation gives the decision-maker some

appreciation for what a "best-case" for a particular scenario might be.

The Mobility-ReS/SITE team employed an evaluation procedure following the spirit of a multicriteria analysis. Each strategic option was evaluated independently based on three feasibility criteria and three effectiveness criteria. Unlike Munoz's analysis of strategic options, described in Chapter 3, these scores were not weighted by any impact factor. These criteria are described below.

***Feasibility Criteria***

***Financial.*** *The financial feasibility criterion is intended to capture the region's ability and willingness to commit resources to a particular strategy. The criterion does not simply imply that a strategy is high or low cost; rather it presents a combination of the cost of an option and the region's ability and willingness to pay for it. One can imagine that in some cases, with conditions of economic prosperity, very expense options will be financially feasible. Likewise, one can imagine that some low cost options are financially infeasible in unfavorable economic climates.*

***Environmental.*** *The environmental feasibility criterion is similar to the financial feasibility criteria in that it is a combined measure of environmental impact and environmental concern. Environmental concern is a function of the scenario since one of the drivers is environment and one of the key local factors is local environmental attitudes and policies. The environmental concern part of this measure is affected by these two scenario-dependent characteristics. Environmental impact is the other factor in this criterion. Environmental impact is independent of scenario and captures the environmental changes implied by each strategy. The environmental feasibility criterion can be stated simply as "How significant is the environmental benefit or impact of the strategy?" and "How important is this impact to the decision-makers in Houston?"*

***Institutional.*** *Like the previous two, the institutional feasibility criterion attempts to capture two aspects of the region's transportation institutions. The first of these factors is how easily the strategic option can be deployed given the institutional environment in Houston. This factor captures whether the region's institutions have the capacity to deploy the strategic option, and if not, can this capacity be easily developed. The second factor in this criterion is how politically acceptable is the strategic option in each given scenario. Much like the environmental feasibility criterion, the political acceptability factor is dependent upon the scenario considered and the institutional capacity factor is independent of scenario.*

***Effectiveness Criteria***

***Accessibility.*** *The accessibility criterion evaluates how well the strategy accommodates the transportation needs of individuals in the region. This criterion is intended to evaluate whether particular strategic options are effective at providing mobility and accessibility between people's residential, employment, shopping, and recreational locations.*

***Goods Movement.*** *The goods movement criterion evaluates the strategic options based on their accommodation of freight flows through the region. The criterion is intended to capture how well certain strategies facilitate both inter- and intra-regional freight movements.*

***Equity.*** *This criterion is intended to evaluate the redistributive effects of the various strategic options. Similarly, this criterion captures whether each particular strategic option serves different groups within the region fairly. (CMP-ReS/SITE2 23)*

Each of these measures is given a score from 1 to 10 where one indicates poor performance and 10 indicates exceptional performance. These scores are then summed for each strategy and the result is a ranking of strategies for that particular scenario. A decision-maker using this evaluation tool could choose to deploy the strategy with the highest total score first, followed by the next highest, and so on until all strategies were deployed or all resources expended. Table 4-1 depicts the evaluation framework employed for this analysis.

**TABLE 4-1**
**STRUCTURE OF THE MOBILITY-RES/SITE EVALUATION FRAMEWORK**

| CRITERIA CATEGORY | CRITERIA | OPTION A | OPTION B | OPTION C | ... | OPTION *N* |
|---|---|---|---|---|---|---|
| ***Feasibility*** | Financial | | | | | |
| | Environmental | | | | | |
| | Institutional | | | | | |
| *Effectiveness* | Individual Accessibility | | | | | |
| | Freight Mobility | | | | | |
| | Equity | | | | | |

(Source: CMP-ReS/SITE1 19)

## Composite Analysis

The final step in the Mobility-ReS/SITE application of scenarios to regional strategic transportation planning is to evaluate the strategies in the context of all scenarios considered. There are two purposes to this exercise. First, it gives the decision-maker a good understanding of the possible range of future outcomes and the strengths and weaknesses of each strategy. Second, it allows for the selection of strategies that perform well across a wide range of futures, those strategies that are robust.

To develop this concept of robustness, the team built on the multicriteria analysis discussed above. The rankings of each strategy in each scenario were left unchanged, but the scores for each strategy in each scenario were summed for all scenarios developed. Just as before, these strategies were ranked according to their composite score with the highest scoring strategy being the most robust. A similar strategy selection process would have the decision-maker choose strategies based on their composite score until all strategies were implemented or the region's resources were expended. This methodology resulted in a new ranking of strategies given a wide range of future views.

An alternative strategy selection was also tested and found to yield similar results. This alternative strategy is a risk-minimization approach in which one would choose the strategy with the highest score in its weakest scenario first, and follow this pattern until all reasonable strategies were selected.

Once the strategies were evaluated in the composite case, the transportation implications of the "robust strategies" in each of the scenarios were analyzed. The last step in the scenario exercise is to compare the transportation implications for each scenario under the following conditions:

- No implementation of strategic options
- Implementation of the "scenario optimal" set of strategies in each scenario, and
- Implementation of the "robust" set of strategic options in each scenario.

## CHAPTER SUMMARY

This chapter begins by summarizing the current regional transportation plan for the Houston, Texas metropolitan area. This plan is used as an example of current planning practice and as a basis for

building scenarios for Houston. The Mobility-ReS/SITE team developed a scenario platform for regional strategic transportation planning based on eight key steps outlined in this chapter. The specific details of the application of this scenario platform to Houston are provided in the following chapter, Chapter 4.

# 5

# SCENARIOS APPLIED TO HOUSTON, TEXAS

This chapter will summarize the details of the Mobility-ReS/SITE application of scenarios to Houston, Texas. This analysis is covered in complete form in the paper *Mobility Scenarios for Houston in the Year 2020* by the Cooperative Mobility Program-ReS/SITE group at MIT presented at the Cooperative Mobility Program Sponsor's meeting in June 1999. The summary will begin by describing the strategic options and continue through the Mobility-ReS/SITE analysis of scenarios for Houston.

## HOUSTON GEOGRAPHY

Houston, Texas is located on the Gulf of Mexico in the south-central portion of the United States. Houston is located in southeastern Texas and the metropolitan area is comprised of 13 counties surrounding the City of Houston. The city of Galveston is located within the metropolitan area approximately 45 miles to the southeast. The major population centers in the region are in Harris County, Fort Bend County, and Galveston county shown on the following map.

**FIGURE 5-1**
**THE HOUSTON REGION**
(Source: H-GAC)


## Strategic Options

The analysis conducted by the team considered many different possible capital investment and policy strategies. The majority of these strategies are currently under consideration by decision-makers in the region, while some are more aggressive or unusual strategies included to further test the methodological framework. In total, 12 different strategies were considered and each of these is briefly described below. The first strategies presented are the capital investment strategies; these are followed by the policy implementation strategies. The Mobility-ReS/SITE analysis of Houston did not include any organizational options. Chapter 7 proposes a framework for including these strategies in a scenario planning exercise.

**Construction of Light Rail through the Central Business District**

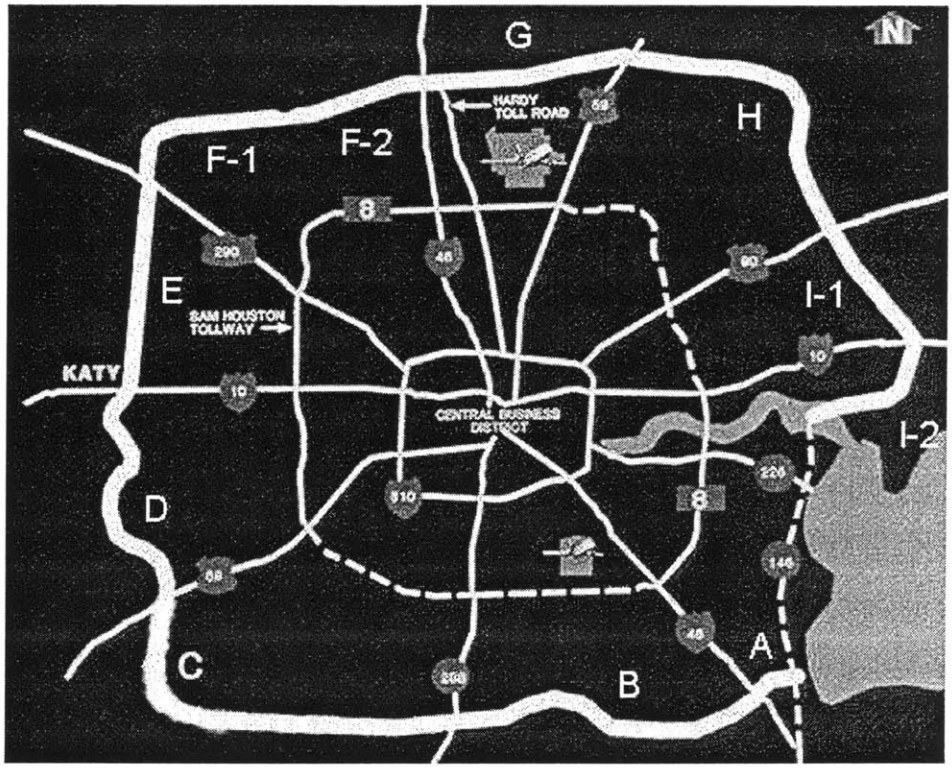
There is currently no fixed-guideway transit in the Houston metropolitan area. One proposal currently under study proposes construction of a light rail transit line through the central business district linking many of the primary activity centers. Many see this possible project as a test of the

viability of transit in the region.

**Construction of the Grand Parkway**

A third beltway surrounding Houston is currently in the planning phase. Some segments are already constructed and the right of way has been acquired for other segments. This "Grand Parkway" is located a radius of 30 miles from the center city and will be a limited access facility. The proposed alignment of the Grand Parkway is illustrated in Figure 5-2 below. The letters shown on the map designate different segments of the alignment.

**FIGURE 5-2**
**GRAND PARKWAY ALIGNMENT**
(Source: Grand Parkway Association)




**Major Expansion and Remodeling of the Two Principal Airports**

Improvements and expansions are on the drawing board for Houston Hobby and Bush Intercontinental Airports as air transportation activity through the region continues to grow. The

concept of a third major airport has also been considered from time to time as has expansions of other regional facilities. These additions and expansions would help accommodate growing passenger and air freight demand at the region's airports, specifically accommodating growth in international trade and travel with Central and South America. The two airports are shown as light colored areas to the north and south of the city center in Figure 5-2.

**Major Expansion of the Port of Houston**

The Port of Houston is one of the primary economic engines in the area. Current operations at the port are reaching the capacity of the existing facilities. It is one of the world's busiest ports and often refered to as "Mexico's largest port" due to its proximity to Mexico and high level of trade in Mexican products. The Port of Houston is considering the construction of major new intermodal terminals, expansions of existing facilities and expensive improvements to the vital Houston Ship Channel, the region's link to the world's oceans.

**Automated Highway System**

One of the more aggressive options included in this scenario analysis of Houston is the deployment of an Automated Highway System (AHS) on the principal highways in the metropolitan areas, those radial links from the central city and the inner beltways. An AHS allows the capacity of existing highways to be dramatically increased through the use of automated guidance systems for vehicles. With a 20-year time horizon, one could suppose that the development of these systems at a large scale is a real possibility, although there are currently no such facilities operating anywhere in the world.

**Expansive Heavy Rail Transit**

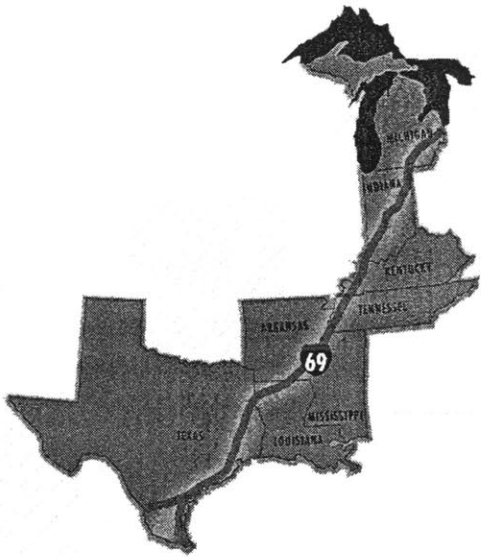
Another strategy included in this analysis, but not under consideration in Houston is the development of an expansive heavy rail transit system through the metropolitan area. The specific option considered would be a system much like the Washington D.C. METRO or Atlanta MARTA system that covers long distances at high speeds with a low-density network supplemented by bus service. Such a system could operate either in conjunction with or independently from a light rail

transit system.

**Designation and Construction of Interstate 69**

Interstate 69 has been proposed as a "high priority corridor" of national significance linking the three North American Free Trade Alliance (NAFTA) nations. The proposal includes continuing the existing I-69 from the northern states of Michigan and Indiana, through the central states of Kentucky, Tennessee and Arkansas, eventually through Louisiana and the Houston area, terminating at Laredo Texas and the Mexican border. The Interstate 69 corridor is shown in Figure 5-3 below.

**FIGURE 5-3**
**INTERSTATE 69 CORRIDOR**
(Source: Humble Chamber of Commerce)



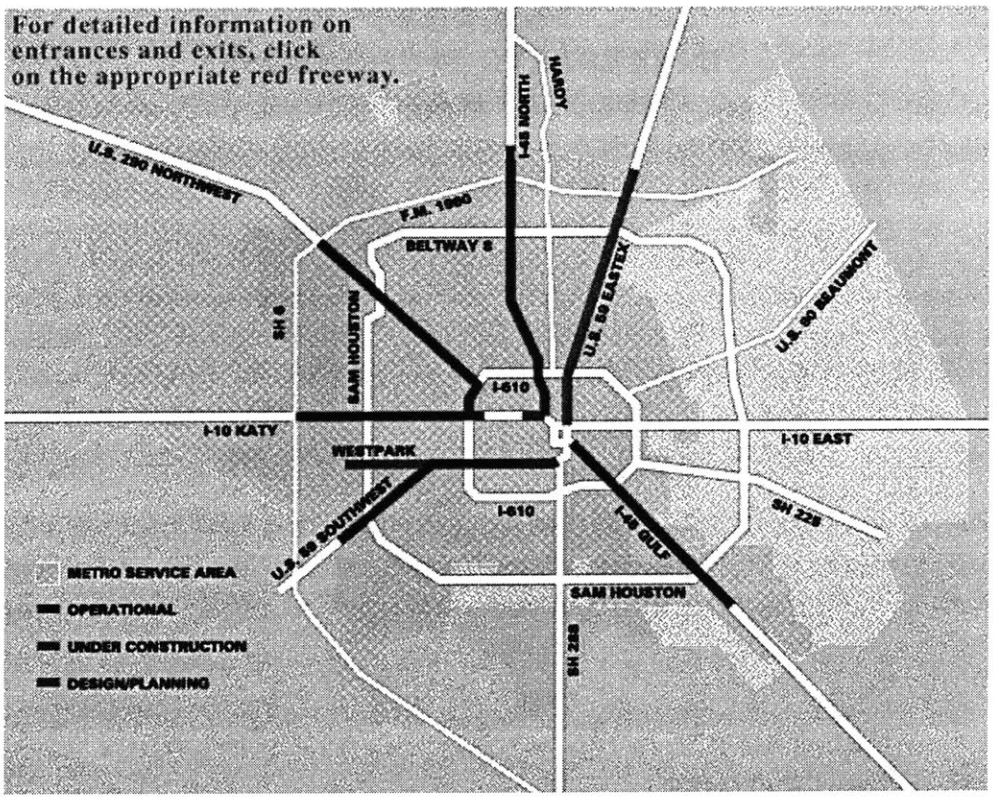

**Intercity High Speed Rail (HSR)**

This strategy would link the major cities of the Gulf Coast, Texas and Northeastern Mexico including: Dallas/Ft. Worth, New Orleans, Laredo, San Antonio, and Corpus Christi with a HSR network (CMP-ReS/SITES2 9). Such systems are readily available from commercial sources and are readily accepted technologies in other parts of the world. The travel times between some city pairs could be comparable to air travel and could reduce demands at the region's airports.

**Expanded HOV System.**

Houston has one of the most extensive networks of High Occupancy Vehicle (HOV) lanes in the world, with over 75 miles of these facilities on the principle highways in the region. There are plans to expand this system by an additional 40 miles and even more aggressive expansions could be planned in a 20-year time frame. The Houston HOV network is shown in Figure 5-4 below.

**FIGURE 5-4**
**HOUSTON HOV SYSTEM**
(Source: Houston METRO)




**Densification/Growth Management and Land Use Controls**

The regulation of development and land use is a common strategy for controlling transportation demand in a region. Houston has a tradition of limited land use controls and attempts to implement these policies have failed tests of popular opinion. While not popular with decision-makers in the region, these policies are a transportation strategy that should be included as an option for the region.

### Congestion Pricing/Value Pricing

Congestion pricing has been proposed as a way of spreading the peak travel demands through the day, thereby reducing congestion on the transportation network. The practice of charging motorists for access to a specific facility during congested periods, is one of the more controversial strategies considered. Houston has experimented with implementing congestion pricing on one highway's HOV lanes with moderate success. One possible strategy would be to expand this value pricing approach on the region's HOV facilities, or to expand to a congestion pricing scheme on the general purpose lanes of highway facilities with the toll varying with traffic congestion of time of day.

### System Maintenance with Incremental Development

The final strategy, a necessary one under all plausible futures, is simply maintaining the integrity of the existing transportation system. This strategy also includes small projects such as lane additions and intersection improvements so that the system can accommodate some of the growth in demand projected over twenty years. The transportation system would be that of today adapted somewhat to "meet the expectation of 20 years of growth and development" (CMP-ReS/SITE2 9).

## Key Local Factors

General categories of key local factors were defined in this Chapter 4 as those regional characteristics that affect the performance of the strategic options. They are the factors that the scenario drivers impact to create different views of the future. The key factors are:

- The health of the local economy,
- Local environmental policies and attitudes,
- Demographics,
- The level of federal and state government investment and control, and
- Local Politics.

Within each of these categories, specific attributes of Houston were defined. These attributes describe the details of the key local factors. These attributes are summarized below.

## *The Health of the Local Economy*

The first key local factor is the health of the local economy, one of the important factors in determining the demand for transportation services in the region. The health of the local economy key factor focuses on the major industries in the region, petroleum, high tech, medical research, and transportation.

Houston is a major commerce center for the Gulf Coast region, and these four sectors are the most important determinants of the state of the local economy in Houston. These four sectors are in addition to the traditional service sector including banking, insurance, retail and other activities serving the local population and business base. While the service sector is large, its well-being is largely derived from the condition of these other sectors which form the economic base for the region. Each of the most important economic sectors in Houston are described in the excerpts below.

> ***Petroleum Industry.*** *Roughly 50% of the economic activity in Houston is in the oil, gas, petrochemical and oil services industries...These industries are highly sensitive to the price and demand for petroleum products. Furthermore, petroleum supplies are highly responsive to political unrest. These two factors lead to a high volatility in the petroleum, petrochemical and oil services industries. Much of the support service economic activity in Houston is driven by this sector...*
>
> ***High Tech.*** *Another important component of the Houston economy is the High Tech Industry...The high tech industry in Houston is composed of two primary sectors. First is the National Aeronautics and Space Administration (NASA) Johnson Space Center. This facility is primarily responsible for design, development testing of spacecraft and associated systems for human flight; selection and training of astronauts; planning and conducting human space flight missions; and extensive participation in the medical-engineering and scientific experiments carried aboard space flights. More than 15,000 engineers, scientists, astronauts, and technical support people work in the JSC community. The second major component of the high tech industry in Houston is the personal computer industry. Compaq, a Fortune 100 manufacturer of personal and business computer systems is headquartered to the northwest of the city. Associated with Compaq are several suppliers and computer services companies further increasing the employment associated with this industry...*

> ***Medical Research Services.*** *A third important sector in the Houston economy is the medical research community. This segment of the economy is insulated from the health of the oil or high tech sectors and is likely to thrive or struggle independently. The major economic threats to this industry involve shrinking Federal research funding, competition from other medical research centers and the availability of specialized labor. By some accounts, the Texas Medical Center is the largest medical center in the world. It encompasses 675 acres and includes 10 hospitals and 6 educational institutions...*
>
> ***Transportation Activities.*** *Houston is one of the most important transportation hubs in the United States. The city boasts hubs for two major airlines, two major railroads, and hundreds of ocean shipping lines. Houston is also an important node in the U.S. Interstate Highway system...Houston is one of the most important US ports in terms of trade with Latin America and Europe. The port is often described as Mexico's largest. Nearly 200,000 jobs are centered on Houston Ship Channel activity with about 53,000 of these jobs directly related to port activity.*
>
> *The airline industry is also an important component of the economic vitality of the Houston metropolitan area. Continental Airlines operates a major hub out of the George Bush Intercontinental Airport...Another airline, Southwest Airlines, operates a hub at Houston Hobby airport to the southeast of the city. More than 1,250 City of Houston Department of Aviation employees and 18,000 additional employees of airport located businesses are centered at these facilities. Together these airports process more than 37 million passengers and 666 million pounds of cargo. (CMP-ReS/SITE2 10)*

## ***Local Environmental Attitudes and Policies***

Houston has historically demonstrated a relaxed environment toward environmental concerns, but there is no guarantee that this relaxed attitude will, or will be allowed to continue. There are three different dimensions of environmental concern affecting transportation strategies in Houston.

- **Air Quality.** The link between transportation and air pollution is well established. Air quality is the most prominent environmental problems that will face Houston over the next 20 years. Two of the primary economic engines in the Houston economy, the petroleum industry and the transportation industry contribute significantly to air pollution and are likely to bear the brunt of any regulatory action in the region. Historically, the transportation and oil industries have been able to shift their responsibility for controlling emissions to the mobile sources such as private transportation. Increasing levels of pollution or increasing regulation from state and federal

regulators could impact local policy making and attitudes about this environmental concern.

- **Flood Plain Development.** Houston is frequently subjected to localized flooding as strong storms move through the area. Larger weather systems like hurricanes have also been known to cause region-wide flooding. Development in floodplains can worsen both of these conditions and as the pace of development increases, these incidents may change local policies and opinions.

- **Open Space.** While not traditionally a concern in the areas surrounding Houston, continued suburban development may threaten recreation spaces and wildlife habitats negatively affecting the quality of life for Houston residents. This continued pattern of sprawling development may change public sentiment and lead to more restrictive controls of land development in Houston.

## *Demographics*

Demographics are broad categories of measures depicting various population and distribution trends in the region. "Houston is a city that may be subject to dramatic changes" (CMP-ReS/SITE2 13). Some of the fundamental demographic issues are:

- Migration/Immigration
- Spatial distribution of population
- Population distributions in terms of household size, age, income, race/ethnicity, and auto ownership.

## *Federal/State Investments and Control*

"Historically, Houston has enjoyed a high level of federal and state investment in its transportation system and local economy" (CMP-ReS/SITE2 14). While these higher levels of government have been willing to invest heavily in the past, this investment is not certain into the future. Furthermore, along with this investment comes a certain degree of control. This key local factor is intended to capture the region's ability to influence and obtain investment from these sources while minimizing their influence in local affairs.

### *Local Politics*

This last key local factor captures the state of cooperation in the local political scene, a function of many social and economic forces. The exceptional unity of vision among decision-makers in the past has been a key determinant of success for the region. This unity of vision is focused on a notion that free enterprise will form the city's future in a desirable way with little direction from government. Cooperation between transportation agencies in Houston is also fostered by the Transtar ITS organization that serves as a forum to discuss regional transportation issues. This unity of vision has an uncertain future as various economic and demographic transformations occur.

## Scenario Drivers

The scenario drivers were discussed in some detail Chapter 4. To summarize, the four scenario drivers employed in this analysis were:

1. **Economy** – Major shifts in the global and national economy and economic shocks.
2. **Environment** – Changes in environmental policy and enforcement at the national and international levels.
3. **Technology** – The development of significant transportation technologies that improve the functionality of the transportation system.
4. **Finance** – The willingness of the national government to fund infrastructure maintenance and development in the region. This key factor also considers the market for private finance of transportation strategies for the region (CMP-ReS/SITE2 15)

These four drivers, with two states each combine to form 16 possible scenarios as shown in Table 5-1. Three of these 16 possibilities were selected for further development as scenarios and are highlighted in the table.

**TABLE 5-1**
**POSSIBLE SCENARIO DRIVER COMBINATIONS**

| Identifier | Economy | Environment | Technology | Finance |
|---|---|---|---|---|
| 1 | Increasing | Limited Regulation | Advancing | Increased |
| 2 | Increasing | Limited Regulation | Advancing | Decreased |
| **3 – USNA** | **Increasing** | **Limited Regulation** | **Stable** | **Increased** |
| 4 | Increasing | Strict Regulation | Advancing | Increased |
| 5 | Declining | Limited Regulation | Advancing | Increased |
| 6 | Increasing | Limited Regulation | Stable | Decreased |
| 7 | Increasing | Strict Regulation | Stable | Decreased |
| **8 –Earth Day** | **Increasing** | **Strict Regulation** | **Advancing** | **Decreased** |
| 9 | Increasing | Strict Regulation | Stable | Increased |
| 10 | Declining | Strict Regulation | Stable | Increased |
| 11 | Declining | Strict Regulation | Advancing | Decreased |
| 12 | Declining | Limited Regulation | Stable | Increased |
| **13 – Balkanization** | **Declining** | **Limited Regulation** | **Stable** | **Decreased** |
| 14 | Declining | Limited Regulation | Advancing | Decreased |
| 15 | Declining | Strict Regulation | Stable | Decreased |
| 16 | Declining | Strict Regulation | Advancing | Increased |

(Source: CMP-ReS/SITE2 15)

## The Scenarios

The three driver combinations selected for further development into scenarios are:

1. **The United States of North America:**
   - Increasing Economic Activity
   - Limited Environmental Regulation
   - Stable Technological Development
   - Increased Financial Means

2. **Earth Day 2020:**
   - Increasing Economic Activity
   - Strict Environmental Regulation
   - Advancing Technological Development
   - Decreased Financial Means

3. **Balkanization of the World:**
   - Declining Economic Activity
   - Limited Environmental Regulation
   - Stable Technological Development
   - Decreased Financial Means

The scenario narratives, which provide an outline of the driver changes and impact on the local area, are quickly summarized below for each of these scenarios. The complete text of scenarios is contained in:. Mobility Scenarios for Houston in the Year 2020. Cambridge, Massachusetts Institute of Technology, June 1999(CMP-ReS/SITE2).

## *Scenario 1: The United States of North America*

> *The world economy is booming. The high-growth era of the 1990's has continued and accelerated for 20 years. This scenario is named "The United States of North America" to symbolize the extraordinary growth in world trade. Gone are the days of competition between national economies. By 2020 even the prominence of regional trading blocks like NAFTA, the EU and Mercosur is fading. International trade is reaching new heights as the world realizes that the environmental scares of the early 2000's, global warming and ozone depletion, were largely unfounded. High tech has remained important and new advances in computing and communications technology have further increased international cooperation and trade. These new levels of economic prosperity have fostered an environment in which the financial resources for funding large infrastructure projects are widely available. The Federal government of the United States and the State of Texas have realized record levels of tax revenue. The private sector is also willing to finance investment in transportation since the demonstrated success of privately financed highway projects in Georgia and California. The major events and their impact on the key local factors are described in the following sections (CMP-ReS/SITE2 17)*

## *Scenario 2: The Balkanization of the World*

*The world is falling apart. Gone is the stable world of economic growth we all enjoyed during the Cold War. The shifts in the balance of power among the major players in the world economy are not going very smoothly. The power vacuum left by the collapse of the Eastern Block has fostered infighting and political instability among formerly friendly countries. There has been little change in environmental regulation as the Federal Government's attention has shifted away from domestic affairs. Technological advances in the transportation field have stagnated as research money is diverted to defense and social programs. The federal government has also reduced its transportation funding allocations in this new global environment (CMP-ReS/SITE2 27).*

## *Scenario 3: Earth Day 2020*

Earth Day 2020 *is a scenario where the environment, broadly defined, rises to the forefront of future concerns. Unlike what might be expected, however, this scenario is not doom and gloom. The economy continues to boom, and technological advances continue at a rapid pace. The major downside to this scenario from a transportation perspective is a decrease in the availability of – and demand for – financing.*

*Some attribute the global shift in environmental consciousness to the Gore Presidency of 2001-2009. Others point to the ongoing severe weather patterns – droughts of the century, record snowfalls, 3 straight summers (2006-2008) of 50-consecutive 110°+ days in Southern California – while others give credit to the developing nations of the world who finally said "enough" and boldly pushed forward a climate change mitigation agenda when the AOSIS (Alliance of Small Island States) was joined by Brazil, India, Mexico, Ecuador, Peru, Chile and China whose continuously battered shorelines began spelling danger for major portions of national populations. Beyond these global problems, the despairing rise of urban air pollution across much of the world – extreme heat combined with abbreviated springs and autumns pushed pollution levels in the early years of the 21st Century to prolonged record highs in cities as diverse as Budapest, New York, Shanghai, Hanoi, Teheran, Cairo, Santiago, and London. The crisis reached its apex in Paris in 2004, when the government banned the circulation of all privately owned internal combustion vehicles for the entire month of July.*

*(Earth Day 2020 Continued) These near calamities played an important role in the shift of global environmental attitudes, but many also believe that this shift was an inevitable next step in human-kind. While the Deep Ecologist candidate Doug Tompkins only captured 12% of the popular vote in his 2012 U.S. Presidential bid and most still dismiss "Earth First"-ers as somewhat radical, the general population has embraced a "back-to-nature" philosophy, perhaps best exemplified by the fact that Earth Day became the single most celebrated holiday around the world in 2009. Nobody can ignore the commercialism partially behind the "green" movement, but most see the integration of commercialism with environmentalism as key to long-term sustainability. In the 2010s Industrial Ecology became to business strategists what Total Quality Management was in the 1980s-90s. Corporations quickly learned that long-term profits lay in incorporating "the environment" into design, production and packaging, with waste streams reduced in most parts of the world by 90% by 2018. The environment also "prospered," benefiting particularly from the increased service/entertainment/information-orientation of the economy...While the environmental challenges have not gone away, most of the world has coalesced to confront the problems. (CMP-ReS/SITE 33)*

These excerpts from the scenarios are intended to give the reader an idea of the basis of each scenario. Each of these scenarios continues by describing how these events affect the key factors in the local environment and how they impact the state of the regional transportation system.

## Transportation Implications

In the "United States of North America" scenario the magnitude of transportation activity increasing significantly and the geographic distribution of this activity spreading far into the hinterlands. In this scenario, many strategies will be necessary to accommodate these new levels and new patterns of activity. The principal challenge in this scenario is to provide adequate transportation services through the distant suburbs while maintaining and improving the transportation system through the urban core.

The "Balkanization of the World Scenario" presents a much different picture. In this scenario, the magnitude of transportation activity remains similar to that experienced in 1990. While the spread to the hinterlands is less pronounced in this scenario there are some shifts in the location of

population and employment centers. This scenario requires very few strategies to maintain mobility in the region. The mobility challenge in this scenario is to provide access to employment opportunities for lower income residents in the urban core.

The "Earth Day 2020" scenario presents another interesting picture of the region. In this scenario, economic activity continues to grow, but the region becomes more constrained by environmental concern and regulation. The result is a densification of the urban core and concentration of activity around certain nodes in the region. In this scenario, the strategic options are highly constrained by financial and environmental concerns. The challenge in this scenario is providing adequate mobility and accessibility through the now densely developed urban core.

## Evaluation of Strategic Options

All of the strategic options described at the beginning of this chapter were then evaluated by the team in the context of the scenarios. The evaluation framework was based on the multicriteria analysis described in the Chapter 4. The results were quite different for each of the three scenarios. Tables 5-2, 5-3, and 5-4 show the ranking of the strategic options in each scenario and are presented below. A brief discussion of the contrasts between the scenarios follows each table.

### TABLE 5-2: UNITED STATES OF NORTH AMERICA STRATEGIC OPTION EVALUATION

| Strategic Option | Financial | Environ-mental | Institutional | ***Feasib-ility*** | Access-ibility | Goods Movement | Equity | ***Effective-ness*** | **Combin ed** |
|---|---|---|---|---|---|---|---|---|---|
| System Maintenance | 8 | 9 | 10 | ***27*** | 10 | 10 | 10 | ***30*** | **57** |
| Grand Parkway | 7 | 8 | 8 | ***23*** | 8 | 7 | 6 | ***21*** | **44** |
| Expanded HOV | 8 | 8 | 10 | ***26*** | 7 | 3 | 7 | ***17*** | **43** |
| I-69 | 7 | 8 | 10 | ***25*** | 4 | 9 | 4 | ***17*** | **42** |
| Airport Expansion | 8 | 8 | 10 | ***26*** | 8 | 3 | 3 | ***14*** | **40** |
| Port Expansion | 8 | 8 | 10 | ***26*** | 2 | 10 | 2 | ***14*** | **40** |
| Congestion Pricing | 9 | 10 | 3 | ***22*** | 7 | 5 | 5 | ***17*** | **39** |
| Automated Highways | 4 | 10 | 5 | ***19*** | 8 | 5 | 4 | ***17*** | **36** |
| Light Rail | 10 | 10 | 6 | ***26*** | 3 | 1 | 4 | ***8*** | **34** |
| Growth Management | 10 | 10 | 3 | ***23*** | 3 | 4 | 2 | ***9*** | **32** |
| High Speed Rail | 5 | 7 | 6 | ***18*** | 6 | 3 | 3 | ***12*** | **30** |
| Heavy Rail Transit | 6 | 8 | 6 | ***20*** | 3 | 2 | 4 | ***9*** | **29** |

(Source: CMP-ReS/SITE Table 3)

For this particular scenario, the study concludes that the first seven strategies are likely to be prudent measures to take given that the high demand for transportation projected. Of particular importance in this scenario is the construction of the Grand Parkway to provide access between the many exurban communities that will develop in this future. The large number of strategies recommended in this scenario is a function of two factors. First, high levels of economic growth and low levels of environmental constraint mean that activity increases greatly and spreads geographically creating a need for new facilities. Second, the region has substantial financial resources to invest in new facilities.

## TABLE 5-3: BALKANIZATION OF THE WORLD STRATEGIC OPTION EVALUATION

| Strategic Option | Financial | Environ-mental | Institutional | *Feasib-ility* | Access-ibility | Goods Movement | Equity | *Effective-ness* | Combined |
|---|---|---|---|---|---|---|---|---|---|
| System Maintenance | 8 | 9 | 8 | *25* | 10 | 10 | 10 | *30* | 55 |
| Port Expansion | 5 | 7 | 9 | *21* | 6 | 9 | 6 | *21* | 42 |
| Expanded HOV | 6 | 8 | 8 | *22* | 6 | 3 | 6 | *15* | 37 |
| Light Rail | 7 | 9 | 8 | *24* | 6 | 2 | 4 | *12* | 36 |
| I-69 | 3 | 8 | 7 | *18* | 1 | 10 | 2 | *13* | 31 |
| Congestion Pricing | 6 | 10 | 2 | *18* | 4 | 6 | 2 | *12* | 30 |
| Heavy Rail Transit | 1 | 9 | 2 | *12* | 7 | 2 | 5 | *14* | 26 |
| Airport Expansion | 3 | 8 | 6 | *17* | 2 | 2 | 4 | *8* | 25 |
| Grand Parkway | 3 | 8 | 5 | *16* | 2 | 4 | 2 | *8* | 24 |
| Growth Management | 8 | 10 | 2 | *20* | 1 | 1 | 1 | *3* | 23 |
| Automated Highways | 1 | 9 | 2 | *12* | 3 | 3 | 2 | *8* | 20 |
| High Speed Rail | 1 | 8 | 2 | *11* | 2 | 1 | 2 | *5* | 16 |

(Source: CMP-ReS/SITE Table 4)

This scenario represents a stark comparison to the previous one. In this scenario only the first four strategic options seem to be justified. While the USNA scenario necessitates the Grand Parkway, the project is largely a "white elephant" in this scenario due to the lack of new development near its alignment. The most critical investments for the region in this scenario are those that are necessary to maintain the current transportation system and investment in the port. The scenario predicts much overseas involvement of the United States Armed Forces with Houston serving as a primary center for supporting this activity requiring investment in this infrastructure. Meeting social needs is

also an important factor in this scenario giving merit to the HOV system expansion and construction of light rail. Given the limited financial resources of the region in this scenario, other investments are likely ill advised and financially infeasible.

The recommendations in this scenario are quite different than those in the USNA case in which many investments in new facilities seem prudent. These differences between two plausible futures highlight the value of scenario analysis in that the two scenarios indicate vastly different types of strategies.

## TABLE 5-4: EARTH DAY 2020 STRATEGIC OPTION EVALUATION

| Strategic Option | Financial | Environ-mental | Institutional | ***Feasib-ility*** | Access-ibility | Goods Movement | Equity | ***Effective-ness*** | **Combin ed** |
|---|---|---|---|---|---|---|---|---|---|
| System Maintenance | 10 | 8 | 9 | ***27*** | 10 | 10 | 10 | ***30*** | **57** |
| Congestion Pricing | 9 | 9 | 8 | ***26*** | 7 | 6 | 8 | ***21*** | **47** |
| Expanded HOV | 7 | 7 | 8 | ***22*** | 8 | 3 | 8 | ***19*** | **41** |
| Light Rail | 9 | 9 | 5 | ***23*** | 6 | 2 | 7 | ***15*** | **38** |
| Growth Management | 10 | 9 | 6 | ***25*** | 6 | 1 | 6 | ***13*** | **38** |
| Heavy Rail Transit | 7 | 8 | 4 | ***19*** | 9 | 2 | 8 | ***19*** | **38** |
| Automated Highways | 4 | 6 | 3 | ***13*** | 5 | 6 | 6 | ***17*** | **30** |
| Port Expansion | 6 | 3 | 6 | ***15*** | 2 | 9 | 3 | ***14*** | **29** |
| Airport Expansion | 6 | 5 | 6 | ***17*** | 4 | 2 | 4 | ***10*** | **27** |
| High Speed Rail | 5 | 6 | 4 | ***15*** | 4 | 2 | 4 | ***10*** | **25** |
| I-69 | 6 | 2 | 4 | ***12*** | 1 | 7 | 2 | ***10*** | **22** |
| Grand Parkway | 6 | 2 | 4 | ***12*** | 2 | 4 | 2 | ***8*** | **20** |

(Source: CMP-ReS/SITE Table 5)

Again, the results of the strategic option evaluation in the Earth Day 2020 scenario are very different from the previous two cases. In this case, the first six strategic options demonstrate adequate performance with policy initiatives making a strong appearance in the rankings. The primary difference between this scenario and the USNA scenario is that little funding or will exists to invest in large scale capital projects, especially highway projects. As a result the best performing options are policy initiatives and transit-oriented projects that serve the newly redeveloped central portion of the metropolitan area.

## Composite Evaluation

The final step in the Mobility-ReS/SITE application of scenarios to Houston, Texas is an evaluation of the strategic options in the context of all three scenarios developed. While these scenario-specific rankings of options inform the decision-maker about what investments are best and worst in each case, they do little to help make judgements about which investments are best in the face of an uncertain future. Many of these transportation strategies, especially the capital investment strategies, have long lead times requiring decisions about which option to pursue be made today to have the options operational by the 20 year horizon. These decisions can be changed, but at a significant cost in most cases. The composite evaluation step in the process attempts to inform this long-term decision-making process.

At this point, we are trying to find options that are robust across a wide range of future conditions, in this case, the three scenarios developed. These robust options will have a moderate to high performance in most scenarios and are unlikely to be poor performers in any.

To find these robust strategies, the Mobility-ReS/SITE team built upon the scenario specific evaluations as described in the first section of this chapter. The results of this analysis are shown in Table 5-5 below. The table is simply the summation of the performance matrices for each scenario.

## TABLE 5-5
## IDENTIFYING ROBUST STRATEGIES

| Strategic Option | Feasibility | Effectiveness | **Composite** | Max-Min |
|---|---|---|---|---|
| System Maintenance | 79 | 90 | **169** | 55 |
| Expanded HOV | 70 | 51 | **121** | 37 |
| Congestion Pricing | 66 | 50 | **116** | 30 |
| Port Expansion | 62 | 49 | **111** | 29 |
| Light Rail | 73 | 35 | **108** | 34 |
| I-69 | 55 | 40 | **95** | 22 |
| Growth Management | 68 | 35 | **93** | 23 |
| Heavy Rail Transit | 51 | 42 | **93** | 26 |
| Airport Expansion | 60 | 32 | **92** | 25 |
| Grand Parkway | 51 | 37 | **88** | 20 |
| Automated Highways | 44 | 42 | **86** | 20 |
| High Speed Rail | 44 | 27 | **71** | 16 |

(Source: CMP-ReS/SITE Table 6)

This methodology for finding robust strategies identifies five options that appear robust across all scenarios. These are the strategic options with a total combined score of over 100 in the list (100 is an arbitrary cut-off). These projects are either moderate or good performers in all three scenarios, so they represent a set of investments that makes sense if one is deciding today what the region will need in 20 years. One of the robust strategies is a policy measure, Congestion Pricing. This strategy requires little lead-time to implement so a decision about this particular strategy could be delayed until it appears necessary. The remaining strategies are infrastructure projects that will need to begin immediately in order to be operational before the planning horizon. The strategies identified as robust are:

- System Maintenance and Incremental Expansion, a prerequisite of all scenarios,
- Expanding the HOV network, a strategy that is a top performer in all three cases,
- Congestion Pricing, a moderate performer in all two scenarios,
- Port Expansion, a moderate to good performer in all three scenarios, and
- Light Rail, popular in two of the scenarios and affordable in the other.

A risk management approach to choosing these strategies was also applied. This approach ranks the options by the best performance in the worst scenario for each option. In other words, the option with the lowest minimum ranking is the most robust. Interestingly, the risk-minimization approach discussed earlier yields the same top five strategic options, although the order varies between the two approaches.

While these strategies are robust across all three scenarios, there are some scenario-specific problems with implementing only this set of options. For example, in the USNA scenario, the Grand Parkway is necessary to accommodate the large inter-suburban travel demand that is projected while Congestion Pricing is included as robust even though it is unpopular in the Balkanization scenario.

It is important to note that this analysis is limited by the academic setting in which it was produced and by the experience of those individuals who performed the analysis. Conducting this evaluation with professionals from Houston more familiar with the regional characteristics would have greatly improved the process. Furthermore, one of the most important benefits of the scenario methodology is that it allows decision-makers to understand what events might foreshadow movement toward one of the scenarios. Scenarios can give insight into the way futures can develop and allow decision-makers to change course of action if a particular future starts to unfold.

## CHAPTER SUMMARY

Scenarios can add significant insight to the regional strategic transportation planning process. The scenario-based planning process applied in this chapter highlights how different pictures of the future can be developed and how these futures have very different implications for transportation strategies.

Developing a methodology for applying scenarios to regional strategic transportation planning was a challenging activity for the Mobility-ReS/SITE project team. After several months of discussion and effort, a consistent and rational methodology developed generally following the process outlined in Figure 4-1. This methodological framework was applied to the specific case of Houston with interesting results:

- First, the three scenarios present very different pictures of the future of Houston,
- Second, different strategies are effective in the various scenarios, and
- Third, a robust set of strategies can be developed in the context of all three scenarios, however, this robust set is not perfect for any of the scenarios individually.

However, the methodology and its application is not without flaws and shortcomings. In fact there are many improvements that can be made to this methodology allowing it to be a more effective and applicable tool for regional strategic transportation planning. These flaws and shortcomings and possible solutions are the subject of the following chapters, Chapters 6, 7, and 8.

# 6

# MOVING FROM PLANNING TO A STRATEGIC CONVERSATION

The application of scenarios in the context of regional strategic transportation planning for Houston, Texas demonstrates that this methodology has promise as a meaningful improvement to the transportation planning process. The application highlights the important issues that will affect Houston's future and how different strategies can help the region cope with a changing environment.

The Mobility-ReS/SITE preparation of scenarios for Houston, Texas was, however, an academic exercise, artificially separated from the ongoing transportation planning activities in the region. To truly test this methodology, it will have to be applied in the context of a genuine strategic planning effort, as a cooperative effort with the planning professionals in the region. Structuring this genuine application is far more complex that setting out to develop scenarios separately from the ongoing regional strategic transportation planning process.

The following chapter outlines a methodology for moving the application of scenarios from an academic setting to an "on the ground" effort in a region. In other words, we move scenarios from theory to "practice". Schwartz defines this practice as "Holding a Strategic Conversation"

(Schwartz 227).

The chapter begins by refining the different objectives for using scenarios as a regional strategic transportation-planning tool. Then it describes how to integrate this "strategic conversation" into an ongoing regional planning process. It proposes that scenarios should be used to inform the regional vision and outlines a four-phase process for holding a strategic conversation.

## APPLICATION OF SCENARIOS TO RSTP - REFINED

In Chapter 2, we described how regional strategic transportation planning is an appropriate activity for the use of scenarios. The following discussion refines this description of RSTP by describing the different objectives for applying scenarios to this activity. These different objectives are complementary and can be based on the same platform for scenario development. This section describes four different objectives of applying scenarios to regional strategic transportation planning.

- **Regional Vision Formulation and Consensus Building.** This first objective directs the remainder of the scenario exercise. At this stage, scenarios depicting different future outcomes, without the explicit consideration of strategic options, can be developed and used as a base for developing a discussion about the future possibilities and opportunities in the region. From this discussion, a regional vision for the future can develop and consensus around this vision can be formed. In general, this vision is not focused on the transportation system; rather, it highlights the economic, social, and environmental future the region would like to achieve.

- **Developing Goals and Objectives.** This second stage of scenario development focuses on an analysis of the strengths, weaknesses, opportunities, and threats facing the region, SWOT in traditional strategic planning. From this SWOT analysis, regional goals and objectives for the transportation system can be developed. This stage views the transportation system as one of many possible tools the region can use to work toward its vision. The goals and objectives can be seen as milestones in the various scenarios for the region's transportation system to achieve. It is likely that these goals will either have to be generalized, or vary between scenarios.

- **Developing Sets of Robust Strategic Options for Regions.** This phase is essentially where the Mobility-ReS/SITE application begins. The scenarios are used to spur creative thinking about what strategies will help the region to meet its goals and objectives in each scenario considered. These strategies can include capital investments, policy implementations or organizational adjustments as described in Chapter 4. These strategies can then be tested for robustness to identify those that are useful across a broad range of possible futures. This phase, and all of the remaining steps in the process are informed by the vision, goals and objectives derived from the earlier steps.

- **Evaluating Detailed Project/Policy/Organizational Proposals.** Conceptualized strategies can often be quite different from the actual designs that result. The previous step describes how scenarios can be used to find strategies that are helpful to the region under a broad range of conditions. These strategies will manifest themselves in the terms of detailed projects, policies, and organizational changes that may end up looking much different than the initial ideas. The detailed proposals can be reevaluated by considering them in the context of the scenarios.

With this idea of the various purposes scenarios can serve in the regional strategic transportation planning process, we must now consider how one might actually structure the process involving professional planners, regional decision-makers, and other stakeholders in the regional transportation system. This process is moving the idea of scenarios for RSTP from the academic world of research to the real world of application. It proposes a way to move from using scenarios as a complement to the RSTP process to redefining RSTP as a "strategic conversation."

## INTEGRATION INTO THE LOCAL PLANNING CONTEXT

The scenario process illustrated in Chapter 4 describes the specifics of applying scenarios to RSTP. This process can accomplish the scenario goal identifying robust strategies, but without the participation of regional decision-makers we will not realize the other benefits, identifying signaling events and trends, and fostering institutional learning. To realize all of the benefits of this methodology, we must now consider how to integrate this process into the local transportation-

planning context. There are two principal aspects to this problem:

- Using scenarios to formulate a regional vision, goals, and objectives, and
- Developing scenarios with the participation of local stakeholders.

## What Does "Integration into the Local Planning Context" Mean?

Most applications of scenario techniques occur within an already established planning environment, as is the case in RSTP. The current regional strategic transportation planning environment in Houston, and most U.S. cities is highly developed and structured. There is a local metropolitan planning organization (MPO), in this case the Houston-Galveston Area Council (H-GAC) that coordinates the preparation of Metropolitan Transportation Plans (MTP) on a regular basis. This process involves all of the public-sector stakeholders and is bound by numerous regulatory and methodological constraints. Scenarios must be integrated into this context in order to have any meaningful impact. The degree of this integration in the short-term is likely to be small, but must occur nonetheless.

This integration is likely to be initially achieved by developing a scenario planning process that is parallel to traditional plan development. This scenario planning process will have to involve many different stakeholders who will have to find value in participating in order for any integration to occur. Integration must also start at the beginning of the planning process, which is visioning.

## Regional Vision Formation

The Mobility-ReS/SITE use of scenarios in Houston began too late in the planning process in that it borrows a regional vision from the current Metropolitan Transportation Plan prepared by the H-GAC. However, scenarios should really be used to inform this visioning process.

Scenarios can develop different views of what the metropolitan region might become. These views can help regional decision-makers understand a realistic set of possible futures based on drivers that are beyond their control. Using these possible futures, a regional vision that is appropriate for the

range of potential outcomes can evolve. The scenarios can also help decision-makers understand what specific goals and objectives are appropriate for each scenario and how different potential strategies might help the region to move toward a desired future.

Houston has been characterized as a "free-enterprise city." This characterization manifests itself in a regional vision focused on growth. This vision is broad and general in that the vision does not specify any particular type or location of growth, but rather, simply growth. One interview revealed that growth is the goal and where and what type are not matters for the planning process. At the same time, Houston wishes to be seen as a "world class city." These two objectives are related, but can be in conflict. Unrestricted growth, can cause many problems that "world class cities" try to avoid.

The vision of the current Metropolitan Transportation Plan reads,

> *The Houston-Galveston regional Metropolitan Transportation Plan will enhance mobility by providing an efficient, affordable, and environmentally responsible transportation system for both people and goods (H-GAC 19).*

This vision is very general, and should probably by related more closely to a broader set of regional goals rather than focusing on the "efficient, affordable and environmentally responsible transportation system." Scenarios in the context of RSTP could be used to refine this vision.

This vision of the region, while general, is *not* flawed. It varies dramatically from the vision of other regions in the United States and the world, but it is legitimate. The scenario process could be used to help focus this vision. There are several examples of "national visioning" applications of scenarios discussed in Chapter 2, these include:

- The Mont Fleur Scenarios for South Africa,
- Scenarios for the Future of Japan, and
- Destino Colombia.

While the Houston-based metropolitan region is not a nation, nor even a state, this "visioning"

application of scenarios could be a useful addition to the exercise in a region that appears to not concentrate on strategic visioning. The process for developing these types of scenarios is well documented in the scenario literature. To accomplish this visioning task, the application of the scenario platform would not really have to be adjusted. The only real change is that the scenario process would begin with a cooperative effort involving different stakeholders and at the visioning phase of the planning process, rather than at the point of developing alternative strategies for different futures. The inclusion of visioning in a scenario-based RSTP process is discussed in the following section.

## Stakeholder Involvement

One of the key purposes for developing scenarios is to give decision-makers insight into the implications of today's decisions in an uncertain environment. The scenarios allow these individuals to develop strategies that are robust across many different futures, and allow them to appreciate how different futures may unfold. The Mobility-ReS/SITE scenarios are lacking this benefit since they were prepared largely without involvement of local participants.

Peter Schwartz, in the latest edition of *The Art of the Long View*, published in 1996 provides a step-by-step guide to building scenario activities involving decision-makers. He calls this activity "Holding a Strategic Conversation". The purpose of this activity is to foster a conversation between different actors in the region in order to develop different alternative futures and then decide how the organization, or in this case, the region, can follow the path toward its goals. Developing a structure for holding a "strategic conversation" is an important step before any scenario exercise begins. Without the proper foundation, the scenario exercise is likely to be unsuccessful. Developing this structure for a "strategic conversation" is a prelude to the framework described in Chapter 4.

Schwartz presents a step by step guide to this activity. His framework consists of eight steps:

1. Create a Hospitable Environment,
2. Establish an Initial Group Including Key Decision Makers and Outsiders,
3. Include Outside Information and Outside People,
4. Look Ahead Far in Advance of Decisions,

5. Begin by Looking at the Present and Past,
6. Conduct Preliminary Work in Smaller Groups,
7. Playing Out the Conversation – Looking at Options, and
8. Living in a Permanent State of Strategic Conversation (Schwartz 228).

This exercise is not as simple as it may seem initially, especially in the context of RSTP with its highly complex planning environment. In fact, the step-by-step guidelines he proposes are likely to require significant modification to this environment. He states:

> *"As with any 'recipe' for managers, this should serve as only a rough guide. Every organization is different, and every manager will want to construct strategic conversations to meet the needs and size of that organization" (Schwartz 227)*

Indeed his framework will need to be modified significantly to fit the transportation planning environment. A framework for developing a "strategic conversation" in the context of RSTP, inspired by Schwartz's methodology is described below.

## The Strategic Environment

The first step in the process of "holding a strategic conversation" is to "Create a Hospitable Climate" (Schwartz 227). This hospitable environment in one in which people are able to express their ideas, be heard, and appreciate the different ideas of others. Schwartz mentions that the group should be open to new information and ideas and refrain from criticism (Schwartz 228).

Transportation plans rarely are prepared in an environment where ideas are exchanged freely and participants refrain from criticism. The financial context surrounding the formation of these plans sometimes fosters a competitive atmosphere between even departments of the same government agency, implying that a strategic conversation will likely need to occur in an environment outside of the normal business environment.

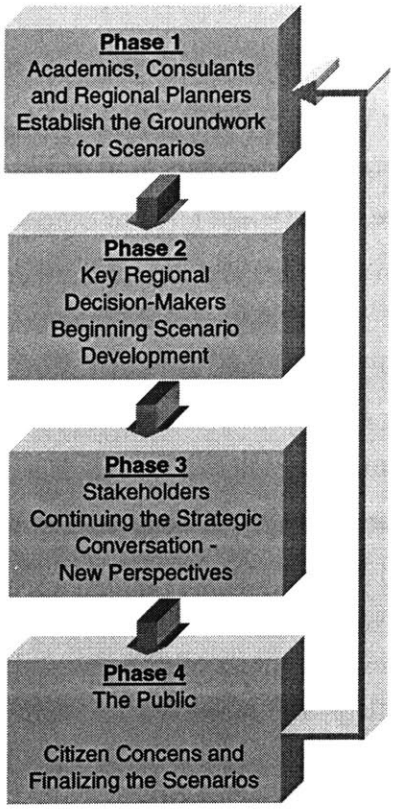
Transportation plans are prepared in the context of different stakeholders, public sector agencies,

private sector firms, non-governmental organizations, and the general public. Often there is disagreement between the objectives of these various stakeholders and dramatic difference between the "culture" of these organizations, each focused on their own day to day concerns. The most likely way for these "strategic conversations" to occur is in a workshop environment with some outside facilitators. This environment will allow the participants to think outside of their normal environment, and allow a degree of freedom from the everyday course of business.

## The "Strategic Conversations"

Schwartz advocates that the key decision-makers and outsiders participate in the scenario exercise. While well suited to a business environment driven toward a common set of goals and objectives, a simple statement like this is inadequate in the context of RSTP. There are just too many key decision-makers with many different perspectives. The strategic conversation needs to be considered in four phases, rather than one. This process is shown in Figure 6-1 below.

**FIGURE 6-1**
**A STRUCTURED STRATEGIC CONVERSATION**



## ***Phase 1 – Academics, Consultants, Regional Planners***

The number of decision-makers involved in the transportation planning process in a major metropolitan area, like Houston, is very large, perhaps too large to involve very early in the scenario process. The concept of scenarios is complex, and understanding the development of the process is hard to understand in a setting with many decision-makers as Schwartz recommends. Rather, the process should be well framed and examples developed before key decision-makers are involved. This framing of the process and possibilities of the future will facilitate a useful dialogue between the facilitators, experts, and key decision-makers later in the process.

In most regions, there is a local cadre of transportation professionals supporting the planning process, but independent from most of the transportation operating agencies and companies. These individuals, usually the staff of a metropolitan planning organization (MPO), supported by consultants, who can provide specific technical expertise, and academics who can help frame the process, will likely need to conduct the initial steps of the process. The consultants and academics help to expand the perspective of the local planning professionals. One of the keys to successful development of scenarios is to include people who understand the world from a perspective beyond the particular region in question. This first phase of the strategic conversation should include between 5 and 15 individuals to maintain the focus of the exercise. These same individuals are likely to participate and coordinate the entire scenario exercise.

Phase 1 of the strategic conversation for RSTP will include summarizing data describing the recent and current transportation system and regional context. These data can be used to determine predetermined elements and critical uncertainties that can be distilled into scenario drivers and key local factors. From these items, the "scenario space" or set of possible futures and simple drafts of possible scenarios can be developed to illustrate the process for the key decision-makers in Phase 2. These are not real scenarios, just basic sketches to illustrate possibilities for the subsequent phase. The work conducted at this phase of the process is intended to inform the later scenario exercises. It is intended to be illustrative rather than conclusive. One must remember that the key benefit of the scenario methodology is that it informs decision-makers about uncertainty, risks and

opportunities in the future. Developing conclusive scenarios at this point in the process would likely short-circuit this important objective.

## ***Phase 2 – Key Regional Decision-Makers***

One of the main points of a scenario exercise is to inform decision-makers of what the future may hold a, how it might develop and what strategies are best suited to an uncertain environment. Therefore, this early stage of scenario development should include key decision-makers from the major stakeholders in the transportation planning process. Most regions have a "transportation policy committee" or similar organization that serves as a forum for discussions among the chief decision-makers in the public sector. Phase two of the scenario exercise should involve these individuals; this will likely take several days in a workshop environment.

At this phase of the process, the summaries of the current situation, scenario space and sample scenarios should be presented. These items can help to structure a conversation between the transportation professionals in the region and the policy makers about how to proceed. The first part of this conversation should focus on the goals of the region and what the various decision-makers see as the regional vision. The first product of this phase of the "strategic conversation" is a coherent regional vision. This vision should be much broader than "an efficient, effective transportation system." It should appreciate that transportation strategies are tools to use toward other regional goals and objectives and should be stated in terms of these other objectives.

This regional vision can then be used to develop goals and objectives that serve as milestones measuring the region's progress toward its vision. Once clear goals and objectives are developed for the region, the group should move into the scenario phase of the process. It is unlikely that there will be agreement between these individuals about which scenarios to consider and how they will develop. Depending upon the size of the group involved, (likely a function of the complexity and size of the region), the group as a whole should discuss the possible scenarios and select three or four, the maximum number considered manageable, to develop (van der Heijden 187). A facilitator should then break the group into smaller teams to develop skeletons of these scenarios. These scenario skeletons will outline the key events leading to the outcomes selected and include a brief

description of the implications for the transportation system. The smaller groups should then brainstorm about some key strategies that will help the region achieve its goals and objectives in the light of their scenario.

The entire group should then re-assemble to discuss their scenarios, implications, and key strategies. At this stage, the group is really developing scenarios. These discussions are not intended to flesh-out the scenarios, but, rather, to share each of the scenarios, their key events, and their implications with the entire group. Based on these scenario skeletons and subsequent discussions, the transportation professionals in the region and the facilitators should flesh-out the scenarios over the following several weeks. The professionals could have simply fleshed-out their illustrative scenarios, but as Schwartz states,

> *"The senior decision makers may not go out and conduct scenario research themselves, but their presence at the conversations is vital. They must live through the scenarios, experience the forces that have created them, and consider, in depth, how their own options might be affected by them" (Schwartz 229).*

One of the final output of this phase of the scenario exercise/strategic conversation is a small group of key decision-makers who are willing to actively participate in the remainder of the process, and serve as representatives of the remainder of the process to the entire group of key decision-makers.

## ***Phase 3 – Stakeholders and Outsiders***

A few weeks after the strategic conversation with the key decision-makers, during which the transportation professionals in the region, facilitators and experts flesh-out the scenarios, the process should include key groups of stakeholders in the system. The scenarios building process should be described to these groups and new insights into each scenario and the strategic options are likely to come forward in the subsequent discussions.

Schwartz also comments on the value of the participation of outsiders in the development of scenarios (Schwartz 229). Outsiders in the transportation planning process are really of two types,

excluded stakeholders, and regional outsiders. The excluded stakeholders are private sector providers of transportation services, and two determinants of demand for transportation in the region. The final group, regional outsiders, is comprised transportation professionals and experts from outside the region.

The strategic conversation with stakeholders and outsiders is most beneficial if some subset of the key decision-makers participates in the remainder of the process. Bringing these stakeholders and outsiders into the process not only ensures that the transportation plan is adequately geared toward the region's needs, but also provides fertile ground for the clarification of the public and private sector roles in providing transportation services. These partnerships are fostered by the interaction created in the strategic conversation.

Once the strategic conversation moves through these participants, the transportation professionals and facilitators should revisit the vision, scenarios, and strategies, making modifications as needed to incorporate the results of this phase. Each of the principal participants in Phase 3 of the Strategic Conversation (See Figure 6-1) is described below.

**Freight Carriers**

These potential participants include ocean shipping lines, trucking companies, railroads, and parcel package carriers. The business of these companies relies entirely on the transportation system in the region as they ensure that goods can be moved through the region. The regional transportation planning process should be informed of the concerns and needs of these entities.

**Passenger Transportation Providers**

This category of possible participants includes airlines, passenger railroads, intercity bus operators, taxicab companies, and other local service providers. These important providers of transportation services in a region are often marginalized in the planning process dominated by public sector participants. The services these companies provide are often essential to maintaining the economic competitiveness of the region and ensuring mobility in the region.

**Developers**

The link between land use and transportation demand is well established. Development activity in a region is a prime determinant of the magnitude and geographic distribution of transportation demand in a region. The development of holdings within the city can have a profound impact on the travel patterns used to forecast future demands in the various scenarios. Likewise, developers require investments in the transportation system to ensure the viability of their projects. The views of these participants must be included in a meaningful scenario exercise.

Developers are commonly seen as adversaries of transportation planning. Their developments can thwart even the best-conceived plans. This scenario approach does not necessarily mean that developers and regional planners will agree on strategies for the region, but the scenario framework facilities constructive discussion between these groups by moving the focus from projects to regional futures.

**Regional Businesses**

The other driver of demand in a region is employment and industrial production. These businesses and institutions are the creators of employment responsible for work related personal travel. These businesses are also the productive engines of the economy creating a large portion of the freight flows through the region. The expansion, contraction and location plans of these businesses can have a major impact on both the passenger and freight transportation demands in the region.

**Outsiders**

The final group that should be involved in the process is non-stakeholders. This group can represent key decision-makers, transportation professionals, or other individuals from outside the region. This group could represent an important contribution for the academic community. Once the region's transportation professions, decision-makers, and major transportation stakeholders participate in the process, the scenarios and resulting strategic options should be presented to a forum of "strangers" to the region. This group is likely to serve as both a reality check for the process by identifying logical flaws in the scenarios and as a creative force by developing novel

additions to the scenario logic and strategic options.

## *Phase 4 – The Public*

The current planning process contains rigid requirements for public participation. This public process is often a forum for advocacy groups and other special interest organizations to be heard. The participation of the general public in this "public" process is much less certain. Nonetheless, the strategic conversation should include these special interest groups and, to the extent they are willing to participate, the general public. Much like the previous phases, these forums for public participation must be small enough to allow the discussion to occur in a hospitable environment. Many times "public hearings" on transportation plans are boisterous, unfriendly forums where few ideas are exchanged given the partisan nature of the proceedings. The strategic conversation must avoid this atmosphere to the extent possible. The facilitators should present the results of the conversation to date including the regional vision, the scenarios, and the strategies. As in the previous phase, these participants will add a new perspective to the vision, scenarios and strategies, these new perspectives should be included in the products of the process.

## *Look Ahead Far in Advance of Decisions*

The current planning process is good at looking at decisions far in advance of strategic option implementation. The plans are prepared every three to five years and generally look at a series of investments over a 20-year horizon. Many of the decisions require long lead-times before they can be implemented, but the process is not generally constrained by these lead times. Using scenarios as a framework for RSTP does not require any real modification to the timing of the process.

## *Conclusions of the Strategic Conversation*

We have presented an extended list of participants in the scenario building process, a process that can be complicated even with a small number of participants. Once the strategic conversation has moved through all four phases described above, the regional transportation professionals and facilitators should revisit all of the discussions about the scenarios and modify any of the work as

needed. Only at this point should the composite analysis of the strategic options be undertaken. Before any final conclusions and recommendations are put forth, the group of key decision-makers in the region should revisit the entire process in order to appreciate the input of the other two groups; stakeholders and the public.

Currently, RSTP is by no means a simple activity. Scenario planning does not have to complicate this activity further. In fact, the scenario framework may eliminate some of the grounds for disagreement in the process. One of the primary problems with the current process is the use of single forecasts to develop a picture of the future. These forecasts are easily challenged and the planning organization often spends valuable time and resources defending its forecasts, based on some single set of assumptions about the future. Scenarios eliminate this less-than-useful activity. It is certain that the forecasts in a plan are wrong, but scenarios allow the plan to capture the range of likely futures. Scenarios allow the planners to acknowledge that their forecasts are wrong and that the plan is based on some wide range of future pictures, rather than a single snapshot. It is the case that all of these future pictures are likely to be wrong, but hopefully, the range bounds the actual outcome giving greater validity to the strategic decisions made.

## A Strategic Environment as Business as Usual

Schwartz's guide concludes that the strategic conversation should evolve into the organization's way of conducting business. This goal is unchanged for RSTP; however the context in which these plans are prepared are far more complex than the business environment in the private sector where all of the actors are directed toward a common, overarching goal. It is likely that the initial full-fledged applications of scenario planning in the RSTP environment will be experimental and compliment the existing planning process, guided by experience and regulation. Scenarios will have to move into the RSTP arena incrementally. There is little chance that the methodology will immediately supplant the current planning process.

This interim state is likely to continue before scenarios are accepted as a reasonable methodology for approaching RSTP. The scenarios will have to demonstrate their ability to guide better decisions in

order to become institutionalized as the standard way of doing business. Hopefully these early applications will be revealing and will capture the attention of the decision-makers who ultimately determine the value of the methodology by their participation.

## CHAPTER SUMMARY

Moving the scenario methodology from an academic setting to professional practice requires thinking carefully about how to structure a "strategic conversation." Peter Schwartz outlines several important ideas for structuring this strategic conversation in the context of a business where the goals are fairly clear and universal. These ideas are important in the context of regional strategic transportation planning as well, but the added complexity of planning for public sector organization requires that these ideas be thought about in a more structured way that maintains the integrity of the process. The key aspects to fostering this movement toward strategic are:

1. Creating a Hospitable Environment
2. Structuring the Strategic Conversation, and
3. Looking Well in Advance of the Decisions

Structuring the strategic conversation is the most critical piece of this process. This chapter proposes structuring this conversation in four phases. The first phase involves the regional planners, academics, and facilitators who lay the groundwork for the strategic conversation and establish the agenda for the remaining three phases. The second phase involves the key decision-makers in the region who further develop the regional vision, goal and objectives and contribute to developing the scenarios. The third phase expands the input into the process to include the major stakeholders in the system and outsiders to add creativity. The fourth phase has the general public contribute to the process and has the decision-makers revisit the scenarios, looking at detailed analysis supporting each developed by the planners and facilitators. The final product of the process is recommendation for a set of strategies to pursue and an appreciation for the trends and events that may signal a departure toward one of the potential futures developed in the scenarios.

# 7

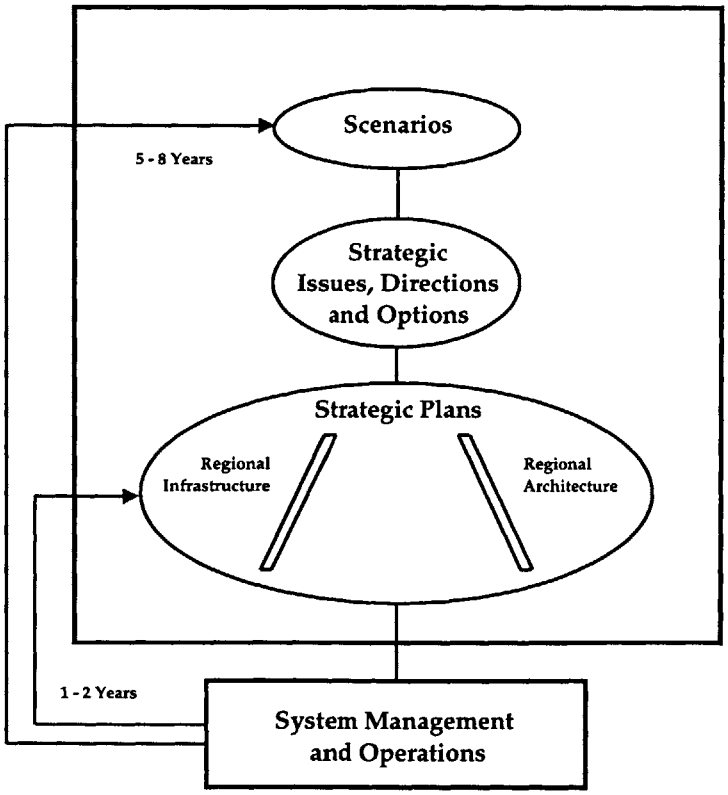
# INCLUDING ORGANIZATIONAL STRATEGIES IN REGIONAL STRATEGIC TRANSPORTATION PLANNING

The Mobility-ReS/SITE application of scenarios to RSTP in Houston, Texas considered only infrastructure and policy strategies; the analysis did not include organizational strategies. Chapter 1 suggests that two important additions to the transportation planning process are scenarios and regional architecture. Regional architecture captures these organizational strategies and scenarios can be used as the evaluative framework for these strategies. This section defines the concept of Regional Architecture and goes on to describe how it fits in the scenario-planning framework. The section draws on the two examples of different organizational strategies for deploying Intelligent Transportation Systems (ITS) and deploying a new Light Rail Transit (LRT) system. These two examples describe how regional architecture generates organizational strategies in the context of scenarios.

## LINK TO REGIONAL ARCHITECTURE

The ReS/SITE group has proposed the concept of regional architecture as a planning tool intended to improve the RSTP process. The ReS/SITE group proposes that there are two products of the RSTP process, regional infrastructure that defines the capital investments recommended by the plan and regional architecture that is the institutional component of the RSTP. A regional architecture defines the transportation institutions in the region, who they must communicate with, and what they are responsible for and how the transportation system operates. Regional architecture is a tool for determining the lines of responsibility and lines of communication between these institutions. It is a design tool that can be used to generate organizational strategies for transportation institutions.

**FIGURE 7-1**
**RES/SITE PLANNING PROCESS**



## Regional Architecture Defined

Pendleton defines regional architectures as follows

> *The regional architecture...represents the institutional component of the regional transportation system. It describes how the region's institutions must relate to one another in order to provide transportation services. In doing so, it defines the interactions of the institutions that own, maintain and operate the physical elements identified in the regional infrastructure. Thus the regional architecture and regional infrastructure are complementary documents. Both support the deployment of services-one from a physical standpoint, and the other from an institutional standpoint (Pendleton 247).*

The term "institution" is not intended to limit the scope of regional architecture to public sector providers of transportation. Regional architectures also include important private sector transportation organizations and important customers of the transportation system. Different relationships between these public and private transportation entities can be structured using regional architectures as the planning framework for discussing public-private partnerships to provide service. Two examples of these arrangements are presented later in this chapter.

The inclusion of regional architecture in the RSTP process is motivated by several factors. Regional architecture is a technical concept that allows a region to implement new technologies by helping the region define what data flows will be created by new technologies, required by new technologies, and how the regional institutions will have to evolve to accommodate them. Regional architecture as a transportation planning tool has its roots as a framework for the deployment of intelligent transportation systems (ITS) by defining communication lines and technologies needed to provide different services.

Regional architecture is derived from system architectures used in the design of computer networks. In the context of computer networks, regional architectures define what different components of the systems will do. The system architecture defines how a network:

- Shares information

- Shares resources, and
- Shares control (Pendleton 27).

In other words, the regional architecture defines the lines of communication and the lines of responsibility necessary to provide a service. It considers what information is shared, through what channels, and how this information is used to make decisions

An example of system architecture is an Automatic Teller Machine (ATM) Network. Pendleton describes the architecture of an ATM network. The system is comprised of a central bank computer and various ATM machines. The system architecture describes where information is stored, where processing occurs and where the control decisions are made within this system (Pendleton 29).

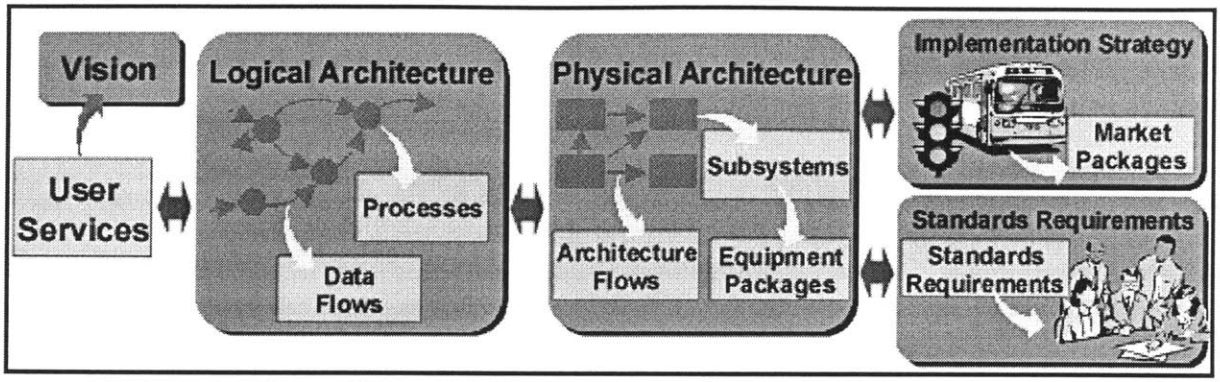
In terms of ITS, regional architecture is focused on these three items: information, resources, and control. An ITS regional architecture defines what the technical components of the systems are, what information is collected, where in the system processing occurs, and where decisions are made.

A schematic representation of a regional architecture is shown in Figure 7-1 below. There are six different components of a regional architecture.

1. Vision,
2. Definition of User Services,
3. Logical Architecture,
4. Physical Architecture
5. Implementation Strategy, and
6. Standards Requirements.

From an organizational point of view, the vision, user services, and logical architecture are the most important components. The physical architecture and standards requirements define the technical specifications of the logical architecture. The implementation strategy categorizes services and describes the technical needs of these services in terms of their market packages, subsystems and information flows.

## FIGURE 7-2
## REGIONAL ARCHITECTURE COMPONENTS
(SOURCE: *ITS NATIONAL ARCHITECTURE, WWW.ODETICS.COM/ITSARCH*)




The key components of a regional architecture related to institutional requirements are described below.

> ***User services*** *describe what the system will do from the user's perspective. To date, thirty User Services have been jointly developed by US DOT and ITS America with substantial stakeholder input. A set of requirements covering each of these User Services are the basis for [a regional] ITS Architecture definition.*
>
> *The architecture* ***Vision*** *provides a general forecast of the ways in which the ITS user services will improve transportation systems over the next 20 years.*
>
> *The* ***Logical Architecture*** *defines the processes (the activities or functions) that are required to satisfy the user services. Many different processes must work together and share information to provide a user service. Data flows identify the information that is shared by the processes.*
>
> *(www.odetics.com/itsarch/ ITS National Architecture Hypertext View)*

These definitions of user services and logical architecture are geared toward the technical implementation of ITS services, but this view can easily be extended to encompass all transportation services in a region. In this broader context, the user services represent the transportation services the region wants to provide and the logical architecture defines the institutions and communications flows that will be needed to provide these services.

Institutions are central to regional architecture. The regional architecture must define what regional institutions will fulfill the roles necessary to provide regional transportation services and it must "identify how these institutions will relate to one another. This would involve resolving such questions as how information will be distributed and how control will be exercised" (Pendleton 97).

In Chapter 1, we noted various shortcomings of conventional RSTP. Regional architecture addresses some of these by improving:

- **Intermodalism** – Regional architecture defines how different modally oriented organizations need to interact with one another in order to ensure the efficient operation of the transportation system.

- **Technology Scanning** – Regional architecture enables technology scanning through its roots in ITS and advanced transportation technologies and by bringing technically sophisticated private sector players into the transportation enterprise (Pendleton 254).

- **Public-Private Interaction** – Regional architecture establishes a framework for the development of public-private partnership for the provision of transportation services. Further, the concept formalizes the role of private sector transportation providers in the RSTP process.

- **System Management** – Regional architectures define the information flows and responsibilities of different transportation institutions in a region, helping to change the focus of these institutions from infrastructure development and maintenance to transportation system management and operations control.

## ***Regional Architecture and Organizational Strategy***

The regional architecture defines how institutions in a region provide transportation services. It establishes which institutions provide different functions and how information is shared between them. The distribution of control and information within these organizations is a key concern of regional architecture. The regional architecture defines what the lines of communication and lines of responsibility between organizations should be and informs each institution about what

organizational characteristics will best accommodate these exchanges. This mechanism allows the region to consider how different organizational strategies work within the regional architecture defined communication and responsibility links.

## Regional Decision-Making

Including the responsibility and communication lines between institutions providing transportation services is an incremental step toward developing coordinated *regional* decision-making. Regional architecture involves reconsidering institutional roles by focusing on user services. Looking critically at these organizational structures can serve to change the institutions into ones that better serve the needs of an integrated economic region.

This idea might seem radical at first; however, it simply represents an extension of the current trends in transportation planning. A 1992 Governing Magazine special report entitled *The Public's Capital: A Forum on Infrastructure Issues* discusses the growth of power in Metropolitan Planning Organizations. These organizations were greatly strengthened in the 1991 Intermodal Transportation Efficiency Act of 1991 (ISTEA) and were seen as the way to move away from highway solutions to the nation's transportation problems. This bill empowered these "low key" organizations "as a way of changing transportation policy" (Governing 67) by shifting power from the state departments of transportation to the MPOs. The article continues to describe many of the difficulties these MPOs will face, but the point is clear in the title "Ready or Not, Here Comes Regional Power" (Governing 67).

Anthony Downs, in his book *New Visions for Metropolitan America* describes the problems associated with a growth oriented vision of the nation's future. One of the fundamental issues he describes is the fragmentation of land use control in a metropolitan area leading to a whole host of social ills. He describes the solution to this problem as metropolitan government, recognizing the current unpopularity of these entities (Downs 170). Short of metropolitan government, Downs lists several "second best" solutions to the problem. Regional architecture included in transportation planning and policy can serve as a tool to move planning to a metropolitan area focus.

### *Example: Atlanta, Georgia*

A movement toward regional government is illustrated in Atlanta, Georgia. The Atlanta metropolitan area has been one of the fastest growing in the United States for approximately the last 10 years. This growth has occurred in an institutional environment fragmented between different municipalities and powerful county governments. The transportation investment and control policies of these institutions have demonstrated a lack of coordination as the growth has accelerated in the region. This lack of coordination has caused serious disagreements at times when a significant investment in infrastructure in one county creates new problems in neighboring counties. The rapid growth in the region has lead to other problems including the longest average commute in the nation and, more importantly, worsening air pollution. The current institutional arrangements in Atlanta have been unable to deal with this problem and the region's federal transportation funding is now in jeopardy. The newly elected governor of the state proposed and the legislature authorized a regional authority with broad powers to manage the transportation system in the face of this impending crisis. This new regional authority, the Georgia Regional Transportation Authority (GRTA) demonstrates that the idea of regional government is spreading, even in politically conservative regions.

Regional government has a longer history in other parts of the United States including areas like Portland which have instituted regional land use planning. More recently than Portland, cities like Houston and San Antonio, Texas have developed regional structures for the coordination of traffic management systems.

Regional architecture is a tool that allows the coordinated implementation of new transportation control strategies, whether they are based on control of infrastructure development, land development, or system operations. Defining the region's institutional roles, organizational strategy, and communications lines can help a region pursue these philosophies.

## ORGANIZATIONAL STRATEGIES

The previous section describes how the concept of regional architecture can help to develop

different organizational strategies for providing transportation services. A remaining question is what different kinds of organizational strategies are there. Different regional architecture choices represent different organizational strategies that can be tested using the scenario framework proposed in Chapter 4. Different futures will imply different degrees of success for different organizations; these organizational strategies can be looked at in the context of the future proposed in each scenario. Examples of different organizational strategies are presented below. The first example draws on the deployment of Intelligent Transportation Systems (ITS) and includes three different organizational structures. The second example is based on the development of new light rail transit (LRT) services in a region with an existing bus transit system and presents four different organizational structures for this service implementation. Following these two examples, a more theoretical discussion of these organizational possibilities is presented and an evaluation framework for these strategies is developed.

## ITS Example

The deployment of ITS is a challenge facing many metropolitan regions in the United States. Before we proceed with a discussion of the challenges of ITS implementation, we must describe ITS. ITS is the application of advanced data collection, communications, and processing technology to the operation of the transportation system. One of the key ideas of the ITS movement is that these technologies will help a region maximize the capacity of its existing transportation system while improving safety (www.its.dot.gov/faqs.htm). ITS is intended to improve the efficiency of existing transportation facilities, making construction of new facilities unnecessary.

ITS refers to subsystems that support user services. These subsystems include Advanced Public Transportation Systems (APTS), Advanced Transportation Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO) and others. One of the most challenging aspects of deploying ITS is to deal with the organizational issues associated with any large scale deployment, technological or otherwise.

Most transportation planners and engineers are quite familiar with the challenges of building new

infrastructure. Associated with these projects are public participation requirements, agency coordination, financial arrangements, environmental permitting and project staging along with a whole host of technical challenges. Deploying ITS faces many of these same challenges; there are however, two major differences.

First, the technical challenges are, for the most part, of a different nature. Deploying ITS requires solving communications and information processing problems while building infrastructure requires solving geotechnical, structural and related other problems. Second, the institutional and organizational issues associated with ITS deployment are much greater. ITS is focused on information gathering, processing and dissemination. An old adage states that "knowledge is power." Developing ITS requires that decision-makers consider how this power is to be distributed. Defining ITS for a region requires the tackling of organizational challenges while traditional infrastructure development rarely raises these obstacles.

These organizational challenges come in two varieties. The first challenge is associated with structuring an organization to operate a new ITS system. This organization challenge is concerned with funding the new enterprise, staffing the organization, and developing its internal reporting structure. The second type of organizational challenge is determining how this new organization will fit into the existing family of organizations providing transportation services.

One could hypothesize that the second organizational challenge is the more difficult one. A system planner has relative freedom in developing the structure of the new ITS organization. Unfortunately, this freedom does not exist when fitting this system into the hierarchy, both formal and informal, of existing transportation organizations in a region. These two challenges are inseparable. The decisions one makes about the internal structure of the ITS organization will impact how it interacts with other players in the transportation arena. Likewise, the institutional and political environment in which the ITS organization will operate will have a profound impact on what types of internal structure are viable. Regional architecture is a tool for considering these two challenges and for developing an institutional structure that facilitates operation of the transportation system.

There has been significant study of these organizational challenges facing the deployment of ITS. One particular study prepared by Booz-Allen & Hamilton under contract to the Volpe National Transportation Systems Center, *Institutional Impediments to Metro Traffic Management Coordination* focuses on these challenges and outlines key organizational impediments to the deployment of ITS, particularly advanced transportation management systems (ATMS). This report also discusses some methods for overcoming each of these shortcomings.

Booz-Allen & Hamilton's review of professional organizational literature and interviews in the six metropolitan areas listed above results in a list of ten issues important to the implementation of ATMS. These ten issues are then narrowed to three "key impediments" to the successful implementation of ITS listed below.

1. Awareness and Understanding of [ITS] and ATMS.
2. Organizational Cooperation
3. Availability and Sources of Funding.

The first and third of these impediments are indeed challenges to be overcome, however these are large topics in and of themselves. This analysis will focus on the second impediment, organizational cooperation.

## ***Problem Areas***

Booz-Allen & Hamilton states that this organizational cooperation impediment was thought to be the most important; however, their research in the various metropolitan areas indicated that the cooperation between institutional stakeholders was greater than originally expected. In their study, each of the regions had formal technical committee meetings regularly to "resolve technical problems that cross jurisdictional boundaries". Booz-Allen & Hamilton found that this cooperation was far less evident at the political level. Further, they concluded, "cooperation among organizations is often driven by a need for pooled funding and federal sponsorship" (BAH 5-7) rather than an interest in the cooperative advantages that can be realized by coordinated planning and implementation of systems. Booz-Allen & Hamilton considers the organizational cooperation impediment in four "problem areas." These problem areas are:

- Current Responsibility and Authority Lines,
- Dispersed Responsibility for Traffic Management System Operations,
- Limited ATMS Skills Available, and
- Private Sector Roles in Public-Private Partnerships.

The first two of these are the most significant and are described in more detail below.

**Current Responsibility and Authority Lines**

According to the report, the first of these problem areas is the root of the organizational cooperation impediment. The consultant states:

> *"Current responsibility and authority lines among transportation organizations within a metropolitan area are a root cause of inter-jurisdictional cooperation impediments. The lines have evolved based on who owns, or is responsible for the assets involved. We are not saying that the lines are incorrectly drawn, but they do hinder any decision-making or planning that involves more than one 'owner's' assets" (BAH 5-8).*

The report continues to describe how various agencies may feel threatened by ceding control of its assets to another institution since the controlling institution may make decisions that are not in the best interest of the owning institution. Booz-Allen & Hamilton suggests that regional ownership of transportation assets may alleviate this concern. However, the report recognizes that this regional ownership is unlikely, even in the long-term given the political forces present in most of these regions.

**Dispersed Responsibility for Traffic Management Systems Operation**

The second problem area that Booz-Allen & Hamilton identifies is that many different agencies are responsible for controlling traffic operations within a metropolitan area. Overcoming these different constituencies and jurisdictions can lead to "turf battles." Apparently, this dispersed responsibility has led to organizational problems in five of the six regions considered. The report highlights that these challenges need to be overcome and highlights the situation in Los Angeles,

where significant investment in ATMS technologies have largely been accomplished within jurisdictions and that this region is embarking on projects that will test cross-jurisdictional implementations.

A recent report has been produced by the Volpe Center, *Successful Approaches to Deploying a Metropolitan Intelligent Transportation Systems*, that outlines approaches for regions to follow when deploying an ITS system. This report looks at the Model Deployment Initiatives (MDIs). These are implementations of ITS systems in Seattle, Washington; Phoenix, Arizona; San Antonio, Texas; and New York, metropolitan area incorporating parts of New York, New Jersey and Connecticut. From analysis of the MDIs the report draws some conclusions about the attributes of a successful ITS program. These attributes related to organizational structures are summarized below.

1. Develop a regional perspective that builds on existing relationships, involves non-traditional players, develops a shared vision for the deployment and that augments existing systems

2. Understand the nuances of partnership by recognizing that participants have different objectives, realizing that it takes time to develop trusting relationships, defining explicitly the roles and responsibilities of the parties and providing incentives for participating.

3. Develop a regional management structure by assigning roles based on the strength of the participants, identifying a full-time project manager and giving this manger authority to make decisions, dedicating other support as required and developing an appropriate committee structure.

4. Facilitate ITS within your organization by considering organizational changes, assessing skills and staffing requirements, and addressing training needs.

These four aspects of a successful ITS deployment do indeed seem central to the success of such an initiative. It is important to note that these recommendations do not prescribe a "cookie cutter" approach to the problem; rather the approach is easily adaptable to any region since it leaves the flexibility of how to accomplish these objective up to the decision-makers in the region. One

approach to following these recommendations for a successful deployment is to develop a regional architecture. These four steps are key to the successful deployment of an organizational strategy for a new service such as ITS.

In the traditional sense, a regional architecture is a technical plan that coordinates the communications and processing technologies necessary to operate an ITS system. Regional architectures have been defined as a broader planning tool by several researchers at MIT. Pendleton defines a regional architecture as "a framework that can (a) guide the distribution of information and (b) govern the deployment of services on a regional scale" (Pendleton 1). A regional architecture is an addition to the current transportation planning process that has historically focused on infrastructure planning.

In order for regional architectures to be valuable as planning tools, they must consider more that the technical aspects of ITS deployment. Developing a regional architecture implies that the planning process also considers the institutional arrangements necessary to provide transportation services. These arrangements may need to change over time as the services the region wishes to provide evolve. Much like the current reevaluation of infrastructure projects, the concept of regional architecture suggests that the regional transportation institutions should be reviewed periodically and changes made to their responsibilities and communication patterns.

This reevaluation facilitates the deployment of ITS services in addition to any other new conventional services a region is considering. The legislative, regulatory and institutional issues that must be overcome are addressed as part of a regular, on-going, formalized planning process, rather than in an ad-hoc manner as new services are deployed. Certainly, the addition of regional architectures to the planning process would require modifications to the charters of the planning and transportation institutions in a region and proposed changes are likely to remain somewhat controversial.

**Architecture Considerations for an ITS Service (Pendelton)**

Pendleton describes four steps in developing a regional architecture. These steps are:

1. Identify the user services the region wishes to implement.
2. Analyze the ITS Service Architecture.
3. Analyze the non-ITS Service Architecture.
4. Aggregate the Services Arhcitectures to create the Regional Architecture (Pendleton 141-145).

A service architecture is defined as the lines of responsibility and communication necessary between institutions to provide a particular user service such as traffic information radio broadcasts. When one integrates all of these service architectures, the regional architecture results.

The process of developing regional architectures involving both ITS and non-ITS services may help solve many of the institutional impediments. In some cases, the regional architectures approach, under certain local conditions will suggest that a new agency is necessary to coordinate ITS. In others, an existing agency in a region may be well suited to manage the service. One can imagine that these decisions will depend greatly on whether the agencies are working in a functional or dysfunctional way. A functional regional transportation "family" of institutions will probably work well with an ITS organization that is less institutionally formalized while a dysfunctional family will require a more structured approach to the deployment of new services. One would not wish to give ITS operating responsibility to an agency that cannot manage its existing mission effectively. The consideration of a formalized regional architecture addresses these issues, solves some of the legal impediments, and addresses the interagency cooperation impediments discussed above. This methodology, however, does little to affect the internal effectiveness of an ITS agency.

## ***Organizational Case Studies***

This section will summarize three different organizational approaches followed for the deployment of ITS systems. The organizational approaches represent regional architecture choices in the context of major metropolitan areas. These organizational approaches are derived from case studies prepared as part of regional architecture research or ITS program research into several operational tests conducted in the mid-1990s. Rodriguez develops three case studies as examples of regional architectures in his thesis, *Developing a System Architecture for Intelligent Transportation Systems with Application to San Juan, Puerto Rico.* These case studies were developed for New York, Boston and

Houston. Several further cases are developed in a report prepared by the USDOT Volpe National Transportation Systems Center, *Analysis of ITS Operational Tests: Findings and Recommendations: Final Report.* There is significant overlap between the case studies considered in these two documents. This report will use those case studies developed by Rodriguez and supplement with information from the Volpe Center study where appropriate.

**New York, NY Metropolitan Region –Decentralized Control**

The ITS deployment in the New York metropolitan region can be categorized as a decentralized, voluntary organization. There are no command and control aspects of the organization. The organization simply collects and disseminates information with the actual decision-making undertaken by the member agencies.

The institutional structure in New York is quite complex as described by Rodriguez. He notes there are 22 different agencies responsible for coordinating transportation activity within the region not including the transportation and police departments of cities and towns. Further complicating this institutional situation is that the region covers three states, New York, New Jersey and Connecticut. Each has its own polices, procedures and interests concerning the metropolitan transportation system. Given this institutionally complex environment, Rodriguez describes how most of the deployments of advanced technology have been agency specific (Rodriguez 94). These local deployments are coordinated by a regional authority, the Transportation Operations Coordinating Committee (TRANSCOM). Rodriguez describes the major functions of TRANSCOM as information dissemination, regional construction coordination and technology development (Rodriguez 95). Rodriguez explains:

> *"In this arrangement, TRANSCOM does not provide any command and control functions, but limits its operations to gathering and disseminating information. Each agency is autonomous in deciding whether or not to deploy a technological application or not."*

> *TRANSCOM monitors the condition of the transportation network and alerts agencies about possible network effects resulting from incidents. Each agency is in charge of collecting and disseminating the information to minimize the network interference of localized incidents and disruptions. The information is multimodal...and TRANSCOM is funded by the Federal government and member agencies" (Rodriguez 95).*

One of TRANSCOM's principal successes has been implementation of the EZ-PASS system, a coordinated automatic toll collection system used by all the agencies within TRANSCOM. It may seem simple to implement such a system, but this coordination is hard to obtain, especially in a multi-state environment. Bringing a diverse set of agencies to implement a common system is by no means an easy accomplishment.

Rodriguez explains that TRANSCOM is an umbrella agency coordinating the ITS deployment of its members. He describes that two of the main institutional considerations in the development of the regional architecture for TRANSCOM is that the autonomy of the member agencies must be respected and that any integration of the system will occur specifically at the TRANSCOM level.

TRANSCOM presents an interesting picture of solving the institutional impediments to ITS described by Booz-Allen & Hamilton by taking a voluntary approach to the problem. Member agencies are free to make their own decisions while TRANSCOM tries to integrate its member agencies' decisions. This model has proven effective in perhaps one of the most complex institutional environments in the world. One of the principal advantages of the TRANSCOM model is that the umbrella structure of the organization prevents agencies from feeling threatened by the ITS organization while still allowing for coordination of their activities. The highly politicized, multijurisdictional transportation community is provided with a common forum for developing technology. In this model, the agencies are encouraged by their own interests to participate in ITS coordination rather than forced by statute or long term agreement. The principal disadvantage to this model is this same autonomy. Agencies can make decisions contrary to the good of the system without any penalty. There is no forcing mechanism for imposing certain technological choices or coordination.

**Boston, MA Metropolitan Region – Public Private Partnership**

Another example of a challenging organizational environment is that of the Boston, Massachusetts metropolitan region. One of the key differences between the situation in Boston and New York is that the Boston metropolitan region is almost entirely contained within the Commonwealth of Massachusetts. In the case of Boston, both the city and state transportation agencies are centered in the metropolitan region, theoretically facilitating cooperation. This cooperation does not always manifest itself as one would expect given that many of the state agencies have not work well together in the past.

One ATIS organization in the Boston, Metropolitan area is SmarTraveler, an example of a public-private partnership developed to provide ITS services. SmarTraveler has been operational for several years. A contractor to MassHighway, SmartRoutes Systems, Inc. operates the SmarTraveler service. This company operates the ATIS service nearly independently from any government agencies. The service includes real-time traffic information dissemination through telephone, radio, cable television and the Internet. The traffic data is collected through four channels. First, SmartRoutes has agreements with regular commuters who act as probe vehicles reporting incidents and travel times along various routes. Second, SmartRoutes monitors communication between law enforcement and public safety agencies in the region to identify incidents and travel problems on the highway network. Third, SmartRoutes monitors a system of traffic surveillance cameras installed and maintained by MassHighway. Finally, SmartRoutes obtains information from the MBTA and Massport, the operators of the transit system and airport about conditions on their facilities. Once this information is collected, it is disseminated through channels operated directly by SmartRoutes Systems: the telephone service, Internet, and cable television. The information is also provided to commercial enterprises include WCVB Channel 5 and MetroTraffic who markets traffic reports to radio stations.

The Boston case illustrates a very different deployment of ITS systems. The SmarTraveler system represents a public-private partnership with little operational involvement from the public sector. The principle advantage of this structure is that the system operator is freed from the institutional baggage that is associated with the transportation providers in the region. Furthermore, the

deployment is testing the marketability of these services and might, one day, operate independently of any public sector support. A major disadvantage is that the information collected in only available for traveler information and not for transportation system management, an activity purposefully avoided by the system operator. Further the data collected is not readily available for strategic planning purposes since there is little day-to-day interaction between the SmarTraveler organization and the operating agencies.

**Houston, TX Metropolitan Region – Centralized Control**

The Houston region is fundamentally different than both the New York and Boston areas. Houston is a large, sprawling city faced with few constraints to building infrastructure and relatively few institutional constraints. In Houston, ITS activities are coordinated by Transtar, a cooperative organization comprised of Harris County, the City of Houston, the Texas Department of Transportation (TxDOT) and METRO, the regional transit agency. This institutional environment is complex, but these agencies have agreed to cooperate and coordinate through this ITS organization. These various agencies have entered into agreements to fund the operation of Transtar and provide staff from their agencies to operate the facility. Transtar is responsible for all aspects of the ITS system. The organization coordinates transportation system data collection for both highway and transit modes, traveler information dissemination, incident response, transit operations control, automatic toll collection management and emergency management including flood control. Transtar represents a highly centralized command and control structure. Member agency's dispatching activities are all handled through Transtar. Transtar also coordinates the deployment of new ITS technologies by all member agencies in the region. Interviews with agency staff in Houston indicate that Transtar provides an important function beyond that of managing the ITS services. Transtar aids the agencies in coordinating their activities from an operational perspective and also serves as a forum for the major decision-makers in the regional transportation institutions. All of the participating agencies and some private sector participants including MetroTraffic enthusiastically support the Transtar organization and it is representative of a operational goal all stakeholders had upon entering the project.

The principle advantage to the centralized Transtar model is that information processing and operations control are more easily facilitated with such an organizational approach (Rodriguez 164). Further, the facilitating role of a centralized organization is quite important in fostering agency cooperation on non-ITS objectives. Further, this centralized structure encourages coordination of each agencies technological deployments, incident response, emergency management (flood advisory system), schedule adjustment, and traveler information provision. Finally, this structure is easily adaptable to new deployments since the information and control is centralized there is little need for additional coordination between agencies.

There are drawbacks to this centralized model too. First and foremost, the agencies must be united in their support for the ITS institution. Without this unanimous support, the ITS organization will suffer from low funding levels and ineffective management of the regional transportation system. Further, since this model is so sensitive to agreement among the member agencies it is susceptible to shifts in the political environment that may change perspectives of the various agencies.

## ***ITS Example Conclusions***

Deploying ITS requires the development of a regional architecture. Three different organizational structures for ITS organizations have been described above. Each of these is based on an actual deployment in a regional context. There are several important differences between these models. First, some are modally focused while others take an intermodal approach. Second, some are highly centralized while others dispersed. Third, some are advisory while others serve control functions. Third, the private sector plays a major role in one of these organizations while the other two are dominated by public sector agencies.

The next section describes similar examples for the development of new light rail transit systems in regions that have little or no experience operating these types of systems. Four different organizational structures for integrating new transit service into a region are proposed.

## New Transit Service Example

Over the last fifteen years, there has been a renewed interest in developing Light Rail Transit (LRT) systems in many metropolitan areas in the United States. New LRT systems have been started in Baltimore, Maryland; San Diego, California; Los Angeles, California; Portland, Oregon; Dallas, Texas; St. Louis, Missouri; and Denver, Colorado just to name a few. In many of these cities, LRT systems have been seen as a way to improve the attractiveness of transit in the face of growing traffic congestion and air quality problems. Some of these systems have proven quite successful and system expansions are planned. Most of the agencies implementing these new systems were essentially unimodal, simply providing bus transportation in each metropolitan area.

There are two types of challenges that face a transit agency in the process of planning and deploying a new LRT service. These challenges are *engineering challenges*: the technical, planning, permitting, design and construction problems; and *institutional challenges*: strategy development, financing, workforce planning, implementation scheduling, organizational structuring, and contractor management.

Planning, operating and maintaining a LRT system is a significant institutional challenge for agencies that only have bus-operating experience previously. Much like when a highway agency deploys a new Intelligent Transportation System, one can imagine a whole host of new managerial problems that accompany such a system implementation. The transit agency must consider:

- Adjusting bus scheduling, routing and staffing,
- Corridor assessments in terms of destinations, demand, and feasibility,
- Development and management of "transit centers",
- Considering new interagency coordination needs,
- Renegotiating labor agreements,
- Building and maintaining expertise and specialized skills,
- Ensuring prudent financial management,
- Developing effective marketing and advertising,
- Understanding new technologies,

- Providing necessary vehicle and right-of-way maintenance, and
- Analyzing performance.

This section will focus on these managerial problems paying particular attention to the organizational structures different agencies have chosen. The section will then outline several organizational models a transit agency might employ. Next, the example will develop organizational case studies that illustrate the four different structures. These case studies will employ examples of existing or planned deployments in Denver, Colorado, San Diego, California; Dallas, Texas; and San Juan, Puerto Rico. The final parts will draw some conclusions about the advantages and disadvantages of these structures and discuss how these different structures can be employed in a scenario analysis.

The transit agency must move quickly to develop an organizational plan for integrating this light rail system. This organizational plan must address the following questions:

1. What management strategy best suits the system and how can this management strategy be implemented?
2. What are the advantages and disadvantages of this management strategy?
3. Will this strategy continue to work as the size of the system increases?
4. How will this strategy work with the agency's current labor agreements?
5. How will this strategy develop the expertise necessary to deploy this new system?
6. How will this strategy facilitate connections between the bus and LRT systems?
7. How will this strategy encourage operating efficiency and service effectiveness?

Organizational strategy is a question that must be addressed in all deployments of new service. In order to help the decision-makers answer these questions, four different organizational strategies that an agency could follow are presented in the following section.

There is an entire spectrum of organizational structures that could be employed to develop a new transit service in a region. These structures range from entirely incorporating a new service into an existing agency to contracting with a private provider to be entirely responsible for the planning and

operation of the new service. Regional architecture can be used to develop and choose an organizational plan from this range of possibilities. Four different structures within this spectrum are presented in this section followed by an analysis of the advantages and disadvantages of each.

## ***Structure Definition***

These structures are all very different in terms of the organizational approach that each implies. The first two structures attempt to incorporate a new service into existing agencies while the second two work toward separating the new and old services. Another consideration in all of these structures is the contracting of the new service. Contracting can occur in any of the structures proposed. In the integrated structures, a private contractor can provide certain activities, such as maintenance. In the umbrella or distinct structure, a private contractor could operate any of the modal "companies." A schematic representation and discussion of each of the four strategies is presented below.

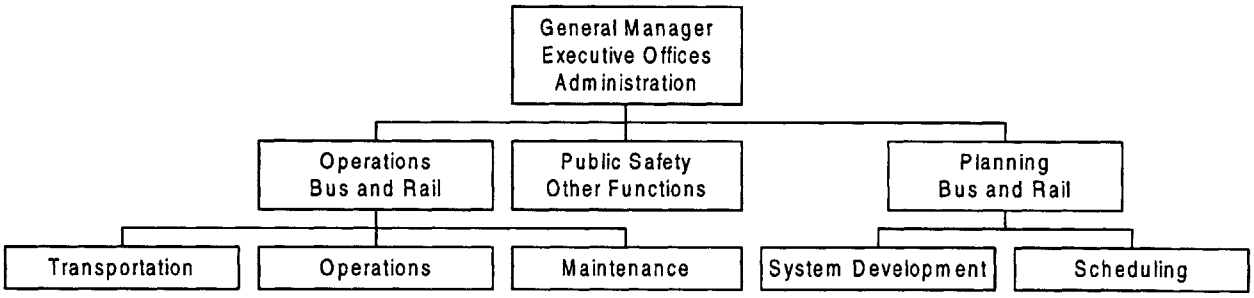
Four different implementations of new modal service are studied as part of this paper. Each of these agencies highlights one of the organizational structures. Each case study describes the implementation and the organizational structure followed. A sense of why that particular organizational strategy was selected is included in each case study.

A system profile obtained from the National Transit Database is attached to this report for comparison purposes. Basic system details are included in each case study for comparison and context purposes. Detailed comparisons of the performance characteristics of the systems are not included in these case studies. Some of these systems have been operational for some time while others have just begun. Furthermore, the size of these systems varies greatly. These differences alone, not considering some of the local factors in each region and organization, appear to make any comparative analysis of structures, *applied in different regional contexts,* difficult. Evaluating these organizational structures in a RSTP requires a more theoretical approach as described later in this chapter.

**Integrated Structure**

In this structure, the new service is entirely integrated into the existing organization. No new organizational structures are created. In this organizational structure, the existing operating and maintenance departments assume responsibility for operating and maintaining the new service. The expertise for operating and maintaining the new service is developed within the existing personnel and departmental structure. The existing maintenance department is trained and responsible for maintaining the new vehicles and right-of-way. The existing planning and scheduling staff is responsible for these activities for both the current and new service. A single department for both services coordinates public safety. The existing transportation department is responsible for training and coordinating drivers for both old and new services. The marketing department handles the marketing for both and the administration of each is combined.

## FIGURE 7-3
## INTEGRATED STRUCTURE




The integrated structure aids an agency in building the skills of its current staff. Workers in each of the main activity areas (transportation, marketing, maintenance, etc.) become experienced with the operation of both the old and the new services. Furthermore, this structure reduces some of the bureaucracy within the transit agency. Conceptually, there are fewer departments and fewer managers with this structure. It allows single, consistent labor agreements and operating procedures to be developed. Intermodal connections are facilitated by this approach since the same planning and scheduling staff is responsible for both services. A hub, or station manager approach in which a

single manager is responsible for the operations of both rail and bus services at a particular station is encouraged by this approach.

There are several disadvantages associated with this structure as well. First, as the new service grows in scale and complexity, each of the functional departments within the agency will become quite large and difficult to manage. Additionally, the skills of individual workers will become less well known by management as the staff size increases. Furthermore, while this structure builds skills and knowledge across the organization, it also encourages the inheritance of bad traits from the existing operation to the new service. Persistent deficiencies in the existing service are likely to be visible in the new service.

This approach seems well suited to smaller agencies with simple organizational structures and labor agreements. These smaller systems will find that this structure allows them to maximize the utilization of their staff while lowering their administrative costs due to a complicated bureaucracy. This structure would be particularly effective where feeder bus systems are planned to provide ridership for the new service.

*Dallas Area Rapid Transit Authority (DART), Dallas, Texas*

DART is an example of an integrated structure. Various performance characteristics of the DART system are shown in the table below. It is interesting to note that the bus system is approximately 10 times larger than the rail system and is more efficient in terms of operating expense per revenue vehicle mile. The rail service is more effective in terms of cost per passenger mile and ridership per vehicle mile.

## TABLE 7-1: DART SYSTEM CHARACTERISTICS

| Characteristic | Bus | Light Rail |
|---|---|---|
| Annual Vehicle Revenue Miles | 18 million | 1.8 million |
| Operating Expense/Revenue Mile | $7.52 | $12.90 |
| Operating Expense/Passenger Mile | $0.87 | $0.54 |
| Unlinked Passenger Trips/Vehicle Revenue Mile | 2.31 | 4.44 |

Source: National Transit Database

The *Houston Metropolitan Study* (HMS) draws upon the DART example for Houston's consideration of a LRT system. Dallas chose an integrated approach to developing their new light rail system. The HMS analysis of the DART initiative is not altogether positive. The study states that DART had ambitious beginnings but was met with criticism and opposition soon after its formation in 1983. Originally intended as a 91-mile LRT system, DART reduced its plans to include a 20-mile starter system that is currently operational and a build-out plan of 53 miles of light rail and 37 miles of commuter rail. The HMS analysis of the DART system concludes that DART is less successful than an HOV and bus system given the automobile orientation of the city, but that there are successes associated with the deployment. For example, the light rail system carries 15 percent of all transit trips in the region, a significant portion when one compares the relative mileage of the bus, LRT and commuter rail systems.

Interviews were conducted with two individuals concerning the deployment of the DART light rail system. These interviews were with a staff member in the Service Planning and Scheduling Department at DART and a consultant from F.R. Harris, the contractor responsible for developing the light rail starter system organization and staffing plan. The comments of the F.R. Harris consultant are reinforced by the DART LRT Starter System report provided.

According to the F.R. Harris interview, DART integrated the new rail system into the existing organizational structure completely. Although the consultant recommended a semi-integrated structure, discussed later in this chapter, the senior management of DART believed that full integration suited the system better. F.R. Harris recommended that the agency develop a LRT division to handle operations, transportation and maintenance in order to develop the specialized skills required in each of these areas while integrating the planning, scheduling, marketing and other office functions of the agency. The senior management did not feel that such a division was necessary and wanted to take full advantage of the presumed economies of scale offered by an integrated structure.

In terms of intermodal connections and coordination, the consultant indicated that the DART system is very effective. In fact, the design and operation of the system allows for cross-platform

transfers between the rail and the bus systems. Also, the integrated structure of DART allows for flexibility in the case of service disruption. A combined approach allows for easy substitution of bus service in the case of a rail system failure.

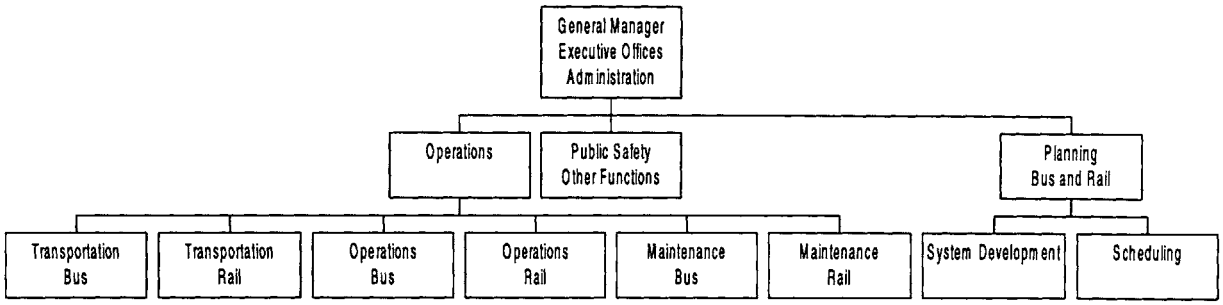
In terms of workforce planning, the DART system does segregate bus and rail operators. Rail operators only operate rail vehicles and bus operators only operate buses. There is no dynamic assignment of drivers to the different services. Originally, the labor agreements were structured such that there was a separate seniority arrangement for bus and rail operators. This dual system allowed preference for train operators in terms of work scheduling and was seen as a way to attract and retain skilled rail operators. As a result of collective bargaining, this dual system was eliminated resulting in the departure of many rail operators causing staffing problems for the agency. Perhaps with one of the other organizational structures this dual system would not have been the subject of a labor negotiation.

In summary, the consultant states that the key to the success of DART was the hiring of effective and experienced personnel to operate the rail system. The consultant indicated that the knowledge and experience of the experts hired could overcome nearly any organizational choice, certainly an important consideration.

**Semi-Integrated Structure**

This structure is similar to the integrated structure except that new operating departments are created for some functions while other functions are shared with the existing services. The administrative functions of human resources, marketing, finance, public safety, and perhaps planning and scheduling are shared between the old and new service. Modally oriented departments, however, handle the "nuts and bolts" of the service. For example, there is a separate maintenance and transportation department for the new service.

## FIGURE 7-4
## SEMI-INTEGRATED STRUCTURE




The semi-integrated structure retains many of the advantages and disadvantages of the integrated structure. There are, however, some key differences. In terms of advantages, the semi-integrated structure allows the development of specific labor agreements and work rules independently for each service. These different labor agreements can facilitate the different operating characteristics of each mode and help to isolate the new mode from the deficiencies of the existing service. This structure can also help to develop a set of highly skilled operators and maintainers for each mode. These employees will focus on a particular mode of operation and become more skilled in either the light rail or bus system. While the semi-integrated structure allows for the development of modal expertise, it maintains the administrative economies and benefits of shared planning, marketing and other administrative departments.

The semi-integrated structure induces some disadvantages not manifested in the integrated structure. This structure introduces more bureaucracy into the transit organization with separated operations, transportation and maintenance departments. Furthermore, labor issues associated with different work arrangements for the different services can arise and complicate contract negotiations. Another disadvantage is that this structure is not as well suited to the station manager concept. While the planning and scheduling may occur in a coordinated fashion, the actual operation of the system is not coordinated in this structure.

This structure seems well suited for an effective transit agency of medium to large size that is interested in building upon the successful attributes of its existing services. In this structure, the

agency can still expect coordination between the various modes while allowing for the development of mode-specific expertise. Research indicates that this structure is the most common in the United States.

*Regional Transportation District (RTD "The Ride") – Denver, Colorado*

The RTD in Denver is an example of a semi-integrated organizational structure. Various performance characteristics of the RTD system are shown in the table below. In the case of the RTD the bus system is more forty times larger than the rail system. The bus system is twice as efficient in terms of cost per revenue mile while the effectiveness of the service in terms of cost is similar. The light rail service is far more effective in terms of ridership with approximately three times the ridership per revenue mile.

## TABLE 7-2: RTD SYSTEM CHARACTERISTICS

| Characteristic | Bus | Light Rail |
|---|---|---|
| Annual Vehicle Revenue Miles | 31 million | 700,000 |
| Operating Expense/Revenue Mile | $4.87 | $11.45 |
| Operating Expense/Passenger Mile | $0.51 | $0.62 |
| Unlinked Passenger Trips/Vehicle Revenue Mile | 2.12 | 6.83 |

Source: National Transit Database

The transit agency in Denver, Colorado, is also pursuing LRT development. Currently the system consists 11 miles of light rail service with several proposed expansions.

E-mail correspondence lead to a telephone interview with an Assistant to the General Manager responsible for non-construction planning of the LRT system extensions. This individual, Jerry Eddy has worked in the transit industry for over 40 years and has served as the General Manager of the Scranton-Wikes Barre, Pennsylvania transit agency in addition to positions at New Jersey Transit, the Bi-State Development Agency in St. Louis, Missouri, and the RTD. Organizational charts for the RTD were also obtained as part of this analysis.

The RTD has followed a semi-integrated organizational strategy in deploying their light rail system. The agency started a new division well ahead of the opening of the system and chose this

organizational strategy to ensure that the LRT system received that special attention that it required early in its development. Given the agencies desire to expand the system dramatically, this organizational strategy seems quite appropriate. The operations, transportation and maintenance functions associated with the LRT system are separated from those of the bus system. The two systems are even operated from separate control centers. Interestingly, Denver is researching the concept of having station managers coordinating activity at the more important rail stations in terms of bus route connections. The service planning and scheduling is unified for the two services leading to effective coordination of rail and bus schedules. This coordination is extremely important in the Denver system expansions since LRT stations will serve as key transfer and connection points in the bus network.

The system development functions associated with the LRT system have been both integrated into the overall planning and development department within the RTD and separated at different points in time. The rationale for having a separate planning and development department early in the deployment of the LRT system was to ensure that proper attention was given to the activity in the beginning. Now that the initial system is operational, planning extensions is a less demanding, ongoing process, not needing the attention it once did.

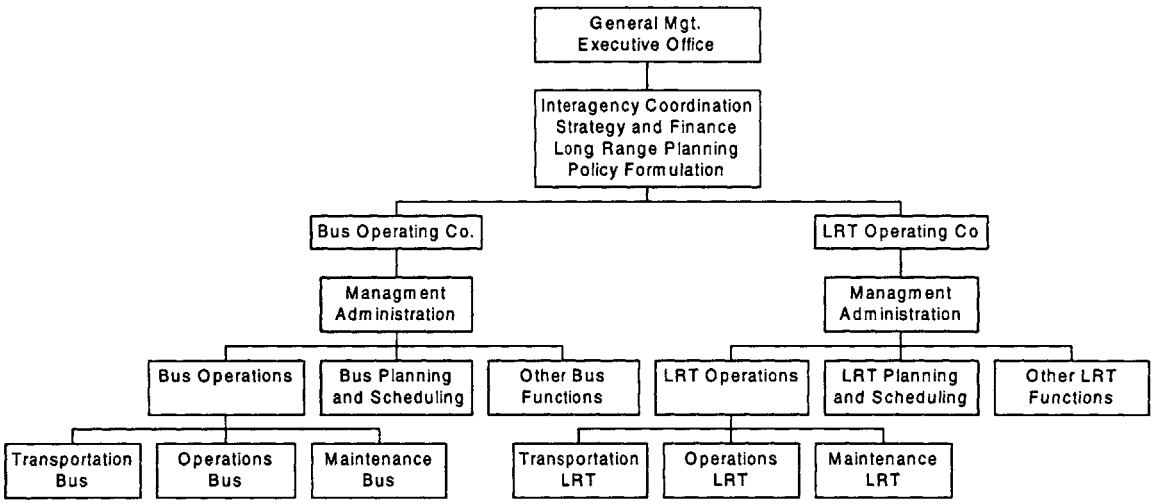
One of the most interesting aspects of the Denver LRT deployment is the agency's approach to design of the LRT system infrastructure. The RTD is performing most of its design in-house with only structural and other specialty designs contracted-out. This strategy is quite opposite of the trend toward design-build contracting of infrastructure projects and provides an interesting contrast to the approach taken in other cities including San Juan, Puerto Rico. One of the main benefits of this procedure is that agency personnel who will one day be operating the systems retain the design expertise associated with developing the system. The RTD states that it has also realized significant cost-savings with this approach. The principal disadvantage is that the agency struggles to retain its staff in the face of stiff competition for skilled workers.

**Umbrella Structure**

A modal structure is employed with separate, independent operating departments or agencies for

each mode. These operating departments fall under an umbrella organization that coordinates transit in the region. In this structure, there is an agency similar to a regional transportation board that coordinates policy and financing for transit. Reporting to this agency are "transit companies" that provide different services and are entirely independently responsible for the administration, planning, management, operation, and maintenance of each of the modal services. In this structure, the services are separate, but connected by a higher level agency that oversees the operation of each.

**FIGURE 7-5**
**UMBRELLA STRUCTURE**




The umbrella structure is quite different from the previous two in terms of advantages and disadvantages. One of the key advantages of the umbrella structure is that it allows the separation of the policy formation and lobbying duties placed on transit systems from the planning, operations and maintenance duties. This separation allows the system managers to actually manage the system while allowing the umbrella organization to worry about the long-range, strategic concerns. This structure further facilitates many of the advantages of the semi-integrated structure in terms of labor contracts, worker expertise and management. In fact, the labor of the various operating companies is isolated from that of the others.

In terms of disadvantages, the level of bureaucracy associated with the transit community is increased, and, in fact, is the highest of any of the four structures. Furthermore, the advantage of

coordinated scheduling, marketing and other administration is entirely lost in this structure. Operations coordination is even more remote a possibility in this structure than the previous one.

This structure is well suited to larger agencies with systematic labor and operations problems. The structure allows service managers to focus on the service provision while others worry about the political environment and policy formulation. The structure also isolates the new service from many of the bad traits of the old service. Unfortunately, this structure is not well suited to providing coordinated service between the modes.

*Metropolitan Transportation Development Board (MTDB) – San Diego, California*

The MTDB in San Diego is an example of an umbrella organizational structure. Various performance characteristics of the MTDB system are shown in the table below. In the case of the MTDB the bus system is more twice the size of the rail system. The efficiency in terms of cost per revenue mile of the two modes is approximately the same. The bus system is more expensive in terms of passenger miles and more effective in terms of ridership per vehicle mile.

## TABLE 7-3: MTDB SYSTEM CHARACTERISTICS

| Characteristic | Bus | Light Rail |
|---|---|---|
| Annual Vehicle Revenue Miles | 11 million | 5 million |
| Operating Expense/Revenue Mile | $4.97 | $4.58 |
| Operating Expense/Passenger Mile | $0.37 | $0.19 |
| Unlinked Passenger Trips/Vehicle Revenue Mile | 3.48 | 3.16 |

Source: National Transit Database

The LRT system in San Diego, California is the oldest of those studied in this paper. It was deployed more than 10 years earlier than either of the other LRT systems. Although the system is much larger in terms of mileage and more established, it is included to present a case of the umbrella organizational strategy.

A telephone interview was conducted with Thomas Larwin, the General Manager of the The Metropolitan Transportation Development Board (MTDB). This organization is the coordinating

and policy board that operates the San Diego Trolley (LRT), San Diego Transit (Bus) and several other services. The MTDB was established by an act of the California State Legislature in 1975. The structure evidenced in San Diego is a result of legislative action rather than any thoughtful decision by the system planners. The theory behind the organizational structure was to separate the development and policy functions from the day to day operations of the various services.

The MTDB coordinates all pre-operations planning and stays entirely out of operations. In this role, the MTDB controls all state and federal financial assistance flowing into the region. The MTDB also sets the fare and transfer policies between the various operators in the region, but does not make any special effort to ensure that the schedules of the agencies facilitate these connections. Contrary to this statement, the MTDB does operate 22 transit centers at which it exercises some minimal control over connections at these facilities.

The interview suggests that the principal advantages of the umbrella strategy are:

- The managers of the individual transit services can do a better job of actually operating the service without concern for strategic vision.
- The upper management of the MTDB can set their sights more strategically and focus on policy issues of regional significance including land use control, growth management and system development.
- Efficiency is improved by this structure (supported by attached service efficiency data).

Other individuals interviewed as part of the other case studies point out some disadvantages of this structure. These disadvantages include:

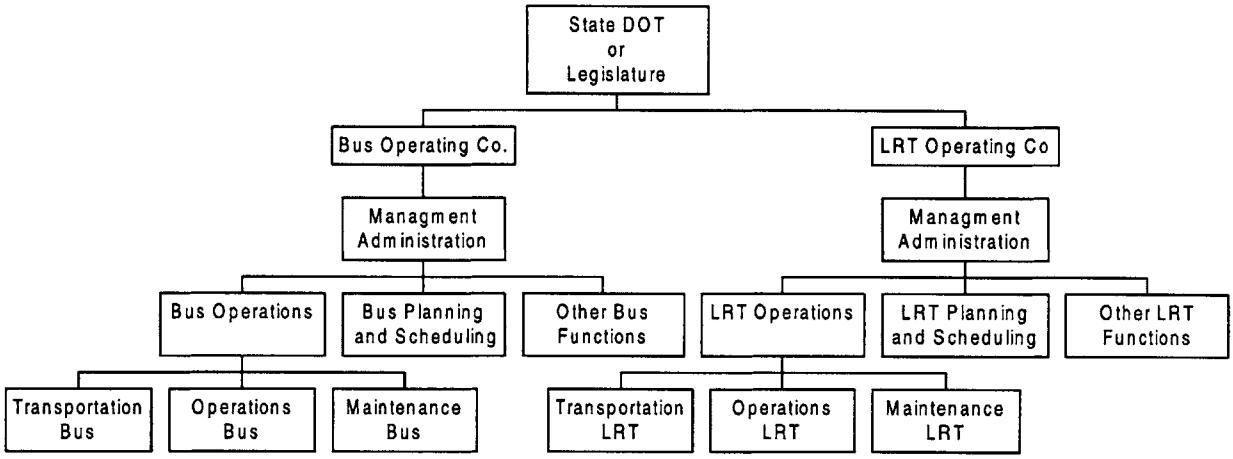
- Coordination between the modes is poor resulting in reductions in service quality and potentially ridership.
- The transit community in the region does not take advantage of the economies of scale that can be realized by combining some of the administrative functions of the operating agencies.

**Distinct Structure**

A fourth structure creates separate, distinct organization for the new mode. This new organization

is not tied to the existing transit agency except for at a higher level of government, i.e. a Department of Transportation level. In this structure, each modal agency is responsible for its own policy setting, financing, administration, planning, management, operation, and maintenance. There is little coordination between the modal agencies except perhaps at the state DOT level.

## FIGURE 7-6
## DISTINCT STRUCTURE




The distinct structure further separates the modal agencies. An advantage of this structure is that a level of bureaucracy and expense associated with transit service is eliminated from the umbrella structure. This structure also allows the complete separation of the modal agencies completely isolating the new service from the dysfunctional aspects of the older service.

The distinct structure requires the removal of the umbrella organization; this has some serious disadvantages as well. Coordination of any type between the modal agencies is problematic in this structure. Furthermore, the political and policy formulation duties and roles of the transit managers are not coordinated. This structure could result in modal managers in conflict with each other in the political arena when arranging financing. Also policies between the two agencies could be in conflict with one another. In this structure, Department of Transportation administrators will be faced with many additional challenges that are resolved at a lower level in the other structures.

This structure seems well suited to deployments of new service in a region where the existing service is entirely dysfunctional. The additional disadvantages and marginal administrative cost savings associated with this structure make it unattractive compared with the umbrella structure in any other situation.

*Metropolitan Bus Authority (AMA), Puerto Rico Highway and Transportation Authority (Metrobus), Tren Urbano – San Juan, Puerto Rico*

The public transportation system in San Juan, Puerto Rico is an example of the distinct structure. The development of the Tren Urbano heavy rail system is much further along in the planning and development process than the LRT initiative in Houston. This deployment presents picture of the distinct organizational strategy followed given the political environment surrounding the bus operations in the city. A telephone interview was conducted with Jim Wensley, an analyst with Multisystems, one of the consultants to the Tren Urbano project

For San Juan, no service characteristics for the rail system are applicable since it is not yet operational. The two principal bus operations are compared in the table below. It appears that the Metrobus system outperforms AMA in all measures considered.

## TABLE 7-4: AMA AND METROBUS SYSTEM CHARACTERISTICS

| Characteristic | Bus (AMA) | Bus (PRHTA) |
|---|---|---|
| Annual Vehicle Revenue Miles | 4.7 million | 0.9 million |
| Operating Expense/Revenue Mile | $7.01 | $5.23 |
| Operating Expense/Passenger Mile | $0.45 | $0.35 |
| Unlinked Passenger Trips/Vehicle Revenue Mile | 4.07 | 4.45 |

Source: National Transit Database

There are two existing bus systems in the city, the AMA system operated by the regional transit authority and the Metrobus operated by the highway department. The development of these two separate systems provides insight into why Tren Urbano is being developed independent of the bus system.

The AMA system is known for its ineffectiveness. This ineffectiveness led to the development of express bus service by the highway authority. At the same time, the name of the highway authority was changed to the Puerto Rico Highway and Transportation Authority. This agency also has authority for planning bus system changes within AMA. In the case of San Juan, evidence indicates that all policy decisions are made at a DOT or gubernatorial level.

Apparently, new system development is occurring without input from the bus authority. In fact, other agencies are planning future bus system changes facilitated by contracts with the highway authority. There is not expected to be any coordinated fare or transfer policies between these two systems upon opening of Tren Urbano, although these decisions are not finalized at this time.

Any impetus for integrating bus and train service in San Juan is coming from Federal Transit Administration (FTA) pressure to coordinate bus and rail planning. The FTA is encouraging the Tren Urbano planning to develop some feeder bus routes to ensure high ridership on the train system. It remains questionable whether this Federal pressure will continue when expansions of the Tren Urbano System are planned and developed. If ridership reaches the projected levels, this pressure is likely to disappear.

The distinct agency structure employed by San Juan in the development of Tren Urbano is intended to isolate the train system from the historic weakness of the bus operating agency. The Commonwealth of Puerto Rico is hoping that Tren Urbano will have an image of reliable, upscale transportation and it is believed that an association with the poor image of the AMA systems is not beneficial to this goal. This strategy will require more decision-making at higher levels of government, especially since the Tren Urbano system will be operated by a private contractor upon completion, but the system is protected from the dysfunctionalities of the bus system.

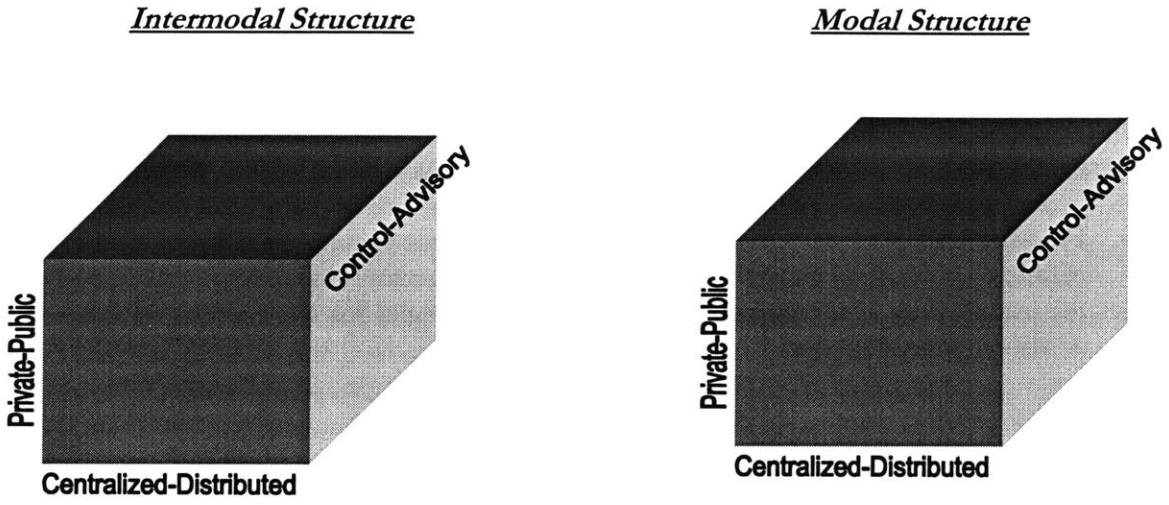
## SCENARIO EVALUATION OF ORGANIZATIONAL MODELS

Finally, we must consider how these organizational strategies defined for ITS deployment and LRT service implementation can be evaluated in scenarios. This section will describe the ways in which the analysis of organizational strategies is similar to and different from infrastructure and policy

strategies. This section will also propose a framework for evaluating these strategies.

There are several axes of variation between the organizational strategies developed in the previous two examples. There is a centralization-distribution axis, an advisory-control axis, and a public-private axis. These degrees of variation are shown in the figure below.

## FIGURE 7-7
## VARIATIONS IN ORGANIZATIONAL STRUCTURE




An additional degree of variation is the intermodal-modal focus of the organizational strategies. In other words, whether the organization views the operation as one cohesive service, or as several modally separate services. This choice is essentially binary in that the organizational strategy is either one or the other. Regardless of the scenario, an intermodal focus is likely to allow the organization to operate the transportation system more effectively. An intermodal focus allows the system operators to consider shifting demands between different modes and to plan for connections between these modes. A region can use the management, information and control requirements developed in the regional architecture to choose between possible combinations of these four organizational characteristics.

## *Scenario Drivers, Key Local Factors and Organizational Strategy Impacts*

Scenario drivers play-out in the local environment in ways that will impact the different organizational strategies. The possible effects of each of these scenario drivers on the key local factors and different organizational strategies are outlined below. To recap, these scenario drivers are:

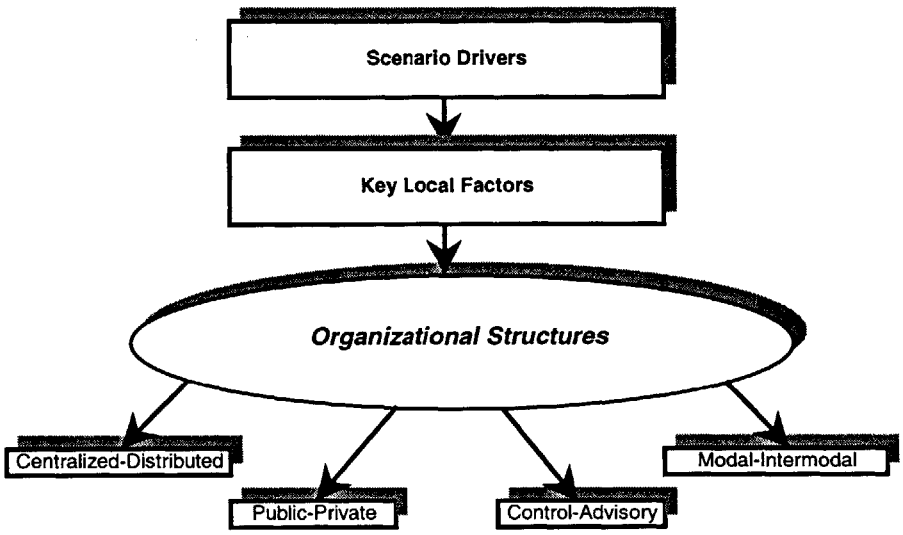
5. **Economy** – Major shifts in the global and national economy and economic shocks.
6. **Environment** – Changes in environmental policy and enforcement at the national and international levels.
7. **Technology** – The development of significant transportation technologies that improve the functionality of the transportation system.
8. **Finance** – The willingness of the national government to fund infrastructure maintenance and development in the region. This scenario driver also considers the market for private finance of transportation strategies for the region (CMP-ReS/SITE2 15)

The key local factors are:

- The health of the local economy,
- Local environmental policies and attitudes,
- Demographics,
- The level of federal and state government investment and control, and
- Local Politics.

The effect of the different scenario drivers on the key local factors, and thus the organizational strategies the region could employ are shown in Figure 7-8 and described in the following sections.

## FIGURE 7-8
## SCENARIOS AND ORGANIZATIONAL STRUCTURES




### *Economy*

While the economy is one of the most important drivers in determining the necessity and viability of infrastructure and policy strategic options, it becomes less important when looking at organizational strategies. Nevertheless, there are economic effects on the key organizational aspects differentiating the options.

As one would expect, the economy driver has the greatest impact on the health of the local economy and local politics. The economy scenario driver also affects demographics by influencing the attractiveness of the region to immigrants. The economy can also have significant effects on people's residential choices within the region. Both of these factors can change the income distribution of the regional population and change regional development patterns. Economic effects can influence local politics by changing the general public's perception of their leaders and by motivating the regional decision-makers to improve the regional economy.

The economy driver, played out through the key local factors can influence the organizational strategies in the following ways.

- **Centralized-Distributed** – A centralized ITS organization is likely to be more efficient in terms of personnel requirements and its ability to attract qualified employees is likely to be greater. In times of rapid economic growth, the organizations often struggle to attract and retain qualified help. Therefore a growing economy is likely to favor a centralized model with lower human resources requirements. An economic downturn is likely to make these personnel concerns less important to a public sector agency as talented professionals will be more readily available and the individual agencies will probably be able to meet their staffing requirements in a decentralized model.

  The impacts for a transit system are similar. Given a growing economy, finding and training workers will be challenging for the transit agency. This difficulty will be exacerbated by the fact that demand for the services is likely to be much greater in good economic times. These conditions tend to favor a centralized model in which the shared resources of the bus and LRT services can be most efficiently deployed to provide the right mix of services. In a contracting economy, ridership is likely to fall and workers will be readily available. In this case a more decentralized model that insulates each operation from the problems of the other is likely to perform better.

- **Public-Private** – Again, economic growth will likely improve the marketability of traffic information through commercial channels and attract greater participation of the private sector in the development of the system. Likewise, an economic downturn will make this participation less likely as private firms are likely not to invest in the new business area.

  In the transit example, a private contractor may operate on a fixed fee basis, which implies that ridership changes are likely to be unimportant. If the contract includes incentives and penalties for ridership changes, a growing trend in these contracts, the economy will greatly impact their willingness to participate and the price they are likely to charge the agency.

- **Control-Advisory** – The economy is a factor that does not have much effect on whether a control or advisory organizational structure is more appropriate for a region. However, in the

case of growing demand, a system control strategy might help both the ITS and transit agency manage the transportation system's capacity more efficiently.

- **Modal-Intermodal –** An intermodal system is likely to perform better under conditions of rapid economic growth since the demands placed on the system are likely to be greater, requiring a better utilization of existing capacity. A slowing economy makes this intermodal focus less important since the demands placed on each individual mode are likely to be less than the mode's capacity.

## *Environment*

At first glance, one might think that the environmental scenario driver is really marginalized in the case of organizational strategies. While less important than the other three, this driving force does impact the differences between the organizational strategies. The environment scenario driver has a significant influence on all of the key local factors.

Changing environmental policies at the national and international level can impact the health of the local economy by impacting the operation of local industries. The most significant impact of global environmental policies is on the local environmental policies and attitudes. These local policies and attitudes have to adapt to meet the requirements placed on the region by higher levels of government. Demographics are influenced by the environment driver primarily though its economic effects and changes in the regional development pattern. Changing environmental constraints may cause changes in the land available for development and the viability of different travel patterns in the region. The level of federal and state government investment and control, is a function of the region's conformance with federal and state environmental regulation. If the region does not take measures to meet these regulations, it will likely suffer from punitive measures implemented by these higher levels of government. Local politics influenced by all of these effects described above. Changing environmental constraints can radically change the face of local politics by increasing tensions as the region struggles to meet new requirements.

These interactions between scenario drivers and key local factors impact organizational strategies as

described below.

- **Centralized-Decentralized** – The environment scenario driver is likely to have little impact on effectiveness of various degrees of centralization in the organizational strategies. One minor advantage might be the coordination of environmental permitting. One could suppose that a centralized model would facilitate this operational aspect. This advantage is likely to be more significant for the capital-intensive transit service than the information intensive ITS service.

- **Public-Private** – The degree of environmental constraint placed on the region will have a greater influence on the private sector's willingness to participate in either of these initiatives. In the case of ITS, new environmental regulation may make roadway improvement projects impossible creating a high demand for the capacity management capabilities of ITS. This high demand will improve the viability of private sector participation in ITS. A decline in environmental regulation could facilitate the construction of new infrastructure reducing the demand for ITS services and subsequently reducing the private sector's willingness to participate.

  Similarly, the LRT system could be seen as an environmentally friendly alternative to automobile travel, which might be curtailed by government regulation. Regulations increasing the cost of automobile travel or mandating reductions through other measures may increase the demand for the LRT system and its financial viability. Likewise, a renewed love affair with highways and the automobile will reduce the motivation for private sector participation in the transit organization.

- **Control-Advisory** – A control-oriented strategy is likely to help these agencies cope with new environmental challenges better than an advisory structure. A control strategy allows the agency to coordinate environmental response from an organization-wide perspective, allowing a better appreciation of the possible environmental consequences of new initiatives. A declining emphasis on the environment is likely to reduce the need for a control strategy. In this case either the ITS or the transit service could handle environmental matters in a more advisory function.

- **Modal-Intermodal** – An intermodal focus is more appropriate in a situation where environmental constraints and concerns are greater. Intermodalism allows the operating agencies to look at different strategies across different modes and decide on the option with the least impact. A modal strategy does not offer this advantage. In times of declining environmental concern, an intermodal focus is less important from an environmental perspective.

## *Technology*

Technology is a more significant driver of both ITS and LRT deployment than the environment or even the economy. Advancing technology has proven itself an enabler of communication, one of the most critical determinants of organizational performance. Technology also impacts the key factors that determine the local manifestation of the scenario.

Technology impacts the health of the local economy by changing the competitive position of local industries. Technology can enable these industries to deal with environmental, financial and transportation constraints in new ways, improving their ability to compete in the global economy. Technology impacts the local environmental polices and attitudes by changing the region's ability to monitor and control its environmental impact. Technology can also affect demographics by changing the spatial distribution of people in the region since it enables teleworking and other substitutes for travel. The effects of technology on federal and state investment and control are likely to include funding for technological deployments and improved monitoring of regional conformance to various regulations. Again, all of the effects listed above will impact local politics by changing people's needs and the constituencies on which the political process is based.

Some effects of the technology driver on different organizational strategies are presented below.

- **Centralized-Decentralized** – While advanced communications technology allow workers in different locations to work together much more easily, they do not have the power to overcoming the political and bureaucratic boundaries between workers. Rapidly advancing technology could facilitate an efficient decentralized ITS organization by improving

communications between the controllers in different agencies. Advancing technology in other fields could reduce the demand for ITS by permitting more telecommuting and other alternatives to travel. Stagnating technology is likely reinforce the advantages of a centralized organization as travel continues to grow and communications between agencies remains weak.

The organizational models for the transit agency are likely to be impacted in similar ways by changes in communications technology. These technologies may also improve worker performance by allowing increased monitoring of job performance, reducing some of the motivation for the less centralized models.

- **Public-Private** – Advancing vehicle technologies may allow more channels of information to reach the driver increasing the marketability of traffic information services. These communications advances may also improve the efficiency of the ITS operation making it even more attractive to the private sector. Changing propulsion methods may also overcome some environmental obstacles to automobiles retaining a large market for these commercial services.

  Much as in the case of ITS, advancing or stagnating technology can affect the demand for transit services and the efficiency of their production, both factors that affect the viability of the LRT system for private sector participation.

- **Control-Advisory** – Advancing technology facilitates a both advisory and control strategies. Communication between controllers and operators in the field improves for both the ITS and LRT system. These communications technologies allow a central decision-maker to be better informed about events in the system and make better decisions. With a stable technological environment, a central decision-maker probably will not have adequate information to make good decisions about dealing with problems on the network. In this case, an advisory structure will probably work more effectively.

- **Modal-Intermodal** – In a similar way, intermodalism can benefit from advancing technology. These technologies can provide better data about the operation of all components of the

transportation system, allowing operators to plan for better connections between modes. Furthermore, as you move toward an intermodal approach for operating the transportation system, the complexity of the decisions made increases. Advancing technology can help a decision-maker cope with this growing complexity by providing needed data and decision support tools.

## ***Finance***

Finance is perhaps the most important scenario driver for these organizational strategies. It has large impacts on all axes of variation between the models. Like the other three scenario drivers, finance impacts all of the key local factors. The ability of local industries to draw upon the international credit markets affects their abilities to reinvest in facilities to maintain their competitiveness. Limited financial means can hurt the region's ability to cope with new environmental challenges. Finance, through public and private sector investment can affect the population distributions in the region in terms of income and spatial distribution. Federal and state governments often use financial tools as a way to control local decisions, a direct impact of the finance driver on the key local factors. Finance is a key concern of the local political process and will undoubtedly impact the local political atmosphere. Politics can become more contentious as the financial means of a region are constrained, likewise cooperation can develop when funds are readily available.

Possible impacts of the Finance driver on different organizational structures are described below.

- **Centralized-Decentralized** – A centralized ITS organization is likely to be more efficient in terms of personnel requirements and its ability to attract qualified employees is likely to be greater. In times of financial constraint, ITS is likely to face budget and staff cuts. Maintaining an efficient operation is key to surviving these times of shortage. On the other hand, distributing staff among many agencies may prove a successful strategy for hiding the cost of the operation and avoiding budgetary scrutiny.

The impacts for a transit system are similar. A centralized model, in theory may allow the agency to accomplish more with fewer resources, but a decentralized model may help preserve these resources in times of scarcity. In both cases, the different models have different implications for obtaining funding for their activities.

- **Public-Private** – Financial constraint on the public sector side is likely to make entering a public-private partnership more attractive as the agencies struggle to provide the services demanded. Financial constraints on the private sector side will have the opposite effect, as the private sector is unable to cover the financial burden of entering into the partnership. The implications are similar for both examples.

- **Control-Advisory** – A control-oriented strategies usually require more initial investment in capital facilities such as control centers, communications networks, and computing facilities than advisory systems. An advisory system can be based on more traditional, less detailed data flows between organizations. In the long run, a control strategy will likely have lower staffing requirements than an advisory strategy where each agency will have its own control mechanisms.

- **Modal-Intermodal** – For both the ITS organization and transit agency, an intermodal strategy is better suited to times of financial constraint since it allows the agencies to choose between different modal strategies, choosing those with the lowest cost and best performance. If financing is readily available, a modal strategy is likely to operate adequately since prioritization between projects is less important.

## *Scenario Driver and Key Local Factor Interactions*

The previous section demonstrates how the various scenario drivers can influence the performance of different organizational strategies. Looking at these strategies in the context of scenario drivers, is only part of the story. The scenario driver combinations and impact on key factors described in the scenario narratives may, in some cases, be complementary, driving the choice toward one particular organizational model. In other cases, the combinations might be contradictory moving the choice toward the center. In either case, the organizational strategies need to be considered in terms of the

entire scenario, not simply the effects of the drivers. The previous section is intended to simply highlight how different drivers can influence key factors and the performance of different organizational models in different scenarios.

## A Framework for Evaluating Organizational Strategies

Looking at different organizational strategies is not terribly different than looking at policy and infrastructure strategies. The only real difference between these types of options is that organizational strategies are a way to facilitate operations while capital and policy strategies are usually intended to increase the supply or control demand for transportation services. Organizational strategies deal with the implementation of these other types of strategies. Organizational strategies look at the way the system is operated and offer different possibilities for improvement.

To review, the Mobility-ReS/SITE team established a multicriteria analysis framework for evaluating strategic options. This framework is based on three feasibility criteria:

1. Financial,
2. Institutional, and
3. Environmental.

And three effectiveness criteria,

1. Accessibility,
2. Goods Movement, and
3. Equity.

Each of the strategies is given a score from 1 to 10 with 10 indicating good performance. These scores are totaled for each strategy in each scenario and then aggregated to form a composite analysis across all scenarios. In this composite analysis, the strategies with the highest total score are considered the most robust. An illustrative sample of this evaluation procedure is shown in Table 7-5 below.

## TABLE 7-5:
## POLICY AND INFRASTRUCTURE OPTION EVALUATION

| Strategic Option | Financial | Environ-mental | Institutional | *Feasib-ility* | Access-ibility | Goods Movement | Equity | *Effective-ness* | Combin ed |
|---|---|---|---|---|---|---|---|---|---|
| System Maintenance | 8 | 9 | 10 | *27* | 10 | 10 | 10 | *30* | 57 |
| Grand Parkway | 7 | 8 | 8 | *23* | 8 | 7 | 6 | *21* | 44 |
| Expanded HOV | 8 | 8 | 10 | *26* | 7 | 3 | 7 | *17* | 43 |
| I-69 | 7 | 8 | 10 | *25* | 4 | 9 | 4 | *17* | 42 |
| Airport Expansion | 8 | 8 | 10 | *26* | 8 | 3 | 3 | *14* | 40 |
| Port Expansion | 8 | 8 | 10 | *26* | 2 | 10 | 2 | *14* | 40 |
| Congestion Pricing | 9 | 10 | 3 | *22* | 7 | 5 | 5 | *17* | 39 |
| Automated Highways | 4 | 10 | 5 | *19* | 8 | 5 | 4 | *17* | 36 |
| Light Rail | 10 | 10 | 6 | *26* | 3 | 1 | 4 | *8* | 34 |
| Growth Management | 10 | 10 | 3 | *23* | 3 | 4 | 2 | *9* | 32 |
| High Speed Rail | 5 | 7 | 6 | *18* | 6 | 3 | 3 | *12* | 30 |
| Heavy Rail Transit | 6 | 8 | 6 | *20* | 3 | 2 | 4 | *9* | 29 |

(Source: CMP-ReS/SITE Table 3)

The criteria necessary to evaluate organizational strategies are slightly different. You can still consider feasibility and effectiveness; however the components of these measures will change. When talking about organizational strategies, all of the feasibility questions are institutional and financial, not environmental. When talking about effectiveness, all of the measures must be changed. New descriptions of feasibility and effectiveness criteria are described below.

### *Feasibility*

For institutional strategies, feasibility is measured against in four criteria.

- **Budgetary** – Are the financial resources needed to implement the new organizational structure available, and will the budgetary commitments demanded by the new structure be sustainable?
- **Political** – Is there political will to implement the organizational strategy, and, if not, can it be developed?
- **Resources** – Are there adequate facilities (buildings) and support structures, (human resources, office supplies, etc.) to support the organizational strategy, and, if not, how easily can they be developed?

- **Human Resources** – Can the human resources challenges to the new organizational structure be overcome and are there adequate skills and labor to staff the new organization?

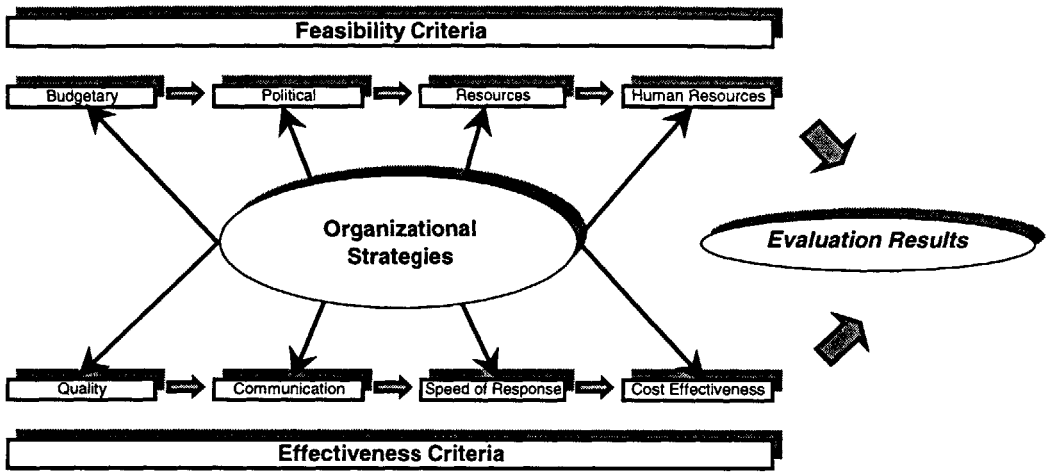
## ***Effectiveness***

The effectiveness measures for organizational strategies are much more nebulous. Organizational strategies are an enabler of operations, and, therefore, many of the effectiveness criteria are indirect measures of the strategies performance. Four effectiveness criteria are described below.

- **Quality** – Does the organizational structure provide the service with a high degree of quality for the end user?
- **Communication** – Are the lines of communication and responsibility within the organization clear and easy to follow?
- **Speed of Response** - Aside from how well the organization provides service, how quickly does the organization respond to new challenges?
- **Cost Effectiveness** – Does the organizational structure meet its performance objective in a way that minimizes its consumption of financial resources?

One could then evaluate these strategies using the framework similar to that shown in Table 7-5 (but distinct from the analysis of policy/regulation and infrastructure strategies) by ranking each of the eight criteria, looking at the best performing organizational strategy in each scenario and looking at a composite ranking. This organizational strategy evaluation framework is shown in Figure 7-9 below.

**FIGURE 7-9:**
**ORGANIZATIONAL STRATEGY EVALUATION**




## CHAPTER SUMMARY

Regional architecture serves as a tool to think about the region's philosophy toward controlling the transportation system and can help to develop different organizational strategies. These organizational strategies are an important part of the strategic options available to a region. This chapter presented examples of organizational strategies based on case studies of ITS and LRT implementations. These organizational models essentially vary in several dimensions:

- the centralization of processing,
- the level of private sector participation,
- whether the structure is intended to be controlling or advisory, and
- whether it is intermodal or modally oriented.

These dimensions, or axes, were used to show how the scenario drivers might influence the performance of organizational strategies in the scenario framework. A method for evaluating these strategies based on feasibility and effectiveness is proposed.

# 8

# REGIONAL EXTENSIONS BEYOND TRANSPORTATION

Chapter 3 discusses how transportation strategies are only a part of the total package of options available for a region to consider. For example, Muñoz describes how Mendoza's overall regional goal is fostering the "generation of sustainable economic development that improves the living conditions of the population" (Muñoz 187). Four different groups of strategies have been identified to help Mendoza work towards this goal. These strategic areas are:

- Information Technology,
- Transportation,
- Industry Competitiveness,
- Energy/Water Resources, and
- Other Possibilities.

Transportation is really only part of the strategic puzzle Mendoza must solve to provide conditions that will spur economic development for the region.

This chapter focuses on the strategic nature of regional planning. It considers how a region can consider a broad range of strategies to position it competitively in the global economy. The chapter

proposes that using scenarios for regional strategic transportation planning is an important endeavor, but only a piece of the puzzle. Scenarios should be used as part of a comprehensive regional strategic planning process involving both the public and private sector providers of public services. Expanding the scope of scenarios beyond transportation in regional planning is not as complicated as one might think. In fact, important lessons can be drawn from the experience of large, multinational companies in order to frame this problem. In fact, the scenario exercises developed by Royal Dutch Shell, as described by Pierre Wack help to formulate this vision for comprehensive strategic planning of public services in a region.

## WHY RSTP; WHY NOT RSP?

Regional strategic transportation planning is an activity that is well suited to the application of a scenario-based methodology. The future demands on a regional transportation system are uncertain and different transportation strategies are better suited to different potential futures. Transportation strategic options often have long lead times and high capital costs reinforcing the importance of looking at the robustness of these investments over many possible future outcomes.

While the transportation sector provides fertile ground for scenario application, transportation is only part of the strategic actions a region needs to consider when positioning itself competitively in the world economy and environment. The needs of a modern society are served by many interdependent systems of infrastructure and services. All of these systems are important to developing competitive advantage for a particular region, and strategies for each can be viewed through the lens scenarios provide. As Gordon Bethune, The Chief Executive Officer of Continental Airlines says in his book *From Worst to First: Behind the Scenes of Continental's Remarkable Comeback*, "Which Part of This Watch Don't You Think We Need?" (Bethune 126) when talking about how all aspects of the airlines operation deserve equal attention. This point is relevant to developing a strategic plan for the competitive region. Paying attention to only one part of the strategy, like transportation, is inadequate. One really needs to look at all of the interdependent systems that allow a region to function and compete in the global marketplace. The point here:

*Scenarios can help a region look at these systems in an integrated fashion.*

## Interdependent Systems

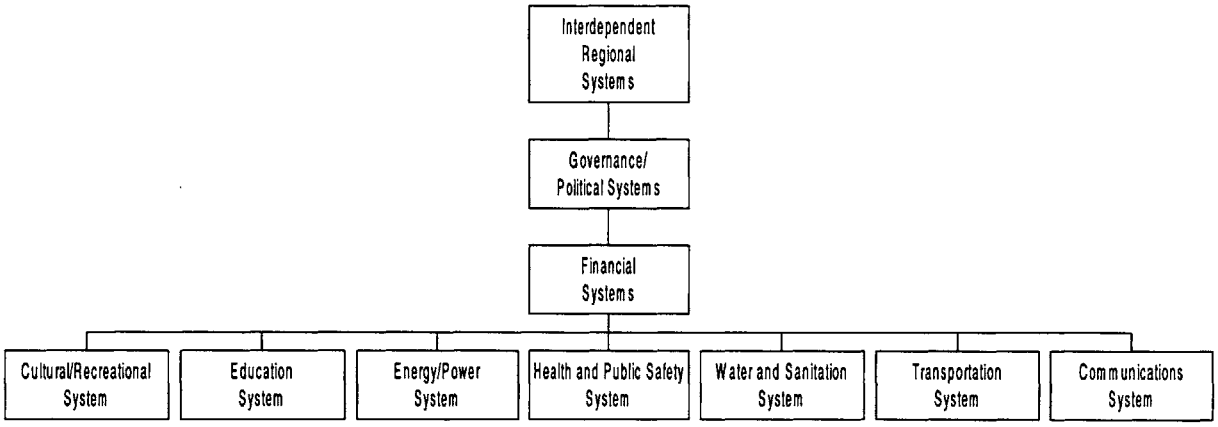
Meeting the needs of a population in modern society is far more complicated than ensuring that the transportation system provides adequate mobility and accessibility. The competitive position in the world economy of a region is determined many factors; mobility within the region and access to world markets are only two of these. Developing a comprehensive strategic plan for a region requires that the planner think carefully about geographically dispersed large-scale systems that provide services and resources. Meeting the needs of a competitive region requires thinking strategically about the development of nine interdependent systems of services that support economic development in a region. These systems are:

- Transportation Systems,
- Water and Sanitation Systems,
- Communications Systems,
- Power/Energy Systems,
- Education Systems,
- Public Safety and Health Systems,
- Cultural/Recreational Systems,
- Financial Systems, and
- Governance/Political Systems.

Each of these systems is important to the competitive position of a region especially given the new global economy. Each of these systems determines the needs for and demands placed on the other systems. Some of these systems are developed and maintained by the public sector or public-private partnerships while others fall entirely within the realm of the private sector. These distinctions do not impact the need to consider the integrated future of these systems and do not curtail the region's ability to plan for the future. Each of these interdependent systems and their importance to the

competitive stance of a region are shown in Figure 8-1 and described below.

**FIGURE 8-1**
**INTERDEPENDENT REGIONAL SYSTEMS**




## *Governance/Political Systems*

One of the most important competitive attributes of a region is a stable, effective government that operates based on a predicable political system. Regions with moderate degrees of political instability and poor government provision of basic services are rarely successful in attracting investment and economic development. Establishing a government based on a solid foundation is key to positioning a region for competition in the global economy. Governance and political systems set the groundwork for all of the other regional systems listed.

## *Financial Systems*

Financial systems are important for both the public and private provision of services. All of the other systems shown in Figure 9-1 depend on access to funds for expansion, maintenance and investment in their operation and infrastructure. Government revenue collection and the institutions responsible for managing these resources are the public sector component of these systems. Capital markets, the private sector component of a regional financial system are important

so that firms can attain the resources they require to make strategic investments in facilities, training and production.

## *Transportation Systems*

Much has already been said about transportation systems in this document. Transportation provides several functions in a region. Transportation permits the movement of people and goods around the region facilitating access to residential, employment, shopping and recreational opportunities. Transportation systems are a facilitator of activity in a geographically diverse region, since they allow travel between metropolitan areas and their hinterlands. Transportation also opens new areas within a metropolitan region for development and expansion. Finally, transportation systems serve as a link to the world economy. Transportation systems tie regions together and permit activity to develop in new parts of the world while drawing on the intellectual and natural resources established in other parts of the world.

Developing transportation systems that meet these needs effectively is a key strategy for a region to pursue in meeting its goals. Without the efficient movement of people and goods into, through, and within a region, its competitive prospects are small.

## *Water Systems*

Clean water supplies and effective wastewater disposal are keys to a successful metropolitan area. The Desert Southwest in the United States and many cities in the Middle east demonstrate that the water need not be abundant in the immediate vicinity of the metropolitan area to allow the growth and development of a region. Even in regions with abundant water supplies, providing systems that allow for its treatment and distribution is a large endeavor. Water is a sustainer of life and ineffective water supplies can lead serious public health and industrial productivity problems. Planning these water systems is an essential part of any strategic plan for a region. The region must think about what sources of this resource are available, how these sources can be made suitable for use, and how these resources can be distributed through the region. The demand for water resources is a function of population and economic activity and the geographic distribution of this

activity determines the complexity of the system.

Water systems are closely tied to transportation systems since expansions of the transportation systems must often be accompanied with expansions of the water systems in a region. Furthermore, the water system in a metropolitan area often uses transportation right-of-way, creating a key link between the maintenance needs of both systems. Often however, the coordination between the organizations responsible for building, operating, and maintaining these systems is minimal.

## ***Education Systems***

A good education system is needed to prepare a workforce capable of competing in the modern economy. Investment in other regional strategies without readying the population of the area to participate in any new opportunities that develop will result in limited quality of life for these people. There are two important pieces to an education system. The first of these is intellectual, curricula and teaching skills. The second is the physical facilities such as schools, classrooms, and communications networks. The future of the educational system and what it will require is just as uncertain as what the future of the transportation system will be. Several questions impact what might be needed from this system in the future.

- What effect will advancing technology have on educational content and techniques?
- What skills will the future economy require?
- How will education be delivered to the residents of the region?

Scenarios can help to inform decision-makers in the region as to what possible answers to these questions might be.

## ***Communications Systems***

Communications systems have demonstrated their impact on society as we move toward the 21st Century. Their impact on all of the activities in society has been great and the limits of this technology are unknown. In many cases, communication can be substituted for transportation making previously inaccessible locations attractive. These networks can be traditional cable-based

networks, or wireless networks relying on transmission technologies. Provision of these networks is often a private sector activity, directed in many cases by public sector regulation. Scenarios can help the planners of these systems to decide what type of system to develop in a region, by developing different pictures of what the potential demands might be, and where key parts of the system should be located.

## ***Power/Energy Systems***

Improving the competitive position of a regional economy requires a dependable supply of inexpensive energy to power industry, transportation, and the service economy. All of these other systems mentioned rely on energy, electricity, natural gas, petroleum or other fuels. All of these power systems require sources and distribution networks. Unlike communications systems, power and energy systems usually require a cable- or pipeline-based distribution network. Raw fuel stocks such as petroleum, or coal can be transported using rail and highways, but they still require an infrastructure of shipping routes and depots. Other power sources such as natural gas and hydro, and electric sources require networks of transmission lines, pipelines, canals and other infrastructure for their distribution through the region. Scenarios can help planners in the region, both public and private sector determine what types of energy resources are best suited to the region given that the future of demand, and in some cases, supply is uncertain.

## ***Public Safety and Health Systems***

Important community services usually provided at the local level include fire protection, law enforcement and health care systems, all of which are infrastructure- and communications-intensive. All of these systems are necessary to create safety, security, and stability in a region, three necessary factors for fostering investment in a region's economy. Each of these systems requires substantial investment in the planning of physical facilities, supply and communications networks linking them, capital investments in equipment, and training of staff. Scenarios are a useful way of predicting what types of these systems will be required in a region since scenarios can help form responses to the following questions.

- Will crime be a serious problem requiring substantial investment in law enforcement?
- How extensive and dense will the network of fire protection services need to be?
- How dispersed will development in the region be and how can the services be deployed to serve these development patterns?
- What types of health care services will be demanded and possible and what types of facilities and expertise will be necessary to provide them?

### ***Cultural/Recreational Systems***

The final geographically dispersed system that a region must consider in its competitive strategy is the amenities that it offers. Current trends have shown that the cultural and recreational opportunities that a region provides its residents is a prime determinant of firm location. With competitive labor markets, regional amenities are seen as a way for companies to attract quality employees who discriminate between professional opportunities. Scenarios of regional development can illustrate what types of workers the region will need to train and attract and what types of cultural and recreational facilities are well suited to these workers. In addition to determining the type of recreational and cultural services that will be important to the region's competitive position, scenarios can help the region decide upon the physical location of these services and the number of facilities required.

## Overarching Issues and Uncertainty

All of these geographically dispersed systems are affected by a similar set of overarching issues. These issues are related to the population and economic activity in the region. Each of these systems will be affected by the future population patterns in the region, both in terms of magnitude, and distribution (geographic, income, age, etc), and economic activity, in terms of magnitude, type and location. Future population and economic activity are functions of drivers in the macro environment and key local factors. The drivers represent those world events and trends that will impact the region and the key local factors represent the local response to these drivers. The drivers that will affect each of these interdependent, geographically dispersed network-oriented systems are

most likely those four described earlier in this document in the context of transportation planning.

- Economy,
- Environment
- Technology
- Finance

The key local factors, those factors that describe how the drivers affect the all of these regional systems are:

- Health of the local economy
- Shifts in environmental attitudes and policies,
- Demographics,
- Federal and State Investments and control, and
- Local Politics.

All four of these driving forces impact each of these interdependent systems through these key local factors. Scenarios consisting of different states of these four drivers can be used to develop and evaluate strategic options for each of these systems. To illustrate how these divers affect each of these systems, consider the technology driver. Specifically, consider the development of e-commerce, teleworking, and distance learning. This example is intended to show how a common driver, such as these technological applications, can affect all of the interdependent systems described previously.

## ***Telecommunications Technology Illustration***

The following example traces how current trends in technology, specifically Internet-based communications technologies might affect each of these interdependent systems. First, three applications of communications technology, e-commerce, teleworking, and distance learning are described. These three applications are then related to each of the regional systems described above.

Advances in computing and communications technologies have lead to dramatic increases in the

numbers of people using the Internet for activities. The Internet has changed the nature of many people's activities. This medium accomplishes two things, it allows improved interaction between people without travel, and it allows people to pursue new shopping and recreational opportunities. The effects of this evolving technology can be considered as three activities that advanced telecommunications and computing have fostered. These three activities are described below.

## *E-Commerce*

E-commerce refers to the electronic buying and selling of goods and services.

In terms of the retail sale of goods, catalog web sites selling a particular type of merchandise dominated the early days of e-commerce. These catalogue sites are still a prevalent form of e-commerce today with popular sites such as Amazon.com. These companies generally specialize in one particular market, books in the case of early days at Amazon.com, and offer a wide selection of choices at discounted prices.

E-commerce also has been very popular in the marketing of services. Internet stock trading and electronic banking has dramatically changed the operation of these markets causing institutions in the business world, such as the New York Stock Exchange, to re-evaluate their practices. Travel services has also been an industry dramatically impacted by the development of e-commerce. With airlines offering incentives to customers who use these new media, Internet travel agents such as Expedia and Travelocity have become very popular ways of planning business and leisure travel, threatening the traditional travel agency business. Two forces are really at play in the case of travel services. First, the service providers, airlines in particular, can provide better service to their customers at a lower cost by eliminating commissions paid to travel agents. Second, consumers can better understand what their travel options are with the mystery of a travel agent removed from the process.

E-commerce is also affecting the way markets for goods and services are structured. Careful observation indicates that e-commerce is moving away from a traditional set price model to an bid-price model of selling. Many e-commerce venues still market products in a traditional way by setting

what is thought to be a competitive, fixed price. Other companies, such as Ebay, and Priceline.com are showing that auctions are a popular way of selling goods in this new marketplace. Ebay is a facilitator of auctions, allowing individuals to put items for sale and buyers to bid on these items. Ebay does not specialize in any particular type of product; the offerings at any particular time are a function of what sellers are participating. Ebay is structured as a true auction since buyers continue to bid on items for a set period of time. Whoever has the highest bid gets the item at auction.

Priceline.com is slightly different. This company allows customers to bid prices for airline tickets, hotel rooms, mortgage rates, and cars. In the Priceline model, the buyer names his price for one of these items and guarantees his bid. Priceline then searches for a seller willing to accept that bid. If a match is made, the buyer is obligated to pay for the product or service. There is no auction in this case since a buyer does not re-bid during the process, but the system uses a bid-price mechanism for matching buyers and sellers. These bid-price and auction models of e-commerce are catching on with other major players in the Internet and could change the way society thinks about the retail sale of goods and services.

The impact of e-commerce on traditional retailing and service businesses is uncertain. Many of the e-commerce businesses are affiliated with traditional retailers who ultimately provide the good or service. However, as more and more products and services are offered in this easily accessible, 24-hour per day market, traditional retailing will have to adjust to these new competitors.

## ***Teleworking***

Teleworking is a different activity enabled by the same technological advances. Teleworking, also known as telecommuting, is people doing their jobs from remote locations, commonly the worker's home. Telecommunications and computing technologies allow these individuals to do their jobs and interact with coworkers without traveling to the job site. Teleworking has been enabled particularly through the use of e-mail and dialup networking. A worker at home, for example, can use a computer with a modem or other remote network connection to access common files and databases, and can exchange messages with coworkers. Teleconferencing has further enabled teleworking by allowing "face-to-face" interaction between coworkers, and even clients without

requiring travel. Teleworking is a business model that is becoming more accepted as it allows employees to continue involvement in the workplace even when other concerns prohibit them from coming to work. Teleworking is may become quite popular with families where both parents work, since it allows a parent to continue their career while caring for children at home.

## *Distance Learning*

The advanced telecommunications technologies have proven themselves to be useful in education. Teleconferencing allows students to participate in classes from distant locations as e-mail and the Internet can be used to provide students with course materials.

Distance learning has been popular as a complement to traditional education as primary and secondary schools can provide classes in unusual topics without having qualified teaching staff in each school. Consider, for example, a school district with 15 high schools. Within this district there are 60 students who want to learn Japanese, a foreign language not commonly offered. While it would not be practical to offer Japanese in each school since that would require hiring a few teachers qualified to teach Japanese. With distance learning, the school district can hire one Japanese teacher and provide classes in each of the schools electronically.

Distance learning has also been used to replace traditional education in some instances where courses can be held at employment sites for workers, and at home for care givers of children, disabled students, or home-schooled children. Much like e-commerce and teleworking, the impacts of these advanced telecommunications systems on traditional education are not certain.

## *Impact on Interdependent Systems*

E-Commerce, Teleworking, and Distance Learning are all manifestations of the technology scenario driver and affect all of the interdependent, geographically dispersed network-oriented systems described to different degrees. Some potential impacts of these technological innovations on each system are described below.

**Governance/Political System**

These three Internet-based technologies could have a profound impact on the way in which a region is governed. Elections could be held through computer technologies eliminating the need for bureaucracy and delay associated with managing the democratic process, traveling to the polling place, counting votes, etc. Furthermore, government monitoring of public sector services and activities could be changed by these technologies.

Scenarios could be developed to highlight the possible impacts of these technologies might have on governance. The scenarios would look at the technological changes in combination with other drivers to develop different pictures of the future for governance. From these pictures, government planners could evaluate strategies that ensure the stability of the government into an uncertain future.

**Financial Systems**

Scenarios are invaluable to planning for a region's financial well being. Scenarios can be used to look at the effects these technologies might have on regional tax policies and revenue collection for the public sector. In the private sector, global economic scenarios based on different degrees of acceptance and response to these three technologies could be used to develop a range of possibilities for the future of the world financial markets.

Scenarios could be used by regional capital sources to define their strategy for meeting the region's financial needs. Regional financial planners can use scenarios based on the driving forces, technology being one of these, to develop ideas of what future revenues and regional investment requirements might be.

**Transportation System**

Many of these e-activities effectively reduce people's need to travel. No longer must people drive to the bookstore, the travel agent, to work, and to a class in the evening. Conceivably, one could accomplish all of these things without ever leaving home. It is unlikely, however, that these developments will have that dramatic an effect on personal travel. Work trips will still be required to

actually meet with people from time to time and to pick up items that cannot be sent easily electronically. Since the trip to work is less frequent, people may be willing to live much farther from their place of employment. If someone only travels to work 2 days per week, and teleworks the other 3 days, they might be willing to travel much further on those 2 days than if they had to drive to work every day.

Furthermore, traditional activities like shopping serve purposes other than simply purchasing goods. It is likely that people will still shop in the traditional way for entertainment and social interaction regardless of how advanced e-commerce becomes. These e-activities are likely to dramatically alter freight flows on a regional scale, as more products will be destined directly to consumer's homes rather than to retail facilities. E-activities are likely to change the demands on the transportation system in a region, but it is difficult to predict the actual changes that will occur.

Scenarios can be built based on the uncertainties associated with these developments to help decision-makers appreciate how these technological changes might affect the future. A transportation planner could look at communication developments such as those described above and use different outcomes to develop different scenarios. For example, one idea is that e-commerce will greatly reduce travel for shopping purposes, lightening the load on a regional transportation system. Another is that people will buy goods more frequently and expect rapid delivery causing increased volumes of delivery trucks, and thereby increasing demands on the transportation system. Scenarios can help develop a range of these possibilities so decisions can be made that select strategies that perform well across a wide range of futures.

**Water Systems/Energy Systems**

Water systems and energy systems will be impacted by these e-activities since they are likely to change the spatial distribution of demand for water in a region. These e-activities facilitate geographical spread in a metropolitan area. This spreading has significant impacts on the type of these systems necessary to serve a metropolitan region. For example, as teleworking increases, the water and energy demand in the central business district of a region may decline dramatically, while the widely distributed demand for water and energy on the outskirts may increase. Different degrees

of centralization have very different impacts on the strategies managers of a water or energy system might choose. Centralized development can rely on a large source of water or energy brought to the activity centers by large capacity distribution systems. A widely distributed development pattern can rely on smaller, more scattered water and energy sources and lower capacity. However, more extensive distribution systems will be needed to accommodate this geographic dispersion.

Scenarios could be developed based on the geographic spread implications of these communications technologies. These Internet-based applications might allow people to locate further from metropolitan centers, requiring one type of investment in water and sanitation systems. On the other hand, these technologies might change people's amount of free time, encouraging them to move closer to recreational opportunities in the city center. This impact has very different implications for the water and sanitation systems.

**Communications Systems**

These systems must be looked at from the point of view of strategic competitive position. Different developments in e-activity in the global environment will require that the region pursue different strategies in the development of their own communications system in order to remain competitive. If the global business model evolves to one of e-commerce and teleworking and the regional communication system must be improved to allow this activity to flourish. Likewise, if these changes have less impact on commercial and educational activity than anticipated, fewer changes to the system will be necessary. The region needs to view its communication system as a competitive factor distinguishing it from other regions in the world economy, much like with transportation and water systems.

Scenarios can be used to illustrate different possibilities for the course of e-activity allowing the region to decide what strategic options are best suited to the development of the regional communications system. Scenarios can be used to predict different levels of e-activity and to develop possibilities for the types of data that a communications network might need to carry by looking at the these three technological applications and their impact on society. If these applications have widespread impacts, significant upgrades to the regional communication system

will be required. If they remain marginal forms of social activity, modest improvements to the systems may be sufficient. Scenarios can be used to illustrate the range of impact that these applications might have.

**Education Systems**

Many of the impacts of these telecommunications advances on the education system are described in the section "Distance Learning" above. Distance learning may mean that a region need not invest in new traditional educational infrastructure if a greater portion of education is conducted through remote means. On the other hand, a movement towards remote education will require that the region invest in new types of facilities.

A region can use scenarios to help determine what the impacts of distance learning might be on education by developing different possible futures for the education system. These different futures can help direct the region's strategic options for the education given a changing state of technological reliance. The National Education Association (NEA) in the United States recently undertook such an exercise where they looked at scenarios for the future of the U.S. public education system based primarily on two dimensions of community:

- Inclusive/Exclusive social structures, and
- Hierarchical/Participatory social structures.

The effects of communications technologies are one of the main driving forces in determining the outcomes of these scenarios (NEA 8).

**Public Safety and Health Systems**

Advancing telecommunications technologies can have substantial impact on public safety and health systems. These technologies can help authorities centrally monitor areas around the region looking for emergencies. These technologies can also help emergency response personnel when involved in an emergency situation. Current technologies allow medical response personnel to consult with emergency room physicians using video conferencing. More advanced applications of similar

technology could allow patients to see doctors and specialists without traveling long distances. These systems could serve as triage systems allowing medical staff to direct patients to specialized medical facilities, reducing the need for acute care hospitals and reducing the breadth of services each must offer.

One could envision scenarios used to help decision-makers in this arena to plan future systems appreciating the effects of changing technologies along with all of the other scenario drivers described in this document. Planners could look at technological impacts on crime patterns using scenarios to highlight possible changes. These scenarios would have to be based on all of the driving forces, technology being one of them. These scenarios could also look at how changing technology could be used to improve law enforcement and public safety.

**Cultural/Recreational Systems**

The Internet and other information technology can serve as a virtual cultural resource in a region. Through audio and video streaming technology, people can attend virtual concerts and other events without having to stage these events locally. These technologies can change people's cultural and recreational desires and needs. On the other hand, these technologies have the possibility of allowing more free time for people. They are likely to fill these newly found free time with cultural and recreational activities, increasing the demand for these facilities and services. Scenarios can be used to help decision-makers decide what type and how many cultural and recreational facilities will be demanded in the future given the uncertainty associated with evolving communications technologies.

These scenarios might look at how the technology driver, in combination with other drivers, influences how people spend their time. One possibility these scenarios might discover is that people simply are more productive, but that they do not really change their work/leisure time allocation. Another possibility is that they spend much more time on leisure, but this time is occupied with other forms of cyber-recreation. Other possibilities than these exist and scenarios could be used to highlight the range of possible effects these technologies might have on people's leisure activities.

## A PLATFORM FOR RSP

Regional strategic planning is far more complicated than regional strategic transportation planning, but one can argue that there are significant economies of scale to looking at all of these systems in a coordinated way. Each of these systems has specific fundamental problems and strategic possibilities. However, many of the same factors will influence the success of these different strategies for each system. This section outlines a framework for coordinating regional strategic planning looking at all of these different systems, and, in fact, looking at any other strategic possibility the region may want to consider.

The framework presented here is based on the description of Royal Dutch Shell's scenario exercise described by Pierre Wack. He describes scenarios as "cherry trees" (Wack1 8).

> *"Scenarios are like cherry trees; their fruit grows neither on the trunk, nor on the large boughs but rather on the small branches. The tree needs the trunk and boughs to grow the small branches.*
>
> *The global scenarios I have described correspond to the trees trunk; the country scenarios developed by the national Shell operating companies can be likened to the boughs...The fruits can be picked from the small branches. These are the scenarios that focus on a particular strategic issue, market, or investment" (Wack2 8).*

Royal Dutch Shell is structured like a large holding company. Within this company are national companies that develop and market Shell products in a particular country. Within these national companies, specific markets and investments are considered. Royal Dutch Shell developed global scenarios about the oil market, these global scenarios were used as the basis for new scenarios at the national company level and other new scenarios to consider particular strategies (Wack1 74).

Regional strategic planning is similar to strategic planning for a large, multinational company like Royal Dutch Shell. There are many different levels of hierarchy, many different decision-makers and many different decisions to be made with perhaps no coordination. Approaching the problem from the point of view where one process is going to include all of these concerns will not work. The problem is simply too complex. It must be looked at in smaller pieces with an appreciation for

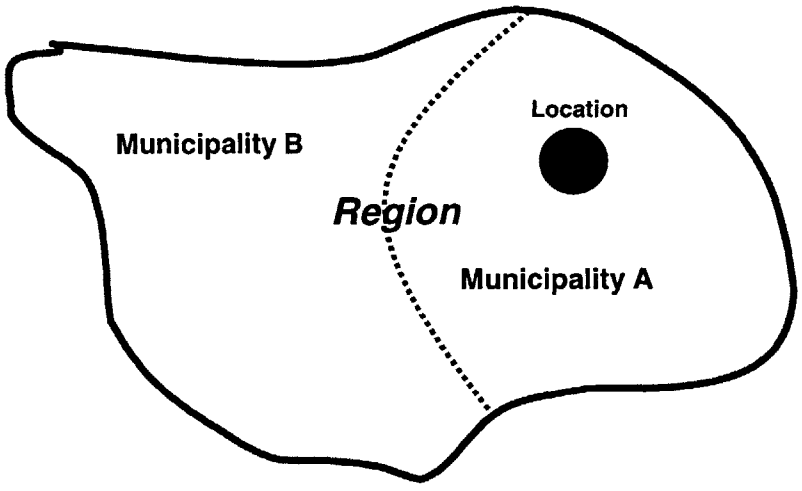
the integrated whole. The process must be comprehensive in its approach to strategy in that no important strategic areas are overlooked, but each strategic area can be considered independently. The process for regional strategic planning can follow a process similar to that followed by Royal Dutch Shell.

## Scalable Scenarios

Regional strategic planning requires the concept of scalable scenarios. Scenarios can be scaled in two fundamentally different ways, or as a hybrid of these two.

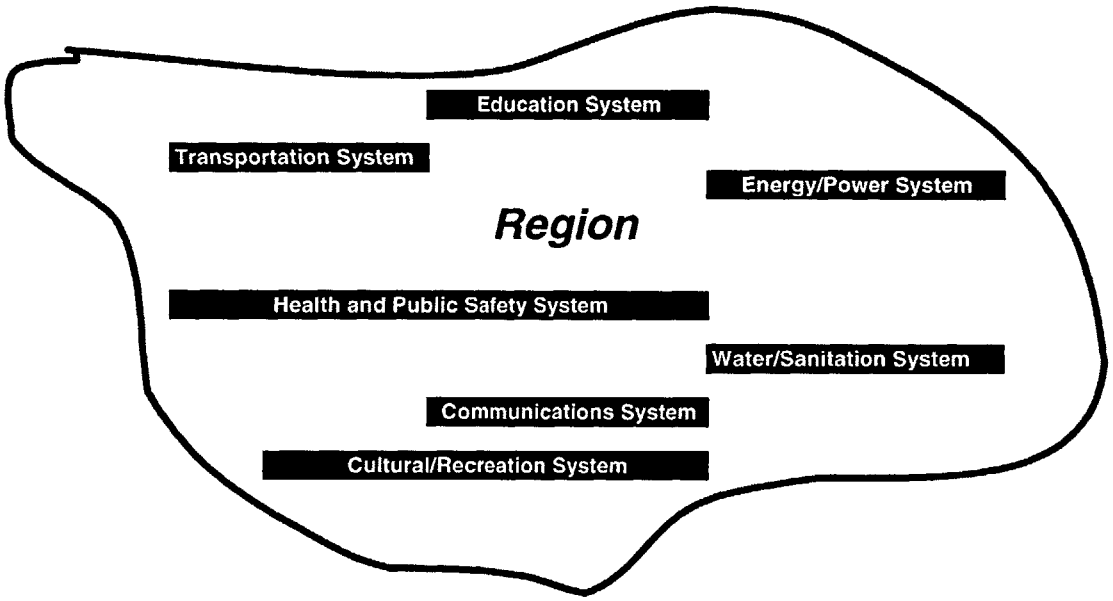
One way to scale scenarios is to look at geographic areas. In this case, one would develop a set of regional scenarios that depict how the region may evolve given world events and trends. From these regional scenarios one would develop scenarios for a particular geographic part of a region, for example, a particular municipality. From these municipal scenarios, rooted in the regional scenarios, smaller geographically-scaled scenarios looking at a particular location or issue can be developed. This geographic scaling of scenarios is depicted in Figure 8-2. In the figure, the units for scaling the scenarios are the two municipalities and a particular location within a municipality, a neighborhood, for example.

**FIGURE 8-2**
**GEOGRAPHICALLY SCALED SCENARIOS**



The second way to think about scaling scenarios uses the idea of interdependent systems developed earlier in this chapter. Functional scaling looks at the regional infrastructure and service systems as the units of scale. Different regional systems are the smaller units of analysis. Functional scaling would develop regional scenarios, just like those mentioned previously. These regional scenarios would then be used by decision-makers responsible for each of the regional systems to develop specific functional scenarios for each system. From these functional scenarios, smaller-scaled scenarios related to a particular part of the system could be developed to consider individual problems or projects. This functional scaling of scenarios is shown in Figure 8-3 below. In this figure, the units for scaling are the different systems within the region shown as black boxes.

**FIGURE 8-3**
**FUNCTIONALLY SCALED SCENARIOS**



## *Choosing a Scaling Method*

Both of these scaling options are equally valid. The first scaling option, geographic scaling is attractive because it is likely to fall within the existing jurisdictional boundaries of the region. This scaling method also allows the planners to account for the peculiarities of particular geographic parts of a region while maintaining a sense of regional strategy since the local scenarios will be derived from as set of regional scenarios. The disadvantage of geographic scaling is that many of the jurisdictional boundaries in a region are arbitrary historical artifacts that have little to do with the functioning of an integrated economic region. In any case, using geographic scenarios may allow introduction of a scenario-based, regional planning methodology without upsetting the political balance.

Functional scaling of scenarios offers much more promise from the perspective of strategic planning for a region, but suffers from the possibility of political opposition given its regional framework. Function scaling allows a region-wide scenario to be adapted, with less modification than in the geographic case, to the specific impact on a particular system. Looking at the system in this way allows planners to see where problems in the system might lie in each scenario, regardless whose jurisdiction it falls in. Functional scaling is more seamless than geographic scaling since the regional attributes used to form each scenario are the same. Geographic scaling fragments the region into different pieces that are likely to by non-homogenous. This fragmentation can lead to problems of application of the regional scenarios to particular localities. Functional scaling avoids this fragmentation and allows a better perspective for strategic planning for an integrated economic region.

### Hybrid Method

Like most issues in regional planning, or other disciplines, for that matter, the real application of scaled scenarios as a regional strategic planning framework is likely to be a combination of the two options outlined above. Most regions have a combination of municipal jurisdictions and regional authorities. Also, some of these systems are seen more as local prerogatives while others are accepted as regional issues. For example, in the United States, education systems are often

considered as the domain of local government while water and sanitation systems are considered regional. It is likely that this scaled scenario framework would be implemented by first using a functional scaling methodology. A regional planning agency would develop its regional scenarios. These regional scenarios would probably be developed into functional scenarios and these would then be used by regional authorities for their planning. In a state-based region, the functional scenarios for local systems might also be developed. From these statewide functional scenarios, local authorities and service providers could then develop scenarios for their particular parts of the system, and so on.

The picture is more complicated for the metropolitan-based region that does not relate directly to a state, Houston, Texas, for example. In this case, the scenarios are likely to be developed at the metropolitan level and then regional authorities will use functional scenarios in their planning. There may or may not be functional scenarios for locally provided services since there is likely no regional board or authority that will develop functional scenarios.

**Private Sector Involvement**

From the previous discussion, it may not be obvious where the private sector fits into this scalable scenario framework. In the case of geographically scaled scenarios, private sector involvement is likely to be either very complicated, or absent. The exception is if a particular municipal government contracts its service to a private sector provider.

Functional scenarios allow a greater participation by the private sector. In most cases, especially in the United States some of these regional systems are likely to be provided by a private sector company. These private sector companies are usually, but not always regionally scaled. In the case of functionally scaled scenarios, once the regional scenarios are developed, the private sector "utility" would be responsible for the remainder of the activity.

There is no guarantee that the private sector's strategic planning will follow the direction the regional planners would like. It is in the nature of the private sector that no government planning authority directly controls it. However, if the regional plan is indeed strategic, that is, oriented toward

improving the region's competitive position in the world economy, the private sector firms that are responsible for these systems should be motivated by self-interest to think along parallel strategic lines. If this is not the case, the regional government can develop incentives to align the private sector's objectives with its own.

### *Iteration*

The idea behind scalable scenarios is that the overarching regional scenario informs the scenario process for each of the smaller units. In other words, the sub-scenarios do not diverge from the basic framework and vision established by the regional scenarios. It is important, however, that the regional decision-makers revisit all of the sub-scenarios to ensure that conflicts between the strategic plans did not arise during the process.

This final stage defines how the regional strategy is selected. All of the strategies proposed for each of the sub-scenarios are looked at in the context of the regional vision and the decision-makers choose a robust set of options from all of the scenarios developed. This step must be focused on two things. First, the strategies must meet the needs of the regional vision. Second, the strategies must ensure that all of the interdependent systems are given adequate attention, regardless of whether the scaling process was functional or geographic.

## Changing the Strategic Conversation

Chapter 6 introduced the concept of a strategic conversation. This strategic conversation is the process of creating scenarios. The concept of scalable scenarios introduced here is part of this strategic conversation. The strategic conversation introduced in Chapter 6 is specifically for regional strategic transportation planning. The strategic conversation outlined in this chapter is really geared toward developing the scaled scenarios for the transportation system rather than toward developing all-encompassing regional scenarios. These all-encompassing regional scenarios would be used to inform transportation system scenarios. Then, these transportation system scenarios, specific sets of scenarios for each of the primary components of the transportation system might then be developed

by each organization. For example, the airport authority should use the regional and transportation system scenarios to develop scenarios specific to the strategic challenges facing the airport system. The highway authority, transit agency, and port authority should do the same.

The major private sector providers of transportation services in the region, trucking companies, railroads, ocean shipping companies, airlines, bus carriers, and others can use these scenarios to inform their own strategic planning process. They can look at the regional scenarios, and transportation system scenarios and build their own scenarios to determine their business's strategy for that particular region.

## A Starting Point

The process for developing scalable scenarios described in this chapter is an unlikely way to introduce scenarios to a region. This methodology for regional strategic planning is far too expansive and involved to be considered in a region with any serious ongoing planning activity. Scenarios will have to be introduced incrementally into a region. The most likely path for success is to introduce the use of scenarios in one of these interdependent systems in parallel to the current planning process in the region. Once the scenario methodology demonstrates its success in one of these areas, it will be much easier to introduce it in other areas. Only after an appreciation for the scenario methodology develops in a large portion of the regional decision-makers will any thoughts of a comprehensive process like that described in this chapter be entertained.

Some private sector operators of these regional systems already employ a scenario framework in their planning namely, Pacific Gas and Electric (Schwartz 103), but acceptance in the context of public sector planning is likely to be much more difficult. Transportation planning may offer the most likely starting point for the implementation of a scenario-based methodology. In comparison with planning for other public sector services, transportation planning is highly developed and well staffed. In many cases, it is also appropriately scaled to an integrated economic region. Transportation planning also is an activity monitored by the Federal government in the United States, which may serve as a possible channel for introducing this methodology.

## CHAPTER SUMMARY

This chapter proposes that regional strategic planning is a logical expansion of regional strategic transportation planning. The competitive position of a region in the world economy is a function of many different complex, interdependent, geographically distributed, network-oriented systems. A regional strategy, to be effective, must really consider all of these systems. Scalable scenarios are a way of looking at these systems in a coherent and strategic way. Scenarios can be scaled in a geographic way, a functional way, or as a combination of the two.

It is unlikely that a broad regional framework such as that proposed in this chapter will be easily accepted in a region. It is much more reasonable to introduce scenarios in planning for one of these interdependent systems to demonstrate the merit of the methodology. Transportation planning may be among the best opportunities for this introduction and demonstration.

# 9

# SUMMARY, CONCLUSIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

This chapter is divided into five sections. The first recapitulates the thesis objective. The second summarizes each of the chapters. The third draws conclusions from this research and presents the key findings. The fourth introduces some recommendations for further research. The fifth section presents some final thoughts about scenarios applied to regional strategic transportation planning.

## THESIS OBJECTIVE

This thesis has explored the application of scenarios in the context of regional strategic transportation planning (RSTP). Scenarios, as the term is used in this thesis, developed as an approach to strategic planning in business during the 1960s and 1970s at Royal Dutch Shell.

Traditional strategic planning methods often employ point forecasts of future conditions from which various strategies are developed. The problem with these methods is that they assume the future will be like the past since they often use extrapolation of past and current trends to develop a

picture of the future. They present a static, single picture of the future that fails to account for uncertainty.

This thesis summarized the theoretical basis for scenario planning; the work of Munoz in Mendoza, Argentina; and the Cooperative Mobility Program – Regional Strategies for the Sustainable Intermodal Transportation Enterprise (CMP-ReS/SITE) work in Houston, Texas. These two applications of scenarios to RSTP demonstrated some of the merits of this methodology.

This thesis proposed three advances to the scenario methodology. First, it presented a framework for introducing scenarios into a region's ongoing transportation planning process. Second, it described how organizational strategic options can be considered in the scenario process using the concept of regional architecture as an approach to developing these organizational strategies. Finally, this thesis recognized transportation as only one part of a region's strategic options, and suggests that scenarios can provide a valuable framework for looking at all aspects of regional strategy in a coherent, structured way.

## CHAPTER SUMMARIES

Each of the chapters in this thesis contributes to the objective of advancing the application of scenarios to regional strategic transportation planning. The following paragraphs will briefly summarize each of the eight chapters.

**Chapter 1** provides some background on the topic of scenarios. The chapter introduces the Mobility Scenarios for Houston Project, the inspiration for furthering this research into scenarios for RSTP by breifly describing the teams analysis of scenarios and some of the characteristics of the Houston, Texas metropolitan area that make it well-suited for this application.

Chapter 1 continues by describing how scenarios are applicable to regional strategic transportation planning. The chapter discusses current planning practice and the ReS/SITE group's identification of eight planning shortcomings. The ReS/SITE framework for regional strategic transportation planning is proposed as a way to address these shortcomings. This framework relies on scenarios to

establish multiple views of the future at the scale of an integrated economic region, usually focused on a metropolitan area. In the context of these views, regional strategies comprised of *regional infrastructure* and *regional architecture* are developed. Regional infrastructure includes the traditional capital investment strategies one would expect to find in an RSTP. Regional architecture proposes that organizational and operational strategies are also important components of the plan. Chapter 1 concludes by describing how this scenario-based framework addresses the planning shortcomings identified.

**Chapter 2** describes the history and application of scenarios as a planning framework. Scenarios are defined as a structured organized approach to strategic thinking, appreciating that the forecasts and single-point estimates of the future are usually inadequate. Scenarios develop logical chains of events and trends, rooted in the current environment, to describe several different possible views of the future. These views of the future serve three important purposes.

1. They can be used to develop robust strategies that perform well across a wide variety of possible futures.

2. They can stretch the minds of decision-makers to make them aware of different world views other than their own and the uncertainties that may cause these worlds to develop.

3. They can help to identify leading indicators of different possible outcomes allowing adjustment of the particular strategies chosen.

Scenarios support the learning organization by enabling decision-makers to recognize that the future is uncertain. These learning organizations can then adapt more easily to changing conditions.

Scenarios have a long history as strategic tools in military organizations. Ringland comments that World War II had a profound impact on strategic planning processes both in the public and private sector since the war effort elicited new ways of thinking about complex large-scale systems. Scenarios moved into the private sector in the post-war era when the RAND Corporation, the Hudson Institute, and the Stanford Research Institute (SRI) institutionalized the practice of

scenarios planning. Movement into the public sector has been slower since public sector agencies often face a whole realm of political and institutional challenges not present in the private sector.

Chapter 2 continues by describing different applications of scenarios in the strategic planning context. The chapter summarizes the well-documented planning efforts of Royal Dutch Shell during the 1970s and 80s. drawing six important lessons from this application:

1. It is important to root scenarios in the current environment,
2. Scenarios can improve risk awareness and help in robust decision making,
3. Scenarios can help formulate new strategies,
4. Scenarios can help formulate the strategic vision for an organization,
5. Scenarios can change decision-maker's microcosm, and
6. Scenarios can help develop leadership.

Chapter 2 then describes the use of scenarios in industry with examples drawn from British Airways, and United Distillers. Scenarios can also be used for national visioning. Three examples of national visioning scenarios drawn from the Global Business Network (GBN) are presented.

Futhermore, scenarios can be used for strategic planning of government services for which two examples are described, the UK's National Health Service, and public education in the U.S. The chapter describes several different applications of scenarios in the Transportation Sector concluding with application to regional strategic transportation planning.

We conclude that regional strategic transportation planning is ideally suited for the application of scenarios. RSTP is a long term planning process in which very few elements are predetermined and the future is uncertain. Scenarios are particularly useful for looking at this class of problems. Further, the strategies these plans usually develop are most commonly infrastructure investments. These investments are risky in terms of popular support, political backing, financing, and the demand for the facility. Furthermore, these investments are not easily reversible or adaptable to changing conditions. These strategies are also influenced by many evolving social and economic factors, not easily captured in a single forecast. Finally, regional strategic transportation plans are in and of themselves a strategy toward achieving other regional economic, social and environmental

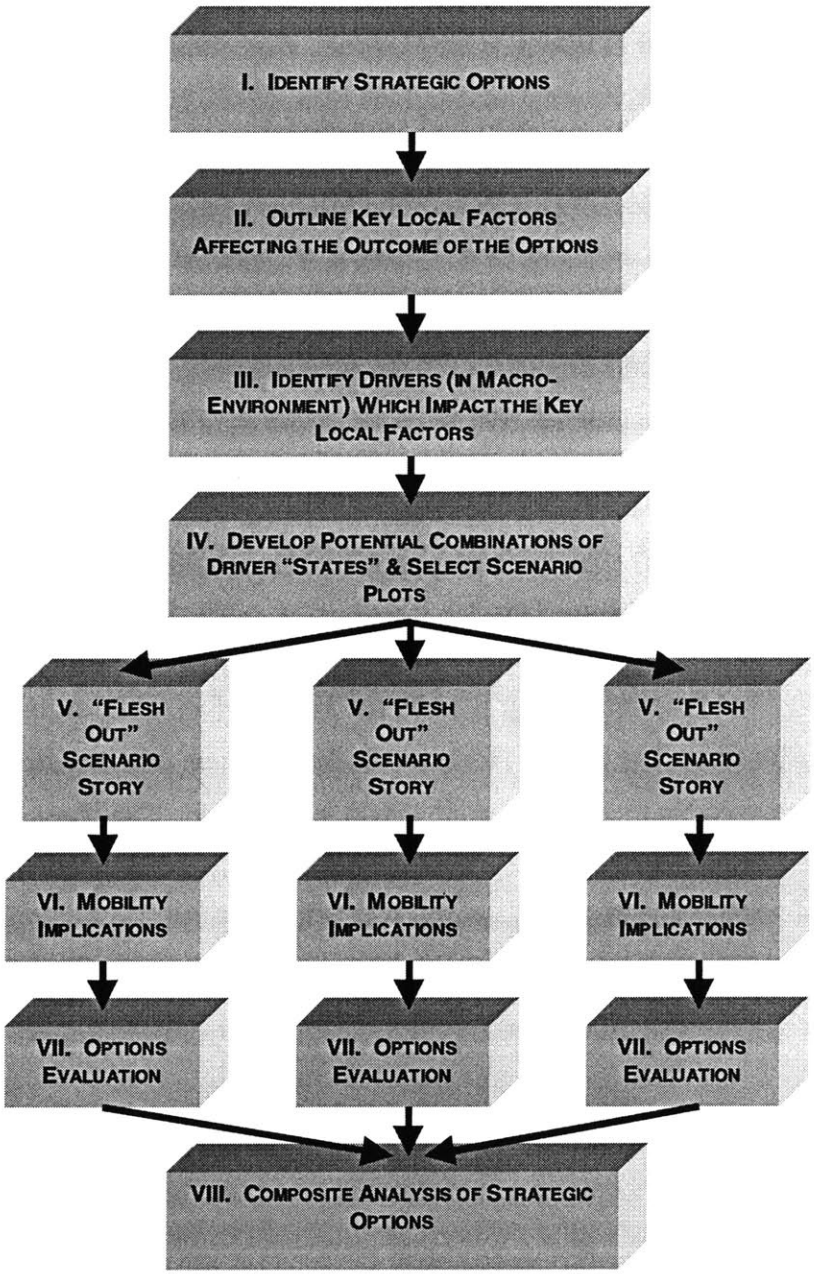
goals so they need to be evaluated in the context of different future economic, social and environmental situations.

**Chapter 3** describes the use of scenarios in regional strategic transportation planning by summarizing Munoz's analysis of scenarios for Mendoza, Argentina. The analysis is driven by the region's goal of socioeconomic development and the consideration of a "big bang" strategy, the construction of a low-altitude tunnel link between Mendoza and Chile through the Andes Mountains. The scenarios he develops influence the viability of the seven strategies assumed available to Mendoza. The implications of these different scenarios are discussed and each strategic option is evaluated in the context of the scenarios. This evaluation includes a ranking of scenario-independent impact and scenario-dependent effectiveness measures for each strategy. The result is an overall ranking of strategies in terms of robustness across all of the scenarios considered.

The analysis of scenarios for Mendoza is thorough, interesting and inspired the Cooperative Mobility Program – ReS/SITE team to develop mobility scenarios including both a region independent scenario platform and specific application in the case of Houston.

1. **Chapter 4** describes the methodology used by the Mobility-ReS/SITE team to develop mobility scenarios for Houston. The chapter describes the development of a "scenario platform" that is intended to be applicable to any geographic region in the world. The chapter begins by describing the current planning context in Houston, Texas by outlining the institutions involved and the *Vision 2020 Metropolitan Transportation Plan.* Once this context is defined, the chapter describes the Mobility-ReS/SITE methodology shown in Figure 9-1

**FIGURE 9-1: SCENARIO FRAMEWORK FOR REGIONAL STRATEGIC TRANSPORTATION PLANNING**
(ADAPTED FROM CMP-RES/SITE PAPERS)




**Chapter 5** applies this eight-step process to the Houston-based metropolitan region. Twelve different strategic options were considered in the Houston scenarios. These strategic options are a

combination of actual proposals in the region and a select number of more aggressive strategies created by the scenario team. These strategies include:

- Construction of a light rail system through the central business district,
- Expanding the regional high occupancy vehicle lane system,
- Implementing congestion or value pricing,
- Construction of the Grand Parkway,
- Construction of Interstate 69,
- Expansion and remodeling of the two principal airports,
- Expanding the Port of Houston,
- Implementing densification, growth management and land-use controls,
- Deploying an automated highway system,
- Constructing an expansive heavy rail transit system,
- Constructing an intercity high speed rail network, and
- Focusing on system maintenance and incremental development.

Scenario drivers are forces in the global environment that will impact the key local factors in the region. These scenario drivers are exogenous to the region, meaning that they are beyond the influence of local decision-making. They are the determinants of the scenarios. Four different scenario drivers were identified:

- Economy
- Environment
- Technology, and
- Finance.

Once these strategic options and scenario drivers were identified, the team focused on identifying specific attributes to Houston for each of the key local factors that represent the local manifestation of the driver. The key local factors proposed in the scenario platform are:

- Health of the local economy,
- Local environmental policies and attitudes,
- Demographics,
- Level of federal and state investment and control, and

- Local politics.

Combinations of different states of these drivers represent the "scenario space" of possibilities to flesh-out. This scenario space is shown in Table 9-1 below.

**TABLE 9-1**
**HOUSTON SCENARIO SPACE**

| Identifier | Economy | Environment | Technology | Finance |
|---|---|---|---|---|
| 1 | Increasing | Limited Regulation | Advancing | Increased |
| 2 | Increasing | Limited Regulation | Advancing | Decreased |
| **3 – USNA** | **Increasing** | **Limited Regulation** | **Stable** | **Increased** |
| 4 | Increasing | Strict Regulation | Advancing | Increased |
| 5 | Declining | Limited Regulation | Advancing | Increased |
| 6 | Increasing | Limited Regulation | Stable | Decreased |
| 7 | Increasing | Strict Regulation | Stable | Decreased |
| **8 –Earth Day** | **Increasing** | **Strict Regulation** | **Advancing** | **Decreased** |
| 9 | Increasing | Strict Regulation | Stable | Increased |
| 10 | Declining | Strict Regulation | Stable | Increased |
| 11 | Declining | Strict Regulation | Advancing | Decreased |
| 12 | Declining | Limited Regulation | Stable | Increased |
| **13 – Balkanization** | **Declining** | **Limited Regulation** | **Stable** | **Decreased** |
| 14 | Declining | Limited Regulation | Advancing | Decreased |
| 15 | Declining | Strict Regulation | Stable | Decreased |
| 16 | Declining | Strict Regulation | Advancing | Increased |

(Source: CMP-ReS/SITE2 15)

Three of the possible combinations for Houston were selected for further development. These three combinations were selected to represent a wide range futures for the region. The three resulting scenarios were:

1. *The United States of North America*
2. *The Balkanization of the World*, and
3. *Earth Day 2020.*

The mobility implications of each of these scenarios were summarized and strategic options were evaluated. The final step was to conduct a composite analysis of the scenarios to identify strategies that were robust across all three future situations considered.

Two of the principal shortcomings of the Houston scenarios are that these scenarios were developed without involvement of local decision-makers and that the scenarios included only policy

and infrastructure strategic options and not organizational strategies.

**Chapter 6** describes the solution to the first of the shortcoming, the lack of involvement of local decision-makers. The chapter proposes moving scenarios into the local planning process by developing a framework for a "strategic conversation" in the region. Moving the scenario methodology from an academic setting to professional practice requires thinking carefully about how to foster a "strategic conversation." The added complexity of planning for public sector organizations requires that the scenario building process be conducted in a more disciplined way. The key aspects to fostering this movement toward strategic conversation are:

4. Creating a hospitable environment
5. Structuring the strategic conversation, and
6. Looking well in advance of the decisions

Structuring the strategic conversation is the most critical piece of this process. This chapter proposes structuring this conversation in four phases. The first phase involves the regional planners, academics, and facilitators who lay the groundwork for the strategic conversation and establish the agenda for the remaining three phases. The second phase involves the key decision-makers in the region who further develop the regional vision, goal and objectives and contribute to developing the scenarios. The third phase expands the input into the process to include the major stakeholders in the system and outsiders to add creativity. The fourth phase has the general public contribute to the process and has the decision-makers revisit the scenarios, looking at detailed analysis supporting each developed by the planners and facilitators. The final product of the process is recommendation for a set of strategies to pursue and an appreciation for the trends and events that may signal a departure toward one of the futures developed.

**Chapter 7** addresses another shortcoming of the Houston analysis, the lack of inclusion of organizational strategies. The chapter defines the concept of regional architecture and uses this concept as a way to think about alternative organizational strategies. Two examples of alternative organizational strategies are developed, one focusing on the deployment of an Intelligent Transportation Systems (ITS) in a region, and the other focusing on the development of a light rail

transit (LRT) system. The chapter then describes how the different scenario drivers can affect attributes of the organizational models developed in the two examples. The chapter concludes by presenting a possible framework for evaluating the organizational strategies that is consistent with the framework used for policy and infrastructure strategies described in Chapter 4.

**Chapter 8** proposes an extension of the regional strategic transportation planning (RSTP) framework presented in this thesis to regional strategic planning (RSP). A region's strategic position in the global economy is determined by a number of factors: political stability, industry competitiveness, workforce skill sets, and regional infrastructure and services. The transportation system is part of a regional infrastructure, but is only one component. Regional infrastructure and services are comprised of nine different interdependent, geographically dispersed systems:

- Governance/Political Systems,
- Financial Systems,
- Transportation Systems,
- Water and Sanitation Systems,
- Communications Systems,
- Power/Energy Systems,
- Education Systems,
- Public Safety and Health Systems, and
- Cultural/Recreational Systems.

Each of these systems is critical to a region's competitive strategy and a strategic planning process should consider alternatives for each of these systems. "Scalable" scenarios are a way of looking at these systems in a coherent and strategic way. Scenarios can be scaled in a *geographic* way, a *functional* way, or as a *combination* of the two. Geographic scaling looks at planning for a region in terms of geographic pieces of a region: municipalities and specific locations. Functional scaling looks at planning for a region in the terms of interdependent systems of services and infrastructure. Hybrids of geographic and functional scaling can be constructed as well.

It is unlikely that a broad regional framework such as that proposed in this chapter will be easily accepted in a region. It is much more reasonable to introduce scenarios in planning for one of these interdependent systems to demonstrate the merit of the methodology. We suggest that transportation planning might be one of the best opportunities for introducing scenarios into the strategic planning process for a region.

## CONCLUSIONS

There are several conclusions that can be drawn from this thesis. Each of these is described below.

**Scenarios are an effective way to consider regional strategic transportation planning.**

Scenarios are a useful way to prepare an organization for the future. Scenarios allow regions to plan for the future in the context of uncertainty, a major step forward from relying on point estimates. Scenario-based plans can develop packages of strategic options that are robust; these are, strategic options that perform well across a wide range of possible future conditions. Scenarios also allow decision-makers to appreciate views of the future other than their own and to be aware of events that may signal the development of a particular future. Scenarios can help to address the many of the transportation planning shortcomings identified in Chapter 1. Specifically, scenarios are an effective method to:

- Ensure an intermodal perspective,
- Conduct a technology scan,
- Consider the National Information Infrastructure (NII) in an integrated way, and
- Ensure that economic considerations are integrated into the strategic plan.

**Regional architecture within a scenario-based framework can address the remaining transportation shortcomings.**

By integrating regional architecture as a tool within a scenario-based RSTP framework, the remaining four shortcomings are addressed. The process can:

- Improve private sector involvement,
- Consider human resource development,
- Ensure freight integration, and
- Develop an operational perspective.

**Careful use of scenarios is required in the complex, multi-constituent public/private transportation context, but the method itself can help to resolve these complications.**

The extension of scenario methodologies into the public sector is more complicated than their application in the business context. In business, most decision-makers are focused on a common goal: profit. In the public sector, an organization's goals are rarely that clear. Most public sector organizations must serve a wide range of constituents, all with different objectives. Public sector organizations are also often bound by numerous legal and regulatory requirements constraining their ability to think strategically.

Local decision-makers can be included in the scenario-building process by moving from scenario planning to a strategic conversation involving all of the principal stakeholders in the regional transportation system. A strategic conversation provides a framework for scenario development in the multi-constituent transportation planning process. In the case of RSTP, this strategic conversation will likely have to take place in several phases due to the large number of decision-

makers and stakeholders involved. Conducting the strategic conversation in phases should allow the region to keep the process focused on building scenarios and developing strategies for each. The process allows participation by many decision-makers and stakeholders without devolving into disorder.

**A wide variety of strategic options can be considered within the scenario framework.**

Scenarios can be used to consider policy/regulatory , infrastructure and organizational strategies. Including organizational strategies in the scenario process can be accomplished through applying the concept of regional architecture. Regional architecture establishes what lines of communication and responsibility need to be established between the organizations operating the regional transportation system. From these lines of responsibility and communication, alternative organizational approaches can be developed that meet these needs. Regional architectures can also be helpful in defining the roles of the public and private sector in providing transportation services.

Scenarios are a formative and evaluative tool for considering organizational strategies by looking at each possible strategy and how the various scenarios affect them. A framework based on feasibility and effectiveness, similar to that used to evaluate traditional policy and infrastructure strategies can be used to evaluate these strategies, although the specific criteria in each category are different.

**Transportation strategies are only a part of the entire package of strategic options a region needs to position itself competitively in the global economy. A scenario-based framework can help a region consider all of the aspects of its competitive strategy in an integrated fashion.**

A region's competitive position in the global economy is a function of many criteria, one of which is

regional infrastructure and services. Regional infrastructure and services can be viewed as several interdependent, geographically distributed, network-oriented systems that serve different functions. Theoretically, one could look at all of these systems together, but the problem would be too complex to be tackled within a strategic planning context. This complexity leads us to the concept of scalable scenarios that break the regional strategy into manageable pieces that can be considered separately. However, the analysis of each piece must be guided by a set of overarching regional scenarios that ensure that each system or area plan is directed toward an overall regional vision.

**Scenarios are likely to develop slowly as a tool for regional strategic planning.**

While this framework for regional strategic planning is ultimately a goal, it is likely that scenarios will have to be introduced as a planning methodology in a some of these regional systems and demonstrate their merit in order for such a regional framework to be considered practical. Transportation systems offer perhaps the best opportunity for this initial scenario application.

## RECOMMENDATIONS FOR FURTHER RESEARCH

The application of scenarios to regional strategic transportation planning, is a complex and evolving methodology. There are several different areas that could benefit from further research. These areas are described below.

### Strategic Option Evaluation

One of the most subjective parts of the scenario platform developed in Chapter 4 and extended in Chapter 7 is the evaluation of strategic options. The framework developed in these chapters uses a subjective analysis to consider the performance of each option in each scenario. Several possible modifications to this evaluation framework have been proposed. These modifications include:

- Weighting the evaluation criteria,
- Considering the relative importance feasibility and effectiveness,
- Capturing the effects of strategic options on each other,
- Evaluating bundles of related strategic options,
- Applying more rigorous, cost-benefit or other project evaluation tools in the scenario framework,
- Introducing utility analysis as a way to evaluate strategic options, and
- Developing methodologies for analysis of network-oriented regional systems.

Further research could help define which of these modifications is appropriate and how this evaluation procedure could be more effectively carried out.

## Regional Architecture

The regional architecture concept as employed in Chapter 7 could benefit from substantial research. Application of this concept, developed from the technical regional architectures for ITS deployments, in coordination with a scenario exercise could help to identify some of the difficulties that are likely to emerge when this construct is applied in a realistic context. Another extension of the regional architecture concept could be to look at different regional philosophies in terms of mobility strategies and economic development. Research could identify reasons why different regions have chosen different regional philosophies and develop a framework to assist regions in choosing between the various philosophies.

## Application within a Local Context

The application of scenarios to Houston, Texas was based on real data and real insights from the Houston region. Unfortunately, the scenarios were not developed with the involvement of any transportation professional working in the Houston metro-based region. This RSTP methodology could benefit greatly from application with participation of regional decision-makers. Chapter 6

outlines one possible way of including these decision-makers in the process. Application of scenarios with the participation of these individuals is likely to highlight methodological issues that could lead to new insights about possible strategies for a region. One of the primary benefits of the scenario process is that it fosters institutional learning. The Mendoza and Houston examples did not yield these benefits since they were conducted in a purely academic environment.

## Revisit Mendoza and Houston

Another useful advancement would be to return to Mendoza and Houston with the completed scenario analyses to determine the local reaction to this methodology and its results. These local reactions could help to better focus the scenario methodology and help to identify ways in which it can be included in the local planning and political processes.

## Build Scenarios for Other Regions

Developing scenarios for another region could test some of the methodological improvements proposed in this thesis, or perhaps subsequent research. It would be best if this application considered a region with different characteristics that both Houston and Mendoza to help identify any other methodological flaws that may have escaped detection. These scenarios could also help to identify a wider range of strategies and provide a basis for comparison among metropolitan regions of different character.

## Develop Methodologies for Analysis of Network-Oriented Regional Systems

Chapter 8 describes several systems that provide regional services. Many of these systems are geographically dispersed and network-oriented. These systems are:

- Transportation Systems,
- Water and Sanitation Systems,
- Communications Systems, and

developed to analyze these systems. These methodologies might all have the common characteristics of considering behavior at nodes, network flows, and shared demand for infrastructure, among other possibilities. Methodologies that can be applied across many of these systems would be a valuable contribution to this regional strategic planning framework.

## FINAL THOUGHTS

This thesis has looked at the application of scenarios in a variety of contexts, particularly focusing on regional strategic transportation planning. While still an evolving methodology, scenarios offer promise. Scenarios are a way for regions to develop better strategic plans that appreciate that the future is uncertain and that strategies need to considered with an understanding of this uncertainty. Scenarios also offer promise as a broader framework for regional strategic planning that allows regions to develop a better competitive position in the world economy. With more demonstrations and further refinement of the methodology, scenarios will make their way into the regional strategic transportation planning process as an accepted and beneficial methodology.

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