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TECHNOLOGY-ENABLED STRATEGY DEVELOPMENT ALTERNATIVES FOR SURFACE TRANSPORTATION

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ABSTRACT

This paper examines strategy development processes in surface transportation systems. In the U.S., transportation organizations typically develop strategy through a formal planning process; however, planning is not the only approach for developing strategy. Other approaches include, for example, negotiation, visioning, learning, and consensus-building. Regardless of the particular approach or combination of approaches, strategy development processes have several elements in common. We identify four such elements of particular importance in surface transportation – revenue sources, information sources, temporal scales, and spatial scales – and analyze the impact that advancements in transportation technology have had on each element. While new technologies (e.g. Intelligent Transportation Systems, or ITS) have been applied extensively to improve transportation operations, they have not been used to enable innovative strategy development processes. By understanding more fully the relationships between strategy and technology, organizations may consider adoption of innovative strategy development processes, such as improvements to the planning process or alternatives to planning altogether.

INTRODUCTION

Technological advancement often brings not just new concepts and products but opportunities to change the foundations of an organization or entire sector. Surface transportation is no exception. The past several decades brought continual advances in the underlying technologies of surface transportation. Deployment of sensors, guidance systems, and other features for vehicles and infrastructure enabled important improvements to the operations and management of highway and transit systems. Researchers and practitioners continue to develop and deploy advanced-technology concepts, products, and services, many of them under the banner of Intelligent Transportation Systems (ITS).

Despite technological gains, many of the organizations responsible for surface transportation have not yet realized the full, strategic value of advanced transportation technologies. For example, data collected from advanced technology systems often go unused beyond operations, and many transportation agencies' strategy development processes remain unchanged. A recent *Los Angeles Times* article discusses that city's failure to save traffic data from an extensive signal control network for more than "a few days" (*1*).

The potential exists to improve the performance of surface transportation systems by fundamentally changing underlying strategy development processes, such as planning, which is currently the predominant approach to strategy development in the U.S. Advanced technologies, as they have in the past, can play an important enabling role. This paper introduces the notion of strategy development for surface transportation and explains the relationships between technology and some key elements of strategy development processes.

BACKGROUND

Strategy is an existential feature and strategy development an existential activity of any organization. Nonetheless, management literature covering the topic of strategy is often conflicting: researchers disagree on such fundamental questions as how to define strategy, how (and whether) to develop strategy, and how to relate strategy to operations. In this section, we present several schools of thought in the field of strategy and describe contemporary strategy development in surface transportation.

Strategy

Management literature provides numerous definitions of strategy. One of the earliest and perhaps most complete was offered by Harvard Business School's Kenneth Andrews, who defined *corporate strategy* as:

> The pattern of decisions in a company that determines and reveals its objectives, purposes, or goals, produces the principal policies and plans for achieving those goals, and defines the range of business the company is to pursue, the kind of economic and human organization it is or intends to be, and the nature of the economic and non-economic contribution it intends to make to its shareholders, employees, customers, and communities (*2*).

Other academics have offered more succinct definitions. Alfred Chandler, for instance, defines strategy as "the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals" (*2*). Henderson defines strategy in terms of competitiveness as "a deliberate search for a plan of action that will develop a business's competitive advantage and compound it" (*3*). Similarly, Porter, one of the most recognized scholars in the field of competitive strategy, frames the development of strategy as an explicit response to (or anticipation of) competition, based on empirical study of firms and industries using analytical techniques from industrial economics (*4*). All of these definitions interpret strategy as an object which can be created or pursued, perhaps rationally, but in all cases deliberately.

Some strategy thinkers, notably Henry Mintzberg, make an important distinction between *deliberate* and *emergent* strategies. Deliberate strategies are consciously developed, formulated, devised, or otherwise crafted by planners, strategists, and decision makers, typically through a rational process such as planning. An emergent strategy, on the other hand, is one that an organization exhibits through its pattern of strategic decisions and behavior over time, necessarily without planning or otherwise deliberately crafting a strategy. Deliberate strategies are developed by organizations to guide future behavior; emergent strategies, on the other hand, are unanticipated and can only be recognized in retrospect. Although elements of a deliberate strategy can appear in an emergent strategy, Mintzberg et al. refer to an empirical study showing that emergent strategies differ from deliberate (e.g., planned) strategies within the same organization as much as 90% of the time (*5*). Nonetheless, deliberate strategy has historically been more prevalent in the literature, as it offers specific, actionable approaches to managers for developing strategy.

More nuanced views of strategy exist as well, as summarized in Mintzberg et al. (*5*). The authors present ten "schools" of strategy, each of which characterizes the way in which strategy comes to exist within an organization. In addition to the deliberate schools of planning, design, positioning, visioning, and cognition, the authors describe strategy development by negotiation, as a reaction to external conditions, as a collective process, through learning, and as a process of transformation. Political science researchers have characterized strategy as emergent from a process of negotiation. Others conceive of strategy as a reaction to an environment over which an organization has little or no control and, therefore, no real strategic "choices." Although this fatalistic perspective has been criticized as not reflective of the true choices available to managers and other actors in most organizations, "strategy as reaction" accurately describes the strategy development process of organizations such as government agencies that are subject to control by higher-level organizations. Still others conceive of strategy development as a learning process, whereby the disparate pieces of an organization "self-organize" and a strategy emerges as patterns recognizable in the decisions of many decentralized individual or business units.

None of these categorized descriptions of strategy is mutually exclusive. Moreover, there is no consensus within the strategy field as to the single best approach for developing strategy. Yet, the categories offered by Mintzberg et al. are often accurate in describing the existing strategy development processes within particular contexts. In the next two sections, we argue that the strategy development process for surface transportation in the U.S. has evolved over the past several decades from largely visioning and negotiation to planning.

Strategy Development in Surface Transportation

Until the latter half of the 20th century, strategy development for surface transportation infrastructure was largely the domain of elected leaders who determined strategy through a combination of political visioning and negotiation. Planning, on the other hand, was seen as a technical activity to support the execution of those politically-determined strategies. Perhaps this explains why Banister laments the lack of "clear theoretical foundations" for transportation planning in the mid-20th century (*6*). Instead, transportation planning was, in its early stages, a strictly technical activity facilitating the largely political objective to complete a national road network. The foundations of planning were in civil engineering; planners used engineering principles to analyze and select the lowest-cost routes for highway facilities.

As vehicle and infrastructure technology improved and transportation networks grew more complex in the latter half of the 20th century, planning processes were continuously refined. At first, residents objected to the highway-focused approach of a civil engineering-dominated urban planning field in the late 1950s and 1960s. This led to the "opening" of the planning process from a strictly technical, engineering activity to one that incorporated the perspectives of other interest groups (*7*). Wildavsky reflects the opening of planning during that era by defining the term *planning* as future control, cause, power, adaptation, process, intention, rationality, and faith, each of which transcends a purely technical perspective (*8*). Elected officials still largely determined strategy and made strategic decisions, although planning provided increasing input to the political process of negotiation.

The 1970s and 1980s saw the planning process expand further to include, for example, community and environmental interests, trends which were eventually codified into the continuing, comprehensive transportation planning process, many of whose elements remain in place today (*9*). Throughout this transformative era, transportation planning has been characterized as a formal, "rational" process (e.g., *7*, *10*, *11*), reflective perhaps of its roots in engineering.

As the scope of planning activities has expanded, the influence of transportation planners over strategy development processes has likewise grown, such that today the control over strategy development rests largely not within the political arena, but within the professional, bureaucratic arena. The planning process produces strategies based on rational technical analysis and stakeholder considerations. Whereas, in the past, the strategic decisions of elected officials were supported by the planning process, today the strategies are actually *produced* through the planning process, and those strategies in turn guide the strategic decisions of executive organizations and elected decision-makers.

Institutional Context of Transportation Strategy Development

The dominance of the planning process as a means of developing strategy for transportation is often tempered by the institutional contexts within which planning occurs. In this section we describe the institutional contexts within which strategy is developed for surface transportation in the U.S.

Hooghe and Marks make a distinction in the political science literature between functionally-defined and geographically-defined units of government (*12*). Geographically-defined governments provide a diversity of public services in non-overlapping, spatially-defined jurisdictions. Several layers can exist, as in the federalist structure of U.S. and state governments. By contrast, functionally-defined governments provide specific services or functions. In the transportation context, port and airport authorities, mass transit agencies, turnpike authorities, and special highway districts are examples of functionally-specific government agencies with relative functional autonomy but substantial spatial overlap. Strategy development in surface transportation is an activity of both geographic and functional government agencies. For example, the transportation planning and investment decision-making activities of cities, MPOs, and states in the U.S. constitute geographically-based strategy development. On the other hand, strategy development activities can also be performed by the more functionally-defined transit agencies, port authorities, and turnpike authorities.

In the U.S. context, the legal powers, political strength, and financial resources of various functional transportation agencies, local governments, regional governments (e.g., MPOs), and state governments are significant factors shaping the strategy development process. For example, Goldman argues that local governments in some areas of California have become de facto transportation *planning* authorities as they use their power to conduct ballot initiatives to raise taxes for particular transportation projects as a means of bypassing “the formal metropolitan planning process” (*13*). Perhaps better stated, ballot initiatives have bypassed planning altogether as a preferred local *strategy development process*. At the state level, variations in legislation and control over the finances and activities of local and regional governments have significant impact. For example, the Michigan legislature requires that 90% of all state transportation funding be dedicated to maintenance and preservation. By contrast, North Carolina’s state constitution requires a state network of highways such that “90% of… residents have access to a four-lane, divided highway within five miles of their homes,” resulting in an emphasis on capacity expansion in that state (*14*). Despite having largely similar superficial organizational architectures (such as MPOs), regions and states across the U.S. vary significantly in the details of their strategy development processes and in the actual strategies and strategic decisions they pursue.

The large number of organizations, often overlapping, that participate in strategy development can appear cumbersome. For example, Chisholm chronicled the condition of mass transit in the San Francisco Bay Area in the 1970s and 1980s, which consisted of numerous agencies making strategic decisions more or less autonomously (*15*). Nonetheless, according to Chisholm, the considerable network of informal personal linkages among the managers of the systems resulted in the successful performance of this institutional structure. More recently, Macario evaluated mobility strategies for urban areas around the world, including the U.S. Observations and survey results support the conclusion that strategies and strategic decisions are fragmented by the organizational and jurisdictional complexity of many large urban areas. This fragmentation prevented any urban areas in the study from developing an integrated, coherent, forward-looking transportation strategy (*16*). However, the absence of a forward-looking strategy study does not preclude the existence of an emergent strategy. In fact, “emergent” strategies exist (in retrospect) *in spite of* the absence of a deliberate or coherent effort to develop a forward-looking strategy.

Summary

We contend that transportation *planning* is but one of many potential *processes of strategy development* for organizations and for regions, although admittedly the dominant strategy development process in the U.S. In turn, strategic decisions (e.g., allocating resources, setting standards, and promulgating regulations) are guided by those strategies. Although in many cases strategic decisions are ultimately subject to the approval of elected and appointed leaders (and sometimes, the electorate directly), the implementation of planning processes in the U.S. has largely removed development of strategy from the political arena and placed it in the hands of planners.

Given that the power over transportation strategy now rests in the hands of organizations and agencies rather than elected or appointed leaders, it is important to exercise that power effectively. The next section discusses four important elements (revenue sources, data sources, temporal scales, and spatial scales) of strategy development processes. By considering technology-enabled changes to these elements, organizations can begin to consider improving their strategy development processes, whether by working within the existing planning processes or by adopting alternatives to planning altogether.

ELEMENTS OF STRATEGY DEVELOPMENT PROCESSES

In this section we explore the relationships between transportation technology and specific elements of strategy development processes, including: revenue sources, data sources, temporal scales, and spatial scales. These elements vary considerably from place to place and organization to organization. We discuss the general role of each element in strategy development processes, and we emphasize the role that technology has played in shaping the current way that each element is used for strategy development.

Revenue Sources

The choice of revenue sources that fund transportation investments is a function of political and institutional factors in an organization or region, and also of the technology available to support revenue collection. As such, revenue sources evolve as political factors and technologies change. Once selected, however, revenue sources play an important role as part of the strategy development process for surface transportation.

The “user pay” principle has been favored in the U.S. beginning with toll-financed private turnpikes of the 1800s until today, where the majority of transportation revenues is derived from dedicated user fees (i.e., fees collected are re-invested in the transportation system), including fuel taxes, vehicle licensing fees, vehicle ownership taxes, and driver registration fees. State governments collect the majority of user fees directly; in addition, with some exceptions, federal user fee revenues are returned to the state governments. Most transit agencies derive some revenues from fares, but the majority of funding comes from a combination of non-user fees (e.g., local sales or property taxes and federal grants for capital expenditures) (*17*).

State DOTs collect revenues, develop strategies, and disburse revenues. MPOs, on the other hand, use a formal planning process to develop strategies for metropolitan regions that then guide the investments of all transportation agencies in a region, including transit authorities, state departments of transportation, port authorities, turnpike authorities, and others; however, they neither collect nor disburse revenues. MPO plans must be "financially constrained," meaning that planners must demonstrate the revenue sources for the projects and investments contained in the plan (*9*). By contrast, many European countries fund surface transportation through general tax revenues (e.g., income, property, fuel, and value-added taxes).

Technology is a major factor in shaping the choice of revenue sources. Although the "user pay" principle has historically been practiced in the U.S., the relatively slow advancement of revenue collection technology (compared to the pace of growth in vehicle and infrastructure technology) has been a factor in the continuing reliance on fuel taxes. As a result of this practice, strategy development processes depend on aggregated sources of funding, for instance at the state level, since states are both strong units of government and efficient geographic scales for collecting fuel taxes. The result is that states must make strategic investment decisions without much resolution on the source of revenues, relying instead on a combination of rational analysis, historical resource allocation formulas, and political resource bargaining to guide investment decisions. The same is true for European countries whose strategy development processes rely on revenues provided through general revenues, typically at the level of the national government.

An exception to the general trend of using fuel and other taxes for transportation is The Netherlands, which is in the process of transforming its highway transportation funding scheme. The objective of the transformation is to replace the existing combination of fuel taxes, registration fees, vehicle ownership taxes, and other revenue mechanisms with a nationally-scaled "pay by the kilometer" revenue scheme (*18*). The Netherlands' scheme is enabled by electronic toll collection (ETC) – more specifically, a system which combines vehicle tracking (e.g., global navigation satellite systems, or GNSS) and communications (e.g., dedicated short-range communications, or DSRC) technologies. As the technological capabilities improve and costs decrease, ETC may allow for a more comprehensive replacement of fuel taxes and other assorted fees with direct, real-time user charges based on time of day, location, type of vehicle, and other factors.

While technology-enabled road pricing schemes such as that in The Netherlands are typically discussed in the context of addressing congestion, they also provide opportunities for reconsidering the role that revenues play in the strategy development process. In general, property taxes, income taxes, and other general sources of revenue for transportation do not generate data of value for transportation strategists. Even the fuel tax provides only aggregate information about revenues, which can be used to compute total travel consumption, perhaps with some geographic disaggregation, depending on the precise method of collection. With ETC, however, the data collected from travelers can provide much greater detail, including locations and distances traveled and amount of charges paid (*19*). This information could be used to improve strategy development, either within the existing planning processes or through a new, "user-driven" approach to strategy development.

Table 1 summarizes some of the factors related to revenue sources, including a relative measure of the level of technological sophistication required to support each type of revenue source and the types of data generated that may be relevant to strategic managers of transportation systems.

TABLE 1 Transportation Revenue Sources

Revenue source	Relative technology investment required	Data generated with relevance to transportation
General taxes (income, sales, VAT, etc.)	Low	Demographic
Property tax	Low	Land-use and land-value data
Fuel tax	Low	Aggregate revenues and fuel consumption
Vehicle/driver registration fees	Low	Vehicles and driver demographics
Manual tolling	Low	Facility-specific revenues, aggregated
Electronic tolling	Medium	Facility-specific revenues, disaggregated at the vehicle/driver level
VMT/VKT-based tolling	Advanced	Travel data highly disaggregated at the vehicle/driver level
Transit tokens/cash	Low	Facility-specific revenues, aggregated
Transit smartcards, tap-in	Medium	Partial travel data
Transit smartcards, tap-in/tap-out	Medium	Travel data disaggregated at the user level

ETC promises to provide a more direct method of revenue collection which can improve the ability of strategists to understand exactly where and when revenues were derived. Such information can enable major changes to the strategy development process. Ultimately, such changes must occur within political and institutional frameworks that are not necessarily accommodative of change. Nonetheless, the potential exists to use new sources of revenues enabled by advanced technology (and the information those revenues represent) to re-think strategic decisions as well as the processes and institutions in which strategic decisions are made.

Data Sources

Like revenue sources, data play a major role in strategy development processes (in many ways, revenues *are* data). There are, of course, a variety of sources and types of data that organizations use in their strategy development processes and in making strategic decisions. However, data look differently and are used differently from place to place and organization to organization. As with revenue sources, technology determines what data are available, while political factors determine how those data may or may not be used.

Surface transportation organizations typically rely on a wide variety of information for strategy development. For example, MPOs produce regional travel models as part of their planning processes, which require substantial input of regional travel data such as the physical transportation network, land uses, and demographics (e.g., population, density, income, age, employment). Models are validated using origin-destination surveys and traffic counts on all modes of travel. At state DOTs, travel volumes, pavement conditions, bridge conditions, and other data are typically collected manually (*14*). Transit agencies monitor ridership through manual ride counts (and increasingly from electronic farecard data), validated by revenues (*20*). They may also monitor congestion and performance through automated vehicle location (AVL) systems. Other sources of transportation data useful for strategic managers include customer feedback and input from the general public, for example through public hearings and “town hall” meetings.

There are many advantages to using new sources of data, generated by advanced technologies, to supplement or replace existing sources of data that support planning activities. For example, FHWA characterizes transportation data when collected by traditional means versus when collected using advanced technologies such as ITS (*21*). Whereas traditional survey data are collected infrequently, cover only small periods, and require intensive labor, ITS data are collected continuously and automatically. Tradeoffs include the higher cost of storage for ITS data and greater difficulty in checking errors. Table 2 presents several examples of types of data that can be supplemented and/or replaced with data from innovative, technology-enabled sources.

TABLE 2 Examples of Innovative Data Sources for Strategy Development

Type of data	**Traditional sources**	**Innovative sources**	**Advantages**
Vehicle volumes	Sampled manual counts at specific points	Complete, continuous counts across a network	More complete coverage of road networks, spatially and temporally
Transit ridership	Sampled manual ride checks	Automated passenger counters and farecard data	More complete coverage of transit networks, spatially and temporally
Travel demand	Mode choice and origin-destination surveys	Vehicle tracking via GPS and/or DSRC	Continuous O-D vehicle flows across a network provide broad coverage
Crash data	Police crash reports	Automated crash reporting systems	More complete records; improved accuracy of crash location and other aspects

As technologies for collecting information about the transportation system change, the types of data available inevitably change. These data can be incorporated into strategy development processes and can support strategic decision-making; however, doing so requires more than simply technology. In organizations with formalized strategy development processes such as planning, data are collected and used almost ritualistically. Surveys, traffic counts, census data, and other sources are utilized to support a routine analytical process. In such a system, advances in technology may or not be useful. For example, if the technology offers an improvement to the quality of data already being used or a new source of data that fits easily within the framework of the existing analytical process, then the technology is likely to be utilized, as illustrated by

FHWA's summary of several archived data management systems (ADMS) for ITS-collected data (*21*). However, new types of data not currently used in the strategy development process will not necessarily be useful without first changing the *process* itself. Conversely, if strategists are interested in making improvements to the strategy development processes of their organizations, then technological advances can serve as key enablers.

Temporal Scales of Decision-Making

In transportation, as in most businesses, strategies tend to be long-term in nature. But exactly how long is long term? The time frame over which strategic are intended to perform varies widely. The selection of an explicit time frame, if taken, shapes the strategy development process. Meanwhile, technology can serve to expand the feasible range of time frames.

Early metropolitan transportation plans in the U.S. employed planning horizons ranging from approximately 20 to 40 years. According to Boyce et al., the reason for these time horizons was that planners modeled their projections of demographic trends and travel demand together with fully-elaborated alternative visions of future metropolitan-scale transportation networks, including highways and transit (*22*). The alternative future networks would take decades to build. Consequently, in order to observe any meaningful differentiation among the modeled performance of alternative future networks, planners had to build and test transportation scenarios at a future time by which the networks could be reasonably expected to be fully built. Today, per federal regulations, state and MPO long-range transportation plans must employ a minimum 20-year strategic planning horizon (*9*). Likewise, transit operators must perform financial planning over a 20-year horizon. Given the long lead times in construction of new physical infrastructure, these time frames fit the original justification.

However, strategic does *not* necessarily mean "long term" and certainly does not necessarily mean "20 years." Many in the transportation industry have observed the increasing importance of operations, particularly in those areas where infrastructure expansion is limited. Application of advanced technologies (e.g., ITS) and operational techniques are viewed as alternatives to the traditional approach of expanding physical infrastructure to provide capacity. Sussman notes that in this environment, transportation planning should no longer be limited strictly to infrastructure; "planning for operations" is an increasingly important parallel activity (*23*). However, he suggests that the time scales of planning for infrastructure (long-term) and planning for operations planning (shorter-term) differ. Actual operations, meanwhile, require a real-time perspective.

In short, the formal, established strategy development processes of U.S. transportation organizations, such as planning, are based on transportation infrastructure technologies with long construction times that required decades-long perspectives. Moreover, the analytical aspects of planning required large amounts of data, long lead times for data collection, and long lead times for analysis. As a result, strategy development through the planning process not only looks to a distant horizon, but it also takes a considerable amount of time to complete the necessary analysis to support the development of the strategy.

Today, advanced technologies allow for consideration of new time frames as data are collected, assembled, and analyzed more rapidly than in the past. Moreover, although investments in the preservation and expansion of physical infrastructure will still be necessary, the growing emphasis on operations requires more responsive transportation strategies, developed more frequently and with shorter life cycles.

Spatial Scales of Decision-Making

Transportation organizations and regions develop strategies that apply to particular spatial scales. In this section we first draw an analogy between the spatial scale of transportation organizations and the size of private sector companies involved in strategy development. Next, we consider both the experiences of organizations and observations in prior literature on the spatial scale of strategy development for surface transportation.

In business, the size and scope of an organization are major factors affecting its strategy development processes. What roles do central management and the various business units play in developing strategy? Is strategy developed centrally and communicated down the hierarchy to business units, or do pieces of strategy emerge within business units and travel up the hierarchy to central management? If a company participates in multiple industrial sectors, rather than a single sector, how does management develop a unified strategy for those diverse components? Does it even try? These are the sorts of questions explored by corporate strategists. Andrews (1980), for example, argues for strong management and strong participation by a board of directors to craft a unifying corporate strategy that guides the diverse segments of the diversified corporation. Mintzberg, on the other hand, argues for management to play a more passive role of recognizing patterns inside the organization before promoting or implementing major changes of direction, or strategy "revolutions" (*24*).

This is analogous to transportation strategy development, which, in practice, occurs at a variety of spatial scales in the U.S. In the early 20th century, the federal government undertook an effort to define highway corridors at a *national* scale, with substantial input from states; these corridors ultimately became the Interstate highway system. Contemporary strategy development occurs largely within *states* and *metropolitan* areas, while operating agencies such as turnpike authorities and transit agencies also develop strategy for geographies coincident with their operating boundaries (*10*).

Statewide strategy development occurs through the transportation planning process at state DOTs. The "state" as a preferred spatial unit for transportation strategy development in the U.S. is a product of both political and financial history. During the early decades of the national highway planning efforts, for example, the states contributed the majority of the decision making to the federal government with regard to determining highway locations, routes, and order of construction. Also, for most of the 20th century, states collected fuel taxes to fund transportation investments (*17*). As owners of fuel tax revenue streams, the states required a process by which to determine how to disburse revenues back to the transportation system. These factors can be understood as the historical influences that have led to the role of today's statewide organizations (state DOTs) as strong actors in the determination of transportation investments.

Despite the financial and political dominance of state DOTs, metropolitan strategy development has grown in importance in the latter part of the 20th century. The origins of today's metropolitan planning efforts date to the technical studies of transportation demand in urban areas of the late 1950s, such as the Chicago and Detroit Metropolitan Area Transportation Studies. Just as a decades-long time scale was needed for technical analysis, the *metropolitan* scale was appropriate for the application of large-scale alternative future visions of a regional highway network and of the mathematical models that had been developed to estimate travel demand on urban highways. In addition to the analytical convenience of the metropolitan scale, planners appear to have been motivated by a belief that the metropolitan area was an important economic unit with dense, strong internal connectivity. Just as Porter would later recognize, the authors of the Chicago and Detroit studies argued that metropolitan regions "are, and will continually be, in competition with one another." Moreover:

> The productive strength of a metropolitan area is affected by the design and operation of its internal transport system. Once again there is great need to secure a more efficient transport system, and there will be great rewards for those areas which do so most effectively. (*25*)

According to Meyer and Miller, the Chicago and Detroit studies, and their successors in the 1950s and 1960s "facilitated 'rational' decision making by developing comprehensive plans… 20 to 25 years into the future" (*11*, *25*). Comprehensive, in this context, refers to the metropolitan spatial scale. Boyce et al. (*22*) observed that the metropolitan land use and transportation planning programs of the 1960s "evolved from the urban transportation study of the late 1950 to early 1960 period." The 1960s metropolitan planning programs were later codified by federal laws as the metropolitan planning process and carried out by MPOs (*10*). Recent research by Porter and others in the regional science field reflect the motivations explicitly stated in the Chicago study and highlight the economic importance of "regions" as units of competition (e.g., *26*). The scale suggested by Porter is not necessarily limited to the conventional metropolitan area; he suggests a broader regional perspective such as a sub-national region or even a nation.

Despite the emergence of the metropolitan scale, there is little direct evidence to support a causal link between the importance of metropolitan areas or larger regions as economic actors and the explicit need for metropolitan or regional transportation strategy development processes. In addition, there is no explicit attempt in the literature to justify the metropolitan scale of strategy development over any other geographic scale – smaller or larger. Meanwhile, technological advances have allowed for new consideration of new spatial scales for strategy development. Sussman et al., for example, suggest that deployment of ITS requires a regionally-scaled perspective for strategic transportation planning (*27*). However, they caution that the institutional issues inherent in pursuing strategic planning at a regional scale require careful analysis and propose the Complex, Large-scale, Interconnected, Open Socio-technical (CLIOS) process as a means of analyzing – in an integrated fashion – the institutional, cultural, and technological hurdles to regional strategy development. This regional perspective for planning follows regionally-scaled operations, as reflected in the development of Regional ITS Architectures. According to Rodriguez, et al., "a system architecture, while guiding the deployment of ITS, is further proposed as the instrument to address the regional transportation planning and coordination needs implied by the competitive region" (*28*).

Amekudzi et al. suggest an even broader, "supra-regional" scale for transportation planning (*29*). Their motivation for recommending this scale is not technological, but demographic: "as several metropolitan areas achieve megacity status and in some cases morph into megalopolises, the planning period and area may effectively have to expand accordingly."

There is no consensus in the literature or in practice as to the "appropriate" spatial scale for strategy development in surface transportation. Metropolitan-, regional-, supra-regional-, statewide-, national-, and organizationally-focused scales have all been proposed and practiced, with no clear preference emerging. It is clear that technology, analytical methods, demographics, economics, politics, and even culture are factors affecting the spatial scale of strategy development, with the relative weights of these factors varying by location. Moreover, as the spatial scale of strategy development for transportation expands, so do the related issues or sectors that must be considered in the strategy development process. Like the diversified corporation that must determine a unifying strategy for multiple business units and products, a strategy development process for transportation that covers a large geography must increasingly consider not only transportation but also other issues that become important at larger scales, including economic development, distributional equity, the environment, and energy.

ALTERNATIVES TO PLANNING

The planning approach to strategy development is well documented in management literature and widely practiced both in the private sector and among transportation organizations. Among U.S. transportation organizations, technology has played a major role in determining the various elements of the planning process, such as revenue sources, information sources, temporal scales, and spatial scales. However, other approaches to strategy development such as through learning and consensus building are worth considering, particularly as they are enabled by further advances in technology.

Mintzberg et al. characterize the "learning" approach to strategy development as a largely emergent one. Numerous actors within an organization make strategic decisions, from which a strategy emerges. Strategists can exercise control in this model by recognizing the emergent patterns of the many distributed decisions and responding appropriately. In surface transportation, it is conceivable that strategists could take advantage of detailed traveler and revenue data, made available by advanced technologies, in order to better see the patterns emergent in the collective decisions of users and respond to them, rather than by proposing (and perhaps imposing) a vision of the future, however rationally determined, on the users.

Another potential approach to strategy development is strategy development through consensus. Although consensus building among stakeholder groups is a feature of existing planning processes, planning cannot account for the viewpoints of the entire population of interest. With advanced, highly-distributed technologies, it is possible to reach a much broader portion of stakeholders, whether directly through an interactive process such as virtual "town hall" meetings or indirectly through real-time measurement of users' traveler behavior over time.

Regardless of the particular approach taken, it is increasingly clear that with advanced technologies, it is possible to conceive of, at minimum, improvements to existing planning process by incorporating data made available by advanced technologies. It is conceivable even to shift to entirely new approaches to strategy development that do not involve “planning,” at least not as planning is currently understood and practiced by organizations in the U.S.

CONCLUSIONS AND FUTURE WORK

Surface transportation organizations in the U.S. usually develop strategy through a formal planning process. Key elements of strategy development for surface transportation include revenue sources, information sources, temporal scales, and spatial scales. To a large extent, technology determines the options available for each of these elements.

- Options for collecting revenues from surface transportation systems have expanded with the growth of ETC and farecard technology. The selection of revenue sources is ultimately a function of political and institutional context; however, once selected, revenue sources play an important role as a feature in the strategy development process.
- The range and quality of available system data has grown with the deployment of transportation technologies. Again, political and institutional context influence *how* data are used in the strategy development process, but technology-enabled sources of data offer the potential for reshaping strategy development processes.
- Deliberate strategies may be developed to cover specific temporal scales (e.g., 10 years, 20 years). The selection of a particular time scale is influenced by the quality and speed of information collected to support the planning process, the amount of time required to perform analyses, and the degree to which operations in the transportation system are emphasized.
- Strategies in transportation inherently span a region of some spatial extent and organization(s) with responsibilities at that scale, which then shapes the strategy development process. Once again, the size and scope of the organization(s) or region are determined ultimately by politics and institutional contexts, but can also respond as technology increases the range of available, feasible spatial scales.

Today, the power to develop strategy in the U.S. rests largely in the hands of transportation organizations, rather than elected leaders. It is important that those organizations exercise that power effectively. A sure way to improve the strategy development process of an organization is to recognize explicitly, first, that one is in fact engaged in strategy development. Strategists in surface transportation, such as managers of transportation organizations and planning agencies, can use this discussion to improve their ability to recognize the explicit strategy development processes they are following and the elements that compose that process. They can also begin to explore ways in which to use advanced technology, beyond operations, to pursue innovative strategy development processes, whether those innovations are incremental improvements to the existing process of planning or a more fundamental shift away from planning and toward a new paradigm such as strategy development through learning or consensus building.

Future research will advance the notion of adopting alternative approaches to strategy development such as learning and consensus building in surface transportation. To support this research, new frameworks describing innovative strategy development processes and their institutional contexts will be required, which will explain in detail how strategy can be developed through approaches other than planning, what roles technology will play, and how we can migrate from the current framework to these possible future frameworks. In addition, it will be necessary to test the feasibility of these alternative frameworks for strategy development, both by examining their political feasibility and by testing whether these new approaches to strategy development can, in fact, improve strategies and strategic decisions to the extent that we can observe measurable improvements in the performance of transportation systems.

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REFERENCES

(1) Bernstein, S. L.A. doesn't save data on traffic growth. *Los Angeles Times*, 1 Oct 2007.
(2) Moore, J. *Writers on Strategy and Strategic Management*. Penguin Books, London, 1992.
(3) Henderson, B. The Origin of Strategy. *Harvard Business Review*, Nov-Dec, 1989.
(4) Porter, M. How Competitive Forces Shape Strategy. *Harvard Business Review*, Mar-Apr, 1979.
(5) Mintzberg, H, B. Ahlstrand, and J. Lampel. *Strategy Safari*. Free Press, New York, 1998.
(6) Banister, D. *Transport Planning*. E&FN Spon, London, 1994.
(7) Gakenheimer, R. *Transportation Planning as a Response to Controversy: The Boston Case*. MIT Press, Cambridge, MA, 1976.
(8) Wildavsky, A. If Planning is Everything, Maybe It's Nothing. *Policy Sciences*, Vol. 4, No. 2, 1973, pp. 127-153.
(9) FHWA and Federal Transit Administration (FTA). *The Transportation Planning Process: Key Issues*, U.S. DOT, Washington, DC, 2007.
(10) Weiner, E. *Urban Transportation Planning in the United States: A Historical Overview*, U.S. DOT, Washington, DC, 1997.
(11) Meyer, M. and E. Miller. *Urban Transportation Planning: A Decision-Oriented Approach*. McGraw-Hill, New York, 2001.
(12) Hooghe, L., and G. Marks. Unraveling the Central State, but How? Types of Multi-Level Governance. *American Political Science Review*, Vol. 97, No. 2, 2003, pp. 233-243.
(13) Goldman, T. Transportation Tax Ballot Initiatives as Regional Planning Processes. In *Transportation Research Record: Journal of the Transportation Research Board, No. 1997*, Transportation Research Board of the National Academies, Washington, DC, 2007, pp. 9-16.
(14) FHWA (Booz Allen Hamilton, Inc). *Relationships Between Asset Management and Travel Demand*, FHWA, Washington, DC, 2007.
(15) Chisholm, D. *Coordination Without Hierarchy*. University of California Press, Berkeley, CA, 1989.
(16) Macario, R. What is Strategy in Urban Mobility Systems? Presented at the 10th Conference on Competition and Ownership in Land Passenger Transport, Sydney, Australia, 2007.
(17) Transportation Research Board. *Special Report 285: The Fuel Tax and Alternatives for Transportation Funding*. Transportation Research Board of the National Academies, Washington, DC, 2006.
(18) Eurlings, C. Anders Betalen voor Mobiliteit/Kilometerprijs. Letter from Dutch Minister of Transport, Public Works, and Water Management, Ref. #VENW/DGP/2007/6277, The Hague, The Netherlands, 30 Nov. 2007.
(19) Cottingham, D., A. Beresford, and R. Harle. Survey of Technologies for the Implementation of National-scale Road User Charging. *Transport Reviews*, Vol. 27, No. 4, 2007, pp. 499-523.

(20) Farzin, J. Constructing an Automated Bus Origin-Destination Matrix Using Farecard and GPS Data in Sao Paolo, Brazil. Presented at 87th Annual Meeting of the Transportation Research Board, Washington, DC, 2008.
(21) FHWA. *Archived Data Management Systems: A Cross-Cutting Study*. Report, Washington, DC, 2005.
(22) Boyce, D., N. Day, and C. MacDonald. *Metropolitan Plan Making*. Regional Science Research Institute, Philadelphia, 1970.
(23) Sussman, J. *Transportation Operations: An Organizational and Institutional Perspective*. Report, ITS Joint Program Office, Washington, DC, 2001.
(24) Mintzberg, H. Crafting Strategy. *Harvard Business Review*, Jul-Aug, 1987.
(25) Chicago Area Transportation Study. *Final Report, Volume 3: Transportation Plan*, Report, State of Illinois, Cook County, and City of Chicago, 1962.
(26) Porter, M. Regions and the New Economics of Competition. In *Global City-Regions* (Scott, A., Ed.). Oxford University Press, New York, 2001.
(27) Sussman, J., S. Sgouridis, and J. Ward. A New Approach to Transportation Planning for the 21st Century: Regional Strategic Transportation Planning as a CLIOS. In *Transportation Research Record: Journal of the Transportation Research Board, No. 1931*, Transportation Research Board of the National Academies, Washington, DC, 2005, pp. 89-98.
(28) Rodriguez, D., et al. Regional ITS Architectures and the Competitive Region. Undated.
(29) Amekudzi, A., L. Thomas-Mobley, and C. Ross. Transportation Planning and Infrastructure Delivery in Major Cities and Megacities. In *Transportation Research Record: Journal of the Transportation Board, No. 1997*, Transportation Research Board of the National Academies, Washington, DC, 2007, pp. 17-23.