CHAPTER 1

THE MACHINE FOR ACCESS

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In 1923, renowned architect Le Corbusier authored what is largely considered to be the best-selling architecture book of all time, *Vers Une Architecture* ("Towards a New Architecture"). Within the pages of his impassioned manifesto, he claimed that "A house is a machine for living." Architecture, he claimed, is able to improve people's lives. For Le Corbusier, Victorian cities were chaotic and dark prisons for many of their inhabitants; he was convinced that a rationally planned city could offer a healthy, humane alternative. Contemporary planning initiatives suggest the time is ripe to revisit this metaphor, albeit on a larger scale.

Much of land use-transportation planning today aims to reduce average vehicular delays, increase passenger throughput, and in general, keep traffic flowing smoothly and safety. The barometers used to measure such attributes include hours of delay, speed of traffic, number of cars in congestion. Such barometers have become accepted lore among populations from both the transportation industry and popular culture. Newspapers around the country wait eagerly for the well-known annual rankings from the Texas Transportation Institute to relay to their residents how well (or in a perverse sense of pride, how poorly) their city is performing.

Measures of congestion, however, have limited utility. They provide a snapshot of only a select dimension of a city's transportation system: the ability of residents to transport themselves under certain conditions (e.g., free flow travel times). Measures of mobility are merely concerned with the ability to move, but not with where one is going. In many respects, such measures fail to adequately capture other essential dimensions of a city's entire transportation environment—that is, how easy it is to get around. Transportation, concerned with the movement of matter (people and goods), is the machine for mobility.

Like a house is a machine for living, cities are the machine for accessibility. In a conference in 1993, Melvin Webber succinctly and eloquently outlined the motivation for and definition of 'accessibility' in a metropolitan context. He described the aim as a desire for greater

connectivity and to maximize opportunities for social and economic interactions. The *ideal* city, he claimed, is "one that *maximizes* access among its interdependent residents and establishments." This central notion has been widely shared. For example, it is entirely consistent with Lewis Mumford's claim that the problem of urban transportation could be solved by "bringing a larger number of institutions and facilities within walking distance of the home" [i]

We agree with such statements even though these ideas are not necessarily novel. Many urbanologists have evoked the notion of accessibility. It has received considerable study over the years from researchers in land use, transportation, regional science, urban economics, and geography. However, the concept is receiving a resurgence of sorts from several professions. In response, at least three issues motivate this work:

- Quality of life and related policy dialogues are increasingly sensitive to the role of congestion throughout many metropolitan areas. The measures guiding such discussions—the Texas Transportation Institute's Congestion Indices—provide an incomplete picture,
- In depth transportation, land use, and city planning surrounding such issues deserve a balanced, and objective criterion on which to base future solutions. There is confusion over use of the various terms in such discussions, (see, for example, Susan Handy's paper in this volume on the misinterpretation of mobility versus accessibility),
- The time is ripe to revisit many of the concepts put forth during the novel work of the 1970's to suggest how matters have changed and progress that is being made over a quarter century later.

The idea of centering a research agenda—and a series of papers—around the concept of access is one that we have considered for some time in informal dialogue. There are several issues involved and questions that each of us have batted around for some time. For example, what are the implications for the different measures of accessibility. How do we know which one is right for which job? Is there a problem with providing excessive amounts of access? How do we know when a policy or project we have implemented achieves the *optimal amount* of access in a *real* city; that which is worth what it costs? There are ongoing debates (and more importantly, things taken for granted that should be debated) that the accessibility hypothesis can inform. First, what is the role of accessibility in the economy at large? Second, which, if any, mode of transportation (auto, transit, or other) should be favored? Third, what is the optimal city structure? And last, how do we best answer these questions and implement the answers given the fractures in the transportation field?

The optimal choice of accessibility today may be tomorrow's white elephant. Perhaps it is the failure to recognize that the optimum amount of access is not infinite, or permanent, and that access is not the result of a single technology or process that has fueled the debate of auto

versus transit (low density versus high) as the appropriate vehicle for achieving access. The following section highlights additional matters.

ADDITIONAL CONSIDERATIONS

What creates accessibility, or why isn't economic and social activity ubiquitous? There are economies and externalities associated with the concentration of activity. These scale economies and spillovers allow greater choice ranging from consumer goods to entertainment to business specialization; how many small towns have a sushi bar, a symphony orchestra, or a stock market? One simply has to look at the differences in the range of opportunities between small towns and larger cities. Once you have economies of density (also called scale or agglomeration economies), it means there will be differences between places. If markets are working, in their attempts to be as well off as possible given the resources available (in the economist's jargon "maximizing utility under a budget constraint"), people will gravitate to those areas which offer them the greatest satisfaction. This is a very important point—small towns exist which have fewer services than larger towns, yet people move there, enjoy themselves, and die there. They have the amount of access they want.

Why should the private sector be concerned with accessibility? When individuals choose an activity, they must consider three elements: what they want to access, what everyone else wants to access, and what the people who run those places which are being accessed want. For instance: I want a bookstore nearby, my neighbors also want bookstores nearby, and somebody wants to sell books—great, we have ourselves a market. The owner, by locating his or her store and having extended operating hours, maximizes access to the most people. But if my neighbors didn't want books, I would be unable to support the bookstore myself. Or if nobody wanted to sell, we have the same problem. Or if the government set rules limiting store hours (for instance, "blue laws") or where bookstores could locate (zoning) we'd have less access.

Why must the public sector be concerned with accessibility? If all of the externalities from concentration were positive (e.g., increased market activity, access to specialized goods), then government should be in the business of encouraging higher density; if they were all negative (pollution, congestion, crime), government should discourage them. In the real world, there is a combination of the two, so there must be some attempt to optimize the level of density. That is the crucial issue; it is a central rationale for planning. But in the end it is a balancing act that reflects the varied preferences of people who want greater density and those who do not.

What constitutes the metric of accessibility, considering costs? In principle this is easy. Given relative costs it is the set of all goods and services (including social interaction) which the population could consume. Again in the parlance of the economist, it is the sum of aggregate consumer surplus. In practice, it is another story. Unlike most studies, accessibility analysis

needs to consider variations in travel and cost over several time horizons (e.g., hour, day, week, month, and year), different modes and routes of travel; and activities in proportion to importance. It would be ideal to weigh each by their duration, frequency, or intensity. Moreover, the analysis should consider historical and forecasts of use patterns, not merely a single point in time, as well as all points in space. This is a much more difficult task to measure than simple congestion, but it will also explain far more. A proper metric for accessibility is essential to discovering the optimum mix of modes of access and optimal city structure.

SOME NORMATIVE PROPOSITIONS

We propose that a central role of cities is to help individuals and organizations maximize choice at the lowest cost. The government, and more specifically the public sector transportation profession, has been charged with providing certain components of the transportation system such as roadways, buses, and commuter rail. Further, the government regulates other components, including vehicles for safety and pollution. Also, communications can be considered a mode for many purposes. How often need we travel physically when all we really want to do is exchange information? But this provision is in response to people's desires. For example, the desire to have greater access to products led to the significant mail order business in America. With increasing demand, couriers supplemented and ultimately supplanted the Postal Service, for the most part, to reduce the transactions cost of shopping.

The parable of the mountains may be useful here. While some disagree, we view the collective goal of the city's residents as economic growth and progress. Analogous to mountain climbing they want get as high as possible, as quickly as possible. Assume there are two mountains, both very tall, named Mt. Auto and Mt. Transit. The final altitude of both mountains is obscured by the clouds. We (as society) had the choice of which mountain to climb. However, by climbing one, we travel further away from the valley that separates them and thus further from the peak of the other (not only do we have its height to overcome, we must retrace our steps). In the year 2005, we are committed to one mountain—Mt. Auto. There are those who claim that Mt. Transit is taller, and we should turn around, climb down our mountain and climb the other; but the farther up we go, the harder this alternative becomes. Moreover, we still have no assurances about the true height of either mountain , only some forecasts which are little better than astrology. Some prophets who preach "Pedestrian Friendly Design" or "Transit Oriented Development" warn that atop of Mt. Auto are dragons and monsters (e.g., Global Warming, environmental destruction, alienation from community). We climbed up Mt. Transit in the 1800s, in that bygone era of mass production and centralization, the era of a single downtown and high-density cities. We decided, from our vantage atop Mt. Transit, that Mt. Auto was higher. By 2005 we have long surpassed our peak on Mt. Transit. Maybe Mt. Transit is taller now than it used to be, the geology of complex systems changes suddenly by introducing new technology. Perhaps the fog will lift, we may yet find a bridge between the two, or more likely, we will see a third and taller mountain. All of this begs continued

discussion—and research—about the form and function of our cities. Accessibility is central to such analysis.

If accessibility is paramount, what is the optimal city form to maximize access at the lowest cost? Clearly this depends on a number of factors: the cost of money, land, risk, construction, energy, information, transactions, and time come immediately to mind. When interest rates are high, short-term investments make more sense. If land is scarce (as on a peninsula such as Hong Kong or San Francisco), density makes more sense than dispersion. While construction is cheap, high rises have merit over low. A city which is particularly vulnerable to disaster (for instance, earthquakes) shouldn't put all its eggs in one basket, but rather spread the risk over more land. Where energy is expensive, one wants to conserve it. If the value of time is low, it is cheaper to make people commute longer rather than build new infrastructure. Further, these costs are not permanent over time. They tend to change from year to year, and in the case of interest rates, minute to minute, making impossible a definitive answer. There is a continuous struggle to find the optimal balance.

Asking the question another way: What should we be doing, maximizing opportunities for people (maximizing jobs, for example) or minimizing the transactions cost of consuming these opportunities? The latter, which transportation professionals have typically undertaken, wears the blinders of mobility; the former widens the view to include access. The optimal amount of access is not infinity; it is only that which is worth what it costs. So it comes back to the balancing of social costs and social gains. Both measures have to include private gains and positive and negative externalities. It is our proposition that the role of the city is to facilitate the market by providing maximum choice in destinations/activities at the lowest full cost (including individual travel time, as well as social cost of infrastructure, cost of externalities, etc. which should be charged to the individual).

While accessibility has as its goal something broader than reducing congestion, there is a place for congestion reduction. One means for maximizing choice includes reducing congestion where cost-effective through supply and demand management and facility expansion. Tools include pricing transportation—as communication and energy transmission are already, so that individuals can make trade-offs between time and money. Similarly, providing information so that people learn a shortest route, and if anyone else is going to the same place at the same time, will help manage the system—only in personal transportation do we rely on individuals to route their packages (themselves). Other utilities, be it the phone or power companies, or even the package delivery services, coordinate that function centrally.

The scientific program of the past few centuries has steadily divided the fields of knowledge into more and more specialized disciplines. In this reductionist approach, each discipline established its own language, journals, goals, and research agendas. On occasion, there were syntheses: Smith's Invisible Hand, Darwin's Theory of Evolution and Natural Selection, Einstein's Space-Time Continuum. Transportation has not escaped the reductionist trend, we have traffic signal controllers, highway engineers, transit planners, traffic modelers, travel

demand managers, transport economists, and the like. Moreover these groups are distinct from urban designers, community planners, growth managers, land use forecasters, and demographic modelers. Each discipline has its own objectives, which are coordinated through the visible hand of government that employs them, and the invisible hand of the market that directs government action.

A CALL FOR ADDITIONAL RESEARCH AND METRICS

Aside from political expediency (the maximization of voter satisfaction), there is no overarching goal of government action in the city. There are the occasional platitudes such as the transportation mobility goal of "safe and efficient movement of people and goods," but nothing on which to evaluate such aspirations. Urban designers are adept at formulating "theories"—manifestoes really, which purport to instruct us how to shape our urban environment. Environmentalists establish their own core beliefs. Engineers adopt various rules, the AASHTO Green Book, the Highway Capacity Manual, which inform and instruct the design of transportation facilities. Planners have various service standards to measure the quality of systems, level of service at intersections, the travel-time response of fire departments, etc. All of these rules lack a core. They are assertions little better than religion in some cases, or averages of (questionable) practice in others.

In the theory of evolution, it is suggested that those individuals (or even their genes) who adopt the best rules are more likely to survive and propagate than those who have inferior behaviors. The same may be true for cultures and societies. We have the advantage over other species that we can rewrite our rules quickly and consciously, with an aim to perfect them. We need hypotheses, which can be refuted and revised, not merely asserted, followed and believed. We need evaluation of policies, not mere promulgation of rules. There is a saying in science "Theories Destroy Facts," an overarching theory explains the accumulation of data in a field, such that once a theory is corroborated, it is essential to learn the theory rather than each specific case. Once a theory is established, the specific observations and rules of behavior can be tested against whether they are consistent with the greater theory. Is "The City is the Machine for Access" such a theory?

The issue of the interaction of location and travel is central to community design, urban economics, regional planning, and transportation engineering. Maintaining, or attaining, job/housing balance is becoming a goal of many regional and local plans. However, this goal conflicts with the restrictive zoning policies mandated by many communities and with the gains from agglomeration that results in central *business* districts. Similarly, growth management schemes are often based on the desire to restrict traffic congestion. Traffic engineers attempt to maximize flow at the highest speed, and have established level of service standards to identify congested areas, and restrict trip-making (land development) in their vicinity. But by looking only in the immediate area, these traffic impact studies ignore more regional effects—restricting development in one area, thereby pushing it into another, may

only increase the total amount of travel and traffic. Traveling 30 minutes at Level of Service C is viewed as preferred to traveling 15 minutes at LOS F. We believe these goals or rules are misguided. If the city is the machine for access, then policies need to be evaluated against that metric—policies that are based on empirically grounded research.

The chapters in this volume provide a focus on which to base such metrics and policies around the central concept of accessibility. They are wide-ranging, including issues of transit, network growth, definitions, and modeling. The papers presented herein are the result of an interdisciplinary conference held at the University of Minnesota in November, 2004. The conference was funded by the University of Minnesota President's 21st Century Interdisciplinary Conference Series as well as the Center for Transportation Studies. Each of the papers presented in this volume was subject to a critical peer review of between two and four experts in their respective field. Because of the broad spectrum of chapters contained within this volume, there is something for everyone. The practicing planner will find several chapters directly applicable to their work; there is theory; there is applied research; and even advanced econometric modeling.

Part I—Overview—begins with Bertini's account of alternative definitions of traffic congestion in U.S. metropolitan areas (Chapter 2). The chapter discusses current definitions of metropolitan traffic congestion and ways it is currently measured and describes the accuracy and reliability of these measures, and reviews how congestion has been changing over the past several decades. The results of a survey among transportation professionals are summarized to assist in framing the issue. Additional analysis of recent congestion measures for entire metropolitan areas is provided, using Portland, Oregon and Minneapolis, Minnesota as case examples. Some discussion of the stability of daily travel budgets and alternative viewpoints about congestion are provided.

In Chapter 3, Gifford complements the above by investigating society's discontent with congestion. He examines the history of congestion and the effectiveness of travel demand management programs and operations programs. He considers the prospects of congestion pricing and High Occupancy/Toll lanes.

Miller argues that traditional, place-based measures of accessibility need to be enhanced and complemented with people-based measures that are more sensitive to individual activity patterns and accessibility in space and time (Chapter 4). He reviews place-based measures, suggests what new tenets need to be incorporated, and offers several strategies for measuring people-based accessibility.

Knaap and Song show the effects of policy on land use and transportation, and ultimately on behavior. After reviewing the literature on the effectiveness of infrastructure on shaping land use they then turn to policy, showing that market-oriented policies will produce conventional density gradients, with the highest densities in the city center, while non-market regimes (e.g. Brasilia, Johannesburg, and Moscow) have much less traditional urban forms. As part of their

description in Chapter 5, they investigate current U.S. land use regulations and incentives, including urban growth boundaries, subdivision regulation, land use plans, transferable development rights, and priority funding areas.

Krizek reviews various perspectives that exist in the literature on both neighborhood and regional accessibility (Chapter 6). He urges the need to consider not only what modes are available, but which ones are attractive in assessing the inter-relationship between infrastructure, urban form, and travel behavior.

Chapter 7 consists of Handy's description of how mobility and accessibility are distinct concepts with vastly different implications for planning. This chapter describes the concepts in theory and in practice by examining the language in a sample of regional transportation plans in Northern California.

The second part of the volume—Behavior and Measures—begins with Kim and Morrow-Jones challenging the assumption that access to the workplace matters in residential location decisions (Chapter 8). Working with a longitudinal dataset based in the fast growing city of Columbus, Ohio, they show empirically how other, more pressing matters of accessibility (such as school quality) dominate most residential location decisions.

Yang and Ferreira (Chapter 9) compare three measures relating the spatial separation of jobs and housing: ratio of jobs to employed residents, accessibility, and minimum required commute (MRC) for both Boston and Atlanta to commuting costs. While concluding that MRC has the most explanatory power, the authors go on to suggest some alternatives such as proportionally matched commuting that should be considered in future analyses.

Horner and Mefford, using a case study of Austin, Texas, examine how an urban bus transit system provides accessibility to residents (Chapter 10). They apply accessibility indices at two different scales: disaggregate measures for the neighborhood level and aggregate measures at the system-wide level.

Relying on detailed parcel level data from Seattle, in Chapter 11, Lee develops some very precise and accurate measures of transit travel time, including both in-vehicle and access times, which can be used to assess accessibility. He applies his method to grocery stores in Seattle and identifies significant gaps in service.

The volume then turns to the third part—Development—where Levinson and Chen use a Markov chain model to analyze the spatial co-evolution of transportation and land use (Chapter 12). They find that existing agricultural and recreational zones that contain highways are much more likely to convert to employment and residential zones than those without highways, suggesting infrastructure drives development. Similarly, highways were more likely to be added to developed areas.

In Chapter 13, Woudsma and Jensen apply transportation and land use data for Calgary, Alberta, Canada to test whether transportation system performance has a quantifiable influence on the timing and spatial character of Distribution-Logistics-Warehousing (DLW) land use development. They find there is a positive relationship between DLW land development and transportation accessibility—those locations with better accessibility (smaller congestion influence) were developed more often over those which did not offer better accessibility. However, there are inconsistencies whereby some destinations are more influential than others suggesting that accessibility is spatially uneven. But they also show that there is a 5-10 year temporal lag in the relationship.

The final contribution under the domain of development comes from Ottensman who describes how matters of accessibility are incorporated into land use-transportation forecasting models (Chapter 14). The LUCI model, he demonstrates, easily allows a user to create and compare of future development scenarios reflecting a wide range of dimensions related to accessibility such as policy choices and assumptions affecting future development.

The final part of the book—Applications—describes how the concept of accessibility has been applied in various contexts. This part begins with Chapter 15 where Primerano and Taylor argue that the accessibility of a location does not necessarily reflect the accessibility of an individual to that destination. They suggest the focus should be on accessibility to activities, which can be satisfied by a number of destination alternatives. They reviews existing measures of accessibility from three different perspectives: the traveler (individual or group); the transport system (mode, roads and traffic characteristics); and land-use (characteristics of land-uses at origins and destinations).

Abdel-Rahim and Ismail present a graph-based approach to model accessibility in urban transportation networks under different scenarios (Chapter 16). Rather than based on the assumption of optimization, their approach incorporates issues of connectivity and functionality.

Using longitudinal data covering entire Switzerland from 1950 to 2000, Tschopp, Fröhlich, and Axhausen analyze the development of spatial accessibility and models its impacts on demographic and economic change by using a multi-level regression approach (Chapter 17). They maintain that Switzerland has been developing a more dispersed form over this period.

Finally, Ferguson considers the relationship between parking and accessibility in Chapter 18. Parking, by consuming space, reduces the space available for other activities, and thus negatively affects most measures of accessibility. However, parking that is difficult to access from destinations also has consequences. More attention needs to be paid to parking pricing, supply, and access costs from parking.

The end result is a collection of papers that serves to broaden our understanding of the meaning of accessibility. As we learn more, we discover more of what we don't know. Many

of the papers raise questions that provide a research agenda for years to come on understanding the relationship between infrastructure, location, behavior, and accessibility.

NOTES

[i] Lewis Mumford (1968), p.70 in *The Urban Prospect*