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Technology and Transportation: A Conversation with David Levinson

David King

David Levinson is an Assistant Professor in the Department of Civil Engineering at the University of Minnesota. His recent books include *Financing Transportation Networks* (2002), *Assessing the Benefits and Costs of ITS* (2004) and *The Transportation Experience* (2005). In 2005 the Council of University Transportation Centers gave him its New Faculty Award.

Introduction

Advances in transportation have always been closely aligned with technological innovation. Most notably, technological advances can give us entirely new transport systems. Railroads, automobiles and telecommunications, to name a few, have had profound effects on how people experience cities. Yet as cities and transportation networks mature, technology can also be used to better manage existing systems, rather than build new ones. In his work, David Levinson models transportation and land use interactions, and seeks to understand why people make the transportation choices they do.

Interview

King: You have referred to yourself as a "transportationist." What do you mean by this, and how does it define your approach to research?

Levinson: I mean to put the area of study above the methodology. We have transportation planners, transportation engineers, transportation economists, transportation policy-makers, etc. Each tries to apply the tools of their field to study transportation, but as a consequence each gets an incomplete perspective. Transportation is about the movement of people and goods. We move people and goods to serve some greater end: people in general are consuming transportation to be able to reach some other place, which ties transportation to land use, because depending on where and what that place is, we require more or less transportation. Transportation is a highly structured process, it takes place on networks, it is time sensitive, and it has issues with queuing and congestion. Transportation facilities themselves are major land uses, transportation requires space to occur, and radically alters spaces both at nodes—the terminals, stations, interchanges, which often become important activity centers—and along links (lines, roads, tracks, etc.).

While there is a unifying structure to transportation, each mode implements transportation differently. "Public" modes (e.g. buses, trains, airplanes on the passenger side, mail, express services, some less-than-truckload shipping on the freight side) operate on schedules, and require economies of scale. There must be more than one person or item going from somewhere near A to somewhere near B for the service between A and B to be provided. If the economies of scale are there, the service can be frequent, and even thought of as part of the permanent infrastructure. If there is high demand in a market (an origin-destination pair in the transportation jargon), a bus company can provide a route with such a high frequency of service that I don't need to think about when to catch the bus, I can step outside and one will be right along, just like turning the faucet on the sink and I get water. But a slight drop in demand will lead to some cutback in service, which will make the time between buses longer, which may make me think about whether I really want to go outside and wait, which reduces demand …

This is a process that I understand as a transportationist. I need to understand economics, of course, but that is insufficient. I also need to understand the technology of bus service (engineering), and how to shape land uses together with transportation so that the result is an internally consistent system: high density urban places with high quality transit service, low density and more rural places with adequate roadways. History is rife with cities building infrastructure that was not suited to their land use, both rail transit systems without adequate local demand and highways through high-density urban cores. The transportation plexus needs to be coupled with the activity place.

King: I know you have used driving simulators in your research. How do these simulated driving experiences improve transportation/land use research? How can planners use simulation technologies in their work?

Levinson: "What do people want?" is a crucial question that affects all of our decisions. As planners, we are planning for people. Of course not all people want the same thing, and we can't be sure that we know even what most people want, because people don't know themselves. As a result, we get community plans that reflect what planners want, and we get transportation infrastructure that reflects what engineers want.

One way of determining what people want is to ask them. Opinion polls and survey questionnaires are means for doing this. But when asking people to understand something they have never experienced, surveys will be potentially misleading. Imagine a surveyor asking "Do you want to live in a crowded city with high rise tenements, or in a more rural pastoral setting, with a large yard for your children to play in?" and then reporting that people want to live in the suburbs. Alternatively you could phrase the question to favor the vibrant street life of an urban area over the isolation of rural areas. Words are inherently loaded. As any photographer will tell you, pictures

and images can also distort reality. I could simply ask which you prefer, and show you pictures of a crowded high-rise tenement on a cloudy rainy day versus an English country mansion. Careful design can provide more accurate and complete representations of the alternatives we are trying to create.

Still, as careful as your design is, it is hard to ascertain truth. We had a study that was trying to assess the value people place on travel time under different conditions: waiting at a ramp meter versus driving in stop-and-go conditions versus free-flowing conditions on the freeway. Clearly people prefer not to be delayed, but if there is a choice of being delayed, a computer-based survey that simply asks the questions using words and a bar chart suggests that being stopped at a ramp meter is more onerous. However, using exactly the same times we presented in the bar graph, but having travelers experience them in a driving simulator (a full sized car positioned in a room with wrap-around screens that provide a virtual-reality like environment of road conditions) produced the opposite results.

There are a number of hypotheses about why the results are different, but the key point is that they are. My colleagues and I disagree about which one is closer to truth, but we agree that as good as the simulator is, it is still not as good as reality, so our next experiments involve having subjects travel on real roads under real conditions, and then telling us which they preferred, giving them the opportunity to actually experience the alternative conditions. This, of course, is still imperfect, as driving a road once is not the same as driving it everyday, and visiting a place is not the same as living there. But the closer the alternative realities that we show people are to things they can fully envision in three dimensions, with actual colors and shapes and sizes, the better their imagination can fill in the remaining details of what life would be like in that scenario, and—we hope—the more accurate their resulting responses about which they prefer.

King: Technology has played a big role in the evolution of urban transportation. Internal combustion engines, automobiles, airplanes and interstate freeways come to mind as obvious examples. How do you feel these innovations had the greatest impact on the function of cities?

Levinson: In a book I am editing with Kevin Krizek, *Access to Destinations*, I have, parapharasing Le Corbusier, called cities "Machines for Access." By this I mean that the purpose of a city is to enable people to be able to quickly reach each other. As technologies such as the streetcar, then the subway, then the automobile, then the freeway have enabled people to reach each other more quickly, or reach more people in the same time, cities (metropolises) have grown both in population and in area, but generally faster in area than in population. The traditional idea of a city as a dense, walkable area is simply one manifestation of the city given a particular set of technologies. The city is really an accessible area, which includes high density development and walking as one way of achieving accessibility, but also includes lower density development and automobility

as another means. Individuals may prefer one over the other, but as long as the market is free to create spaces in response to consumer demand we will continue to have both kinds of places. Planners should, when addressing the potential for new development, enable those places to be created (without needless restrictions) in response, and ensure that neither kind gets subsidies. The difficulty is that in order for me to live in an area with a dense population, others must do so as well, while in order for me to live in a low density area, others must not do so. I can't have density without people: other people are creating positive externalities for me if I want to live in an urban core; other people are creating negative externalities if I want to live in a rural setting.

King: Technology innovations in transportation can be used to improve the way we currently do things, or can be used to do new things altogether. Oftentimes, new technology is implemented with the capability of doing new things, but ultimately does things the same as before. An example of this is contactless parking cards, which have the capability of data management or dynamic pricing, but mostly are just replacements for the parking cards that were used previously. What are the difficulties of implementing new technologies in order to get the most out of them, or of calculating the costs and benefits of technology?

Levinson: New technologies require learning, experimentation, trial and error, and perhaps several failures before the best path can be found. Often there is an impatience with failure, and a rush to pre-judge. As professionals, we need to be able to separate the wheat from the chaff. There are lots of new ideas that are junk, and some that require further investigation to pull out the useful bits from the noise, and once in a while a bona fide winner (a steam railroad, a streetcar, an automobile) emerges. But the automobile had been on the inventors' collective radar screens (so to speak) since the 1780s; it took over a century to become a useful product. We need to place multiple bets, and pursue multiple paths, before we fully deploy any particular technology. We cannot know the costs or benefits of any truly revolutionary technology in advance, we can only estimate them for existing technologies deployed in new places, or for relatively minor tweaks. Overall, however, we need to "let a thousand flowers bloom," and then tend to our garden, pulling out the many losers and supporting the few winners.

King: What is the role of planners and public officials in getting the most out of technological innovations? As an example, you studied ramp meters on Twin Cities freeways when the legislature ordered them shut down for six weeks. When the ramp meters were turned back on, they were programmed differently than before, so that the waiting time was minimized rather than the freeway travel time. Did political interests play a role in this change, and how does it affect the original intent of the ramp meters?

Levinson: This is actually a good (if uncommon) example of politics affecting science in a favorable way. Ramp meters have two major purposes. The simplest one, on which there is little disagreement, is

to break up the platoons of vehicles entering freeways. Merging is easier if only one car enters the freeway at a time. The other is to ensure that the flow through bottlenecks is just below capacity. This, our engineering research tells us, ensures almost maximum flows at almost maximum speeds. But this means that a lot of delay is transferred from the freeway to the ramps. This in turn means that the delay is transferred from some individuals to others. Ultimately this is an equity issue as much as an efficiency issue. It turns out the most efficient solution to the ramp control problem is also the least equitable one. If we want more efficiency, we lose some equity.

As political as the entire ramp meter shutdown process was, in the end an experiment was done. If left to the traffic engineers and managers at the Minnesota Department of Transportation, nothing would have changed. The experiment was not perfect—no experiment is—but a great deal was learned from it. The experiment affected three million people, and I have called it (with some hyperbole, but I have yet to see it contradicted) "the single most comprehensive experiment in the history of surface transportation." People were shown a world with aggressive ramp metering, resulting in delays of sometimes over twenty minutes at freeway on-ramps, and a world with no ramp metering. And they were asked, with opinion polls, which they preferred. And what they seem to have preferred is something in between, a world with some metering, but with maximum waits capped at four minutes. Is four minutes the right number? The study I mentioned before, involving the driving simulator, was intended to get a better sense of this (and perhaps suggests there is no single magic number that is the right maximum). But because the science gives us contradictory evidence, and we do have to act, we decide with incomplete and imperfect information, which is where the transportation professional's judgment is brought to the fore.

King: Continuing on the subject of ramp meters: they are an example of using technology to manage the existing capacity of transportation systems. Do you feel that managing existing resources is where we will see new technologies implemented in transport, or are there innovations along the lines of the automobile out there? Why or why not?

Levinson: The automobile truck-highway system is mature, and the public transit system is senescent. As such, we can make changes to make them somewhat healthier, but we cannot expect either system to radically change the way we do things going forward. In terms of management, introducing pricing would present the most significant change. We can eliminate congestion if we choose; it has just not been worth it in most places (yet).

New technologies may come from the outside (the long-forecast but yet-to-be-really-implemented substitution of telecommunications for transportation). The Internet may ultimately be as radical as the automobile in how it affects our use of time and space. Flying cars (a la The Jetsons), if they could ever be mastered, would have a radical effect. In the mean-

time, truly automated cars (cars that drive themselves) would pose a significant change over the current auto-highway system. A driver can (safely) do many other things in much greater comfort if he or she is not distracted by the task of driving. While now people use cellphones and even laptops while driving (neither is advised), this involves multi-tasking, resulting in neither the driving nor the cellphone being used well. Relieving the driver of his or her role would make transportation sufficiently more comfortable (perhaps) that commutes would again increase. In a sense, just as we see that commuter rail users travel longer distances than automobile users, automated vehicle users would behave similarly.

King: How can public agencies and government encourage technological innovations? Should they institute technology standards or stay away from this? It seems difficult for government to spur innovation in managing publicly owned transportation systems, but it seems equally difficult for competition to produce innovations on public systems, largely because they are unpriced. What do you think the role of public agencies should be? What incentives can be put in place to encourage technological innovations?

Levinson: California has pushed the adoption of cleaner cars with various zero-emission vehicle standards through the years. By mandating performance standards on new vehicles, two things happen. First, new vehicles do meet higher performance standards. Second, because new vehicles are now more expensive, old vehicles are kept around longer, perhaps offsetting the gains. Mandating performance on existing vehicles (e.g. through inspection programs) is one way of trying to eliminate this problem. But government standards should be limited to things with a strong public purpose (e.g. minimizing the pollution externalities that arise because no one owns the air). People used to think about telecommunications as "natural monopoly", until the phone company AT&T was broken up in the early 1980s. The state DOT's and public transit agencies are very much in the same position as the phone company. Is there some feasible way of breaking them up? I don't know. But if they were broken up we might see new innovations in transportation.

Roads have been around a long time, and have been both public and private, and have failed (at various times) under both ownership regimes. Transit has been around over a century as well, again both public and private, and has seen losses in both sectors. Something one could see with private roads that we do not have with public roads is service quality differentiation. Different routes could have different prices and different levels of service (low cost and congested, high cost and reliable free-flow conditions). We see service differentiation in almost every aspect of human life, including transportation. We can FedEx (a recent transportation innovation) a package same-day, overnight, two-day, five-day, etc.

Perhaps the worst thing government can do is to try to pre-specify everything. The world (outside of transportation) is a dynamic place, and establishing standards and protocols before deployment needlessly places artificial constraints on progress. The

most widely deployed Intelligent Transportation System technology is Electronic Toll Collection (ETC)—this was introduced independently in several parts of the country with incompatible systems. On the other hand, it was introduced. The marketplace will sort out the standards and achieve compatibility downstream. Requiring it a priori reduces functionality.

One needs to ask if there are rewards. During the 19th century railroad booms and the late 20th century Internet boom, successful technologists made (and lost) their fortunes. Who makes their fortune in surface transportation? Who even thinks this is possible? We accept that surface transportation is managed by middle-class technocrats employed directly by government (or indirectly as consultants and vendors). To create the railroad boom, the government gave away vast tracts of land for rights-of-way. Towns competed to be stations on the railroad for fear of being bypassed. Are there rights-of-way left to be exploited in new ways without taking away from the old (at least at first)? To create the Internet boom, the government (the Department of Defense) funded research into what evolved into the Internet, deregulated telecommunications, and largely got out of the way. Are there seed research opportunities where the government can offer support (it does some of this already), but then stand back and let the system grow on its own?

David King is a current PhD student in the Institute of Transportation Studies at UCLA. His research interests focus on the implementation of new technologies on transportation systems and land use patterns, the influence of the built environment on travel behavior and the emergence of sub-local governance within metropolitan regions.