About Kermit

Kermit's history includes a Bachelor of Arts in Geography from the University of Michigan in 1982, a Master of Urban Planning, also from Michigan in 1984, and a Ph.D. in Public Policy Analysis from University of Illinois at Chicago in 1993. Meanwhile he also worked 30 years at the Chicago MPO, known by many as the Chicago Area Transportation Study (or "CATS") before reinventing itself as the Chicago Metropolitan Agency for Planning (or "CMAP").

Early on, Kermit learned travel modeling using graph-paper and a scientific calculator. He learned urban planning using textbooks (which are also made of paper). He looked up words in a dictionary (these used to weigh about 10 pounds), paid for mainframe CPU time and smuggled a 40-lb microcomputer into the office (it had 512k of RAM and a 12 megabyte hard-drive). Around this time, he also noticed that travel modeling had little apparent effect on transportation planning decisions.

We've asked Kermit to give his historical perspective of innovations in travel modeling.

A historical perspective of innovations in travel modeling

This title appeared in the preliminary conference program all by itself. I was flattered that the conference committee assigned me a topic which they must have sensed would interest me. Hopefully it wasn't because I have recently acquired the label "retired". In fact, I have always been fascinated by the history of our profession. Especially by trying get inside the heads of our predecessors from decades past as they worked

to do exactly what we are doing; solve real problems with less than ideal tools. So, hopefully, you will be relieved to know that this will not be a session seated at Uncle Kermit's knee listening to me wistfully recall a simpler and more benign past. Nor will it be an attempt to recount the uncountable number innovations that have flooded transportation modeling during my career.

There was a panel discussion earlier today called "Moving Innovation into Practice" which tried to deal with the overwhelming complexity of sorting, choosing and implementing innovation. For the most part, this discussion involved practical matters of leadership, funding, expectations and indifference. My talk on innovation will be more cerebral and discursive. It centers on the importance of modeling's metaphoric role in urban planning and how innovation arises from evolving dissatisfaction with once accepted and, often beloved, metaphors of human behavior.

I came to travel modeling by way of the social sciences in the early 1980s. My intended undergraduate major was classical linguistics which I thought would be a good way to learn about life and the world around me. (I still do). During my first semester, I was surprised to learn that linguistics is treated as a sub-discipline of anthropology which, in turn, was a cognate of geography which was divided into three sub-disciplines of its own: physical, cultural and urban. I have always loved maps and urban geography seemed to have more immediate social relevance than linguistics, so I drifted over.

Urban geography concerns itself primarily with systematically defining the spatial determinants of human settlements and, unlike other branches of urban study, includes mathematical models to represent and predict how cities take the form they do. Concepts like; central place hierarchy, concentric rings and bid-rent theory are the primary

means of explanation. Outside geography, I took of classes in economics, history and natural science.

Upon starting graduate school in Urban Planning, I unexpectedly found myself in the company of students from two other disciplines: Architecture and Civil Engineering. The architects seemed motivated primarily to create new urban designs. At the time (pre-AutoCAD), their "models" consisted mainly of cardboard and balsa wood; and of course they could draw beautiful renderings of things that did not yet exist. The civil engineers, on the other hand, were motivated to solve existing and more mundane infrastructure-related problems. Rather than cardboard and balsa wood, their "models" were made of math and computer code.

Civil engineers, in fact, with the help of computer scientists, had recently launched a mainframe computer package called "The Urban Transportation Planning System" (UTPS) that spelled out, in computer code, a very satisfying and apparently complete story of urban mobility told in the language of geography, economics and fluid mechanics. And, unusual at the time, UTPS was intended for use by non-computer scientists. It was made user-friendly by hiding the actual model formulations in very robust libraries, requiring the user to supply only a few parameters. There were many hard-coded defaults and execution was very forgiving. It was, for the most part, idiot-proof. Users found it easy to successfully complete a model run even if they had made egregious coding errors. A rookie user could, and often did, produce very convincing looking results that were, in fact, complete garbage.

Fortunately for me, simply knowing how to run UTPS was sufficient to get hired at almost any MPO at the time, whether or not one actually wanted to engage in travel modeling as an intellectual pursuit. It certainly wasn't my primary career motivation. I was still fascinated by

the natural determinism of city form. But had, by way of Urban Planning School, been introduced to zoning law and public finance and, by way of moving to Chicago, introduced to big-city politics and, what one journalist called, “the urban development confidence-game”.

So during my first year at CATS, I ran UTPS over and over and over again. My competency was demonstrated by my uncanny ability to match the observed base year volume to the network assignment on the link of interest, and then simply swapping a trip-table to produce a forecast volume. What I had to do to the rest of the model to achieve this success was my own business. And, since turnabout is fair play, the justification for transportation investment decisions made by the MPO policy board was their own business. There might have been a memo with some numbers on it passed between us, but that was about it.

But I was young, having fun in the big city, and was certain that over time those silly grownups would come around and see things as clearly as I did.

To keep myself out of trouble in the evenings, I enrolled in a Ph.D. program at the local university. They didn’t offer a stand-alone doctorate in Urban Planning but rolled it up into a multi-disciplinary program called “Public Policy Analysis” cross listed with Economics, Political Science and Education.

It was here that I learned that these other “real” social sciences regularly blamed Urban Planning for most of the problems currently plaguing cities. Highway investment had bankrupted public transit; urban renewal had wrecked historic neighborhoods; zoning had legalized housing discrimination; suburban malls had killed downtown retail.

The political scientists informed me that at the root of Urban Planning's malfeasance was its embrace of something called the "rational planning model", a method still widely employed in preparing comprehensive municipal plans, where stakeholders cooperatively define mutually desirable goals, state measurable objectives and identify specific actions to bring them about. The rational planning model performs splendidly given the absence of any historical inertia and within a complete political vacuum. Otherwise (as it is in most of the real-world) goals, objectives and actions quickly begin tripping over each other, contradicting themselves and leaking unintended consequences.

In fact, it was this failure of "rational planning" that led Civil Engineering to promise that "scientific modeling" could entirely replace political decision-making to plan, design and build urban infrastructure systems. Computers could be programmed to keep track of millions of bits of information about travel, and Mathematics would provide optimization algorithms to put everything in the proper order.

What came to be known as our "four-step model" was initially a one-shot sequence of calculations that was believed to mimic a rational individual's thought process of planning their daily travel. If we stack up these individual's travel plans and place them in a spatial context, then we have a virtual representation of the urban travel market. Transportation networks could then be designed, managed and operated to maximum efficiency based on market demand.

The fact that TRB has been sponsoring this modeling conference since the late 1980s means that we have long-since acknowledged that travel demand is much more complicated than simply cloning household travel diaries and assigning traffic. Innovation has always been celebrated, debated and promulgated within TRB, often seemingly for its own sake. But it's when our models display a tendency to produce

an unexplainable or implausible outcome, then others outside TRB also cry for innovation.

Fortunately for us, badly needed computational and technological improvements have dominated modeling innovation for the past few decades. Much of the detail, precision and sheer volume of information we can manage has been made possible by exponential growth in numerical processing speed, information management, data storage and streamlined mathematical algorithms.

More sporadic and incidental, however, are innovations to the actual behavioral framework we employ to represent the urban travel market. This lack of advancement can't be because any of us actually believes that we have succeeded in fully capturing every nuance of travel behavior. It may be because impressive technological innovations are more interesting and entertaining than any concern over whether our models actually do what we claim they do. Then, of course, there is the fear, well-documented by actual experience, that theory-based innovations to the behavioral elements of our models will, in practice, perform much worse than what we had before (if they work at all).

My thesis in preparing this talk was to revisit the intellectual roots of our discipline and re-examine the Grand Metaphor we employ to justify and communicate travel demand modeling to the outside world and then to explore the fallacies that undermine its legitimacy.

The Grand Metaphor: Social Physics

Newton's laws of motion are, for most, our first introduction to physics. In grade school, we learned about Things, the Forces acting upon them, and the Motion that results. Newton's laws are simple to teach, demonstrate and replicate on the playground during recess. As such,

their fundamentals are grasped at a stage in our education when making intuitive connections to everyday life is easy.

These intuitive connections are often expressed using metaphor. We all know that in literature, the success of a metaphor requires the reader to replace the literal image of an object in favor of its symbolic intent. The most satisfying metaphors are those that encourage us to actually suspend disbelief in hopes of learning something new.

Social Physics was the metaphor adopted by many liberal arts disciplines in the early 20th century as an intuitive leap from a popular philosophy called "logical positivism". Logical positivism states that only empirically verifiable statements can be cognitively meaningful. Our dear friends in the survey research industry are sustained by the belief that if we observe and measure the actions of a few individuals we can factor-these-up to account for the actions of everyone in the population. As modelers, we know that this factoring-up is not enough. The connection between a population's accumulated activity and something as inherently unobservable as "population behavior" is not trivial. Modelers leap from those empirical observations using metaphor; that social behavior can be understood through the lens of physics.

Our acceptance of this metaphor as practitioners, however, is not entirely sufficient to justify the use of mathematical models in urban planning. The Social Physics metaphor must also be accepted by the decision-makers being asked to act on exogenously generated recommendations.

Decision-makers, and this includes high-level agency technocrats like those who run MPOs and State DOTs, generally earn their stripes through a combination of practical experience, personal charisma and political gamesmanship. As such, their "decisions" are often the

product of a mental juggling act involving the practical, visionary and political components of their ego. Also important to remember; they are only human. Their decisions are discrete events that occupy a single moment of their day; had the decision point come yesterday or tomorrow, it might not be the same. For travel demand models to be relevant in this context; we learn to produce needed information quickly, clearly and concisely.

It is often the case that our social physics metaphor appeals to decision-makers not because it promises to obey the laws of nature, but rather because it offers to find the intellectual means needed to justify pre-determined political ends. If the preferred course of action is not known or must be delayed, there is nothing better than a "modeling study" to buy needed time or political cover.

This "understanding" between decision makers, modelers and urban planners might therefore be viewed as a somewhat un-holy alliance between modern-day epicureans and stoics. Urban planners and modelers, in this case, are the atomic materialists with their social physics in defiance of human self-determination. Decision-makers, being the self-proclaimed champions of human will, only consent to discuss the rules of natural order since it might, in the end, be inescapable.

Since decision-makers often sign our paychecks, we have developed a survival strategy based on helping them maintain credibility. The strategy is: We are trying to solve the "Big Urban Planning Problem" by telling a "Very Long Story" … (kind of like how Scheherazade kept her head through 1001 Arabian Nights). The storytelling strategy requires balancing two messages: 1) The story is very complicated, but that 2) the plot line is coherent and believable. Our Social Physics metaphor

offers numerous tools to both illuminate this complexity and manage the plot line.

So what is the "Big Urban Planning Problem"? My version of the story keeps it relatively simple by focusing on four themes: Mobility–using metaphors of connectivity and cost to model new roads, alternate modes, congestion, safety; Environment–using metaphors of land use to model sprawl and livability; Economic – using metaphors of exclusivity, externalities and surplus to model eminent domain, air quality and EJ; and finally Political – using metaphors of autonomy, due process and fiscal constraint to represent regionalism, government and taxation. Most decision-makers will already have a fundamental grasp of these themes. And luckily, if they are even talking to an urban planner, it means that they would like some help understanding them.

So the first message is that that the story of the Big Urban Planning Problem is very complicated. Among the themes there is a messy tangle of causes and effects – that re-occur over hours, days, months, years and decades - performed by a revolving cast of actors who are, for the most part are fickle with regard to their preferences and uninformed with regard to their choices.

The second message is that the plot line is coherent and interesting – if one is willing to indulge considerable metaphor-laden storytelling. While it is probably not advisable to dive directly into Newtonian mechanics, tried and true images from Social Physics abound: Activity is similar to motion, utility is akin to proximity, traffic flows like water. These examples, of course, form the metaphorical make-up of our traditional four-step modeling sequence. But this only scratches the surface of what Social Physics offers travel demand modeling innovation. Our current focus on activity-based models and dynamic traffic assignment is the product of extensive rummaging through Social

Physics to bring additional order to the sequential and temporal constraints on activities as well as the physical operation of vehicles on a network. By their titles and abstracts alone, almost every technical presentation at this conference depends on some element of this Grand Metaphor in the same blind and unknowing way that one might believe that eternal salvation depends on some form of baptism.

If Social Physics is such a rich source of metaphor, why then is innovation such a sticky business? It's tempting to think that the rate and type of innovation is regulated solely by advances in computing power and data storage. And, by all 21st century appearances, technology is the *sine qua non* for most innovation. But, with respect to more mundane considerations of being able to sleep at night and looking at one's self in the mirror, the Social Physics metaphor is failing us (or maybe We are failing Social Physics). The fallacy of substituting laws of physical mechanics for urban travel behavior is becoming too obvious. We have already stepped over the line by renaming our product from "trip-based" to "activity-based". But under the hood we are still treating human beings as perfectly-informed, utility-maximizing, always-rational objects living in a static world where everything from the weather to the economy is always plain vanilla. Thirty years ago, this was the goal. Today, we all know better.

Fallacies and Innovation

Recall that our survival depends on balancing two storytelling messages: that the big urban planning problem is very complicated, but that the plot line is coherent and believable. If the listener no longer finds this compelling, it is usually because some metaphoric fallacy has grown too obvious to ignore.

Many of us become acquainted with theory-based research fallacies at some point in our modeling education. The most common in our field

being the Ecological and Exception fallacies that have to do with being unclear about statistical inference. Also common on the network side, we learn about Braess' Paradox that comes from confusing system-optimal with user-optimal equilibrium.

While these theory-based fallacies are prevalent, they are ultimately explainable and controllable. If theory-based fallacy is the stated cause of dismissing model results from the transportation decision-making portfolio, there is no one to blame but the modeler himself. In my experience, however, someone invoking the Ecological Fallacy or Braess' Paradox during a public discussion of a transportation investment will be met with as much derision as someone complaining about the incorrect sign on a mode choice coefficient. Decision makers expect us to have these disputes ironed-out before bothering them with model results.

More critical, and potentially damaging to the Social Physics metaphor in Urban Planning, is when the listener becomes suspicious that the model is not even metaphorically representing what it claims. It's a slippery slope that quickly implicates the storyteller with respect to credibility, competency or ulterior motive.

We all know the story of Little Cindy Lou Who (who was no more than two). She asks Santy Clause why he is taking her Christmas tree. The clever Grinch gives a plausible explanation and sends her back to bed. If Cindy Lou Who were not a fictional two-year-old, she would have kept asking: "But Why?... But Why?... But Why?" until the gig was up for the Grinch. I mentioned earlier, Scheherazade and the 1,001 Nights. Now here we have the consummate storyteller. Like a very successful consultant, her strategy was, at each daybreak (i.e. the end of her current contract), to convince her homicidal husband (i.e. her client) that the story was not yet over and that she needed an

extension. Her version of Social Physics is worth quoting (in English translation): "[Scheherazade] had perused the books, annals and legends of preceding Kings, and the stories, examples and instances of bygone men and things; indeed it was said that she had collected a thousand books of histories relating to antique races and departed rulers. She had perused the works of the poets and knew them by heart; she had studied philosophy and the sciences, arts and accomplishments; and she was pleasant and polite, wise and witty, well read and well bred."

Good advice to an urban planner: Stay mentally several steps ahead of the story being told. Here are quick examples of modeling innovation that were born from the pain of an embarrassingly incoherent urban planning story line: Destination choice because people don't really revolve around their place of employment like planets around the sun; tours because people habitually order their travel to minimize the cost of a sequence of activities as opposed to the cost of individual trips, nested-logit because people don't consider all of their alternatives simultaneously; time-dependent shortest path because vehicles do not appear on all network links simultaneously.

But how did these fallacies become apparent to decision-makers who couldn't care less about how sausage gets made? Our comfort with Social Physics had led us to accept a number of assertions about population behavior as conventional wisdom that, as it turned out, could not withstand "But why?... But why?...".

Here's a real-life example of the gradual and pathetic decline of one of trip-based modeling's most cherished metaphors from Social Physics: Gravity. A perennial urban planning question in Chicago is: "Who works Downtown?" We're very proud of our downtown. It's where we put all of our cultural and economic eggs; most of our transportation planning

effort and investment dollars go to preserving the historic center of our region. The first urban geographers made a habit of using Chicago as the best empirical validation of their models. (This sentimental history ensures that modelers in Chicago are a hit at any cocktail party.) Invoking the Social Physics metaphor in storytelling as well as in model code worked because, at the time, the region was densely developed and almost all of the jobs were in the Loop. When higher income professionals fled to the suburbs (allegedly to get away from all that "density"), some fancy modeling footwork was needed to demonstrate that these folks still work downtown and, indeed, use public transit to get there. This was accomplished in the CATS models by now familiar means: estimate trip distribution and mode choice with geographic K-factors and apply generous calibration constants. So far so good. Even without understanding what modeling innovations were introduced, the results matched the first-order empirical evidence; i.e. the higher-income professionals seated in the MPO policy boardroom had taken the train from their suburban home to their downtown jobs that very day with a bunch of people who looked and dressed exactly like them.

As more and more higher-income professionals moved out of the city to the suburbs, the grocery stores, gas stations and fast food joints followed. The suburban couples bred like rabbits and before long, schools, hospitals and shopping malls were popping up like mushrooms. Suburban arterials were now heavily congested, even on weekends, not only with high-income professionals driving to their suburban train station, but also with regular people driving to suburban jobs from the city (which was still the only place they could afford to live). The MPO policy board member also knew that the woman behind the counter at his suburban dry cleaners was a single mom holding down three jobs, drove her own car even though public transit was available and chained her trips together in a way that defies comprehension. What's more,

she did one chain on M,W and F and a completely different chain on T, Th and S.

Meanwhile, as wireless communications made commuting by auto more productive, many decided to drive downtown and park, even though this was far from being their least-cost alternative. Congestion became ubiquitous on a regional scale and diurnal peaks became increasingly flat throughout the day and well into the evening. Tired of this, CEOs moved HQ from downtown to the new suburban office campus, which, of course, meant more janitors, lawn crews and food service workers commuting from the inner city. Within a few years, the suburban kids grew up and began yearning to attend modeling cocktail parties in the city. So they and their grandparents moved back to Chicago and then took jobs at the suburban office campuses, eventually convincing their CEOs that they be allowed to telecommute or work flextime as the mood struck them.

The original question "who works downtown" is now answered "everybody works everywhere" and our poor gravity metaphor is spread too hopelessly thin to explain why or what can be done about it.

Strangely, in practice, we continue applying the old metaphors to this new and wholly inappropriate context perhaps to see if the decision-maker at hand will wonder at them. Usually, the first evidence that the metaphor is irreversibly obsolete is the model's failure to produce intuitive forecasts or, even worse, failure to respond to typical planning scenarios.

For example, most trip-based models still allow only on a limited number of trip purposes; usually three. The total number of home-based-other and non-home-based trips are calculated independent of the tours along which they might occur. As people begin to more strategically plan non-work activities to coincide with their mandatory

work commute, the number of actual non-work trips in a trip-based model will grow dramatically. Assigning three trip purposes, two of which are dominated by very short average trip lengths and a comparatively flat diurnal distribution means that the typical exercise of finding a capacity solution to relieve congestion is futile. Everyone is just hopping from one zone to the next where network alternatives are limited at best. This was the symptom being addressed by the introduction of tour-based techniques to standard model practice. Unfortunately, the metaphorical problem doesn't go away in current tour-based formulations because the model has no information about whether a stop actually lies on an intuitive tour trajectory.

And don't even get me started on Freight. The decades-long practice of shoehorning commercial goods movement into the four-step metaphor was just plain lazy. Once upon a time, trucks were treated as backfill to bring assigned volumes up to observed counts. No one was really too concerned about what mobility function trucks were actually serving. Now that the Freight cluster is central to many regions' economic development planning, our persistent avoidance of understanding the determinants of supply chains and freight logistics has put our freight models way behind where they should be.

Going forward

Even though we have made exceptional use of technology and some remarkable advances in the formulation of model algorithms, it appears to me that we are losing ground in our ability to convincingly tell "the very long story about the big urban planning problem". In this day and age, everyone is pretty willing to concede that the story is very complicated. But our success in keeping the plot line coherent is flagging. This is particularly embarrassing when, far and away, the most successful use of Technology and its twin sister "Big Data" is in the

marketing of pharmaceuticals. I would venture to say that not one of us in this room really understands how drugs cure disease…apparently Pharma has concluded that it is not important that we do. What is important is that we must entertain the notion of becoming quite ill so that we can live like the people in those drug commercials. Our willingness to embrace almost every aspect of our daily existence within a "virtual (or metaphorical)" framework has only grown more vivid.

Even TRB (which is us in this room) is guilty by separating Planning Applications from Innovations. The original reason for separating the two topics (as I recall it) was so that the nerds didn't have to compete with the jocks for podium time. But the truth is, we need each other. And, in fact, each of us needs to be both modeler and storyteller.

I think it really boils down to our willingness to update our storyline. It's more than being a good technical writer or following an accepted manual of style and exposition. It's the ability to re-establish a plausible and believable mental image in the minds of decision-makers between what's happening on the computer chip and the real world they see every day.