

Cutting to the Chase in Designing New Measures of Transportation System Performance

**Dr. Barry Wellar
Distinguished Research Fellow
Transport 2000 Canada
wellarb@uottawa.ca**

**Transport 2000 Canada
Box/C.P. 858, Station B
Ottawa, Ontario
K1P 5P9
Email: t2000@transport2000.ca
URL: <http://www.transport2000.ca/>**

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Context and Synopsis

Analysis of the learned and advocacy literature, as well as reviews of media accounts and federal election pronouncements, suggest considerable support for the idea of a transition to a “new transportation order” for Canada. To summarize the transition idea as I see it, the era of the private motor vehicle (car, SUV, truck, etc.) as the dominant mode choice for land transport needs to be brought to an end, to be replaced by a new era of what is variously referred to as sustainable, alternative, or active transportation with emphasis on the walk, cycle, and transit modes for people movement, and rail for freight movement.

This paper posits that such a transition will not come easily, and that a basic paradigm shift in attitudes and actions by governments, corporations, and citizens is required to achieve the transition. Moreover, if the call for the “new order” is to amount to more than just idle chatter, fundamental rather than cosmetic changes are needed to effectively, efficiently, and equitably deal with obstacles to achieving a new transportation order.

A core problem in achieving the transitions between eras, I suggest, is that performance in moving people and freight in Canada has usually been measured by how quickly and easily more and more private motor vehicles can be driven from Point A to Point B. However, decades of pursuing this measure is widely seen to have a number of downsides, such as escalating fossil fuel prices, greenhouse gases, air pollution, and urban sprawl. The proposed “new order” solution includes less road-building and fewer private motor vehicle trips, and more people trips by walking, cycling, and transit (bus, rail), more telecommuting, and more rail and less truck freight movement. The perceived new measures of transportation system performance are ecosystem-based, sustainability-based, climate change-based, and energy-conserving,

Clearly, the proposed solution and associated new measures represent major departures from our transportation history of the past 40 years. As a result, I suggest the needed shifts in attitudes and actions will only be achieved in a timely manner if they are propelled by compelling forces. In the spirit of that scenario, five catalyzing influences are presented which may help Canada cut to the chase in deriving and implementing a new set of measures which are sound ecologically, socially, economically, financially, and geographically. Further, and, very importantly, these new measures will inform us whether we are on the right track and need to accelerate the transition.

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1. Origins and Purpose of this Report

The origins of this paper reside in sessions at two major international conferences in 2008, and an ongoing project with Transport Canada. The contributions of the sessions and the project are outlined as follows.

At both international conferences the focus of attention was transportation system performance. The first conference was that of the Association of American Geographers (AAG), and two sessions were held under the title “New Measures of Transportation System Performance”. The following excerpt from the session description provides context for this report:

“This session provides a venue for presentations on designing, proposing, prescribing, or demonstrating new or different and more robust ways of measuring how, and how well transportation systems, sub-systems or components are performing. New measures that address spatial issues or incorporate spatial characteristics or attributes are of particular interest.” (Wellar, 2008c).

Immediately after that conference I organized a Roundtable session on a related topic for the Joint Congress of the American Collegiate Schools of Planning (ACSP) and the Association of European Schools of Planning (AESOP).

For the Joint Congress, the Roundtable session was titled “New Planning Measures of Transportation System Performance”. The planning orientation of the session is illustrated by this excerpt:

“Of particular interest are discussions of how planning theories and principles affect the design of the measures, and discussions of experiences in introducing, championing, implementing, testing, and evaluating the new planning measures of transportation system performance.” (Wellar, 2008b).

Feedback from the sessions at both the AAG and ACSP-AESOP conferences includes requests to organize similar sessions for other associations, suggest reading materials for university courses, provide copies of papers and literature references, and comment on proposed thesis and dissertation topics. Clearly, the sessions struck a chord with academic and practicing transportation geographers and planners from a number of countries, and all signs point to the need to extend the measures work started at the conferences.

The second stimulus for this paper is provided by the in-progress project sponsored by Transport Canada, “Methodologies for Identifying and Ranking Sustainable Transport Practices in Urban Regions”. Two tasks from the Synopsis Report (Wellar, 2008d) indicate the connection between that project and this paper:

Task 4 – Using the results of literature reviews and the suggestions of experts and practitioners, prepare a first approximation inventory of variables representing sustainable urban transport practices ranging from worst to best.

Task 5 – Prepare an interim report on findings about the state of the art/science of measuring sustainable transport practices in urban regions, and the variables representing worst-to-best sustainable transport practices in urban regions.

As we know from Research Methods 101, the variables referred to in Task 4 are the means of operationalizing the concept of sustainable transport practices. In addition, however, we also know that the mention of variables in empirical research is automatically accompanied by the observation phase of research; that is, phenomena are observed and data are collected and organized to describe the variables over time and space.

And, as we also know from Research Methods 101, the “... state of the art/science of measuring sustainable transport practices in urban regions” referred to in Task 5 includes a critical data base development feature. That is, measuring the state of sustainable transport practices in urban regions requires an information system that can accept or acquire observed data which are then organized, plotted, analyzed, interpreted and mapped in order to calculate and display the worst-to-best scores and rankings.

As indicated, specifying and implementing performance measures is a multi-step activity. Other steps include developing a data base to

generate information and knowledge about the state of the measures over space and time and, in dynamic or large urban regions, developing a computer-based information system which is capable of processing the observed and collected data to yield outputs of interest to elected officials, professional staff, corporations, interest groups, citizens, and the media.

This paper serves as a means of elaborating some of the ideas and responding to some of the requests to extend the discussions at the AAG and ACSP-AESOP conferences. Further, it provides a vehicle to explore common themes among “New Measures of Transportation System Performance”, “New Planning Measures of Transportation System Performance”, and “Methodologies for Identifying and Ranking Sustainable Transport Practices in Urban Regions” which are the titles of the sessions and the project, respectively.

2. Need for New Measures

The topic of measuring transportation system performance is not new, having begun its rise to prominence in the 1960s and 1970s. Moreover, much of what seemingly passes at present for ‘new thought’ describing or evaluating transportation system performance is not new at all, with many of today’s issues having been identified three and four decades ago. As an illustrative document I refer to that written by Wilbur Steger (1966) titled, “Transportation Output Measures: Needs for Decision-Making”.

A key feature of this insightful paper by Steger is that while it has a focus on public and private policy-making, the variables comprising the discussion are pertinent to the operations, planning, engineering, economic, and other aspects of transportation system performance. It is, to put it mildly, a very comprehensive piece of work by the standards of any day, including those in 2008. Further, and this observation is especially fitting for a number of present-day transportation commentators who seem to fret about the cost of one transport input (fuel), and are seemingly concerned about little else. Steger observed 40 years ago that “...a variety of output measures is needed, not just one or a few ...” I suggest that this advisory is even more appropriate today than it was in 1966.

As discussed by Steger in 1966, and in numerous dissertations, research reports, transportation master plans, media stories, and other documents made public over the intervening years, a core challenge of transportation research has been and remains measures-oriented. That is, to develop pertinent, accurate, reliable, verifiable, reproducible, and understandable measures to describe, analyze, and evaluate initiatives proposed, designed, and implemented to improve transportation system performance.

Since the argument about the need for new measures is a critical aspect of the paper, a paragraph of intention is justified to ensure that the significance I attach to measures is as explicit as words allow. First and foremost, this paper has no interest in the development of measures for measure's sake.

Rather, this discussion is geared to the pursuit of measures that serve productive, practical purposes, such as contributing to: enlightened public transport policies; better evaluation of transport programs; more insightful transportation master plans; better ways to anticipate and mitigate carbon lock-in, technological lock-in, etc., resulting from transportation infrastructure decisions; more informed procedures for anticipating and responding to market conditions; more sensitive means for assessing public values and attitudes; and so on. These and other statements about the value of measures have been well-covered in the literature by Brown (2008), Garrison (2007), Steger (1966), and Wellar (2007a, 2007b), among others. The reader is referred to their works for more commentary on the importance of measures for such transportation system performance tasks as assessment, forecasting, modal split adjustments, and prioritization.

Surprisingly, despite its agreed importance as well as its widespread acceptance as a staple among transportation research concerns, to date the measures issue has not been a high-profile matter of public interest, nor has it received concerted academic attention. In the former case, lack of presence may be traced to the seemingly technical and perceived dry or boring nature of the measures issue, plus the fact that it is not a subject to attract much insightful media attention. In the latter case (academia), there are a number of inherent difficulties in measures research, and that fact alone can restrict interest. Further, there has not been a bounty of funding in this field in Canada, which may account for the limited attraction of transportation system performance measures as a thesis topic.

Overall, then, it appears fair to say that measuring transportation system performance has not been a popular topic of conversation, or of research, over the past several decades. However, in this report I suggest that a powerful set of circumstances are combining to create an environment whereby what has been 'on the back burner' for decades may finally be translated into action. The forces in play can be summarized as follows.

On the one hand, the ingredients for a body of new measures have actually been on the transportation agenda for years and in some cases decades. That is, we already know about strategies that refer to transportation demand and supply management principles, sustainable transport best practices, inter-modal integration, walkability standards, teleworking programs, connectivity hierarchies, mobility-based land use planning, alternate transport zoning provisions, smart growth, and so on.

All of these ideas and approaches have considerable conceptual appeal as means to enhance transportation system performance, and are widely known among Canada's university, government, business, and advocacy communities. Further, as revealed by comprehensive searches and reviews of academic, popular, vested interest, public interest, professional, and other literatures, all these approaches receive high marks as 'right things to do' to improve transportation system performance.

On the other hand, however, although these and numerous other ways to improve transportation system performance have been known for decades in Canada, as well as in the U.S. and Europe, a major problem remains.

That is, only limited progress has been made anywhere in achieving robust measures of the effectiveness, efficiency, equity, or utility of these initiatives in even the relatively simple case involving road transportation networks with a focus primarily on the private motor vehicle.

As a case in point, consider the discussion about standards for so-called high occupancy vehicle (HOV) lanes. The minimum number of persons in a vehicle is one, which represents the lowest, legal level of occupancy for a moving vehicle. However, by adding one person, this vehicle is now rated as a high occupancy vehicle in some jurisdictions. How this kind of 'measuring system' by-passed the levels of lower and low and skipped from the lowest class to the high class, is at best an affront to the laws of logic, and the rules of elementary arithmetic. Worse, perhaps, is the likelihood that it represents a revealing slice of the private vehicle-oriented attitudes that stand in the way of achieving new, informed, and forward-looking measures of transportation system performance.

Moreover, and this may come as a surprise to those who have not been paying attention to the deep structural and functional changes taking place in all modes across the transportation field, the task of developing measures associated with private motor vehicles and road transport networks was likely the easy part. The much more difficult problem is to clearly articulate what is involved in defining and then achieving better, more enlightened returns on transportation investment decisions involving all modes. (Note: I underline investment so as to distinguish it from expenditure, and all to reflect the basic idea of the "new transportation order", that is, the full range of ways to move people and freight.)

And at the risk of belabouring the obvious, the intelligent way ahead in transportation does not mean adding more highway lanes or bridges or larger intersections to accommodate private motor vehicle traffic flows. Rather, it means meeting challenges in such increasingly significant realms as specifying and achieving ecosystem-based transportation infrastructure design guidelines, formulating and achieving sustainability-

based urban and regional multi-modal transportation network plans, and formulating, validating and responding in practice to climate change-based transportation impact assessment accounts. And, it means creating new measures to represent those significant realms.

It was emphasized above in several places that the transition to a new transportation order will be difficult, and that motivation of a compelling nature is required to turn wishes or expectations into action. The next section explores the motivation topic.

3. Motivation to Achieve New Measures of Transportation System Performance

The situation as presented above is that we need new measures of transportation system performance in order to cope with new transportation realities. However, to continue the realities theme, we also need to be realistic about the nature of the challenge. That is, we know full well that introducing new measures will face many obstacles.

By way of illustration, the observable evidence provided by the transportation measures record of the past 40 years is that it will be extremely difficult to break away from past habits and associated shortcomings. Moreover, even a casual reading of current North American news stories, including those involving Canadian cities, yields daily reminders of political and vested interest support for the failed road-building agenda that contributed to the current urban transportation mess in many cities.

And that assessment of the measures situation brings me to the question used as the title for this section of the report.

<p>What will it take to move us into a regime of designing and implementing new transportation system performance measures that will enable us to cope with “new” transportation realities, some of which have been unfolding over the past 10, 20, 30, and 40 or more years?</p>
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The short answer to this question, it seems to me, is that since a major paradigm shift from attitudes to actions is involved, sweet reason will not carry the day. Instead, several catalyzing influences with considerable powers of persuasion need to be introduced into the performance measures research and applications agenda.

Further, and knowing what we know about the pervasiveness of the automotive industry and private motor vehicles in Canadian and North

American society, there needs to be a reinforcing and perhaps cumulative relationship between the catalyzing influences.

I suggest that several catalysts are causing the measures issue to move towards the 'front burner' in the transportation field, and are setting the stage for transportation system performance measures to receive serious, active attention at local, national, and international meetings and conferences, in academic research, in deliberations by governments, and in media stories.

These catalysts and their implications for research into new measures of transportation system performance are outlined in the next section.

4. Catalysts for New Measures of Transportation System Performance

There are a dozen or so pillars that could be discussed as the foundation that appears to be forming to support the idea of a new transportation order, which in turn promotes a research and implementation agenda involving new measures of transportation system performance. The following five pillars are among those that may be the most likely catalysts to bring about significant change in thinking about how we value, and measure, transportation system performance.

Catalyst A: Shift Away from the Private Motor Vehicle

One of the catalysts behind the movement to create new measures of transportation system performance is the shift away from the private motor vehicle for transporting people or freight. I have mentioned elements of this trigger previously, including those in a 1975 newspaper column, "Taking steps towards the end of the automobile era" (Wellar, 1975).

The following comment outlines my impression as to why the argument that I made 33 years ago is now more favourably perceived as an appropriate basis for valuing and measuring transportation system performance, and designing and building transportation systems accordingly.

First, I believe there has been a major mindset shift of national proportions, and that as a result more Canadians are prepared to consider that the time for change is either here, or "just around the corner". Among the reasons for the shift are the following:

- Rising cost of fossil fuel;
- Escalating difficulty of adding road capacity in urban regions across Canada;
- Concerns about greenhouse gas concentrations;

- Growing awareness about the impacts of private motor vehicle transport (cars, SUVs, trucks) on health;
- Worries about loss of agricultural land due to urban sprawl;
- Rapidly increasing and never-ending costs of repairing, re-building, re-surfacing, and maintaining current road systems;
- Deepening sense that private motor vehicle travel is contributing to climate change.

I hasten to add in this regard that I am specifically referring to a shift in mindset, and not to actual changes in behaviours. This point was emphasized in a previous paper (Wellar, 2006b), where it was noted that while Canadians in general are aware of these reasons for change, and many support the need for change, most of them want others to do the changing while they keep on driving for at least for a little while longer.

There is a second factor at play, however, which because of its personal nature may be the more probable trigger for setting this catalyst in motion. Many Canadians, it appears fair to say, are afflicted by an excessive proclivity to drive. The term 'dependency' is frequently used to describe the driving habits of some Canadians, but "popping into the car" four or five or ten times a day to go to a store two blocks away is proclivity, not dependency, as is driving children three blocks to school, four blocks to a park, two blocks to a public library, or driving three or four blocks to get a coffee, french fries, a hamburger, a slice of pizza, or a video.

The kicker in this factor that could transform mindsets into action is that the downsides of the proclivity to drive are personal, and can be very uncomfortable to say the least. Data and analyses on the negative health impacts of riding in cars, SUVs, etc., versus walking and cycling are now revealing a picture of ill health that is not pretty. Terms associated with too much time in vehicles and too little time walking and cycling on the parts of children, teens, adults, and seniors include obesity, stress, road rage, high blood pressure, poor circulation, poor physical condition and increased risk of physical injury, respiratory illness, and cardiovascular disease. And, of course, there are the death and injury problems (Wellar, 2006a).

Insofar as the transition to a new transportation order is concerned, therefore, it is my reading that the shift away from the private motor vehicle is a highly likely catalyst to aid and abet the process. That is, there is now growing appreciation among members of the public, politicians at all levels, public service professionals, business people, and media commentators, that Canada is in urgent need of new transportation system performance measures that are quite different from those generally discussed 40, 30, 20, or even ten years ago.

Further, to be specific, and recognizing the international level of contributions to the new kinds of thinking throughout the field of transportation, the current interest in new performance measures has moved far beyond the previous focus on the private motor vehicle. As discussed above, interest in transportation system performance now covers all the modes for moving people, freight, or data (text, numerics, graphics), that is, walk, cycle, scooter, mass and rapid transit (bus, light rail), private motor vehicle, heavy rail, water, air, pipeline, telecommunicating, teleworking, teleconferencing, and distance learning.

Catalyst B: Geographical Limits to Development

Canada is one of the largest countries in the world in size, and with a relatively small population it has one of the world's largest land/per capita ratios. Unfortunately, this relative richness in land mass appears to have promoted a cavalier regard for land as a limited resource, a statement which could be supported by pages of examples documenting many dozens of geographically perverse land use planning and development practices that have been widely acceptable in Canada to this point in time. For the purposes of this paper on transportation, however, it should be sufficient to offer this brief reminder on how land affects transportation in the Canadian space economy, and to then give several generic examples of land use planning and development practices to illustrate why I suggest that geographical limits are a likely catalyst of a new transportation order:

- Land comes in many varieties, and can be used for many different purposes, viz., for housing, commerce, institutions, recreation, industry, waste disposal, agriculture, forestry, and transportation. And, it can remain unused in the sense of remaining undeveloped, and serve valuable purposes as green spaces, wetlands, beaches, flood plains, etc.
- Land is an input to production and consumption.
- Land is a valued input, sometimes valued in market terms and sometimes the values are set by political, social, ecological, historical, military, and other considerations.
- Land uses at any place have relationships with and impacts on other land uses and places which may be adjacent, nearby, or relatively more distant.
- Land has a transportation/access dimension which directly affects all the characteristics of land noted above, and all of them in turn affect transportation system performance.

The last bullet entry is the vital message for this paper, and warrants a comment before going to the examples.

The intimate linkage between land use and transportation has been known for at least 50 years, and is the basis of what are referred to as 'second generation land use and transportation planning models'. The principles of integrated land use and transportation models are set out in *Urban Development Models* (Hemmens, 1968), an extraordinary 40-year old conference proceedings which upon examination reveals a point which is particularly critical to the transition to a new transportation order.

That is, due to the intimate relationship between land use and transportation, a new transportation order that is not accompanied by a new land use order is doomed to fail. I return to this point in the next section (Legacy), because I am reminded on a near-daily basis of politicians, planners, engineers, media commentators, and others who talk about multi-billion dollar transit expenditures, yet seem to have very limited understanding of how transportation affects land use, and land use affects transportation, over both time and space.

The following capsule comments illustrate some of the decisions about land development which seem to have been made in the spirit of 'land to spare'. Further, much of the decision focus appears to have been, and seemingly remains, on our ability to drive to and from these sites with ease in the comfort of our private motor vehicles:

- Rezoning prime agricultural land in the metro region fringe to commercial uses such as big box shopping centres which are remote from residential areas, designate fifty percent or more of the commercial land area for parking lots, are not served or are badly served by transit, and require road network expansions.
- Rezoning rural land uses to permit sports complexes in areas which are not serviced by transit, have no walk-in traffic, use sixty per cent or more of the sports complex area for parking lots, are not serviced by busway or light rail transit way, and could not be serviced by light rail transit for at least a decade.
- Approving low-density residential subdivisions in the outer reaches of metropolitan regions which are not serviced by transit, and necessitate private motor vehicle trips for work, school, shopping, recreation, etc.
- Approving policies that do not require treatment of residential and commercial solid waste (garbage) in the neighborhood or jurisdiction

where it is created, and 'solve' the garbage disposal problem by transporting it somewhere else for burying, burning, recycling, etc.

- Locating industries and facilities that handle toxic, explosive, flammable, and other dangerous materials in areas proximal to residential neighbourhoods, or vice versa.
- Allowing brownfields in already-developed areas to lie idle and unused, while approving rezoning applications and committing large amounts of public funds to build infrastructure, including roads and more roads in outlying greenfield areas.

These are the kinds of land development activities that are regularly found in scans of Canadian newspaper articles over the past decade. The casual approach to land disposition, characterized by the 'willing buyer-willing seller' pitch, suggests that in many parts of Canada land is often not explicitly recognized or respected as a finite resource. Further, the articles also frequently reveal that speculators, the development industry, the real estate industry, commercial interests, some governments and government agencies, as well as property sellers and buyers, will continue to support the kinds of practices noted above. For those enterprises and individuals, there are no geographical limits to development along the lines that I have in mind for this report.

On the other hand, what we also see from many newspaper accounts, including editorials and columns, is genuine concern that there are geographical limits that should be explicitly taken into account during planning and development deliberations by local, regional, and provincial/territorial governments. And, I hasten to add, there are frequent, highly critical references to the lack of regard shown for geographical limits by appointed, quasi-judicial bodies such as the Ontario Municipal Board, which are seen to have superficial awareness at best as to how geographical factors affect communities.

The following are among the questions involving geographical limits and issues that are frequently found or are implicit in current newspaper articles:

- How large should metro regions be?
- How large should commuter sheds be?
- How much of the natural environment should be converted to urban use, and where should those conversions occur for what reasons?
- How much downtown intensification is needed to offset urban sprawl?

- How will large, low-density school districts fund transportation of pupils?
- Where and how will we dispose of garbage so that it does not contaminate the water supply or foul the air, but also will not affect other land uses?
- Where do we locate tank farms and hazardous materials facilities so that they do not compromise residential neighbourhoods?
- Where are we going to locate homes and public facilities for an aging population?
- Where are the appropriate places for increased residential densities?

In what might be termed ‘intelligent communities’, those questions have already been asked and answered, to a degree at least. And, as is being learned, answering those questions in practical terms invariably means decisions affecting transportation network structures and functions. That occurs because transportation networks provide connections between different kinds of land uses and serve different kinds of transport users, and changes in uses and/or users tend to mean changes in walk, cycle, transit, private motor vehicle, rail, telecommunications, etc., networks.

The suggestion being made, therefore, is that geographical limits are increasingly making themselves felt in urban and regional development decisions, and as a result a new perspective is required to better account for geographical factors when designing modern measures of transportation system performance. That said, this paper is a “heads up” for planners and politicians who have to produce the answers to those kinds of questions, and offers a question to kick-start their thinking:

Are you aware of new ways of using market clearing processes to incorporate geographical limits in the new land use order that needs to accompany the new transportation order?

Finally, readers wishing to know more about ‘geographical factors’ may wish to examine the 2007 Fleming Lecture in which 100 geographical factors are identified (Wellar, 2007a). While not a comprehensive list, the terms are sufficient to illustrate why transportation is affected by geography, and why geographical limits are likely to be a catalyst for the development of new measures of transportation system performance.

Catalyst C: Legacy Systems

This catalyst involves the awakening that is now occurring with regard to ‘legacy systems’, and the associated issues that William Garrison (2007) has identified. For the purposes of this report it is sufficient to illustrate

the legacy issue by pointing out that once transportation infrastructure and facilities are built, legacies are created. Examples of legacies that arise from transportation system decisions include 400 series highways, interchanges, on-ramps, off-ramps, overpasses, major urban arterial roads, superstructure bridges, railroad lines, subways, urban train stations, busways, airports, bike paths, walking paths, etc. Further, in addition to physical assets, there are also legal, social, and cultural legacies involving institutions, customs, mores, ideologies, laws, and regulations that cannot be overlooked when trying to transition to a new transportation order.

As we have seen and continue to see, it is very difficult to convert some of these infrastructures and facilities to other uses, or to readily modify the transportation and land use activities and patterns that originally resulted from these infrastructure and facility expenditures. Consequently, when things go wrong in the transportation field, whether they involve cut-through traffic, block lock, genuine gridlock, overcrowded LRT cars, under-used buses, piecemeal and non-contiguous cycle paths, or treacherous walking conditions for pedestrians, attempts to correct transportation problems invariably seem to be more complicated than the initial installation or implementation decisions and actions.

While every city no doubt has a story or two to tell about legacies, the City of Ottawa, Canada, is an instructive place to examine by those wanting to know more about how governments initiate the creation of legacies, but without giving adequate thought to an exit strategy. Or, to re-phrase the issue, councils can approve motions to build transport infrastructure, but they seem to have great difficulty undoing or modifying the legacy when the initial decisions and actions have run their course.

In the case of Ottawa, it built a bus-based transit system in the 1970s and 1980s, and for the past 10 years it has been discussing whether and how light rail-based transit should be or could be factored into the transportation system mix. As media articles document, musings about light rail cover the gamut from whether it should be complementing, supplementing, or displacing buses and, if light rail is to be implemented, where it should be located, the staging of construction, diesel or electric, tunnel or above ground, single- or double-tracked, etc., etc., etc. Regrettably, and hence the use of the term 'musings', the discourse seems no more informed now than when it began a decade ago (Wellar, 2008a).

The interest in new measures associated with legacies, therefore, is to achieve a much better understanding of "What we are letting ourselves in for" prior to embarking on transportation construction programs. Further, and in a related vein addressed by Garrison (2007), there is sharply increased interest in asking and answering questions about what we know and what we need to know concerning the flexibility (or, more

appropriately perhaps, inflexibility) that characterizes proposed initiatives involving the different modes of transport.

By way of brief elaboration of this catalyst, Canada has a long history (or legacy, if you will) of making transportation decisions whereby roads, intersections, rail lines, bridges, sidewalks, subways, docks, terminals, airstrips, etc., were built, extended, widened, and so on, and occasionally as in the case of rail tracks, removed. In my experience, including discussions with persons long-acquainted with Canada's transportation decision review processes, it appears fair to say that only on the rarest of occasions, involving the simplest of interventions, were answers provided to address questions about the amount of flexibility or room to manoeuvre that accompanied decisions to build or remove transportation infrastructure or facilities.

However, now that the concerns noted in the Catalyst A and Catalyst B discussions are starting to register among the Canadian population, it seems that we are moving towards a new appreciation of the legacy issue. We are slowly gaining an increased awareness that "do overs" in transportation are frequently difficult and expensive, and that the old measures of transportation system performance did not adequately lay out the full lifecycle costs of a private motor vehicle-driven transportation legacy. Consequently, aspects of the legacy issue are prompting the pursuit of new measures to better inform citizens, elected officials, and the business community about the degree of flexibility (or inflexibility as the case may be) associated with different transportation investments.

As a case in point, examination of media stories about efforts to reduce a six-lane road to four, or a four-lane road to two, are often very revealing about how difficult it is to undo a transportation infrastructure decision. One unanticipated or serendipitous benefit of those revelations from a measures standpoint, however, is that they underline the critical importance of taking a long, thoughtful look before we leap into creating transportation legacies which precipitate nasty environmental, economic, financial, social, and development legacies.

Closing this section, it is my suggestion that Canadian governments, corporations, and citizens have considerable work to do in order to achieve the levels of vigilance and thoughtfulness needed to effectively anticipate and deal with legacy issues. Moreover, a review of conference programs of national associations in the land use, planning, transportation, and geography fields failed to locate more than several references to legacy issues. Clearly, this catalyst needs a lot of attention to get beyond the idea stage and into the action stage of designing and operationalizing new performance measures for a new transportation order.

Catalyst D: Safety and Security Issues

For the fourth catalyst, I refer to the growing concern over the past decade regarding safety and security issues. By way of brief comment, the transportation sector was one of the ten sectors identified for the Joint Infrastructure Interdependencies Research Program (JIIRP) sponsored by Public Safety and Emergency Preparedness Canada (PSEPC) and the Natural Sciences and Engineering Research Council (NSERC, 2004).

The JIIRP is fully discussed elsewhere (see the NSERC 2004 reference), so there is no need to examine it in this paper. Rather, it is sufficient to observe that establishing degrees of safety and security requires the existence and use of measures to describe both situations and processes. Further, decisions and actions involving corrective initiatives also require the existence and application of measures to evaluate whether what is proposed is appropriate to needs, whether there are more effective, efficient, resilient, flexible, etc., options.

I hasten to add here that the scope of this catalyst is not limited to national transport safety and national transport security issues. As more citizens, politicians, professionals, the courts, and the media are affirming, safety and security concepts and concerns apply to all transport modes, at all jurisdictional scales. And, in particular, the new measures initiative is very much associated with addressing a serious deficiency in past measures work by showing more regard for the most vulnerable transport system users, namely pedestrians and cyclists, with emphasis on the safe and secure mobility of children, youth, the elderly, and the disabled.

A point to make explicit here is that the safety and security catalyst is driven in part by an unfairness issue that is likely to be a major factor in how quickly the new measures agenda moves forward. The issue is summarized as follows.

In brief, the transportation profession, as well as law enforcement, the media, and the courts have expressed deserved concern about the safety and security of private motor vehicle operators and their passengers.

However, and as increased numbers of academic publications, government reports, and advocacy group statements and campaigns are pointing out, these bodies suffer a major shortcoming. All of them have thought too little and done too little in pursuing a commensurate standard of care for users of 'alternative transport modes'. That is, persons walking, cycling, and using transit, as well those using wheelchairs and mobility scooters.

One of the major forces behind the emergence of this catalyst, therefore, is the emphasis on achieving a much better understanding of what the

organizations responsible for transportation system safety and security are actually doing across all modes, and for all mode users. Consider, for example, the situation whereby a largely cosmetic treatment of vehicle windows creates a dangerous walking, cycling, and driving environment for those trying to make eye contact with the drivers of these vehicles.

Tinted windshields and darkly-tinted side windows may feed the vanity of vehicle owners, but those window-treatment practices are illegal in many jurisdictions in Canada. Further, they put the safety and security of pedestrians and cyclists at risk, because such window-tinting practices make it difficult if not impossible to confirm that eye contact has been made with vehicle operators before entering or proceeding through a crosswalk if on foot, or making a turn if on a bike.

As to the magnitude of this problem, millions of pedestrians and cyclists use Canadian streets on a daily basis, and more are on the way. (Recall Catalyst A above.) Nevertheless, their safety and security has seemingly been treated with disdain by organizations responsible for the safety and security of all transport mode users. That is, those organizations have deferred to the automotive industry and a particular group of private motor vehicle owners at the expense of the safety, comfort, and convenience (security) of pedestrians, cyclists, wheelchair, and portable scooter users, and even other vehicle operators and their passengers.

Two forces are at work, however, which could quickly and effectively bring this catalyst into play.

First, due to residential intensification in some neighbourhoods, and the consequences of Catalysts A, B, and C, in many neighbourhoods there could be an increase in the numbers of pedestrians and cyclists on the streets by ten, twenty, or thirty or more per cent in the next several years. The increased volume of people walking and cycling as opposed to riding in vehicles will likely trigger Catalyst D into action, leading to more transportation system measures, including enforcement initiatives, that address pedestrian and cyclist safety and security issues.

Second, there may be municipalities which are reluctant to actually produce transportation system measures that have due regard for pedestrians and cyclists. The heads-up for these municipalities is that issues involving 'standard of care' are often at the heart of civil suits launched against municipalities on behalf of pedestrians and cyclists. Following from the reference to increased volumes of pedestrians and cyclists, it seems that municipalities would quickly adopt the new transportation system (roadway, pathway, and sidewalk) measures, rather than risk lawsuits due to inferior performance of elements of the transportation network.

Catalyst E: Better Information Systems

The final catalyst has many roots, including the Steger (1966) paper, the Wellar (1975) newspaper column, Garrison's 1965 paper in the Journal of the American Planning Association and the 2007 Anderson Lecture (Garrison, 1965, 2007), and numerous other publications on the topic of transportation measures over the past 40 years.

As Steger, Garrison, Wellar and other commentators observe, creating transportation system performance measures is a difficult and significant achievement. However, creating measures is just one part of the applied measures activity, because operationalizing the measures requires collecting, organizing, and processing the data needed to test and re-test the measures, and then performing analyses, calibration, evaluation, and so on using the measures in real-world engineering, traffic, planning, health, and other operational environments (Wellar, 1998, 2002).

This point is emphasized by Schneider (2008) who recently indicated that the importance of having data available for measures applications in the walking and cycling modes cannot be over-emphasized: "Data collection is critical for measuring pedestrian and bicycle characteristics over time. This aspect of pedestrian and bicycle performance measurement is often a barrier for transportation agencies." Further, the critical importance of having an information system/geographic information system (IS/GIS) capability in place to support large-scale measures, such as those developed for the Walking Security Index, has also been documented (Wellar, 2001).

Fortunately, a concerted effort has been made by professional organizations such as the Urban and Regional Information Systems Association (<http://www.urisa.org/>) to address various data problems that confront researchers, consultants, professional staff, elected officials, and members of the public who undertake transportation and related studies at the local and regional scale. Further, there is a large North American industry of private corporations which have also been active as data providers, and as sources of information system hardware, software, and services, and, most notably for this report, of geographic information systems (GIS) software, peripherals, and services.

As participants in the evolution of GIS are acutely aware, tremendous steps have been taken in the last decade, indeed, last half-decade, to dramatically increase the functionality, scope, and ease associated with using GIS in transportation studies.

Evidence in this regard is illustrated, for example, by the ten websites that were selected for each of GIS Day and Transportation Day during

Geography Awareness Week 2007 hosted by the Canadian Association of Geographers. (http://www.cag-acg.ca/en/geography_week.html.) And, as further evidence of the growing popularity of GIS, witness the rapidly growing number of Canadians of all ages who are comfortable users of Google Maps and global positioning systems (GPS).

That progress notwithstanding, however, the use of GIS for developing, testing, implementing, and evaluating new measures of transportation system performance still faces several major challenges. First, although the concepts and measures introduced by the Walking Security Index project 1994-2002 spawned numerous follow-on projects and studies, it appears that only limited progress has been made in developing the IS/GIS capabilities that were discussed in several WSI publications a decade ago (Wellar, 1998, 2002).

Second, IS/GIS applications in the walk mode involve issues of scope, scale, and functionality which are very different from the private motor vehicle experience, and evidence of lessons learned seems slow to materialize. Third, it appears that in a number of municipalities, only very limited progress has been made in applying geographic information systems and geographic information science to address issues involving the cycle mode. And fourth, there appears to be very little published work describing how GIS is being used to analyze and improve the connections between and among active transit modes, that is, walking, cycling, and transit.

Those challenges are significant, but they are more the result of lack of regard and action for active transportation than technical or technological shortcomings in GIS. Consequently, given the need for new measures on the one hand, and the rapid advances in how GIS technology can be used to produce better transportation system performance information across all modes, it is expected that within the next several years GIS will play a major role in advancing efforts to design and implement new measures of transportation system performance.

5. Methodologies of Sustainable Transport Measures

Parallel with activities involving the AAG and ACSP-AESOP meetings, a project proposal was being developed for Transport Canada involving an examination of the methodologies used to assist in making decisions to identify, adopt, and implement sustainable transport practices.

The project, "Methodologies for Identifying and Ranking Sustainable Transport Practices in Urban Regions", was approved and funded, and task 1 has been completed. The Synopsis Report (Wellar, 2008d) which contains

information about the project's objectives and body of work is posted at <http://www.wellar.ca/wellarconsulting/TCProjectSynopsis.pdf>.

The overall objective of the project is to document the rationale, that is, the reasons and reasoning processes, used in making decisions about identifying, adopting, and implementing transportation initiatives that are regarded as sustainable transport practices.

Information on methodologies and the connections between methodologies, measures, variables, and practices will be acquired through surveys of two groups. Government officials will be asked about the methodologies that are used in each phase (identify, adopt, implement), and members of academic, advocacy group, professional, and other non-government groups will be asked to assess the methodologies that are used, and to suggest those that should be used.

Returning to the line of thought about inputs and outputs discussed by Steger (1966), the methodologies used to define how measures are derived are critical inputs of the measuring process, and the measures that are created or produced are the outputs of the process.

As briefly demonstrated below, the intimate relationship between inputs and outputs is central to the Transport Canada project. However, it is also central to the research on new measures, and the use of those new measures, as we transition from the focus on private motor vehicles to achieving sustainable transport practices across all modes.

Tasks 4, 5, and 6 in the Project Synopsis summarize how the final report of the Transport Canada project is designed to make connections between methodologies, measures, variables, and practices. The comments in italics are added to each task to make the connections explicit.

Task 4 – Using the results of literature reviews and the suggestions of experts and practitioners, prepare a first approximation inventory of variables representing sustainable urban transport practices ranging from worst to best. A key design feature of Task 4 is that the variables are derived from the inputs of experts and practitioners, rather than prescribed by the Principal Investigator. This approach helps to ensure the validity of the variables that are use to construct the measures.

Task 5 – Prepare an interim report on findings about the state of the art/science of measuring sustainable transport practices in urban regions, and the variables representing worst-to-best sustainable transport practices in urban regions. Variables too often appear 'out of thin air', and there is no scientific and often

no logical way to assess the merits of the variables, the measures in which the variables are used, or the ways that the measures are calculated.. The emphasis in this project on ascertaining the art/science, that is, the rationale behind selecting, adopting, and implementing sustainable transport practices, makes an explicit connection between the why's and how's of decisions, and the results of those decisions. It is intended that the research on methodologies contribute to a much-improved understanding of the differences between practices in all the worst-to-best categories, which in turn contributes to understanding the relationship between practices and measures.

Task 6 – Prepare a final report that includes appendices of: 1) methodologies on measuring sustainable transport practices; 2) variables used to represent or identify sustainable transport practices in urban regions; 3) a bibliography of references used in the project; and 4) a list of contributors to this project who agree to be included in a list of resource people on the topic of “Methodologies for Identifying and Ranking Sustainable Transport Practices in Urban Regions”. *The final report connects Tasks 1-5, and also includes several appendices which provide essential information for connecting the body of work of this project to other projects which are also examining relationships among and between methodologies, measures, variables, and sustainable transport practices.*

It is anticipated that Catalysts A, B, C, D, and E will play a key role in contributing to the body of methodologies, measures, variables, and practices which become available for consideration in completing Tasks 4, 5, and 6 of the Transport Canada project. However, there could very well be other catalysts behind the decisions to identify, adopt, and implement sustainable transport practices, and I look forward to learning what they are, and the reasons for their influence.

6. Conclusion

The sessions on new measures of transportation system performance at the meetings of the Association of American Geographers, and the Joint Congress of the Association of American Schools of Planning and the Association of European Schools of Planning, were instrumental in formulating this report, and I am pleased to recognize the contributions made by participants.

The presentations and discussions confirmed the need for new measures, suggested the scope of a measures research agenda, outlined a number of goals, issues, and concerns associated with new measures, and identified

a core group of researchers with whom to collaborate in an important but difficult research and applications domain. Moreover, the sessions appear to have become a basis for further measures research by geographers and planners in the respective associations.

In this report, the focus is on identifying catalysts to move us away from the entrenched view of adding highway capacity to deal with real and imagined urban and regional passenger or freight transportation problems. Instead, in the spirit of a transition to a new transportation order, the new, preferred view is to promote the design and adoption of new transportation system performance measures that are ecosystem-based, sustainability-based, climate change-based and energy-conserving based.

Towards that end, five catalysts are discussed as likely triggers or precipitators to move Canada into a new paradigm for defining, formulating, and then adopting new measures of transportation system performance. The five catalysts are:

- The growing shift away from private motor vehicles for passenger trips, and possibly for freight trips/shipments;
- Geographical limits to development;
- More regard for legacy systems;
- More concern about safety and security issues;
- The increased availability of better information systems and better geographic information systems (GIS) in particular.

Finally, the two conference meetings revealed that a body of individuals with expertise and experience in the design and use of new transportation system performance measures wish to remain in contact as an informal resource network.

As a result of that interest, and the need to have access to a network of experts in order to undertake the Transport Canada project, I end this paper with an invitation. That is, readers with expertise and experience in the design and use of old or new transportation system performance measures, and who wish to participate in communications among the network of researchers, are invited to send a name, email address, and a brief bio-note to wellarb@uottawa.ca.

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About the Author

In 1965-66, Barry Wellar began his research on transportation measures at Northwestern University under the direction of William L. Garrison, who was Principal Investigator for an NCHRP project examining the characteristics of diverted, induced and generated traffic. He retired from the University of Ottawa in 2005, and formed Wellar Consulting Inc. More information about Barry Wellar is available at <http://www.wellarconsulting.com/>.