SUSTAINABLE TRANSPORTATION

PROBLEMS AND SOLUTIONS

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CHAPTER 1

The Problem of Sustainability in the Transport Sector

> There can be no understanding of sustainability at any level other than global.
>
> —JOHN WHITELEGG (1993)

It is reasonable to begin a volume on sustainability with some of the definitions of sustainability and sustainable transport that have appeared in the literature over the past 15 years or so. Before we do that, let us see if we can find some common ground, or some consensus, as to the meaning of "sustainable." We would all agree that if something is sustainable it is something that can be maintained or is something that endures. When we begin to use the word to modify certain nouns, such as *development*, or *cities*, or *transport*, we do little to make them clearer concepts. While the discussion that follows will focus primarily on sustainable transport, the inherent ambiguity or impreciseness applies in all cases.

One of the first of these clarifying phrases was used in the so-called Brundtland Report of 1987 (United Nations World Commission on Environment and Development, 1987). That report discussed what was referred to as "sustainable development," which was defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Without major changes this definition can be extended to sustainable transport, which may be defined as transport that satisfies "the current transport and mobility needs without compromising the ability of future generations to meet these needs" (Black, 1996, p. 151). This is easy to understand on the surface, but soon we have to face the fact that the *needs* are not specified very well, and even if we resolve this matter, we must then stop and decide how many *future generations* we are talking about.

Another way of expressing these ideas would be to state that sustainable transport represents transport and mobility with nondeclining capital, where capital would include human capital, monetary capital, and natural capital (see Pearce et al., 1989; Daly, 1992). Followed to its logical end, this would imply that natural resources could not be used in the system (sometimes referred to as "strong sustainability") unless these were used to develop additional natural capital (sometimes referred to as "weak sustainability").

Daly (1992) does not define what he means by sustainability, but he specifies certain parameters for any sector to be considered sustainable. Within this context transport is sustainable if it satisfies three conditions:

1. The rate at which it uses renewable resources does not exceed the rate of regeneration.
2. The rate at which it uses nonrenewable resources does not exceed the rate at which sustainable renewable substitutes can be developed.
3. Its rate of pollution emission does not exceed the assimilative capacity of the environment.

If we apply Daly's conditions to the transport system of the 1700s and 1800s, which are often viewed as sustainable, we would find these systems were on the verge of becoming nonsustainable at the time. The major long-distance transport mode of the 1700s was sailing ships. Although they used renewable wind energy, they were becoming nonsustainable because they were depleting the lumber stocks used in their construction and repair. The typical transport mode of urban areas during the 1800s was the horse-drawn wagon, buggy, or carriage. This system resulted in tens of thousands of horses polluting the streams, wells, and streets of these urban areas, obviously exceeding the assimilative capacity of these environments.

Schipper (1996) states that sustainable transport is transportation where the beneficiaries pay their full social costs, including those that would be paid by future generations. He further notes that changes in travel are associated with a number of potential externalities, including accidents, air pollution, congestion, noise, damage to the species' habitat, increases in carbon dioxide production, and the importing of oil. "It is these externalities, not transportation or travel per se that threaten the sustainability of the system" (p. 1).

Gordon (1995) is less willing to be drawn into the debate over the definitions of "sustainable transport" and states instead that underlying these ideas of sustainable transport are three different visions. "The first of these visions centers on changing people and the way they live, the second on changing technology, and the third on changing prices" (p. 2). In effect, she is proposing, in rather broad terms, the actions that are necessary to make the transport system sustainable.

Probably in an attempt to be more comprehensive, the Centre for Sustainable Transportation in Canada states that a sustainable transportation system is one that (1) allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations; (2) is affordable, operates efficiently, offers a choice of transport mode, and supports a vibrant economy; and (3) limits emissions and waste within the planet's ability to absorb them, minimizes consumption of nonrenewable resources, reuses and recycles its components, and minimizes the use of land and production of noise (Centre for Sustainable Transportation, 1998).

Europeans generally refer to the notion of sustainable transport as "sustainable mobility." Some U.S. groups also prefer the use of this term. The Mobility 2001 report defines sustainable mobility as "the ability to meet the needs of society to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological values today or in the future" (MIT & CRA, 2001).

Transport Canada (that country's department of transportation) skirted the issue of directly defining the concept of a sustainable transport system and sought instead to define "a more sustainable transportation system" as "one which provides *affordable access* to freight and passenger service and does so in an *environmentally sound* and *equitable manner*" (Transport Canada, 2003, p. 10; emphasis in original).

It should be apparent from this discussion that the definitions have moved from the academic realm to more practical constructs that can be implemented. There is considerable interest in using the concept of sustainable transport to help guide future policies and to evaluate activities and programs in measurable ways. We have identified many of the elements of a sustainable transport system, but let us see if we can go further and conceptualize something that is substantive enough to be measured.

If one wants to measure anything, it is necessary to ask the fundamental question of what the phenomenon really is. Now, in some cases, we want to measure such vague notions as intelligence, safety, equity, faith, justice, freedom, and so on. Once again, we think we know what these terms mean, but do we really? It is more likely that, on closer examination, these words would yield precisely the same types of debates we hear about sustainability, but for the most part we are comfortable with the ambiguity that surrounds these terms and their use.

THE COMPONENTS OF NONSUSTAINABLE TRANSPORT

I once set out to measure sustainable transport. In order to do this, one has to ask the question "What is it that makes a transport system sustainable?" This is practically an impossible question to answer since everyone expects so much of such a transport system. Instead, let's turn this question around and ask "What is it that makes a transport system *nonsustainable*?" If we start from this vantage point, we can better come to some agreement on a definition. It will probably not be acceptable to everyone, but few definitions are. Now let us address this question.

Diminishing Petroleum Reserves

It is generally recognized that in the hundred or so years of motor vehicles using gasoline as a fuel, the world has used approximately 1 trillion barrels of petroleum for this and other purposes—all of this at a time when only a small proportion of the population of the world had access to such vehicles or other uses for petroleum energy. The major question at this point is "What is the future demand for this fuel, and will the planet be able to supply it?" Given that the developing countries, in particular, are expected to increase substantially their demand for energy resources for transport and other sectors—indeed, this trend is well established—global demand will surely increase significantly over the long term.

What can be said of supplies? The optimist would say that there are about 2 trillion barrels of recoverable conventional petroleum reserves out there. In general, current production roughly keeps pace with demand, but if demand increases significantly, as we now anticipate, additional production will be needed. Unfortunately, at the present time new consumption is exceeding new reserve discoveries by more than a 3:1 ratio. If we consider only the conventional sources, some experts believe that we have already discovered and largely exploited all of the major oil fields in the world. If more are found (one relatively new area of exploration is the South China Sea), the world's oil producers might be able to stage a delaying action (Deffeyes, 2001). Others would say that, while conventional sources may not last much beyond 2020, there is significantly more petroleum out there, but we will need to tap such "unconventional" sources as shale oil, oil sands, and tar sands (Greene et al., 2003). Estimates are that the first of these, shale oil, is substantially more expensive to produce and deliver, while the oil sands and tar sands oil entail costs that result in a price that is comparable to the price of gasoline from conventional sources, assuming the price is inflated by suppliers. If the price of gasoline drops, then production from these sands is not competitive. Depending on what the actual costs turn out to be, we will see the slower or faster development of alternative petroleum sources. In the final analysis our current transport systems are nonsustainable because at least at present they chiefly use a fuel that is finite, nonrenewable, and fast being depleted. This is true whether we are talking about oil from conventional or unconventional sources.

Global Atmospheric Impacts

Some scientists believe that humans are placing emissions into the atmosphere that will eventually have a catastrophic impact on the world's climate. Many of them believe the impact has already begun, with perceptibly higher global temperatures and a measurable rise in sea levels. The increased emissions of what are commonly called greenhouse gases may lead to the enhancement of the "greenhouse effect," which under normal conditions enables the planet to retain enough heat to make it conducive to life forms. More specifically, the increased burning of fossil fuels has released substantial amounts of carbon dioxide, a greenhouse gas, into the atmosphere, resulting in a higher global average temperature. As of 2001, carbon dioxide concentrations have increased 31% over their levels in the year 1750 and are now at levels not seen in the past 420,000 years (IPCC, 2001c). Since transportation's use of petroleum-based fuels is responsible for roughly one-third of these emissions, by this definition our current transport system is demonstrably nonsustainable.

One might reasonably ask whether global warming will create major problems or whether it will be only a minor inconvenience. We really don't know the answer conclusively, but the general consensus is that negative impacts could be substantial from only small changes in temperature. Although many sectors of the economy or society might remain relatively unaffected, for a while, transport is not one of these. Transit tunnels flooding due to a rise in sea level, airplanes not taking off due to high temperatures, highways and railroad tracks buckling due to excessive heat, coastal highway and railway flooding, and the submersion of dock facilities are not problems that can easily be dismissed. Even more important is the potential shift in agricultural production to new areas with moderate climates and away from areas that are too hot or too dry, which would result in having to relocate and redesign transport infrastructure in these areas (Black, 1990).

Local Air Quality Impacts

Motor vehicle emissions are a significant contributor to urban air quality problems, which is something that makes the current transport system nonsustainable. According to the U.S. Bureau of Transport Statistics (2009), mobile sources (as of 2007) accounted for 3.7% of sulfur dioxide, 57% of nitrogen oxide, 68.4% of carbon monoxide, 2.9% of PM10 particulates of and 11.8% of PM2.5 particulates, and 33.9% of volatile organic compounds emitted into the air. A substantial portion of the production of urban ozone also has its origins in mobile sources. These various pollutants must be viewed as contributors to nonsustainability, as they are by European countries and the Organisation for Economic Co-operation and Development (OECD), which encompasses the developed nations of the world. That these pollutants have not always been viewed as part of the sustainability problem in the United States may reflect the fact that these problems were and are being addressed, but this attitude seems to have changed in recent years.

The negative health impacts of these emissions, primarily on the human respiratory system, must be viewed as a significant problem that cannot be allowed to fester. While U.S. policymakers have made substantial progress in reducing the level of these emissions, some even asserting that they will cease to be a significant problem in the foreseeable future, nevertheless at this time these emissions are a major factor making the current transport system nonsustainable.

Crash Fatalities and Injuries

It should be an accepted premise that a transport system that kills off its users is not sustainable. However, many policymakers do not wish to include motor vehicle fatalities and injuries in the calculus underlying the sustainability debate. Indications are that the world's motor vehicle fleet is responsible for nearly a million fatalities each year and some 70 million injuries (WHO, 2001, as cited in Evans, 2003). Global forecasts of fatalities and injuries during the next 10 years are almost beyond comprehension, given the growth in demand for personal mobility in China and India, for example.

In the United States the number of fatalities per vehicle mile is dropping, but mostly as a function of increases in vehicle miles driven. Until recently, total fatalities were also dropping, but this improvement is now disappearing or at least leveling off. We are no longer sure what is happening with injuries. In March 2004 the U.S. Department of Transportation set a national target of a 33% reduction in fatalities during the next 4 years, largely through greater use of seat belts, stronger enforcement of drunk driving laws, and closer regulation of the hours worked by motor carrier drivers. This is an achievable target. Other countries have set even more ambitious targets (e.g., Sweden has a target of zero fatalities), but the actions taken by U.S. authorities represent a significant improvement over prior goals they have set. Most countries, however, have not set *any* goals in this area. In any event, motor vehicle accident fatalities and injuries matter enough to be included in any debate over sustainable transport systems.

Congestion

Policymakers generally do not regard congestion as a major barrier to transport sustainability, apparently because the resulting impacts are so diverse. Congestion decreases the speed of vehicles, resulting in both *lower* fuel efficiency and increased emissions detrimental to human health. While increasing motor vehicle incidents, congestion actually decreases fatalities. Perhaps congestion is viewed as a manifestation of all the other criteria leading to nonsustainability, making its inclusion as a negative factor seem redundant.

Several years ago at a Transportation Research Board (TRB) annual meeting the question was asked, "If we adopted a renewable transport fuel with zero harmful emissions, would we have a sustainable transport system?" The question was never properly answered, but it is one that should be posed again. Clearly, replacing gasoline with hydrogen as the universal fuel would eliminate concerns about depletion of fuel stocks as well as the problems of global atmospheric impacts and local air quality. It could also contribute to a reduction in fatalities, as motor vehicle accident fires would be reduced with the use of hydrogen fuel (hydrogen dissipates almost instantly, making hydrogen fires vertical and localized rather than lateral as with gasoline). However, we would still have the problem of congestion in urban corridors and increasingly on major interstate highways and this, along with eventual gridlock, must certainly be viewed as contributors to nonsustainability. So, the answer to the question is that even a "wonder" fuel would not necessarily make the transport system sustainable. We would still have congestion, which will only worsen in the future.

Noise

One major difference between sustainable transport in the United States versus Europe is the latter's greater concern with noise. Considerable research suggests that loud and continuous noise is harmful to human health. This harm may be psychological, resulting in nervousness and behavioral disorders, or it may be physiological, resulting in impacts as significant as heart disease (from an excess production of adrenaline). As a consequence, many European nations are attempting to lessen the level of noise, particularly in urban areas. Of course, the same psychological and physiological effects are inherent to the transport systems in North America, and researchers are at work trying to minimize these. However, the problem and reactions to it are rarely viewed as relevant to the debate over sustainable transport systems here. The greater density of urban areas in Europe undoubtedly makes this factor more significant there.

Level of Mobility

While it may be unnecessary to state this premise, a sustainable transport system should evidence a reasonably high level of mobility. Consider the lesser developed countries in the world. In most instances we find that transport systems there use lesser amounts of petroleum, contribute little carbon dioxide to the atmosphere, and the other pollutants that we associate with motor vehicles, while not absent are certainly present in significantly smaller amounts. Motor vehicle fatalities and injuries are also comparatively low. Congestion is largely absent. Is this a sustainable situation? No, because the level of mobility is so abysmal that the transport system actually prevents development from occurring. So, we must take as a given that the transport system must provide a reasonable level of mobility, and this factor must be added to our criteria.

Other Contributors to Transport Nonsustainability

Biological Impacts

Much attention has been directed at the need to protect our biological resources from the damage wrought by transport activities (TRB, 1997). Animals killed along U.S. highways (estimated to number 4–6 million annually; Black, 2003), rivers and streams polluted, plants destroyed by emissions, and marine animals killed by runoff from highways, runways, and the like are all representative of these diverse biological impacts.

Perhaps the most devastating and highly publicized transport incidents that affect biological resources are the oil spills occasioned by oil tankers breaking up and spewing countless barrels of oil into the ocean or waterway they are traversing. Marine animals and water fowl are the most visible victims of such incidents, as the evening television news makes clear, but long stretches of beach are often despoiled for months or even years at a time. While no species has been extinguished by such transport accidents, their consequences for the local marine environmental and habitat are nonetheless substantial. Richard Forman's *Road Ecology* (Forman, 2002) and the 1997 TRB report *Toward a Sustainable Future* (also known as the Dean Report; TRB, 1997), both attest to the seriousness of the adverse biological impacts of transport systems.

Equity

Some researchers who have examined what makes the transport system nonsustainable have focused on matters of equity (e.g., Bae & Mayeres, 2005; Feitelson, 2002; Litman, 1999a), that is, the notion that operations of the current transport system should not jeopardize the possibility of future generations also satisfying their transport needs adequately. This notion of equity is not meant to imply that future generations should necessarily have the same type of transport system that we have today, but simply that if we are going to continue with a system based on finite petroleum reserves, then we should have either adequate fuel or another fuel available for those future generations. In this way we would avoid profound shocks to the social and economic systems that we rely on.

Beckerman (2003), however, has attacked the equity notion as something that is not desirable, arguing that an "equitable" system does not really maximize social welfare and that the present generation moreover owes nothing to future generations. On logical grounds he argues that future generations have no inherent right to anything at this time and that, indeed, most of what the current generation relies on will probably be viewed as having very little value to future generations, and therefore it makes little sense to try to preserve resources for them.

Other commentators believe that if the transgenerational equity argument is legitimate, then the current transport system should be made to be equitable, that is, fair, impartial, and just. Contrary to popular belief, equity has nothing to do with transport facilities being equally accessible or available to all potential users—that confuses incomes policy with transport policy. These questions have not yet been adequately dealt with in the literature, but hopefully we will get better insight into these aspects of sustainable transport in the future.

To bring this discussion of definitions to a close, let us summarize it by reducing it to a single definition. *A sustainable transport system is one that provides transport and mobility with renewable fuels while minimizing emissions detrimental to the local and global environment, and preventing needless fatalities, injuries, and congestion.* The absence of equity considerations is not accidental but rather a reflection of the fact that if the conditions in the definition are met the system will be equitable.

Those who find this definition to be too narrow probably view sustainable transport as relating to all aspects of the transport system (facilities, services, and use as well as urban development patterns) that affect the ability to sustain a society or an economy without compromising the ability of future generations to do the same. If we expect a sustainable transport system to do all of this, we are dooming it to failure. Even if we expect it to meet the narrower criteria, this rigorous set of requirements for the transport system raises the question of whether transport can be truly sustainable.

CAN THE TRANSPORT SYSTEM BE MADE SUSTAINABLE?

The current transport system is nonsustainable. A colleague once asked me why anyone would work in an area such as sustainable transport since it is obviously something that is not attainable. I would reply that, first, it is not at all certain that a sustainable system is unattainable. Ed Jordan, the first chief executive officer of the Consolidated Rail Corporation, once said there isn't a single problem that—given enough time, money, and people—could not be solved. Is the same thing true of sustainable transport? One can possibly envision hydrogen fuel as ultimately eliminating our concerns about the problems of diminishing resources, global atmospheric pollution, and local air quality. Similarly, major safety programs in highway and vehicle technology (e.g., intelligent transport systems, or ITS) might one day virtually eliminate fatalities and injuries. There is even some possibility of eliminating congestion as a dimension of the problem, particularly so if some of the ideas of Garrison and Ward (2000) are ever implemented. However, the major stumbling block or obstacle to implementing these solutions is adequate funding. Thus, the major dilemma is not that we don't know how to solve the problems of sustainable transport but that we don't know how to do it in an affordable manner.

In addition, the types of changes endorsed here lie decades away or would require many years of transitions. It is unlikely that hydrogen as an alternative fuel will ever gain a competitive foothold so long as the price of gasoline remains as low as it is today (or gyrates so radically in price). Since hydrogen may be a key component in powering a sustainable transport system, the sustainability of that system must await the full development of hydrogen fuel technology.

What We Really Mean by "Sustainable"?

Given that we can't do it cheaply and it won't happen overnight, does this mean we should not try to solve the problems? The answer is, obviously, "No." If we move toward sustainability and in the process fall short of achieving it, this is still likely to be a major improvement over where things stand at present. To do nothing will result in a continuation of the buildup of carbon dioxide in the atmosphere and a more severe future warming than currently anticipated, deteriorating urban air quality, additional highway fatalities and injuries, and potentially severe socioeconomic adjustment problems as fuel supplies diminish or the price of these climb to unprecedented levels.

Should we expect to ever achieve a sustainable transport system? Some commentators believe this is an unattainable goal. In the case of "sustainable development," Glasby (2002) argues for a totally new paradigm since, in his view, the world is embarked on a course that is manifestly unsustainable. That may be so in the case of sustainable *development*, but that doesn't mean that we can't develop a transport system that is more sustainable than the one that currently exists.

IMPLEMENTING SUSTAINABILITY IN THE TRANSPORT PLANNING PROCESS

It is reasonable to ask to what extent the various perspectives on transport sustainability have an impact on the manner in which new initiatives are implemented by different agencies as part of the planning process. This is not an easy question to answer since the transport planning process differs from one place to another, whether we are talking about plans for the countries of North America, South America, Asia, Australia, or Europe, or even plans for particular cities.

In addition, the approach to transport problems varies significantly from one place to another. Note, for examples, the tendency in European nations to call for reduced transport use through regulatory and pricing mechanisms (e.g., confiscatory taxes on vehicle purchases as well as fuel). In the United States, by contrast, transport and vehicle taxes are a common revenue source, but their explicit use as a tool for implementing transport policy is rare and unusual. Mechanisms used to implement transport policy are more typically voluntary, containing no real punitive consequences if one fails to deliver. The United States prefers to champion technological solutions to most of its transport problems: air bags (front and side), seat belts, and front and rear vehicular radar to cut down on needless fatalities; catalytic converters to cut down on emissions; and GPS and GIS systems to eliminate "extra" driving. Even much of government's policy is technologically oriented. For example, the original California zero-emissions mandate for automobile manufacturers in 1990 required them to sell a specified percentage of electric cars in California by the year 2000. Despite setbacks on the timing, more recent proposals from that state will mandate zero carbon dioxide emissions from those vehicles during the next decade, a policy requirement with multifaceted technological implications.

CONCLUSIONS

This chapter initially explored several definitions of sustainable transport, finding some to be either too cursory or too complex. The question was then posed, What is it that makes a transport system *nonsustainable*? Several variables were identified: use of a finite and diminishing petroleum resource; emissions of carbon dioxide that are detrimental to the global environment; emissions harmful to urban areas; excessive crash fatalities and injuries; and congestion. The issue of biological impacts was discussed briefly, and the idea of devising an equitable system was reviewed and found to be implicit in one's properly providing for transport and mobility.

The definition derived from this review and analysis is: *A sustainable transport system is one that provides transport and mobility with renewable fuels while minimizing emissions detrimental to the local and global environment and preventing needless fatalities, injuries, and congestion.*