A TEMPLATE FOR SUSTAINABLE TRANSPORTATION

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Introduction

Transportation providers have an array of options to meet the mobility demands of their stakeholders, but they lack a comprehensive approach that follows the principles of sustainability for evaluating and selecting those options.

Sustainable Development is defined as: "The ability to meet the needs of the present without compromising the ability of future generations to meet their own needs." Closely following that definition, *Sustainable Transportation* is: "The ability to meet the needs of current society to move freely, gain access, communicate, trade, and establish relationships without compromising the ability of future generations to meet their own needs."

In other words, sustainable transportation systems do not consume more raw materials or energy than can be replaced. Nor do they degrade the ability of the environment to support life, including human life. The test for such sustainability is applied through The Natural Step (TNS) Conditions. TNS, created by Karl-Henrik Robert of Sweden, is becoming the worldwide standard for gauging sustainability. It has been embraced by such major U.S. corporations as Nike and Interface (a multibillion-dollar corporation that is one of the world's largest interior furnishings companies.)

Many transportation providers are already applying sustainable transportation options. But they have been unable to incorporate those options into an overall sustainability strategy. Furthermore, these providers do not always receive appropriate credit for the sustainable practices that they are implementing.

The Case for a New Decision Model

Needs of Users and Providers

Transportation stakeholder groups and their transportation providers are asking for the following:

- Proactive stakeholder involvement.
- Options that are less expensive to construct, operate, and maintain.
- Options that consume less non-renewable energy and fewer natural resources to construct, operate, and maintain.
- Options that introduce fewer noxious by-products into the biosphere.

In short, they are asking for a comprehensive approach that incorporates the knowledge and experience of the transportation community around mobility requirements and which embraces sustainable thinking.

Ingredients for Sound Decisionmaking

Given the complexity of the issues affecting transportation solutions, there is no singular, easy-to-implement option. However, an effective decisionmaking structure should provide for the following:

- Address the mobility / transportation need while balancing competing environmental, societal, and mobility demands.
- Provide for incremental steps and, therefore, show how every step toward sustainability is meaningful.
- Demonstrate how to handle the growth in transportation demand with sustainable solutions.
- Match economic reality (insufficient funds to construct new freeways) with sustainable solutions.

The challenge is to find a balanced approach that consistently leads to supportable, defensible, and sustainable solutions. A principle-based approach provides this consistency as well as the basic structure for decisionmaking. As used here, a "principle" describes the ideal situation or condition. Each principle leads to corresponding actions, such as strategies, techniques, and applications, to help achieve that ideal situation.

Two emerging transportation practices provide elements of such an approach:

> *Context Sensitive Design* (CSD) seeks flexibility in the application of design standards. It also seeks to provide guidance to designers who are confronted with situations where design standards must be deviated from to address site-specific situations, without compromising transportation safety or exposing the designer to legal liability.
>
> *Context Sensitive Solutions* (CSS), as coined by the Utah Department of Transportation, is a principle-based approach to transportation planning and decisionmaking that has greater breadth and depth than CSD. CSD is one logical design component of CSS, whereas CSS spans the horizon of transportation, from long-range planning through the operation and maintenance of transportation facilities.

Most of the template for *Sustainable Transportation* is embodied in CSS. However, CSS falls short of sustainability because it does not specifically consider sustainability factors, such as the TNS system conditions, in transportation decisionmaking and implementation.

As shown in Figure 1, sustainable transportation is defined by three guiding principles.

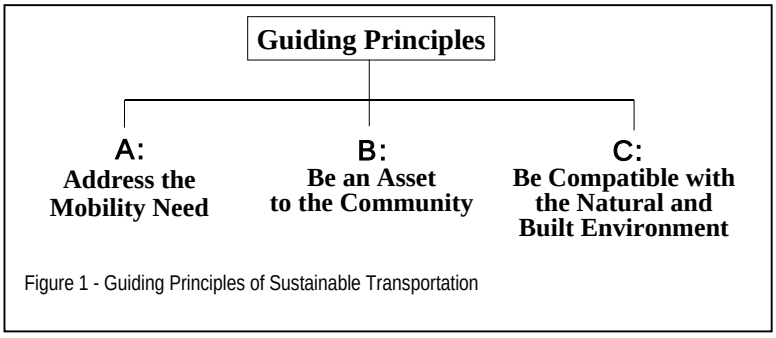

Figure 1 - Guiding Principles of Sustainable Transportation

The Framework

The framework for evaluating the TNS principles, strategies, and techniques / applications is one that flows logically in two directions. The downward flow begins with the guiding principles. From each principle flows a set of implementing strategies. In turn, techniques and applications provide means to implement each strategy. Techniques and applications are transportation approaches that have been successfully and repeatedly implemented.

The second direction of flow is laterally at the strategy level. For example, the strategies for Principle A, *Address the Mobility Need*, begin with the most sustainable practices on the left and move to less sustainable practices on the right (Figure 2).

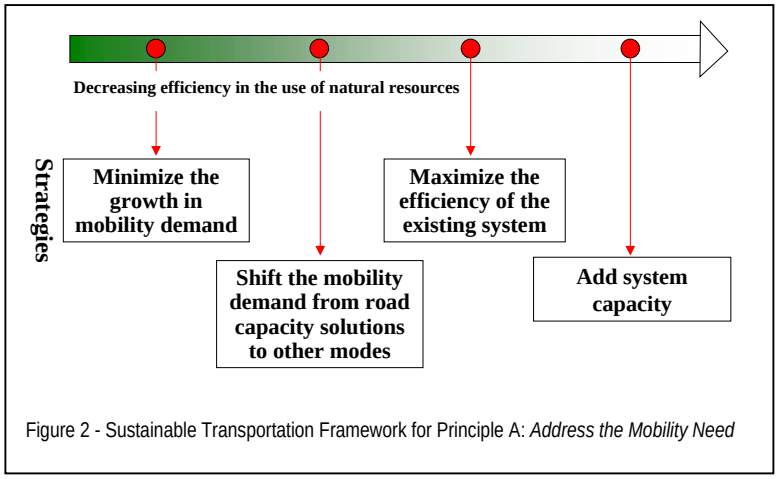

Figure 2 - Sustainable Transportation Framework for Principle A: *Address the Mobility Need*

Principles

Each principle statement includes "evidenced by" and "achieved by" criteria that summarize the principle in practical terms. For any given project, it is normal for dynamic tension to exist among the principles. A "good" solution is one that provides the best balance among all three principles.

Strategies

A strategy is a broadly defined approach to implementing a principle. Each strategy has a set of techniques and applications for implementing the strategy (Figure 3).

The strategies should be evaluated and accepted / rejected by working from left to right on the framework. The strategies on the left side help transportation providers work toward increasing sustainability. For example, building additional road capacity (a right-side strategy) is frequently a lengthy, expensive, and contentious undertaking because of the extent of community / environmental impacts. From a sustainability (as well as economic) perspective, it makes sense to seek other options first. Options such as light rail transit (a left-side strategy) are not always viable alternatives, and can

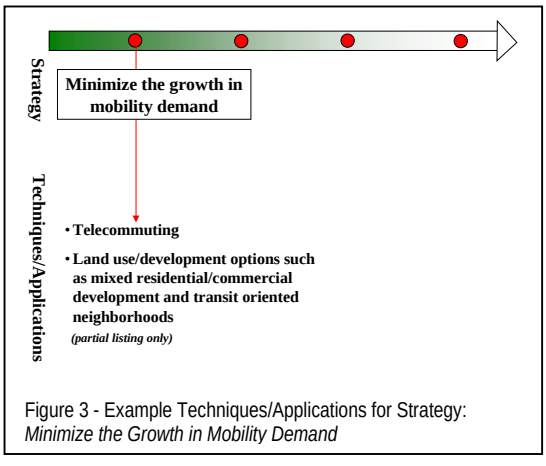

Figure 3 - Example Techniques/Applications for Strategy: *Minimize the Growth in Mobility Demand*

be similarly contentious. But they also occupy less land, cause fewer visual and noise impacts, and are more energy efficient than highways.

In a similar manner, the strategies for Principle C, *Be Compatible with the Natural and Built Environment*, begin with the notion that a transportation project should first "enhance the surrounding environment" (Figure 4). To the extent that such an approach is not viable, the second and third strategies, respectively, are to "minimize the adverse impacts" and "mitigate the adverse impacts."

Strategies for Principle B, *Be an Asset to the Community*, do not follow the same left-to-right logic stream of sustainability (Figure 5). While they still flow from left to right, they are aligned with phases of a project / infrastructure life cycle, from planning through operations and maintenance.

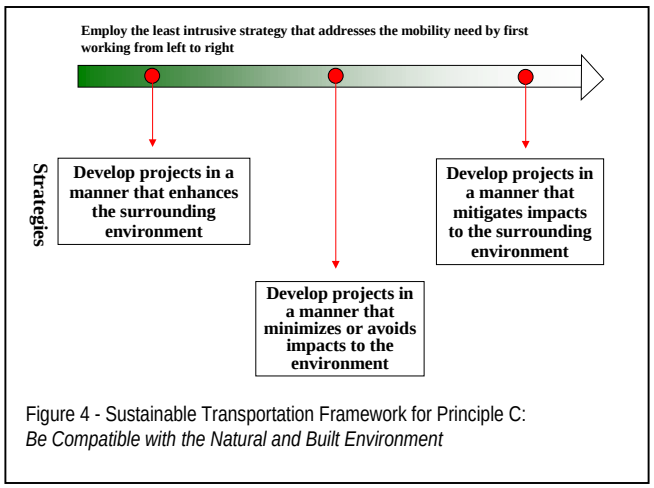

Figure 4 - Sustainable Transportation Framework for Principle C: *Be Compatible with the Natural and Built Environment*

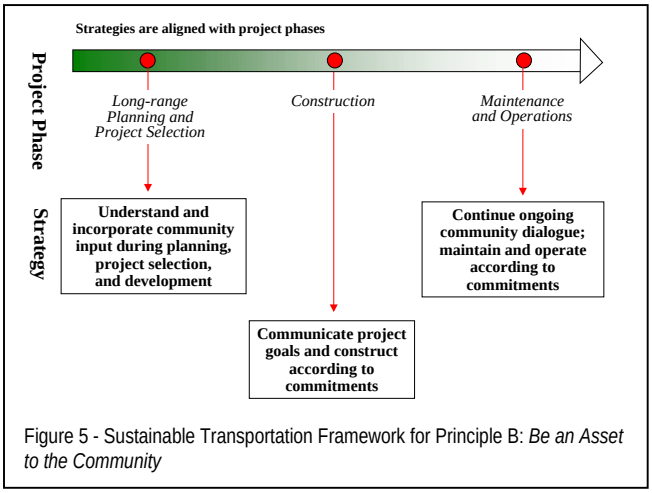

Figure 5 - Sustainable Transportation Framework for Principle B: *Be an Asset to the Community*

Techniques and Applications

The techniques and applications corresponding to each strategy are not intended to be all-inclusive. Because circumstances may vary widely from community to community, describing potential techniques for every circumstance is not productive. More importantly, developing strategies is the area in which stakeholders, policy makers, and designers can exercise the most creativity. Keeping the list of techniques and applications in the template to a representative sample provides decisionmakers just enough guidance to prompt their creativity.

The Natural Step Conditions and Sustainable Transportation

TNS seeks to reorganize businesses, government, and communities around four "system conditions"[1]:

1. *Substances from the Earth's crust must not systematically increase in the ecosphere.* Fossil fuels, metals, and other minerals must not be extracted at a faster pace than they can be re-deposited and re-integrated into the Earth's crust, i.e., turned back into nature's building blocks.

[1] Quoting and paraphrasing liberally from Ray Anderson, CEO of Interface, and the paper "*A Compass for Sustainable Development*," by Karl-Henrik Robert, Paul Hawken, Herman Daly, and John Holmberg.

2. *Substances produced by society (man-made materials) must not systematically increase in the ecosphere.* Man-made materials must not be produced faster than they can be broken down and integrated back into the cycles of nature, or deposited into the Earth's crust and turned back into nature's building blocks.
3. *The productivity and diversity of nature must not be systematically diminished.* We must not over-harvest or reduce our ecosystems in such a way that their productive capacity and diversity are significantly reduced.
4. *There must be a fair and efficient use of resources to meet human needs.* Basic human needs must be met in the most resource-efficient ways possible. Meeting basic human needs must take precedence over providing luxuries in the richest nations.

> *"…our organizations must systematically decrease their economic dependence on metals, fuels, and other minerals. Our organizations must systematically decrease their economic dependence on the production of persistent, unnatural, man-made substances. Our organizations must systematically decrease their economic dependence on activities which encroach on the productive parts of nature. And our organizations must systematically decrease their economic dependence on the use of unnecessary amounts of resources in relation to added human value; i.e., they must systematically move toward fair and efficient use of resources to meet all human needs…."*
>
> — Ray Anderson, CEO of Interface

Each of the TNS system conditions is dramatically impacted by transportation. Viewing each of these system conditions from a transportation perspective leads to the following:

1. *Substances from the Earth's crust must not systematically increase in the ecosphere.* Petroleum products fuel many of our transportation modes and supply materials for transportation infrastructure, such as asphalt. Heavy metals, such as chromium, are used in the assembly of vehicles. By-products of combustion accumulate not only in the atmosphere, but on roadway surfaces, from which they flow into groundwater.
2. *Substances produced by society (man-made materials) must not systematically increase in the ecosphere.* Chrome, plastics, and rubber compounds accumulate as generations of cars pile up in salvage yards.
3. *The productivity and diversity of nature must not be systematically diminished.* Rights-of-way for transportation systems can impact productive farmlands, forests, and prairie habitats, as well as rivers and streams.
4. *There must be a fair and efficient use of resources to meet human needs.* The consumption of transportation resources in the developed nations far exceeds the resources consumed in the so-called developing and Third World nations. Independent of that inequity, fair and equitable access, safety, convenience, and use of transportation systems within the United States engenders considerable debate, particularly regarding funding for public transit, funding and siting of transportation system corridors, and the pricing of transportation services.

Transportation Alternative Evaluation Matrices

Transportation options can be evaluated against the TNS system conditions by using two tools. The first tool (Figure 6) is a matrix that compares the relative attractiveness of transportation options, with the attractiveness represented by a number of "convenience" factors. The second tool (Figure 7) is a matrix that compares transportation options against TNS System Conditions 1, 2, and 3. These tools can be applied with various degrees of rigor, from informal and intuitive rankings by lay audiences in stakeholder meetings to computer-supported quantitative comparisons.

The sum of the convenience attributes below determines the relative "willingness" of users to travel by a given mode. This matrix can be used to identify "gaps" for a given mode that can lead to projects that will close the gap and make the mode competitive.

Transportation/Modal Option to Meet Mobility Needs

Convenience Attributes	**Modal Option 1**	**Modal Option 2**	**Modal Option...**
Connectivity	*These attributes are evaluated qualitatively across options to determine the relative viability of each option.*		
Accessibility			
Frequency of Service			
Total Travel Time			
Affordability			
Reliability			
Comfort			
Security			
Safety			
Total Score			

Figure 6 - Transportation Options "Convenience Factors" Evaluation Matrix

The first matrix can be used to identify gaps in the transportation system, as well as help prioritize projects.

Example Application: ***Comparing Options — Closing the Gap***

Community leaders are comparing the relative merits of several transportation options that provide better neighborhood access to a nearby retail mall. They compare the relative convenience factors for a new street connector, improved transit service, and a pedestrian/bike path linking the neighborhood with the mall.

In evaluating the options, it turns out that the pedestrian option ranks as high as the transit and street options, except for security. Further exploration reveals that the security issues can be readily addressed with better lighting and by thinning adjacent underbrush.

Given these circumstances, community leaders identified a gap that prevented one option from being as attractive as another. They further identified possible "projects" that could close the gap. At the end of the analysis, community leaders have an opportunity to better assess the relative merits and costs of the three options.

If the community were to proceed with constructing the pedestrian/bike path, they would be choosing the option that was also most compatible with the other three TNS system conditions.

The high-priority projects that emerge from the first matrix can be further evaluated in the second matrix, which compares the projects by the degree to which they meet the TNS system conditions. This evaluation should be done for both the transportation vehicles as well as the transportation infrastructure, such as a road, bike path, or rail line. Vehicles and infrastructure should be further evaluated across the primary phases of their life cycle — construction, maintenance, and operations.

Transportation/Modal Option Compatibility to Support TNS Conditions 1, 2, and 3

	VEHICLE			INFRASTRUCTURE		
	Construction	**Maintenance**	**Operations**	**Construction**	**Maintenance**	**Operations**
TNS 1						
TNS 2						
TNS 3						
Subtotal:						
Grand Total:						

Figure 7 - TNS System Conditions / Transportation Options Comparison Matrix

Conclusion

Sustainability is becoming an increasingly significant issue for transportation users and providers alike. Achieving sustainable transportation solutions, however, requires a systematic approach, to ensure that sustainability principles are factored into the decisionmaking process when evaluating and selecting options. The "Template for Sustainable Transportation" provides the tools for incorporating a balanced and systematic approach to achieving supportable, defensible, and sustainable solutions.

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