

## 2008 AUTC Governing Board Five Year Roadmap

Three critical issues face the industry today: energy, environment, and funding. The rising cost of energy manifests itself not only through fuel costs, but in construction and maintenance costs of the infrastructure. Rising fuel costs are spurring the use of fuel efficient vehicles, a reduction in travel, and often a change in the mode of transportation. As a result, gasoline tax revenues are dropping. Capacity of transit and our nation's railroad is becoming inadequate.

Environmental concerns relating to transportation grow. Air quality, green house gasses, water quality, impacts on habitat regulations continue to increase. Climate change now dominates transportation policy.

Rising costs and increased environmental constraints come at a time when transportation revenues are diminishing. Transportation agencies and industry struggle with meeting transportation demands in a financially challenged environment. There are two basic solutions: reduce costs and/or find new revenue streams.

Consequently, all transportation education and research must address these three fundamental issues. We must become more energy efficient, environmentally friendly while reducing costs and finding new revenue streams. Each focus area discussed below must tie back to these three goals. There is, however a synergy between these goals. For example, improved energy efficiency will reduce environmental impacts while reducing the overall cost of transportation.

To meet these needs, this roadmap divides transportation research and education into six loosely grouped overlapping categories:

- ② Environmental Stewardship
- ② Operating Transportation Systems
- ② Planning Transportation Systems
- ② Designing Transportation Systems
- ② Constructing Transportation Systems
- ② Maintaining Transportation Systems

**Environmental Stewardship** has become an increasingly important factor to consider during design, construction, and maintenance of transportation systems, This is particularly true as regulatory agencies have refined and developed more stringent environmental regulations over the last several decades. In cold regions, the impact of transportation systems on the environment are often more acute than in more temperate climates. This is influenced by slow contaminant degradation rates, sensitive environments and recently changing climatic conditions.

**Air Quality:** Extreme and relatively long lasting air inversion systems aloft may result in violations of air quality standards for fine particulate matter (PM 2.5) creating “non-attainment” areas according to EPA regulations. Transportation and air quality officials must be prepared to make changes in these affected areas such that the air quality regulations are met.

**Dust abatement:** Reduction of PM10 and PM2.5 is a potential “non-attainment” issue in many rural Alaska communities. Thus, an effective and economical means of controlling dust is needed. Pressure to reduce dust is causing transportation agencies to focus on the development of dust abatement programs appropriate for affected areas.

**Water Quality:** Water quality may be impacted through construction, maintenance, and operation activities and is a more significant challenge in cold climates than temperate climates. Natural attenuation processes for contaminants such as petroleum products work much slower in cold climates. Accidental spills of contaminants may occur in very remote locations, resulting in delayed response. In addition, cold climate environments are inherently more sensitive to physical and chemical impacts. Sediment control is also especially difficult in northern latitudes. Many streams carry glacial sediment which may be supplemented by sediments from construction. In other cases, thawing permafrost due to construction disturbances causes sediment transport over many years. Traditional sediment control methods do not always work in cold climate regions.

**Habitat Conservation:** -Transportation systems can adversely impact fish and wildlife habitat, including travel corridors and migration patterns of salmon, bear, moose and caribou. Unfortunately, our understanding of the cumulative impact of roads and transportation systems on cold region habitat impacts is limited. Effective mitigation alternatives must be developed to optimize habitat conservation strategies.

**Sustainable Wetlands:** In many portions of Alaska, there is an abundance of wetlands. The dynamic nature of wetlands in cold regions and their ecological functions are not well understood. More information is needed to understand how these wetlands function and how the transportation system development can minimize both short and long term impacts on such areas. Strategies specifically tailored to cold regions must be developed in cooperation with the permitting agencies since those used in temperate climates simply do not work in cold regions.

**Managing Impacts of Climate and Weather Changes on Transportation Structures:** It is generally recognized that the world is in a warming trend, and that the most immediate and severe effects are appearing in northern latitudes. However, while temperature increases in and of themselves may have only minor impacts on transportation, Changes in weather patterns can have significant and costly impacts. Changes in climatic conditions in the arctic and sub-arctic regions seem to result in more intense storm events, as well as melting of permafrost soils. Management strategies are necessary to address the impact of these changing conditions on the design, maintenance and operation of transportation systems.

**Operation of Transportation Systems** is especially difficult in cold regions. This is due to the harsh environment and vast distances between population centers. Transportation systems are often more concerned with moving freight and people through the system rather than with system maintenance. Consequently, operations must consider a variety of factors, including mode of transportation, equipment, origin-destination, traffic density, and environmental impacts.

The Intelligent Transportation Systems (ITS) program, sponsored by USDOT, provides potential improvements in the operation of transportation systems through improved information and automation of operational activities. Operating transportation systems is becoming increasingly complex. In cold regions, snowfall, icing, increases in extreme weather and increases in environmental constraints (such as air quality) coupled with increased demands on the system, make ITS attractive. Improved information in conjunction with an automated system like ITS can give decision makers' greater ability to "get it right the first time,"

**Improve Energy Availability and Efficiency in Rural Communities:** Most Alaskan communities have no land based or at best poor land based transportation. Consequently fuel used for transportation, power generation and home heating is very expensive.

**Managing Traffic in Cold Regions:** Snowstorms, ice storms and rapid temperature changes often result in adverse transportation impacts. Current practice is based on the idea to warn drivers of a hazard and let them adjust to the conditions. If conditions are severe enough, the system may be closed. Rarely do managers adjust the system to respond to the actual conditions, For example, dynamically changing speed limits may improve the system. Should traffic management be different for icy roads and ice fog versus a dry or wet road and clear visibility?

**Improving Operations of Transit Systems:** Managing mass transit systems in cold regions poses unique challenges. One of the major issues involves getting potential riders to the system in cold temperatures. Once a rider gets to the stop, keeping warm becomes an issue. Generally, ridership tends to be focused on those who live and work very close to the transit lines. One option is to develop strategies for financing and operating low volume systems for riders who have the ability to choose between personal and public transportation. Further, transit systems and land use policies in cold regions are typically disconnected. The solution requires institutional rethinking and this is not trivial.

**Enhancement of Freight Movement and Logistics:** In our freight-centric economy, efficient freight movement is critical. We depend upon just-in-time delivery, which requires careful scheduling and tracking of both manpower and equipment. Application of new technologies including Radio Frequency Identification, Global Positioning Systems and improved communication systems offer the ability to efficiently track the position and condition of the freight and equipment. This reduces the need for repeat orders and the need to maintain inventories.

Most power generation in Alaska is dependent on natural gas and coal. An increasing number of power generation plants are being proposed using coal gasification techniques. The transportation system must be optimized to ensure continued delivery of both natural gas and coal to ensure continued operation of these plants.

In addition, Transportation systems have barriers such as substandard bridges, congested intersections, interchanges and short runways. Reducing or eliminating these barriers offers increase freight efficiencies.

**Enhancement of Vehicle Performance in Cold Regions:** Vehicles operating at cold temperatures operate at far lower efficiencies than vehicles at warmer temperatures. Reports indicate that vehicles operating in sub-zero temperatures burn as much as 30% more fuel and generate much higher air emissions. Sources of inefficiencies include incomplete fuel burn, increase friction as lubricants are less effective and increased rolling resistance of tire. Improvements in each of these have the potential to reduce operating costs and improve air quality.

**Managing for Improved Efficiency:** Transportation systems are deteriorating at rates that exceed the funds needed. This is because the demand continues to grow while the system continues to age. Further, events as small as a traffic accident or as catastrophic as a flood,

snowfall or earthquake can cripple a transportation link. Improvement in the management and maintenance of our transportation systems is becoming increasingly critical. For example schools are de-linked from neighborhoods leading to large increases in school related trips (by some estimates 30% of rush hour traffic!). If schools are well located, sidewalks and crosswalks provided, a large reduction in travel demand results, during otherwise peak travel periods.

**Improving Safety:** Safety continues to be a major concern to USDOT and AASHTO. Because less than 5% of the crashes are directly due to the roadway or equipment failures, traditional roadway improvements do not appear to be the primary answer. Similar trends appear in other modes of transportation. Consequently, if we are to improve safety, we must better understand the relationship between human behavior and transportation systems. For example, does the yellow light on a traffic signal cause the driver to begin to stop or become more aggressive? Further, if we are to improve safety, we must consider the interaction between driver, pedestrians, bicycles, and motor cycles. Without significant change in the next ten (10) years, Alaska will witness 750-1,000 fatalities, 6000-8000 major injuries and about \$5 billion in societal costs from traffic accidents! It is a major public issue. Consequently, implementation of new technologies such as roundabouts, rumble strips, in-vehicle warning systems and yet to be developed systems are becoming increasingly critical. Alaska, like many other states, is developing a Strategic Safety Plan (currently in draft) to address safety issues.

**Security:** The vulnerability of transportation systems to threats is also an increasing concern. We often focus on human-initiated attacks on our system, fearing loss of life and adverse impacts on our economy. However, recent extreme weather events demonstrate how vulnerable our systems are to events totally beyond human control. Understanding and managing for disasters of both natural and human origin is critical to the economy and quality of life in the United States. Unfortunately, we are seeing that weather patterns are rapidly changing in the northern latitudes. A lack of tested evacuation plans for critical ground systems is a concern. The I-35 disaster in Minneapolis is also instructive. They had bypasses, such that traffic could be rerouted. Alaska has few redundant routes, meaning our vulnerability is even greater. Thus in addition to terrorism, nature, there is also the need to be secure from neglect.

**Planning:** Transportation systems are constantly evolving and often in unanticipated ways. Land use planning, changes in recreational patterns, even changes in weather patterns may alter our transportation needs. Potential improvements in the planning process for a given transport mode are often overlooked as a key element to improving all aspects of the system. Both ISTEA and SAFETEA-LU added considerable new planning demands and process. Planning is neither a goal nor a deliverable. Rather planning is a process which leads to improvement in transportation. If done incorrectly, planning can result in delays or less than desirable outcomes.

Continued increases in energy costs, environmental costs and declining revenues make multimodal planning critical. Planning must recognize the reallocation of freight movement to other modes to improve efficiency.

**Modal Integration:** The planning process typically occurs along modal boundaries. As a result, we see each mode trying to improve its own efficiency when a better solution may be to improve the efficiency of all modes. The trend to move long-haul freight from the roadways to rail requires improvements to rail-highway interfaces.

**Financing:** We routinely read about the shortfalls in transportation funding. The current fuel tax structure simply cannot fund all highway needs. Railroads struggle to remain financially strong. Ports are becoming over-crowded. These issues become more acute in northern regions because central population centers are surrounded by large unpopulated areas. Further, our harsh environment requires annual repairs to many of the roadways. Couple this with a probable shift in federal funding, and northern rural states are facing a potential transportation financial crisis. Public resistance to tax increases to pay for public programs also continues to be a serious obstacle. Further as vehicle fuel economies improve and the use of hybrid vehicles and possibly hydrogen fueled vehicles increase, our current gasoline taxes will continue to decrease. If we are to maintain our transportation network, alternative funding mechanisms must be found.

**Asset Management:** Transportation agencies need effective tools for assessing and managing the condition of transportation infrastructure. Investigation is needed on how to manage transportation infrastructure strategically and economically. Decision makers need sound advice for wise investment and management. This should be based on good data, proper data evaluation techniques, information-supported conclusions, and public process.

**Public Outreach:** The Alaska public has low level of understanding regarding issues affecting the transportation infrastructure. Providing public outreach will have a positive benefit and should help the people understand more about their system.

**Designing** transportation system components that can withstand exposure common to cold regions continues to challenge the state and USDOT. Infrastructure is affected by climate, type and magnitude of loading (which changes with market demands), material types and seismic conditions. Consequently, we must improve transportation infrastructure performance in cold regions.

**Innovation in Transportation Materials:** Infrastructure replacement costs are becoming more of a problem as the demand for government and private budgets increase. Therefore, it is imperative that we develop alternate materials that will provide safe economical solutions for longer periods of time. It is now clear that improved materials are important for the future of multi-modal transportation systems including highways, airports, railroads, ports and pipelines. Further, inexpensive techniques to monitor and assess the condition of the materials used are needed.

**Designing for Accelerated Construction:** Construction costs in northern regions are significantly affected by such factors as short construction seasons, lack of alternate freight sources, and wetlands. Building on or near wetlands dramatically affects costs. Subsequently, designs are needed that will reduce construction time and minimize the project footprint. It is anticipated that designs using accelerated construction techniques will lead to cost savings.

**Structures in Cold Regions including Seismic Considerations:** Consider that structures

such as highway and railroad bridges all carry traffic during extreme temperatures. Many materials are more vulnerable to brittle fracture and/or fatigue at cold temperatures, and these conditions may lead to premature failure. Combining these conditions with a winter seismic event may result in structural damage. These load combinations are poorly understood and should be investigated. How a structure responds depends largely on the natural frequency and the energy of the seismic event. This is a soil-structure problem, and at present there are no data to provide designers with the tools to mitigate these issues. Conditions that must be considered are system stiffness, and support soil conditions (e.g. liquefaction potential of the supporting system).

In addition to the above considerations, there is a need to develop a design methodology that will accommodate accumulated damage and remaining life. This approach is not included in the current codes and yet one bridge that has been loaded with a overloaded truck may have a smaller design life than an identical bridge of the same age that has not been overloaded. Therefore there is a need to develop intelligent informational systems that will provide engineers with data to become pro-active towards evaluating structural safety and the remaining life of our bridge structures. This is particularly important in Alaska where the infrastructure is by comparison younger than other states but most of the road system is subjected to heavily loaded freight demands in both mild and extreme temperature conditions.

**Increasing the Use of Locally Available Materials:** Construction costs are generally affected by material availability. Research to increase the availability of local materials has the potential to enhance performance and economic return. Research to develop more usage of available materials will help reduce overall construction costs.

**Designing for Permafrost:** Consider that a large portion of the land-based transportation network in northern regions passes through permafrost (ice rich support materials). In the past, highways and railroads built over these areas have performed poorly. This leads to higher expenses and dramatically impacts maintenance budgets. Therefore, exploring and developing designs that will perform better over these sensitive areas is an important cost cutting measure.

**Designing for the Community:** Communities no longer view transportation simply as a means of moving from place to place. Transportation systems impact property values, business use patterns and property accessibility, community health and quality of life. These impacts affect all modes of transportation. The location of a rail line, airport, highway, transmission line, port or pipeline affects the entire community. While we routinely consider these issues on a project-by-project or mode-by-mode basis, rarely are the cumulative impacts considered.

**Designing for Pipeline and Related Infrastructures:** Pipelines are the lifeline of the Alaskan economy. The existing crude oil line and the proposed natural gas line are unique in that they traverse permafrost and are expected to operate over a wide range of temperatures. In addition, the environmental and security constraints under which they operate create unique challenges and opportunities.

**Improved Design Tools:** Changing and ever-improving design standards are requiring a greater level of design effort. Designers must increasingly depend on the use of computer

automation to efficiently perform these designs. Unfortunately, current software packages are unable to accurately perform the required analysis; these need to be upgraded. Alternately, new software will need to be written. Computer software that specifically addresses Alaska's design concerns (climate, seismic, etc.) would improve the performance of the infrastructure while making more cost-effective use of the design effort.

**Construction** of transportation systems should be examined for ways to reduce costs by developing strategies for minimizing contract costs, permitting costs, and the impact of temporary structures in sensitive wetland areas.

**Accelerated Construction Technologies:** The cost of building in remote northern regions is impacted by a narrow window of time and by limited freight options. Subsequently, an accelerated construction timeline will reduce the construction window necessary for each project and trim costs. Research into developing alternate construction techniques and supporting technologies for remote areas is imperative.

**Construction Contracting:** Disputes are generally expensive to owners and contractors, and are all too common in northern regions. Methodologies and/or procedures for developing more complete and less controversial construction documents will reduce costs. In addition to formulating a quality control method for producing contract documents, using a third party quality control contractor should be examined; such contracts can be jointly paid by owner and construction contractor. Quality control engineers employed solely by contractors are often put in a position that is inevitably a conflict of interest. Other approaches should also be examined.

**Maintenance** of facilities and equipment in cold regions continues to be a problem for transportation maintenance personnel. As our infrastructure ages, associated demands on maintenance increase. As maintenance budgets become tighter, improving maintenance techniques becomes more critical. Critical maintenance issues include:

**Infrastructure Preservation:** Preservation of our transportation infrastructure remains critical. This requires improving our maintenance techniques, as well as management and performance measurements.

**Snow and Ice Control Technologies:** Snow and ice control represents a major budget item for maintenance of surface transportation facilities. As traffic and user expectations increase, past practices become unacceptable. Couple this with increasing environmental constraints, and maintenance personnel must be provided with new snow and ice control technologies.

**Vegetation Control** is critical to the safety of surface transportation facilities. Past mowing practices have become cost-prohibitive and ineffective. In addition, invasive and noxious plants, often transported by vehicles and vessels, are reaching unacceptable limits. More effective methods of vegetation control must be found, including environmentally friendly herbicides or other control measures.

**Managing Corrosion:** Corrosion of transportation structures including bridges, pipelines and marine structures continues to be a problem. As these structures age, managing corrosion becomes an increasingly important maintenance activity. Unfortunately, our ability to detect and evaluate corrosion in pipelines, bridges and other transportation structures is lacking.

Further, better techniques are needed to avoid or remove corrosion. For example, one question to consider is which techniques will better serve the state in the long run: alternate cathodic protection systems, or coatings such as epoxies, or construction using nonferrous materials.

**Maintenance Over Permafrost:** Transportation facilities which traverse permafrost terrain require constant maintenance. Failure to perform maintenance invariably results in facility failure. Unfortunately, we continue to be reactive to permafrost damage, rather than planning for the inevitable.

**Intelligent Transportation Systems (ITS)** has much to offer in the area of transportation maintenance. Examples include Remote Weather Information Systems for scheduling snow and ice control activities, ground temperature probes to manage spring load restrictions, and devices to control icing on bridges. Testing such systems in cold regions conditions and developing ITS other applications can greatly improve our long term maintenance performance.