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Industry Study

Final Report
Transportation Industry

The Industrial College of the Armed Forces
National Defense University
Fort McNair, Washington, D.C. 20319-5062

Transportation Industry Study

ABSTRACT:

The transportation industry is an interconnected network of systems and infrastructure focused on safe, secure, and efficient movement of people, food, fuel, raw materials, and manufactured goods throughout the country and overseas. The industry's primary aim is maximizing profit. Industry management and regulators typically focus on single mode optimization, often to the detriment of the larger system. An important role of government is to induce the industry to pursue environmentally and socially responsible actions that may not provide immediate economic benefit. A coherent National Transportation Plan that addresses economic, environmental, and social issues is needed to ensure long-term industry sustainability.

COL Skip Adams, U.S. Army
CDR Patrick Becker, U.S. Navy
CDR William Cox, U.S. Navy
COL Adam Duda, PL Army
Lt Col Todd Fogle, U.S. Air Force
Mr. Jim Frederick, Dept of Army
COL Cameron Leiker, U.S. Army
LCol Tim Marcella, CA Army
CAPT Dean McDougall, Royal NZ Navy
COL Roger McCreery, U.S. Army
CAPT Phil Schifflin, U.S. Coast Guard
Col Daniel Shoor, U.S. Air Force
Col Karl Stark, Air National Guard
Col Darrell Steele, U.S. Air Force
CDR John Wilshusen, U.S. Navy

Ms. Kelly Morris, DLA, Faculty
Dr. Christina Lafferty, Faculty
Dr. Donald Losman, Faculty
CAPT Kyle Luksovsky, U.S. Navy, Faculty

PLACES VISITED

Domestic:

U.S. Department of Transportation, Washington, DC
Federal Aviation Administration, Air Traffic Control System Command Center, Dulles International Airport, Herndon, VA
Steven F. Udvar-Hazy Center, Chantilly, VA
National Transportation Safety Board Training Center, Ashburn, VA
United Parcel Service Freight, Richmond, VA
U.S. Army Transportation Corps, Fort Eustis, VA
National Railroad Passenger Corporation (Amtrak) Headquarters, Washington, DC
Wells Fargo Securities, New York, NY
U.S. Coast Guard Sector New York, Staten Island, NY
U.S. Army Corps of Engineers, New York District, Jersey City, NJ
American Trucking Associations, Washington, DC
American Airlines Flight Academy, Fort Worth, TX
Burlington Northern Santa Fe Railway Headquarters, Fort Worth, TX
Burlington Northern Santa Fe Classification Yard, Haslet, TX
Shell Pipeline Company LC, Houston, TX
U.S. Coast Guard Sector Houston-Galveston, Houston, TX
Port of Houston Authority, Houston, TX
Federal Aviation Administration, Terminal Radar Approach Control and Tower, George Bush Intercontinental Airport, Houston, TX
American Association of State Highway and Transportation Officials, Washington, DC
U.S. Senate, Committee on Science, Commerce and Transportation, Washington, DC
U.S. Senate, Committee on Homeland Security and Government Affairs, Washington, DC
Washington Metropolitan Area Transportation Authority, Washington, DC
American Maritime Congress, Washington, DC
Transportation Research Board, Washington, DC
The Vane Brothers Company, Baltimore, MD
USNS GILLILAND, Baltimore, MD

International:

598th Transportation Group, Capelle aan den Ijssel, Holland
Dutch Inland Shipping Information Agency, Capelle aan den Ijssel, Holland
Port of Rotterdam Authority, World Port Center, Rotterdam, Holland
Flower Auction Flora Holland, Aalsmeer, Holland
Heineken Nederland Supply, Zoeterwoude, Holland
Van der Vlist Special Trucking, Groot Ammers, Holland
Dutch Customs, Port of Rotterdam, Holland
Maersk Lines Terminal, Port of Rotterdam, Holland
APM Terminal, Port of Rotterdam, Holland
Europe Container Terminal, Port of Rotterdam, Holland
Régie Autonome des Transports Parisiens (RATP), Paris, France

Union Internationale des Chemins de Fer (UIC), Paris, France
French Ministry of Transport, Paris, France
Normandy Beaches and D-Day Memorial Visit, Normandy, France
Central Europe Pipeline Management Agency, Versailles, France
London Transport Museum, London, UK
Royal Observatory, Greenwich, UK
International Maritime Organization, London, UK

Introduction

The transportation industry needs a coherent National Transportation Plan that ensures long-term sustainability by addressing economic, environmental and social issues. The current condition of transportation as a whole, the challenges facing the industry, and necessary changes in national policy all flow from this fact. The transportation industry is focused on economic forces and maximizing profit. An important role of government is to induce industry to pursue necessary environmentally and socially responsible actions that may not maximize economic benefit. Industry management and regulators typically focus on single mode optimization to the detriment of both the system as a whole and the sustainability of the nation's transportation. Worldwide environmental concern and the need for socially responsible action are factors driving investment in new areas. Where improvement has had clear economic impact, industry has taken the lead to address these issues. However, where the return on investment is less obvious, progress has been less consistent.

Sustainability is a term that is used to represent a number of ideas based on its context. The National Security Strategy includes sustainability as a critical factor in pursuing our enduring national interests: "Balanced and sustainable growth, at home and throughout the global economy, drives the momentum of the U.S. economy and underpins our prosperity."[1] As used here, a sustainable transportation industry is one that "meets the needs of the present without compromising the ability of future generations to meet their own needs."[2] This is the same definition used by the Department of Transportation, the Transportation Research Board, and others in discussing sustainability in the transportation industry. Central to this idea of sustainability are the overlapping but different economic, social and environmental concerns of participants in the transportation industry. As indicated in Figure 1, it is possible to maintain economic growth while ensuring the compatibility with the environment and meeting the social needs of the population. To do this will require a coherent, integrated transportation plan.

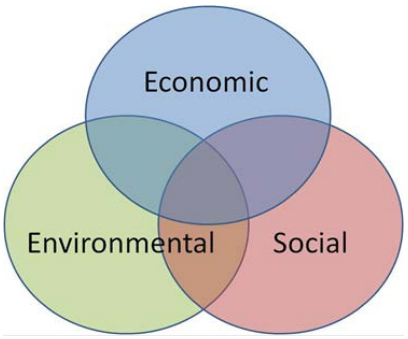

Figure 1. Sustainability Diagram

A viable and sustainable transportation industry is critical to the nation's security in the future given the increasing national security emphasis on rapid deployment from the U.S. and reduced force sizes overseas. Thus, a review of current conditions and challenges in the industry, as well as the outlook for the future of transportation in the U.S., will provide an indication where government action would be most appropriate to maximizing the sustainability of the transportation industry.

Industry Defined

The nation's transportation industry is an interconnected network of systems and infrastructure focused on safe, secure, and efficient movement of people, food, fuel, raw materials, and manufactured goods throughout the country and overseas. Key subsectors, or modes, include the following:

- ***Highway/Trucking*** is comprised of more than four million miles of interstate, federal, state, and local highway roadways, bridges, tunnels, interchanges, and other supporting infrastructure, the vast majority of which is publicly built, maintained, and operated through a combination of federal, state, and local registration and licensing fees, fuel

taxes and bond issues. Although automobiles, buses, motorcycles, and trucks of all sizes share relatively unfettered access to the road network for commercial and private purposes, for this paper the primary focus is on local, and long-haul commercial freight trucking.[3]

- ***Rail*** includes a national passenger rail service, seven major freight rail companies, 21 regional rail lines, and 537 local rail operators. Together they operate more than 23,000 locomotives and 1.3 million freight cars across more than 138,000 miles of railway that is predominately privately-owned.[4]
- ***Aviation*** is comprised of major and regional airlines; more than 19,000 civil and joint military use airfields, heliports, and seaplane bases, including over 270 military airfields and over 500 commercial airports; air traffic control systems; ground support equipment; and aircraft of all types and sizes.[5]
- ***Maritime shipping*** consists of more than 360 federal, state and privately-owned ports; over 3,700 marine terminals; more than 25,000 miles of publicly maintained navigable inland and intercoastal waterways; domestic and international shipping companies; barge operators; open ocean coastal and international shipping; and intermodal landside connections that provide other transportation modes the capability to move people and goods to, from, and on the water.[6]
- ***Pipeline systems*** encompass a network of nearly 1.7 million miles of privately-owned and operated pipelines that serve to gather, transport, and distribute crude oil, refined petroleum products, natural gas, chemicals, liquid hazardous materials, CO2 gas, and other liquid and gaseous products from sources to end users across the country. This mode also includes more than 100 critical storage sites around the nation, used to provide handling room and surge capacity to manage the flow of materials being handled.[7]

As Figure 2 depicts, the transportation industry faces a number of business forces that shape the competitive environment.[8] While the various modes operate independently under regulatory regimes peculiar to the economic, social and environmental characteristics and impacts of each

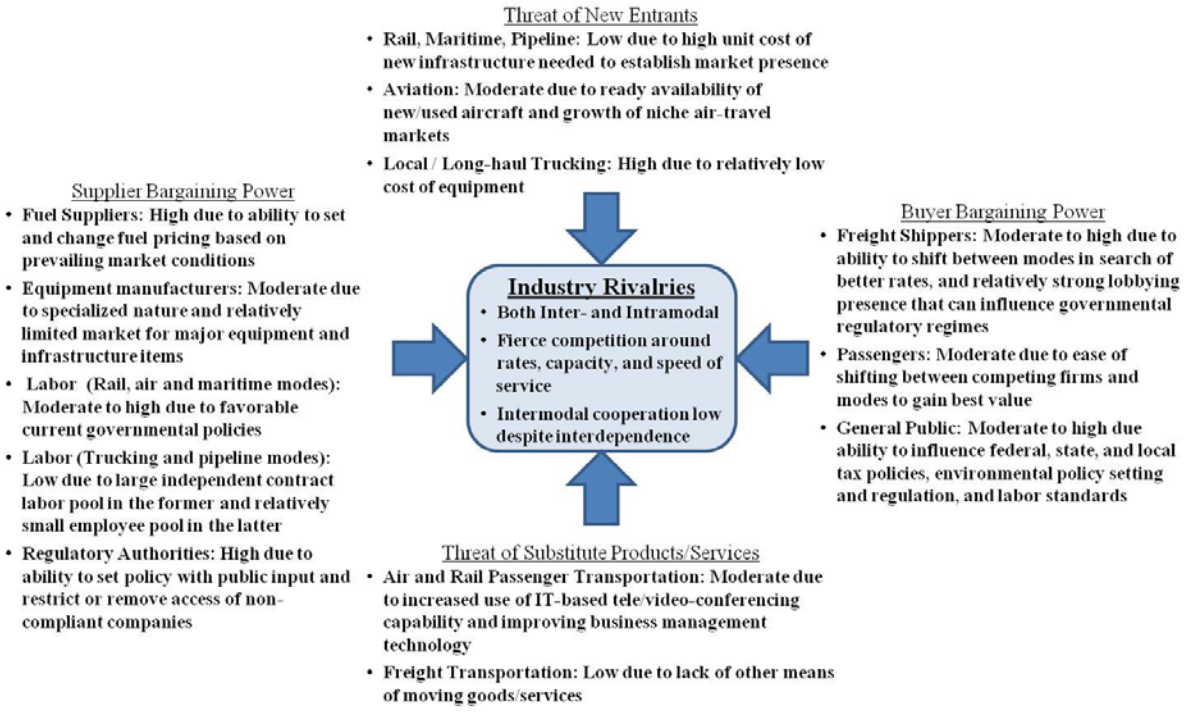

Figure 2. A Five Forces View of the Transportation Industry

specific mode, there is also a high degree of interdependence between each of the modes. Businesses within modes vary in size from individually-owned and operated companies to sprawling nationwide entities employing tens of thousands of people.

Because of their central roles in the national economy, the transportation modes collectively require a significant portion of national energy resources. They also have significant social and environmental impacts due to noise, greenhouse gases and other pollution production; land usage requirements; and the employment of large numbers of people. Finally, the transportation industry as a whole is vital to national security because it allows for rapid movement of forces and equipment as required; ensures the uninterrupted flow of materials and products to and from key parts of the defense industrial base; and supports the economy that is generating the resources and revenue to pay for national security needs.

Current Condition

The transportation industry is a leading indicator of the U.S. national economy and links the other industries throughout the economy and security infrastructure. The current condition of the transportation industry reflects a tendency toward oligopolistic firms controlling large market shares. As discussed above, this landscape is based upon increasing economies of scale, large capital investment requirements, regulatory requirements and social issues reducing the threat of new entrants and substitutes. Figure 3 below depicts the competitive landscape that results from the five forces analysis presented earlier, with significant barriers to entry resulting in a strongly oligopolistic market structure for most of the transportation industry.

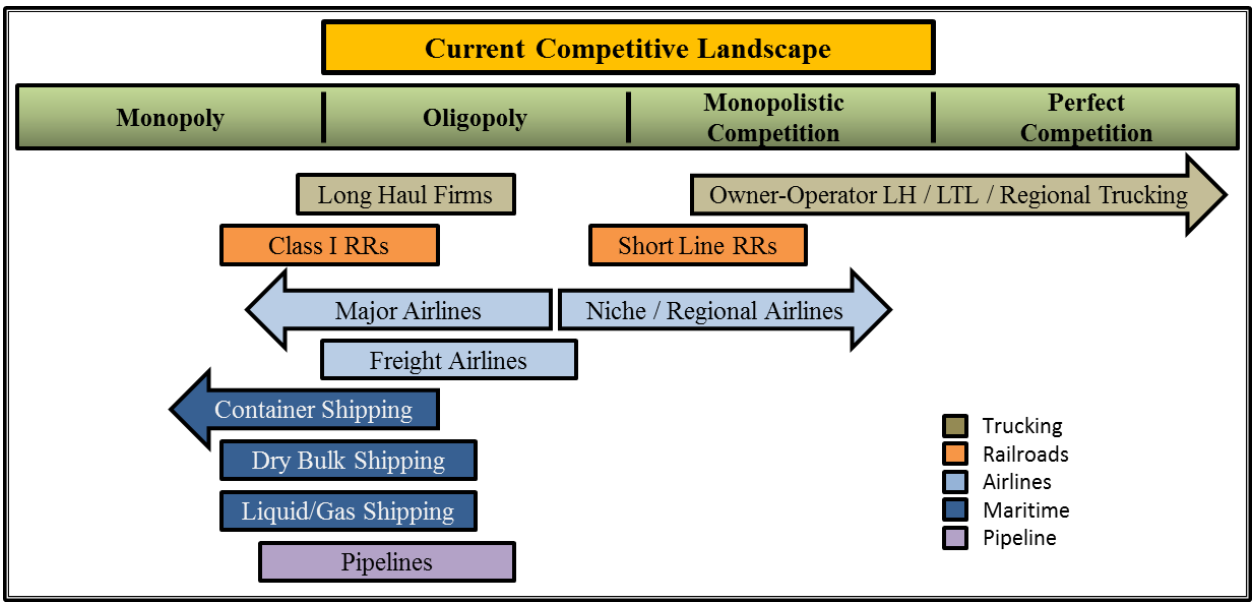

Figure 3. Current Competitive Landscape

Competitive Landscape and Health of the Industry:

Trucking: While the majority of the transportation industry operates in a market structure with limited competition due to strong barriers to entry and weak threats of substitution, trucking has unique challenges. The market for trucking is strongly competitive with price and speed being dominant factors. Although there are three major long haul firms, together they account

for only 3% of the market. Due to low barriers to entry, truck owner-operators make up 94% of the long-haul, regional and less-than-truckload (LTL) market and are driving the trucking sector toward perfect competition.[9] Revenue declined sharply during the economic downturn due to reduced freight movement, with profit margins falling from 9.1% in 2006 to 4% in 2011. Cost of fuel is the primary driver of profitability and is directly tied to entry into/exit from the industry by independent operators; changes in fuel cost significantly influence the number of competitors in the industry. New Hours of Service (HOS) regulations set to go into effect in 2013 may also impact profitability due to limitations on the number of miles per day that drivers are permitted to log. Recognizing their environmental impact, trucking is advocating for measures related to fuel conservation and environmental impacts. Support for decreasing the nationwide speed limit and decreasing idling time are seen as key initiatives to save fuel and decrease the industry's carbon footprint. Given the industry's aging workforce, the impending shortage of drivers will only be exacerbated until the industry finds a way to attract and retain new drivers.

Rail: Unlike the trucking industry, railroads have remained stable in the competitive landscape due to regulatory factors, highly trained and well paid workers and costly infrastructure requirements as significant barriers to entry. Railroads can be divided into three groups: seven large Class I freight railroads that compete with each other in an oligopolistic market based upon geography; hundreds of dedicated short line railroads that feed major railroads or focus on local deliveries; and national, regional and local passenger rail services. Like other modes, freight rail has been affected by the economic downturn, but it is uniquely positioned to transport raw materials and manufactured goods as the economy rebounds and set to regain market share lost to trucking over the last few decades. Investments in infrastructure and equipment upgrades have resulted in more access to key routes and increased fuel-efficiency, which favors freight rail when compared to other modes. Freight rail is also set to benefit as increasing focus on environmental sustainability drives companies to use rail for their own competitive advantage. In contrast to the freight rail industry, passenger rail continues to struggle for viability in the U.S. market. While some small local or regional commuter lines are able to achieve profitability, national passenger rail service (Amtrak) remains a federally-subsidized monopoly that is only profitable in a small portion of its total operations.

Aviation: Looking at the competitive landscape, major passenger airlines are moving toward oligopolies due to consolidation to achieve economies of scale, whereas niche airlines and regional airlines are moving toward greater competition as new markets open and larger airlines shed their regional jets. Freight airlines remain stable, with three major carriers dominating as significant capital and corporate infrastructure are necessary. Major passenger airlines have seen rising fuel costs and rising ticket prices threaten both profitability and demand. Reduced discretionary income for consumers during the economic downturn, coupled with the rise in ticket prices, led to a decrease in air travel. Most airlines will continue to implement fuel hedging strategies and extra fee structures (e.g. baggage fees) to combat unpredictable fuel costs and passenger loads. Given rising fuel costs, major airlines are recapitalizing their fleets with more fuel-efficient aircraft and dropping less profitable routes to cut costs. These dropped routes in turn provide niche and regional airlines with growth opportunities. As airlines struggle, the traditionally well-compensated workforce with envied benefits will likely continue to see irreversible erosion in pay and benefits. All of these factors provide an environment that favors further consolidation among major airlines and more competition in regional and niche markets.

Maritime: Shipping remains relatively stable with a few global firms able to compete due to increased costs for large, efficient specialized ships and lower profit margins. Container

shipping is consolidating as a few major international firms have emerged to dominate trans-oceanic routes. Dry bulk and liquid/gas shipping are relatively stable with few firms able to enter and compete in these markets. Adding to sector stability is a relatively small but well-trained workforce characterized by good labor relations. Shipping has been negatively impacted by an overabundance of ships and containers given the state of the economy and the downturn in freight. While rising fuel costs have certainly impacted the profitably of the industry, shipping firms are equally concerned with keeping currently available ship capacity utilized to the maximum extent possible. With the volume of U.S. trade expected to double by 2020, shipping will play a critical role, especially in light of the expansion of the Panama Canal. Profitability should improve as the global economy improves and cargo shipments increase.

Pipelines: Pipelines are very stable and oligopolistic in nature with either large independent companies or several major companies consolidating resources to build, maintain and operate pipeline networks. Barriers to entry include significant regulatory requirements, environmental requirements, enormous capital investments, and the need for a tech-savvy, highly trained workforce. Pipeline revenue has increased over the last five years, even though there has been less demand from refiners for overseas crude oil due to a shift to cheaper domestic oil. Unlike other modes, the pipeline market price is determined by a government entity, the Federal Energy Regulatory Commission. Prospects for the pipeline industry are dampened by the lack of support to expand U.S. domestic oil production and to construct oil refinery capability beyond the existing infrastructure. Increasing demand for natural gas is a bright spot for the pipeline sector as capital investment increases for long-term production.

Successful Business Strategies:

Some very successful transportation firms have built a comparative advantage over their peers based upon their choice of placement on the strategic gameboard. UPS Freight sets itself apart by being a "technology company that has trucks and ships packages" focused on continuous investment in technology, environmental efficiencies and training. This differentiation has enabled their growth and expansion into the LTL business. Several Class I railroads are investing in newer energy efficient locomotives while at the same time shedding less profitable rail cars to minimize sunk costs. Allegient Airlines, a young "niche" airline, operates standardized point-to-point flights to major vacation destinations from smaller airports and minimizes overhead costs to achieve comparative advantage. Pipeline companies are mainly master limited partnerships or major oil company consortiums that leverage extremely large amounts of capital and technology for profitability. Successful companies rely on a mix of technology, efficiencies, economies of scale and a highly trained and loyal workforce to set themselves apart from their peers using either differentiation or cost to compete successfully.

International Factors:

The increasing number of free trade agreements (FTA) bodes well for the U.S. transportation industry. Of particular interest is the manufacturing boom in Asia. As manufacturing and national economies continue to expand in Asia, U.S.–Asia economic relationships will only deepen, giving the U.S. potential leverage to seek social and environmental reforms in Asian countries. The recent signing of the U.S.-Columbia FTA represents another region with great economic opportunity for the maritime sector in particular, and the transportation industry as a whole. Since the passage of the North American Free Trade Agreement, an estimated $1 billion worth of goods legally cross the borders between Mexico, the U.S., and Canada every day and will only increase as the world economy improves.

The international transportation industry has weathered the economic recession fairly well, but continues to see consolidation in three modes: airlines, shipping and pipelines. Class I railroads remained unchanged, whereas trucking has seen a very competitive local and LTL market based upon manufacturing and supply chain changes. As the industry moves forward, there are many economic, environmental and social challenges and opportunities that will influence the future and its economic and national security impacts.

Challenges and Opportunities

Within the modes comprising the Transportation Industry, there are a number of common challenges that are limiting progress toward a world class intermodal system, and that will generate strategic security challenges going forward. Predominant challenges include regulatory changes, infrastructure and labor.

Regulatory Landscape:

The transportation industry in general is heavily regulated with the expectation that global trends will require further regulation. The driving factor for new regulation is the social desire for a cleaner, greener and safer transportation industry. This regulatory trend frequently creates economic challenges for the transportation system, specifically impacting the profit margins within the trucking and pipeline modes. For example, within the trucking sector, new work hour regulations will reduce available capacity by limiting the amount of driving an operator can perform each day. Additionally, this mode has sought an increased maximum truck weight limit which has not been granted. The expected impact will be a less competitive trucking industry as compared to other transportation modes. While these regulations are not supported by the trucking industry, they have been put in place to address public concerns with respect to safety. Another example of increased cost due to regulation is in the pipeline industry. In this mode there are conflicting regulations across multiple levels of government (local, state, federal), as well as multiple agencies, all regulating this single mode. The result is increased cost and time to put in new pipelines. A very visible example is the recent Keystone Pipeline project, where immense amounts of time and money were invested in the development of a new pipeline only to be denied approval due to environmental concerns.

Infrastructure Landscape

Transportation industry sustainability is impacted by a number of infrastructure challenges. These are centered on capacity, condition and technological advancement. For example, only 50 percent of the top 59 ports in the U.S. have sufficient channel depth to allow ships to operate at full capacity.[10] Nearly 25 percent of U.S. bridges are rated structurally deficient, functionally obsolete or both.[11] Within the air mode the majority of radar and navigational aid technology is more than 40 years old.[12] While the impacts of these infrastructure challenges manifest themselves in social issues such as congested roads and airways, the strategic importance of a world class transportation industry cannot be overlooked.

Without intermodal synergies, security and economic wellbeing is not assured. These infrastructure challenges are well documented and rectification paths have been identified. However, the financial wherewithal to carry out improvements is frequently extremely limited. The lack of a coherent National Transportation Plan complicates development of a financial solution to any infrastructure challenge. The vast capital injection required and the lack of central funding leaves it in the hands of the state or local authorities, who have interests that do

not always reflect national priorities. The frequent result is creation of an incoherent stovepiped approach to resolution of these challenges.

Labor Landscape

A sustainable transportation system depends upon a viable work force. This is not only those currently within the industry but also within the various training pipelines. As the transportation industry becomes more technologically advanced, a more technology capable workforce is required. Demographics are an important consideration; the U.S. population currently has an aging workforce of approximately 76 million baby boomers being replaced by approximate 45 million next generation workers. When coupled with the continual shortage of science, technology, engineering, and math (STEM) majors,[13] the result is fierce competition for qualified workers amongst all modes. Again, regulation has an impact. For example, air traffic controllers are required to retire at age 56, yet airline pilots can remain employed until age 65. Extension of service for the current workforce could provide some near-term relief; however, it only delays the inevitable and in some cases is impractical. Additionally, the rate of technological advance has the potential to leave some older workers behind.

The shortage of a technologically proficient STEM-qualified replacement workforce will not only impact the U.S. economically, but will also affect national security. This will manifest by way of the technologically advanced U.S. military being unable to recruit the required numbers, or those recruited and trained will become very attractive to outside industry. No matter how it is viewed, the total labor shortage creates national security concerns.

International Landscape

While the U.S. is free to exercise any regulation within its own borders, as an international trading nation the international regulations will impact the national transportation industry. For example, as trade has expanded with Mexico the trucking industry has seen international concern raised with respect to U.S. safety requirements for cross border trucking. This has led to a review of internal regulation and a change that now allows this international trade to be conducted using foreign drivers and trucks.

Another example is that the U.S. being a signatory to the International Convention for the Prevention for Pollution from Ships (MARPOL) generates the requirement to reduce emissions at sea.[14] These international regulations are driving technological changes within the maritime industry for both shipping companies and port infrastructure. They will also cause the development of a greater alternative fuel supply chain, which while requiring large capital investment, should create employment opportunities and has the potential to create increased energy independence.

Industry Outlook

As previously described, the transportation industry must contend with multiple challenges arising from both internal and external factors associated with economic, environmental, and social changes. Current sustainment trends within the transportation industry have been shifting to a slightly negative outlook in the short term with a similar trend potential for the long term if a path of status quo is continued. Addressing issues in the short term presents few opportunities to make substantive improvements, but ground floor actions can set the foundation for long term corrective action. Subsequently, the long term view, offers the

potential for measured opportunities by structuring regulation, oversight, infrastructure, and labor in a manner that services both private and public entities.

Short Term (0-5 years)

Shrinking operating margins within the transportation industry offer limited opportunities to proactively fund solutions sets without some level of public private partnership interface. This, in combination with decreasing governmental funding, will present significant challenges within the industry as well as to the supporting infrastructure. There are several major projects over the next 5 years that will likely consume much of the available capital. In rail, PTC is a $13.2 million dollar investment over the next 20 years that is predicated on safety improvements.[15] Required funding to support the PTC project will force trade-offs in capital investments that potentially could result in missed opportunities due to investment capital shortages. Recently the rail industry has been experiencing an increased freight volume demand due to rising energy costs and changing global intermodal shipping trends that are raising the utilization rate of rail capacity. Similarly, FAA's NextGen project will likely cost in the tens of billions of dollars with equally high promises to revolutionize the air traffic system, but the promised efficiencies may not justify the cost.[16] Also, implementation will be slowed by the limited FAA budget and the cost to retrofit existing airframes for the private sector. In both cases, there may be an economic benefit in the future, but the short term economic and opportunity costs must be weighed and prioritized in a manner that supports both sustainability and profitability in order to promote the health of the industry. Conceptually, it is easy to understand the need to invest in the future of any industry; it is the ability to respond in a calculated manner that meets short term strategic objects while aligning economic, environmental, and social concerns in a balanced approach that results in a synergistic effect.

One area that has seen regulatory capital investment continuing to occur and even welcomed is in the short haul trucking industry. Regulations promoting environmentally friendly changes such as alternative fuels and aerodynamic changes have a small but achievable return for the local trucking system. Already, we have seen corporations try natural gas, hybrid vehicles, and even fuel cells to minimize fossil fuel consumption and green house gas emission. Unfortunately, due to limited fuel delivery infrastructure and needed technological improvements, extending those changes to the long haul trucking industry is more problematic. Additionally, "green" technologies come at an increased cost that further degrades potential profit margins.

Labor in the near term presents a much more stable but potentially tenuous picture. While a sufficient work force is currently available to meet most industry needs, the trucking industry is experiencing increases in driver shortages that are projected to reach 111,000 by 2014 if current trends continue.[17] This aging work force is likely capable of meeting current employment skill sets, but may encounter difficulties keeping up with technological changes. Changing technology is driving a need for a more educated workforce industry wide as productivity pressures continue to drive replacement of human capital by technology. Difficulties in finding prospective employees due to qualification deficiencies in technical skills, STEM education, or lifestyle choices, to include arrest records and drug usage, must be mitigated in order to sustain the required work force. Finally, many jobs within the industry can negatively impact employee quality of life due to requirements to spend significant time away from home. Prospective younger employees often must deal with a mismatch between the erratic, on-demand, and traveling culture of the industry and the Gen X/Y worker's desire for stable,

predictable personal time. Addressing labor concerns will require increasing focus for the short term.

Long Term (15-25 years)

Projecting forward 15-25 years within this industry is as much about looking at currently available options as it is about forecasting new options based upon economic, environmental, and social changes. Projected population growth, emerging markets, and demand changes will continue to force the industry to respond to customer needs to stay viable. Technological advancement is likely, and the effect on oversight/regulation, infrastructure, and labor will be significant in defining the industry's future.

Current and near term planning, as well as oversight for this industry, is completely stove- piped. A comprehensive plan is needed for all modalities that provides a synergistic road map to a future that is more focused on efficient resource utilization, infrastructure advancement, and sustainment, with integrated policy that considers second and third order effects. Without such, not only at the federal level but also in concert with the state and local levels, the industry is likely to continue to fight overlapping, inconsistent, and competing regulations. Efforts must be made to link public and private concerns in a manner that allows options to federal and state policy makers to provide acceptable solutions. Trade associations will continue to represent industry specific concerns on behalf of their members. Efforts focusing on industry-wide stakeholder collaboration are paramount to the sustainment of this industry.

As previously stated, technological advances are likely. If one considers the current automated ports of Rotterdam or the potential of fleets of remotely piloted vehicles that could significantly increase productivity and improve safety while reducing costs, one might assume this will improve overall sustainability. However, such actions lead to other questions for the future. For example, are there going to be enough STEM based workers to handle the complex maintenance required to design/support these systems? What will happen to the people currently holding traditional operator positions? With more potential throughput, what is the impact on the infrastructure? Are road and rail networks capable of handling more traffic without unmanageable congestion? Are intermodal connections fast enough to handle it, and are other support structures/systems in place? Questions such as these emphasize the importance of having a comprehensive plan and highlight the importance of understanding second and third order effects.

Semi-autonomous systems are not the only technology advance that could significantly shift the outlook for this industry. Alternative fuels or propulsion systems and other control systems could be the paradigm shift necessary to propel this industry. However, many of the sources of investment for research have traditionally come from government agencies which will most likely continue to experience budget shortfalls resulting in less industry specific research. Profitability will be the driver for the technology industry to invest significant capital in research and development, so if a large enough market exists, a corresponding investment market may exist as well.

Finally, consideration must be given to the second and third order effects of continued resource limitations on the industry's outlook. Unless technology and planning change, traffic congestion, fuel limitations, and the cost of legacy maintenance on both operational equipment and infrastructure will continue to be significant limiting factors to success of this stressed industry.

Government Goals and Role

Despite the challenging landscape described above, it is clear from looking at the current state of the transportation industry and the outlook over the short and long terms that government has a major role to play in ensuring a sustainable transportation industry capable of meeting future requirements and supporting national security. The Organization for Economic Cooperation and Development describes three appropriate roles for governments.[18] First, governments can act as a stimulator, focused on removing barriers. Second, governments may play the role of producer through direct investment in things like infrastructure. Last, governments should be the market regulator, fostering a competitive marketplace and protecting consumer rights. The recommendations below clearly fall within those three roles and specifically focus on promoting a sustainable transportation industry in all three factors of sustainability: economic, social, and environmental, with many of the recommendations having implications in all three sustainability realms.

Throughout this paper, many themes are constant, but several should stand out. Notably, the U.S. lacks a coherent, integrated National Transportation Plan dedicated to ensuring sufficient resources, infrastructure, and labor are available to meet commercial, consumer, and national security needs. Each transportation mode tends to be fractured, with industry leaders and advocacy organizations often focused on their own mode to the detriment of another mode or region. Additionally, the plan should incorporate initiatives to reduce congestion and delay, which also will have positive environmental and social effects. The Department of Transportation has started the effort to integrate all modes with their Strategic Plan,[19] but it lacks the force of legislation that a congressionally approved National Transportation Plan would have. The Department should author and Congress should approve a National Transportation Plan. This plan must be comprehensive and include planning, designing, building, operating and maintaining phases. To achieve this goal, it is important to develop metrics and methods for evaluating sustainable transportation including a strategic sustainability assessment, which uses both qualitative assessment and scientific models to create and analyze future states. A coherent National Transportation Plan would also have to deal with the second economic theme: aging infrastructure. As previously noted, roads, airports, ports, and pipelines all suffer from inadequate infrastructure to meet emerging transportation needs stemming from increasing globalization, the construction of a new Panama canal, and even America's strategic shift to Asia and the Pacific. Congress should allow the privatization of airports and air traffic control services and incentivize public-private partnerships that have already been successful in many domestic and international arrangements.

Next, the U.S. government should engage in two major areas with respect to transportation industry labor. The first area involves continuing support for the aging workforce. The stark realities of population demographics in the U.S. will require continued support of federal policies that encourage individuals to continue to work for as long as they are physically able, in order to continue to satisfy the needs of the transportation industry. As life expectancies continue to increase, it is logical to pursue an increase in the retirement age. Therefore, the federal government must strongly pursue new age anti-discrimination legislation, flexible work policies, and workplace accommodation regulations. In addition, for hard-to-fill labor categories, Congress should enact targeted immigration policies in order to provide temporary support until they can establish targeted domestic training and recruitment. However, government support for extending the useful productivity of a senior workforce and providing

encore careers will not, by itself, enable the U.S. transportation industry to remain competitive or support the national security implications of transportation.

The second labor issue requiring an increased role of the government is support of STEM education. Younger workers entering the transportation industry often lack the science, technology, engineering and math skill sets required to function in a globalized technological workplace. At risk is the ability to innovate and compete in this industry. Increased government support to STEM programs at both primary and secondary education levels, support of STEM via public private transportation industry partnerships, and incentivization via reduced interest on college loans for technical education will serve to support and preserve our transportation industry.

The final issue government must tackle is to ensure balanced development of the transportation industry without sacrificing essential current or future environmental values. Given the transportation industry's enormous impacts on the environment, including approximately 25 percent of energy consumption and carbon dioxide emissions, the issue of how to limit these negative aspects of human activity remains an acute problem for policy makers. There is a common consensus that government must take steps to significantly diminish these environmental concerns. First, it is vitally important to minimize consumption of nonrenewable resources for transportation. Government can achieve this by increasing transportation fuel taxes; implementing vehicle efficiency standards; lowering carbon standards for transportation fuels; offering rebates or other financial incentives to motivate interest in vehicle efficiency; investing in transportation infrastructure to increase vehicle operating efficiencies; controlling land use; and implementing travel demand management measures to discourage people from use private cars. Second, it is also important to minimize the impact of transportation on environmental systems and limit transportation-related wastes and pollution. To fulfill this task, it is imperative to reduce the use of chemicals such as salt for winter maintenance; to support people's use of hybrid/electric vehicles by developing networks of charging stations and preferences in public parking areas; and to implement an integrated intermodal transportation plan to reduce redundant movement of people and goods. Third, due to increasing globalization, government must not operate in isolation but must synchronize environmental requirements with international policy in order to minimize barriers to global trade such as the carbon taxes in the EU's airspace. Finally, in relation to national security, it would be beneficial to require alternative fuels in the DOD to diminish dependence on fossil fuels, to replace obsolete means of transport used by government, and to implement modernization plans, such as the Next Generation Air Transportation System (NextGen) on schedule.

Demands on the transportation industry will only increase over the next 15 years. The current state of the industry will not produce a sustainable transportation industry capable of meeting these increasing requirements. Therefore, government must act to stimulate public-private partnerships to combat declining budgets, to invest directly where public-private partnerships are not viable, and to regulate when change is not in the economic interest of a mode but is required to sustain the industry. Above all, Congress must pass a National Transportation Plan to enable seamless interoperability between all modes of transportation to ensure America's national security transportation needs are met.

Essays on Major Issues

Essay 1: U.S. Port Infrastructure

The vital contribution ports have always played in U.S. economic wellbeing and national security may be in serious jeopardy. The aim of this paper is to conduct a U.S. port infrastructure sustainability analysis within the framework of the transportation industry as a whole. Firstly, key definitions related to infrastructure and sustainability will be established in order to provide context and this will be followed by an overview of port capabilities, operations, and economic impacts. Port sustainability factors will then be examined and capability requirements will be determined. Finally, a national port strategy framework will be proposed that will best meet the economic and national security needs of the U.S. now and into the future.

Simply put, port capability can be defined as the ability of a port to move freight from one transportation system to another. This intermodal capability role can further be broken down into the level of "access" a port has to other transportation systems as well the rate at which freight can "flow" through the port infrastructure. Sustainability can be defined as the maintenance of port systems that are able to meet the intermodal capability requirements of current and future generations while also being physically secure, cost effective, environmentally viable, and socially equitable.[20]

Port Infrastructure Overview

The immense network of U.S. ports are an absolutely vital component of national economic wellbeing through which an average $3.8 billion worth of goods transit in and out of the country each day. These activities account for 99% of U.S. international trade by volume, 25% of the GDP, and create over 13 million jobs. [21] The U.S. port infrastructure is immense with over 360 commercial ports providing over 3200 handling facilities across the nation.[22] It is essential to note however, that over 50% of container traffic transits the top five ports[23] and 14% of all petroleum products move through the port of Houston.[24] Thus the U.S. port infrastructure, while vast, has capacity concentrated significantly in a mega-ports framework. Despite its importance, port infrastructure is currently performing well under its potential. Currently the top 59 ports are only operable 35% of the time due to infrastructure, channel depth and congestion challenges.[25] This less than optimal productivity does not position the nation well for current economic recovery efforts or future market challenges.

There are numerous sustainability factors that place demands on port capabilities and these factors also act upon each other in both positive and negative ways which can be a challenge in terms of maintaining effective balance within the sustainability framework. The first sustainability factor to consider is that of government and more specifically that of politics and funding. Port infrastructure is capital investment intensive however, due to the current economic budget situation; the U.S. government possesses very limited means to fund port capability improvements. The realities of U.S. politics are also important as ports are owned by individual States which compete intensely for Federal funding. As a result, short term political objectives often take precedence over the optimal economic or national security outcomes.

With 90% of world trade moving by sea, reacting to global markets pressures is also a critical factor for port sustainability.[26] Due to globalization, ports also can no long operate in isolation but rather face rivalry from competitors just as in other industries.[27] This in turn has driven port authorities towards higher productivity through increased privatization.[28] Ports must also adapt to larger ship sizes and increased East Coast traffic that will result from the

completion of the Panama Canal expansion.[29] Current planned port expansions will not meet the expected 20-80% increase in capacity (flow and access) demand that these ports are expected to see by 2020.[30]

Transportation systems interoperability, which can be defined as the ability of two systems to match flow rates for freight moving in either direction, is another critical sustainability factor. An imbalance in flow rates creates "intermodal asymmetry" which already exists in the U.S. transportation system where congestion costs $200 billion a year and results 2.3 billion gallons of wasted fuel and needless emissions.[31] Regulation in other industries also can have unintended negative impacts as is the case with road transportation service hours, which will limit considerably the ability to clear port congestion via trucks. Ports must also adapt to changing commodity trends such as natural gas consumption which is expected to increase 70% globally and 30% within the U.S. itself by 2025.[32] Unfortunately, the current U.S. port infrastructure will be unable to provide the forecasted handling capacity for this commodity.

It is clear that the U.S. port capability must also continue to become more environmentally sustainable. Tremendous progress has been made in reducing port vehicle and materiel handling equipment emissions, in some cases up to 80%, through new vehicle acquisition and the use of alternate fuels.[33] However, aside from speed reduction measures, vessel emissions reduction initiatives are proving less attractive. For example, the use of distillate fuels in port as well as shore power vice onboard diesel generators requires costly infrastructure and ship modifications reduces emissions however these measures do not increase productivity. [34] These types of deadweight environmental protection costs are not attractive to industry and can work against overall productivity by increasing costs.

Port security has become and will remain a very powerful factor affecting port operations. The implications of an attack on a major U.S. port could have catastrophic impacts on the economy. For example, the closure of a single major port for a 12 day period could cost approximately $58 billion.[35] To meet this considerable challenge, the U.S. has adopted a layered defense that extends outward to 58 foreign ports that account for 90% of U.S. bound container shipments. Customs and Border Patrol (CBP) personnel screen 100% of all cargo before and after it arrives in the U.S.[36] Despite these strong safeguards, the sheer volume of shipments remains a challenge with less than 5% of containers actually undergoing physical inspection and available technology still cannot effectively detect shielded nuclear or radioactive material.[37] In order to add depth to the security framework CBP also created the Customs-Trade Partnership Against Terrorism (C-TPAT) which is a public-private and international organization that works to improve supply chain security.[38] In terms of emerging factors, foreign ownership of U.S. ports remains a concern. However, this issue must be balanced with the real need for foreign investment to revitalizing U.S. port infrastructure.

Port Infrastructure Sustainability Strategy

In order to meet the economic and national security demands of the future, the U.S. port infrastructure strategy must be based on smart investment and vertical/horizontal integration. Smart investment will involve a disciplined allocation of government funding and incentives in locations with the highest potential for overall increased capacity.[39] What must be avoided is a 'spread the wealth' approach that wastes resources and only achieves mediocre results. The strategy must also be nested in a larger integrated and multi-modal transportation infrastructure plan that also includes a clear understanding of the complex effects and inter-relationships, both positive and negative, between the sustainability factors. Difficult decisions and tradeoffs will

need to be made. However, this is the only way a balanced strategy and optimal use of resources can be achieved.

The U.S. must modernize and expand its port infrastructure capability with the main effort focused on East Coast container port capabilities. This approach best addresses the global market factors of ship size and shifting trade routes and best leverages the emerging eastern U.S. distribution networks. U.S. ports must also expand their LNG capabilities to address global markets, as well as environmental factors. This infrastructure development surge will allow the U.S. to remain competitive, increase productivity and reduce national dependence on foreign oil.

It is clear that U.S. port infrastructure improvements will require significant funding and this challenge can be met in several ways. First and foremost, the Harbor Maintenance Trust Fund (HMTF) must be used for its intended purpose, which is not currently the case.[40] A container fee should also be considered which, even at just $35/container, could generate almost $4 billion a year in funding. Finally, the current U.S. fiscal situation will drive the need for considerable foreign investment in order to generate the capital necessary for infrastructure rejuvenation and government policy must promote and not needlessly hinder this process.

In terms of transportation interoperability and intermodal symmetry, the National Corridor Infrastructure Improvement Plan should be expanded in terms of detail and federal funding and incentives directly linked to those objectives. This should include heavy incentives to develop the 25,000 miles of underutilized navigable waterways through the Maritime Highway concept.[41] Finally, regulatory measures in different modes must also be more carefully considered in terms of second order effects and revised as required.

The strategy for environmental sustainability is for government to focus on incentives and funding towards deadweight costs and allow port operators to focus more resources on efficiency producing programs. This approach will achieve the greatest positive environmental impacts in the shortest time. Efforts to globalize port emission standards and level the "playing field" through the International Maritime Organization should also be pursued.[42] This will ensure port competitiveness while addressing environmental pressures.

Security factors exert perhaps the most challenging pressures on port capabilities. It is clear that an attack on or through a U.S. port would have a devastating economic and national security impacts. It is also equally clear that 'perfect security' is not attainable. The current U.S. layered defense is the right strategy and even greater emphasis and resources should be applied to the C-TPAT program and supply chain security. The U.S. must embrace foreign investment and related security concerns should continue to be addressed through the Committee on Foreign Investment and through additional port operations mitigation strategies such as mandatory U.S. citizenship for all security personnel.[43] Finally, Port Authorities should always retain landlord status to ensure proper oversight and situational awareness.

Conclusion

Ports continue to play a crucial role in U.S. economic wellbeing and national security. This assessment has demonstrated however, that these vital assets are lacking productivity and are not well positioned to face future challenges. Factors related to global markets, transportation infrastructure interoperability, government, environmental issues, and security threats all place significant and often conflicting pressures on port infrastructure. In order to meet the challenges of the future, the U.S. requires a comprehensive port infrastructure strategy that is firmly based on smart, productivity centric investment and full integration within the sustainability factors as well as the transportation system as a whole. Funding must be made available through the proper use of the HMTF and additional foreign investment. In terms of

security, the layered defense approach is the right course of action and in particular the C-TPAT program should be reinforced. The U.S. is at a critical decision point in terms of port infrastructure. Reinvestment is clearly the correct path; however, there are sustainability factors that can present significant obstacles. The real challenge will be finding the right balance.

-Lieutenant-Colonel Timothy Marcella, Canadian Army

Essay 2: Positive Train Control - An Opportunity for Investment in Long-Term Sustainability

According to the 2010 U.S. Government Accountability Office (GAO) report on *Rail Safety*, the majority of railroad accidents are caused by human factors, track defects, or equipment problems.[44] Although railroads have been getting safer since deregulation in 1980,[45] there is still valid concern for public safety where passenger trains share track with an increasing volume of heavy freight lines, including carriers moving hazardous material. In light of two high profile accidents in which human error was the causal factor, the U.S. Congress enacted the Rail Safety Improvement Act of 2008 (RSIA08) which mandated Positive Train Control (PTC) be installed on all passenger and major freight lines by 31 December 2015.[46]

PTC is a technology designed to prevent loss of life due to human error or incapacitation. The Federal Railroad Administration (FRA) defines PTC as a communication based system capable of preventing train-to-train collisions, overspeed derailments, incursion into established work zone limits, and the movement of trains through switches left in the wrong position.[47] Surprisingly, the concept of intelligent railways is not new. The National Transportation Safety Board (NTSB) has listed PTC in their "top-ten" list since 1990.[48] However, overwhelming capital cost, ever-changing technology, and lack of government mandate has made adoption slow and disjointed. The key controversy over PTC revolves around the benefits justifying the cost of capital investment, and prior to the 2008 ruling by Congress, the majority of writing was geared towards this debate. The RSIA08 is the single most expensive piece of railroad legislation ever enacted,[49] requiring PTC installation on all tracks used to move passengers, toxic-by-inhalation (TIH) materials, or major freight lines. The FRA estimates the cost to install and maintain PTC to be $13.2 billion over the next 20 years.

Industry argues that studies weighing the cost and benefits of PTC are lopsided and they will never see a return on investment (ROI), while government and other professional writings claim opportunities abound to cash-in on the sustainability benefits available. Railroads have the opportunity to invest in long-term sustainability for their industry, but will most likely choose a conservative approach by investing only the minimum required capital to meet the conditions of the RSIA08. Contrary to opposition claims, the U.S. railroad industry will eventually see sustainability benefits from PTC implementation; however, with their short sighted strategy it will take decades to achieve.

Background

Deregulation and the Staggers Act of 1980 allowed the railroads to operate like other businesses and compete effectively in the market place with other modes of shipping.[50] This in turn allowed the industry to take stock of its operations, cut non-profitable lines and routes, and improve productivity through efficiencies in operations.[51] From 1980 to 2010, revenue-ton-miles, average lengths of haul, and fuel productivity all increased.[52] Similarly, the ROI went

from 1.20% in 1975 to 10.36% in 2010.[53] Needless to say, deregulation and allowing the railroads to compete in the free market was the right move at the right time.

A key component of increasing productivity is reducing accidents by improving safety, thus reducing lost workdays, loss of life, and costly litigation. From 1980 to 2007 the industry reduced overall train accidents by over 98%,[54] railroad collision rates by 99% , and on the job employee deaths by 80%. Nevertheless, "while the positive shift in safety performance is undisputed, accidents and incidents caused by human error, and employee fatigue specifically, remain a significant problem."[55] In the 5-year period from 2000 to 2005, the FRA reported that 38% of all railroad accidents were in some part due to human error.[56]

Although beyond the scope of this analysis, there were numerous high profile accidents involving human error and track degradation in the years preceding the RSIA08. Congress, the FRA, and industry commissioned studies and held hearings, while industry lobbied against any new laws, touting their ever improving economic and safety record. However, two major accidents – one in Graniteville, SC, in 2005, and another in Chatsworth, CA, in 2008 were the straws that "broke the camel's back," providing the impetus to push the RSIA08 into law. In light of the legislation, the question of whether or not to install PTC is rendered irrelevant; however, that hasn't stopped industry complaints about the implementation timeline and cost associated with compliance.

In a report entitled *Positive Train Control: Economic Analysis*, the FRA clarifies legislation language and provides analysis of the benefits expected from the implementation of PTC. Additionally, the report analyzes and lists added benefits that industry and society can expect if the railroads take full advantage of the opportunity. Although not referred to by the FRA in this manner, the possible benefits from PTC can be termed sustainable benefits. Not surprisingly, the railroad industry disputes many of the findings.

"Sustainability" has numerous definitions depending on the context. For the purpose of this discussion and analysis, "sustainability" will refer to the economic, environmental and social benefits of actions taken by an industry.[57] Although the railroad industry rebuts most suggestions that PTC will boost sustainability, studies by various institutions show promise.

The table below lists the three categories of sustainability and depicts the benefits that industry can achieve through targeted strategies and capital investment. These categories are rarely viewed as independent entities, rather as fluid areas that overlap and supplement each other to achieve overall sustainability.

Table 1 – Sustainability Benefits

Category	Benefits
Economic	Waste cost production, sustainable products and services, future profitability, the balance of interchangeable assets with linkages and risk, ecosystem services, and stock value
Environmental	Pollution prevention, waste management, raw materials and feedstock, carbon footprint, disaster prevention, industry norms and standards.
Social	Community engagement, employee safety and well being, governance and governmental affairs, poverty alleviation, increased health care security, diversity, strategic philanthropy, supply chain, and human rights

Analysis

The railroad industry has the opportunity to leverage PTC for more than just meeting the requirements of government regulation. Among the listed economic, environmental and social categories are sustainable benefits that can boost productivity, efficiency, and capacity and at the same time achieve the safety aspects that society demands.

Perhaps the most contested opportunity with the implementation of PTC is over the possible economic benefits. FRA studies from 2004 and 2009 point to several areas in which the railroads would benefit from PTC without additional investment, and other areas that could result in benefit with only modest increased investment.[58] The 2009 report lists enhanced locomotive diagnostics, fuel savings through train pacing, capacity enhancement and precision dispatch as possible future business benefits of PTC.[59] The FRA is not alone on this; these same benefits are all also supported by Steven Ditmeyer[60] in his research on Network-Centric Railroad Operations, where he advocates for an interoperable system combining the attributes of the individual components to create an intelligent network.[61] In the same 2009 report, the FRA admitted PTC technologies had not yet matured to a level for these benefits to be realized; however, the future communications backbone and infrastructure required for PTC make adding these capabilities easier. With time and continued investment they are not beyond the industries' reach.

Unlike the economic benefits of PTC, the environmental benefits are hard to dispute; however, many are attributable to the economic benefits, so arguments still abound. Of the benefits listed in Table 1, pollution prevention, carbon footprint, and disaster prevention can all be realized through PTC and the modestly priced add-on technologies.

The rail industry already boasts being the most efficient and green provider of freight shipping. They use nearly 3.5 billion gallons of diesel fuel each year, spending a total of $7.89 billion ($2.50/gallon avg) and accounting for nearly 20% of their total operating budget.[62] Leveraging PTC technologies could conservatively reduce locomotive fuel consumption by 5% and save $437.5 million each year. This fuel savings has the side effect of reducing pollutants and overall the carbon emissions by as much as 1.9 million tons of CO2/year.[63] Additionally, by forcing railroads to adopt PTC, the FRA estimates the safety benefits alone from PTC Preventable Accidents (PPA's) will be nearly $90 million per year.[64]

Critics are quick to point out that railroad operations are the safest form of transportation, and that only 4% of train accidents on Class I lines are likely to be PPA's.[65] Additionally, the FRA estimated safety related benefits alone would only yield $674M over the next 20 years. This means for every $20 spent on PTC, there is only a $1 return in safety benefits.[66] Nevertheless, the severity of accidents involving human error and track degradation are indisputable when combined with the high probability of mass casualties where passenger trains run concurrently with heavy freight or where TIH shipments pass through populated areas.

Besides fuel savings due to economic efficiencies, there are the social benefits. The FRA estimates that with an increased demand in rail service over the next few years, intermodal diversion (truck to train) will account for an annual highway safety benefit of up to $744 million annually by 2022 and $1,148 million annually by 2032.[67]

An analysis of PTC benefits would not be complete without mentioning the key hurdles to implementation that remain. While the railroads are investing heavily and making honest efforts to meet the RSIA08 timelines, technology gaps remain that could result in delaying implementation. Currently, the areas for concern are adequate communication technologies, improved braking algorithms, and overall interoperability. These gaps in technology add substance to industries' claim that the rush to implement PTC on a predetermined timetable will

negate any opportunity to benefit from the technology. And while there may be sustainable benefits, they will come in the 2nd or 3rd generation of the technology and not with that which is currently available.[68]

Recommendations

Although industry continues to argue against increased government regulation, there is little doubt now is the time for PTC deployment. Industry profits are at record highs,[69] and although the initial outlay of capital is high, the sustainment benefits achievable through implementation outweigh the risk. In this case, regulation appears to be having a positive effect. As we move into the implementation phase, Congress needs to be prepared to hold its ground with the railroad industry who will no doubt try to buy more time in an attempt to spread out the capital investment for PTC over more years.

To keep things going in the right direction, Congress and the FRA should consider the following policy recommendations. (1) Maintain the requirement for PTC implementation and deployment by 31 December 2015, and consider waivers on a case-by-case basis instead of legislation to rollback requirements. (2) Develop a National Strategic Railroad plan that eventually sees 100% of U.S. railway operations incorporating PTC, with a common architecture allowing seamless operation and transition from one rail system to the next, and providing a safer more sustainable railroad industry. (3) Encourage through incentives, research and development that promotes net-centric rail operations in order to shore up sustainment benefits possible through the use of modern digital technology.

Conclusion

When there is little chance of an immediate ROI, industry is slow to adapt new things. In these cases, it often requires the Federal government to draft and enact legislation forcing private industry to incorporate safety and sustainability measures for the greater public good (like airbags and seatbelts in automobiles). The rail industry will eventually see a business benefit from the implementation of PTC; however, it will most likely be realized several years out. Due to the massive amount of capital required during the initial procurement of PTC technology, the majority of the railroad industry will initially only invest to meet the minimum requirements of the RSIA08. However, after the systems are operational and refinements are developed, industry will be hard pressed to ignore the sustainability benefits possible with further investment in a more intelligent and network centric approach to operations.

-Commander William Cox, U.S. Navy

Essay 3: Take Off into the Wild Green Yonder

Today, the sustainability of the aviation industry is more precarious than ever with escalating fuel costs and regulations that have the potential to threaten the economic viability of the industry. The greatest sustainability challenge for the industry is balancing growth with mitigating environmental impacts. Government and industry mutual cooperation is essential to tackle the environmental issues that afflict civil aviation. Presently, the industry understands voluntary participation with environmental initiatives has substantial benefits through reduction in resource requirements, prevention or postponement of regulatory actions, boost in their public image, and lastly gains in competitive advantage within the industry.[70] Government support of smart development of new aviation technology in fuels and aircraft design is the most viable strategy to pursue for the assurance of the sustainability of the industry and the environment.

Aviation's Impacts on the Environment

The airline industry impacts the environment through its effects on air quality, noise pollution and carbon emissions, both at the local and international level. Currently, the aviation industry accounts for about 2% of the total CO2 emissions.[71] As with other fossil fuel consuming industries, the airline industry discharges a variety of compounds that impact the environment; however, a large portion of the emissions are at higher altitudes that have a different impact than those at the ground level.

In 1999, the International Civil Aviation Organization (ICAO) funded an assessment by the Intergovernmental Panel on Climate Change (IPCC) on aviation and the global atmosphere to specifically gage the atmospheric impacts of the aviation industry. The study concluded that the discharge from aircraft at the upper atmosphere alters the concentration of greenhouse gases and trigger the formation of condensation trails and may increase cirrus cloudiness which contributes to climate change.[72] An updated study released in 2007 found that total global CO2 emissions are expected to grow at 3-4% per year and fuel efficiency can serve as a medium-term mitigation strategy.[73]

The increase in air traffic has had a corollary effect with the increase in noise pollution. Since the 1970s international and national agencies have instituted standards, policies and regulations to abate the noise levels produced by civil aviation. In fact, aircraft noise has the most adverse reaction among the populace due to the impacts at the local level. Residents residing in areas outside of conventional "close in" noise contours are pressuring local governments to impose operational constraints and limitations on the airline industry and airport growth. [74] The United States government passed the Noise Control Act in 1972 to take control of the noise pollution issue from the various state and local governments.

Regulations

In the early 1980s, ICAO established the Committee on Aviation Environmental Protection (CAEP) to specifically focus on environmental protection issues. CAEP is mandated to formulate new policies and adopting new standards on aircraft noise and engine emissions.[75] ICAO established policies that have progressively restricted noise emissions from aircraft. Their newest management system for noise abatement is the "balanced approach" which focuses on operational procedures, restrictions, and improved land use management.[76] The aircraft certification process is progressive and noise reduction standards are more stringent for newer generation aircraft. The current standards, chapter four conditions, are the most stringent and reflect current state of the art technology.

In 1981 greenhouse gas emissions was adopted by ICAO in its operating standards and the standards have become progressively more stringent. The international nature of operations makes regulation difficult.[77] ICAO has focused its efforts on technical solutions instead of regulatory actions such as those passed by the European Union with its "Cap and Trade" policy for the aviation industry. Another point of contention is the higher fuel burn per passenger kilometer for short-haul flights over long-haul flights.[78] Current market based measures, the cap and trade system and other taxes are precluded under the existing networks of bilateral agreements.[79] The global nature of the business requires multilateral actions to make progress with binding resolution.

The Environmental Protection Agency and the Federal Aviation Administration have oversight responsibility to regulate emission and noise abatement standards within the United States. The greatest impact on the industry with noise pollution abatement policies has been the

limitations emplaced with expansion for heavily trafficked airports. These policies have constrained the expansion required to meet the demands of the market place.

Technological Innovations

The highly competitive airline market has put pressure on the airline industry to become more fuel efficient. The industry consumes crude oil at an extraordinary rate; coupled with the alarming increase in the cost of aviation fuel, the industry has relied heavily on technological innovation to meet its sustainability needs. In fact, today's aircraft are designed with a 15% improvement in fuel burn compared with aircraft a decade ago and with a 40% decrease in emissions.[80] However, there are complex interrelationships that force tradeoffs between noise and emissions. The high-bypass turbofan engines were specifically designed for increased fuel efficiency and noise reduction; however, these engines generate more NOx emissions than the engines they replaced.[81] The FAA, the airline industry, and manufactures have joined efforts to study the interrelationships in an "environmental design space."[82]

A focus area for technological innovation has been with aircraft design; specifically focused on aerodynamics, weight reduction, and control systems.[83] New technological breakthroughs with composite materials are expected to reduce aircraft weight, while improving structural integrity and overall fuel economy. Aircraft manufacturers have utilized new technologies to improve aerodynamics with turbulence and vortex reduction of the wings and new manufacturing techniques to produce smoother outer skins.[84] Every technological innovation that can save on fuel consumption improves the sustainability of the industry, while simultaneously limiting the impact on the environment.

The present trend in technologically development with existing aircraft design is expected to plateau and the focus has started to look at alternative fuel sources for aircraft to lower operating cost and decrease emissions of greenhouse gases. The search for a cleaner burning, environmentally compatible fuel is necessary to stave off the threat of an economic collapse of the industry.[85] Biofuels are increasingly recognized as viable alternatives to fossil fuels, producing compatible combustion characteristics and performance, while providing economic and environmental advantages.[86] The current concern with biofuel utilization at operating altitude is they clump together and freeze at higher temperatures than kerosene; which means current technology requires biofuels to be blended with kerosene.[87] An additional shortcoming with biofuel usage is the decrease in energy compared to an equivalent amount of kerosene. This equates to a larger fuel requirement to go the equivalent distance as kerosene; as well as an increase in fuel payloads which in turn means greater weight of the aircraft and a decrease in flight distance. Another option is liquid hydrogen which is significantly less dense than kerosene and requires four times the volume to deliver the equivalent amount of energy.[88] There are two other significant shortfalls with hydrogen: first, keeping the hydrogen liquid requires thick, heavily insulated and strong tanks; and secondly, the emissions from burning hydrogen is water which is the most abundant greenhouse gas and would emit more climate-warming contrails.[89] These alternative fuels would require some radically changes in aircraft design and new technologies to accommodate the substantial increase in fuel payloads along with mitigating the shortfalls each of the alternative fuels bring to the table.

Policy Implications and Recommendations

The aviation industry has been an active partner with the government through voluntary enrollment in emission reduction and noise abatement programs. Currently, the European Union spearheaded an international methodology to emission controls with implementation of a market

approach to control aircraft emissions. The EU used its experience with emission regulations in pushing forth an Emission Trading Scheme (ETS) to address the problem with aviation pollution and greenhouse gas emissions.[90] The EU failed to garner support from ICAO and its members outside of the European Union.

Projections for the cost incurred for cash-starved airlines to meet the EU standards are substantial, which could otherwise go into biofuels or other clean technologies research. The European Regions Airline Association (ERA) estimates the initial first two years of the ETS would cost European carriers 7 Billion Euro ($11 Billion USD) and progressively increase to 90 Billion Euros ($141.4 Billion USD) by 2022.[91] In today's current economic environment, the healthiest air carriers, which consequently do not include any of the traditional U.S. international carriers, are only operating at 5% for their return on investment (ROI). Airlines are operating at about 50% below the average for the S&P 500 ROI of 10%. This substantial outlay of cost will have considerable impacts on the economic sustainability for air carriers.

Preliminary results from analysis of market based options show that emission related levies are not cost-beneficial.[92] The government needs to establish policies that focus efforts that support technological innovation to decrease emissions and noise. The ever increasing cost for fuel has forced manufacturers and the industry as a whole to develop less fuel dependent technology, which is critical to the long-term sustainability of the industry and the environment.[93] Additionally, governmental agencies at all levels need to consider all aspects of the industry in development of policies to responsibly control emissions, from engine and aircraft design, alternative fuels, and aviation network controls.

Conclusion

The long-term sustainability of the aviation industry is dependent on its ability to build relationships with government and communities that lead to aviation environmental impacts being managed in a way that is perceived by the public to be fair and equitable.[94] Market based environmental regulations such as the EU "ETS" policy is basically a tax on the aviation industry and potentially has negative impacts on the overall viability for airlines. Government in coordination with the aviation industry needs to institute policies that are balanced, integrated and forward thinking to secure the sustainability of the airline industry.

-Colonel Skip Adams, U.S. Army

Conclusion

The challenges facing the transportation industry are diverse, while the resources available to overcome those challenges are limited. Further complicating the situation is the existence of numerous competing interest groups and constituencies, each with independent goals and objectives that frequently come into conflict with those of other groups and organizations. Above all, the lack of a coherent integrated framework for making rational policy decisions on issues requiring decades to shepherd from conception to fruition, makes it difficult to apply scare resources where they will do the most good.

These challenges lead to three recommendations for future action. First, the Department of Transportation should continue to take the lead by expanding their strategic plan into a comprehensive, integrated, and sustainable National Transportation Plan. Second, address systemic labor issues resulting from an aging workforce and misaligned skill sets. Finally, all of these actions must be executed using sustainable practices. Minimizing consumption and waste and enabling a viable fiscal framework will ensure an economically, socially, and environmentally sustainable future.

Development of a National Transportation Plan that encompasses all the modes of transport and clearly establishes priorities for resource allocation is the best first step in addressing the challenges facing the industry. Engagement by the Congress and the Executive Branch must be focused on a holistic approach in order to make the most of limited resources. Most importantly, any plan must address the sustainability of the transportation system. The economic, environmental and social impact of the decisions made by government regulators and transportation industry executives must all be considered. As well, this plan must reflect the fact that the United States exists as a member of the global economy, not as an isolated state. As President Obama said in his National Security Strategy, "Our engagement will underpin a just and sustainable international order, …sustainable because it is based on broadly shared norms and fosters collective action to address common challenges."[95] Engagement between industry, government, and international stakeholders is the best chance for a successful National Transportation Plan.

Notes

[1] Barack H. Obama, *National Security Strategy* (Washington, DC: The White House, May 27, 2010), 31.

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to reap huge economic benefits. Some of these related systems above and beyond the minimum for PTC deployment would be; Locomotive Health Monitoring Systems, Energy Management Systems, Tactical Traffic Planners, Strategic Traffic Planners, and Automated Crew registration and time keeping. According to Ditmeyer, the railroad industry has the opportunity to embrace PTC and make it more than just a safety tool. By leveraging the backbone of PTC and coordinating all the components, railroads could expect PTC to improve safety and security, raise effective capacity, improve asset utilization, improve running time and running reliability, improve customer satisfaction, measure and control cost, reduce energy consumption and emissions, increase economic viability and profits, and manage the unexpected.

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