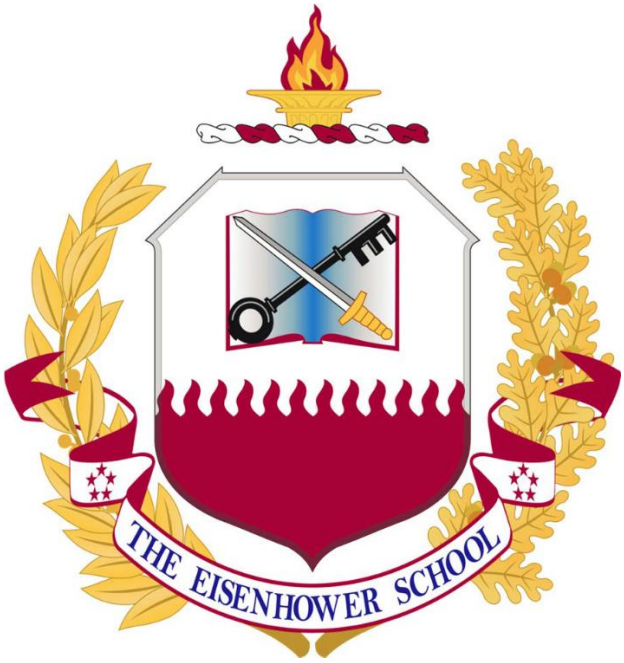
Spring 2015
Industry Study

Final Report
Transportation



The Dwight D. Eisenhower School of National Security and Resource Strategy
National Defense University
Fort McNair, Washington, D.C. 20319-5062

TRANSPORTATION 2015

ABSTRACT: The transportation industry is an enabler for economic growth and development, and is a critical resource that requires attention from the government to sustain its long-term productivity. In order to support economic growth into the future, the US government needs to move towards a supply-chain network view of transportation in lieu of incremental focus on specific modes as it works with industry to inspire innovations and sustain the underlying infrastructure. Additionally, the government must develop solutions for environmental and security issues that accompany increases in system capacity.

LTC Andre Baldanza, US Army
CDR Keith Barton, US Navy
COL Gregory Bunn, US Army
Lt Col Jeff Downs, US Air Force
Mr. Thomas Favret, Dept of State
CDR Derek Fleck, US Navy
Dr. Jerry Higman, Dept of the Army
LtCol Julia Hunt, US Marine Corps
Mr. Larry Kinder, Dept of Defense
Ms. Elizabeth Kozey, Dept of Homeland Security
Ms. Jodie LaFreniere-Dajc, Dept of the Navy
Lt Col Daniel Lemon, US Air Force
COL Robert Manning, US Army
Col Virginia Tattersall, Canadian Army
Col Sean Tyler, US Air Force
Lt Col John Zapata, US Air Force

Dr. Steven King, Department of Homeland Security, Faculty Lead
Ms. Betty Hoapili, Defense Logistics Agency, Faculty
LTC Gina Adam, US Army, Faculty

PLACES VISITED:

Domestic:

Eno Center for Transportation (Washington, DC)
The MITRE Corporation (McLean, VA)
Federal Aviation Administration Operations Center (Warrenton, VA)
Virginia Port Authority, Virginia Inland Port (Front Royal, VA)
Vane Brothers (Baltimore, MD)
Military Sealift Command (Baltimore, MD)
Virginia Port Authority (Norfolk, VA)
Norfolk Southern Railroad (Norfolk, VA)
Transportation Security Administration Test Lab (Arlington, VA)
UPS Freight (Richmond, VA)
American Trucking Association (Arlington, VA)
Department of Transportation (Washington, DC)
Amtrak (Washington, DC)
Wells Fargo-Wachovia (New York, NY)
US Coast Guard Sector New York (New York, NY)
New Orleans Public Belt Railroad (New Orleans, LA)
U.S. Army Corps of Engineers (New Orleans, LA)

International:

Port of Duisberg (Duisberg, Germany)
UPS Distribution Facility (Cologne, Germany)
Port of Antwerp (Antwerp, Belgium)
Flora Holland Flower Auction (Aalsmeer, The Netherlands)
Van der Vlist Logistics (Groot-Ammers, The Netherlands)
Rotterdam Port Authority (Rotterdam, The Netherlands)
STC Shipping and Transport University (Rotterdam, The Netherlands)
FutureLand Maasvlakte 2 (Rotterdam, The Netherlands)

INTRODUCTION

Hidden amongst the dikes and bike paths of the quaint Dutch low country is an unassuming 642-acre co-op facility that houses the world's biggest flower exchange – FloraHolland. Inside, nearly 6900 buyers and sellers interact in the daily exchange of 34 million fresh plants and flowers, received from locations as far away as Nigeria and distributed immediately to customers in the US, Russia, and throughout the European Union.[1] Just 20 years ago, such an operation would have seemed inconceivable, but new technologies have ensured flower preservation aboard container vessels and improved handling at airports. The reality of this unique business is that its success is as much about innovations in transportation as it is about a revolution in horticulture. The ability to integrate recent advances in aviation, maritime, rail and trucking transportation for just-in-time delivery, as well as coordinate the immediate and orderly distribution of products via auction trolleys within the FloraHolland warehouses, proves that transportation not only moves business, it has the ability to create new business models.

FloraHolland's success shows why the transportation industry is such a powerful force in our lives. The ability to move inputs cheaply across a supply chain reduces costs of production and allows producers to develop techniques never dreamed possible. Those same advances make it possible for Russians to enjoy exotic Kenyan Hepericum flowers and Americans to receive fresh tulips in December.[2] The significance of the transportation industry is that it moves the economy; therefore, it is also relevant to our national security.

The relationship between transportation and national security demonstrated by the movement of personnel and equipment has been the hallmark of every great military force since the Roman Empire. As Winston Churchill noted, "Victory is the beautiful, bright colored flower. Transport is the stem without which it could never have blossomed."[3] In modern military logistics, commercial industry contributes to the national security apparatus through the Civil Reserve Air Fleet (CRAF), Strategic Rail Corridor Network (STRACNET), Voluntary Intermodal Sealift Agreement (VISA), and Maritime Security Program (MSP). But this direct contribution may be the least significant relationship between the industry and national security.

Indirectly, a strong transportation industry becomes a lever for the economic instrument of power. The ability to produce is nothing without the ability to move supplies and products. This economic instrument of power not only promotes national prosperity, but ensures security and provides leverage in negotiations with Iran, in sanctions against Russia, and in competition with China when implementing the Trans-Pacific Partnership. Furthermore, our growing economy, moved by a vibrant transportation industry, is the means by which we fund our national security. While the debate continues about whether 3% or 4% of gross domestic product (GDP) should be spent on national security, the bottom line remains that if the economy and GDP are growing annually then the potential spending available for national security is also growing each year. In 2014 the US economy grew 2.2%, and in 2015 it is expected to expand 3.1%,[4] potentially keeping pace with the global growth rate for the first time since 2000.[5]

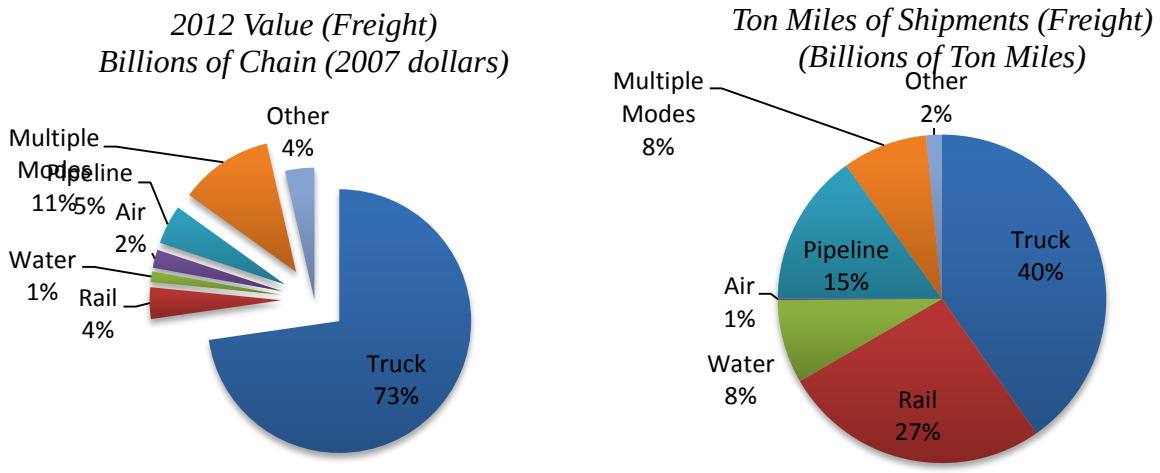
Transportation's contribution to economic expansion is the focus of this report. A growing economy results in more producers and consumers placing demands on the transportation system. From basic economic theory, we know that with a finite amount of resources in a mature transportation industry, one of the few ways to expand the industry's production possibility frontier is through innovation and technological changes, vice increases in capital or personnel which are constrained along the same curve.[6] As such, this paper will highlight areas where innovation and technology have the ability to increase the capacity to transport goods and services, reduce the environmental impact that is caused by fossil fuels used in transportation, and provide security for

an industry that is increasingly become a preferred target for both criminals and non-state actors to slow the wheels of the economy.

THE INDUSTRY DEFINED AND CURRENT CONDITIONS

In its simplest form, the transportation industry moves people and freight from around the corner to around the world, on a mass scale or individually. However, the complexities of the industry involve not only the physical means of movement, but also a vast network of supporting services, infrastructure and equipment to affect that movement. The industry consists of both public and private sector owned operations and spans five modes: air, maritime, road, rail and pipeline transportation.[7] "Major industries within the transportation services sector include airlines, trucking, railroads, waterborne transportation, transit and ground passenger transportation, and pipeline transportation."[8] It is the transportation industry that "makes possible high levels of personal mobility and freight movement and linking the country to the rest of the world for trade, travel, and tourism."[9] Overall the industry is underpinned by an infrastructure of "over four million miles of roads, nearly 139,000 miles of railroads, over 25,000 miles of navigable waterways, over two million miles of pipelines, and more than 5,000 public use airports..." [10] In 2012 the US industry moved over "375 million US people,"[11] and "17.6 billion tons of freight." [12]

Figure 1: Comparison of Freight Modes



Source: Pocket Guide to Transportation[13]

Market rivalry between the major modes is strong, [14] with "each industry in the group acting as a substitute for others, although each industry has its own specific advantages and disadvantages for users."[15] Within each industry group the rivalry is intensely competitive driven by capacity, cost, and service.[16] Buying power in the industry is influenced by the degree of competition available and varies across the industry groups. "Due to the importance of transportation services for their users, there are numerous buyers … their power may have different intensity, depending on the given transportation sector."[17] Specialization by suppliers within the industry diminishes their leverage over the industry even though other sources of supply may not be readily available.[18] Finally, barriers to entry in the industry vary as well, with lower barriers in the road group than in

the air and maritime industries.[19]

Transportation impacts everything in our daily pattern of life, from where we live and what we eat, to how we make a living and the taxes we pay. "In 2012, Americans spent an astronomical 175 billion hours in transit, which averages out to about 100 minutes per day for each and every American, valued at some $760 billion."[20] The transportation industry "is both a part of the economic output of the economy and a contributor to that economic output."[21] In 2011, the industry added approximately $1.5 trillion [22] to US Gross Domestic Product (GDP); in 2012 it comprised 8.7% of overall GDP.[23] Estimates are that "one out of every seven jobs in the United States is transportation related." [24] It is "a vital sector of the US economy based on consumers', firms', and government's enormous expenditures in money and time and on its effect on virtually all other sectors in the economy." [25] The industry was not immune to the pressures resulting from the global recession, which was further exacerbated by high oil prices.[26] As the economy has recovered, so has the industry. "The US transportation services industry has performed well in recent years, producing strong growth overall. The market is expected to decelerate slightly yet remain in a strong position through the forecast period to 2019."[27]

Given the diversity within the Transportation Services Industry it was not possible to study every major mode. The emphasis of the study was on major sectors – primarily focused on freight – and completely excluded movement by pipeline. The description of the modes that follows provides a domestic industry overview and the impact it has on the US economy.

Maritime

The maritime transportation industry is the mode that connects the US with the rest of the world. Although it's largely invisible to the general population, it accounts for the movement of 95% of the nation's foreign trade, and nearly 80% of all US import and export freight transits through US seaports.[28] Defined as the waterborne transportation of people and cargo via floating vessels such as barges, boats, ferries and ships, the maritime transportation industry is the lifeline to global markets and supplies, driving the destinies of both the trucking and rail industries.

US ocean and coastal transportation and inland water transportation includes 198 ocean-going vessels, 31,550 barges, 180 ports, and 25,000 navigable inland waterway miles with 239 lock chambers.[29] Waterborne cargo and associated activities contribute more than $649 billion annually to the US GDP. In 2012, the industry moved $224 billion worth of freight weighing over 2.176 billion tons, and employed 69,000 Americans.[30] The industry is currently dominated by a handful of companies accounting for 40% of container volume leaving the US and 50% of industry revenue.[31] The other 743 companies compete for the remaining revenue.[32]

While the largest maritime domestic freight companies compete in the global shipping market, smaller companies are more insulated and benefit from demand for inland and coastal (shore sea) shipping, as well as protections from foreign competition by the Jones Act. Ocean-going shipping companies have attempted to reduce competition as a result of recent overcapacity by entering into alliances or mergers.[33] The maritime industry is closely tied to the economic health of the nation, as growth in disposable income leads to higher consumer spending and creates demand for imports. Increased industrial production and trade will drive up demand. Expanding markets, such as the growth of oil and gas production, will continue to fill existing freight shipping capacity and create value in this industry.

Road

The trucking industry accounts for the largest share of the transportation services industry within the US primarily because it is the dominant mode in movement during the last mile of delivery. According to the US Department of Transportation (DOT), as of December 2011, there were 408,782 for-hire carriers, 662,544 private carriers and 168,680 other interstate motor carriers on file with the Federal Motor Carrier Safety Administration (FMCSA).[34] The American Trucking Association (ATA) estimated that 6.8 million people were employed in jobs related to trucking activity in 2010, excluding three million self-employed truck drivers. These drivers logged 397.8 billion miles for business purposes (excluding government and farm) and carried 9.2 billion tons of freight in 2011, representing 67% of total domestic tonnage shipped.[35]

Economically, road freight accounts for over 5% of the US GDP and collects over $800 billion annually.[36] It is estimated that the industry moved approximately 70% of US freight in 2014.[37] Additionally, commercial trucks, which represented 10.9% of all registered vehicles, paid "$33.1 billion in federal and state highway-user taxes in 2009."[38] The expanding economy and demand for movement of goods has resulted in a 6.7% increase in truck rates per-mile, which combined with lower fuel prices, has enabled trucking companies to increase profits.[39] While there has been some recent consolidation in the industry highlighted by TransForce's acquisitions in 2014, it still remains a mode that is dominated by small carriers.[40]

Rail

In 2013 the railroad industry experienced "record passenger ridership (up by 1.3%) of 31.6 million passengers and freight train car originations of 28.8 million carloads originated."[41] The rail industry, which dominates the inland movement of commodities because of its cost efficiencies, is comprised of line-haul railroads and the shortline (or beltline) railroads. "The line-haul railroads are the primary means of transporting goods, commodities, and people by rail across the US rail network and consist of 7 Class-I railroad companies and Amtrak passenger rail service. The shortline and beltline railroad industry, consisting of 568 Class-II and III regional and local railroad companies, is engaged in operating railroads for the transport of goods and commodities over short distances not on the railroad network."[42]

Rail is gaining market share amongst modes, "railroads account for approximately one third of all US exports" [43] with freight rail directly "sustaining 1.2 million jobs, and indirectly sustaining another 4.5 million jobs across the economy."[44] The country's demand for goods and commodities, averaging 40 tons per person per year, resulted in "15.9% of all freight transported by rail or 1.757 billion tons moved and generating $72[billion] in gross revenue in 2013."[45] Commodities transported by rail show that "intermodal, automotive, crude oil, and grain have each grown from 2012 to 2013, with crude petroleum and automotive leading the growth."[46]

Aviation

The aviation industry only carries 0.5% of the world's freight, but dominates just-in-time delivery services for high value items, carrying over 35% of the value of freight.[47] It has also become the major form of long distance passenger travel, due to its speed of delivery. This includes more than 87,000 daily domestic flights, consisting of an average of "28,537 commercial flights (major and regional airlines), 27,178 general aviation flights (private planes), 24,548 air taxi flights (planes for hire), 5,260 military flights and 2,148 air cargo flights (Federal Express, UPS, etc.)."[48] This amounts to over 31 million flights a year carrying approximately 662 million

passengers and 20,305 million pounds of freight.[49] To truly understand the size of aviation and its impact on the world economy, the Air Transportation Action Group (ATAG) has shown that "[i]f aviation were a country, it would rank 21st in the world in terms of [GDP], generating $606 billion of GDP per year, considerably larger than some members of the G20."[50]

Industry reports show that the aviation industry is declining in size, with minimal profit gains over the past 10-15 years,[51] leading to less capacity to support our economy and national security transportation needs. Though there are 4858 smaller air carriers, the majority of the airlift and revenue in the industry comes from the 70 major carriers[52] (those with 1000 or more employees). As the cost of operations increase, the decrease in the number of airlines and aircraft may continue, directly affecting the ability to rapidly ship high-value freight and people, and decreasing the ability of the Department of Defense (DOD) to rely on commercial support via CRAF to meet our military transportation needs.

CHALLENGES

The main challenge facing the transportation industry is meeting increased capacity demands. There are three main challenges facing surface transportation capacity on America's highways: crumbling infrastructure, a truck driver shortage, and road congestion. The 2013 American Society of Civil Engineers report card graded national road infrastructure as a D.[53] While federal, state, and local capital investments have recently increased to $91 billion annually, this falls well short of the $170 billion in annual capital investment that the Federal Highway Administration (FHWA) estimates would be needed to significantly improve conditions.[54] This level of investment will not be reached with the current federal gas tax. Because rates were last raised in 1993, "taxes on motor fuels dedicated to the Highway Trust Fund are worth about 38 percent less than they were 20 years ago."[55]

According to the ATA, there is a truck driver shortage that translates to a lack of capacity to move freight. In 2013, the industry reported it was short 30,000 truck drivers, and, if the trend continues, the shortage could reach 239,000 by 2022.[56] The scarcity of drivers is due to a number of factors, including pay/compensation,[57] quality of life, an aging workforce, and increased regulations. Traffic congestion further exacerbates capacity issues and is a drag on the economy. The Texas Transportation Institute's *Urban Mobility Report* showed that urban congestion cost the economy $121 billion in 2011, with $27 billion of those costs coming from the effects on the trucking industry.[58]

The rail transportation system is a key component to resolving the capacity issues related to trucking, but demand is eating away at its capacity as well, "as of 2014 [rail] comprises 40% of the total share of freight ton-miles moved across the U.S with the total tons transported by rail increasing over the last decade by 7%."[59] This growth is fueled by the ever greater demand for intermodal shipments and movement of energy products and supplies. Congestion is particularly noticeable in the Midwest where multiple commodities compete for service, and the convergence of rail lines around Chicago interrupts service. In general, high-volume rail traffic is putting strong pressure on capacity, stretching it to its very limits.[60] It is predicted that within 20 years, if significant technological and infrastructure changes are not made to the US railway system, enduring capacity shortages will become systemic at key regions.

Despite dramatic increases in shipping technology, US seaports and ocean terminals have operated the same for decades and lag the automation of many international ports, putting US ports at a competitive disadvantage. A container can transit nearly 7,000 miles of ocean from Hong Kong to California in 11 days; however, once it arrives at the Port of Los Angeles, it may take an additional nine days to move 50 miles.[61] Line haul truck drivers often spend over five hours at major US ports waiting for their loads. Without changes, American ports may lose market share to more efficient ports in Canada and Mexico.[62]

Government regulation in the form of the Jones Act presents an additional hurdle to coastal shipping. Policies that protect domestic industry in the interest of national security are rational, but the high level of government intervention has hampered innovation, reduced the adoption of changing technologies and efficiencies, and inhibited design advancements in the capacity of ships. While road and rail congestion make ships the natural alternative for oil and natural gas transport, there are only 13 tankers that can legally move oil between US ports and they are "booked solid."[63] Additional domestic ship construction is possible, but capacity is limited and costs are high due to the lack of volume and economies of scale.[64]

The shipment of petroleum products is a direct concern for the whole industry because it is heavily reliant on fossil fuels. While current prices are historically low and have reduced economic impact, the industry is increasingly confronted with the challenge of responding to pollution from these fuels. Carbon dioxide, sulfur oxides, and mono-nitrogen oxides (CO_2, SO_X, and NO_X) all threaten the environment and our quality of life. In January 2015, the International Maritime Organization (IMO) began enforcing Annex VI to the International Convention for the Prevention of Pollution from Ships (MARPOL) in numerous Sulfur Emission Control Areas (SECAs), including both North America and Europe.[65] Additionally, while numerous initiatives are underway to address fuel efficiency and reduced emissions for automobiles, manufacturing, and other major oil consumers; aviation faces the challenge of burning the equivalent of 23 billion barrels of oil a year – all of which creates emissions.[66]

On the highways, low revenue generated by the gas tax has already been cited as a barrier to increasing capacity, but also contributes to negative environmental impacts. The current gas tax does not capture the full cost of the activity it fuels, so it can be seen as a subsidy for negative behavior and a drag on the overall economy. "A new report from the Tax Foundation shows 50.7% of America's road spending comes from gas taxes, tolls, and other fees levied on drivers. The other 49.3%? Well, that comes from general tax dollars, just like education and health care."[67] The current drop in oil price is no friend to conservation or innovation, as "the sharp drop in fuel prices is undermining government policies that bet expensive gasoline would prod Americans to find alternatives to gas-guzzling automobiles."[68]

Alternative modes of transportation that could reduce emissions have been embraced by numerous developed countries, but have not gained widespread support in the US. High-speed passenger rail has been supported in various pieces of federal government legislation since 1965,[69] but only incremental progress has been made. American focus on freight rail transportation and private ownership of most tracks by the Class I railroads cast doubt on the efficacy of high-speed passenger rail.

The third challenge facing the transportation industry is providing efficient security to all modes, as they are increasingly targets for terrorists and criminal activity. Aviation is a highly

visible and major strategic concern for homeland security, encompassing approximately 450 commercial airports and 19,000 additional airports, heliports, and landing strips including civil and joint-use military facilities.[70] Due to the impact of past terrorist attacks, aviation continues to be a focus area that is considered vulnerable to harm and destruction. Additionally, the speed with which aviation can deliver people and supplies makes it a mode of choice for humanitarian and governmental entities alike, increasingly putting this mode in the most critical and dangerous environments and further expanding the challenge of its protection.

The Federal Aviation Administration (FAA) projects that by 2032 1.3 billion people will fly from US airports each year.[71] The 9/11 attacks cemented the reality that the aviation security requires consistent attention, but budgets do not always support this requirement. Funding for the Transportation Security Agency (TSA) is vulnerable to fiscal constraints, and it is likely that the TSA's $4.6 billion budget for manpower and resources will continue to decrease as government institutes cost cutting measures. The administration's budget was cut more than $300 million dollars in the last congressional spending bill, which includes $26.3 million dollars in cuts to personnel.[72] Federal Air Marshals (FAMs) positively impact passenger confidence, but that program is again in jeopardy because of funding and scandals. Early last year, TSA Director Robert Bray announced that "six of the Air Marshal Service's twenty-six offices will be closed by the end of 2016 due to a budget reduction."[73]

Rail is increasingly becoming an attractive target for terrorists due to the "limited security measures, large numbers of passengers, wide geographical coverage, the possibility of anonymity and the many escape routes"[74] throughout the industry. While railways in the US have not yet been attacked, there were 838 worldwide attacks resulting in 1,373 fatalities against passenger and commuter rail systems from September 2001 to December 2011.[75] Defending against this threat is not easy because most measures applied at airports are not easily transferred to rail traffic, "because train systems are expected to be accessible, convenient, and inexpensive."[76] With a majority of rail profits already allocated towards Positive Train Control (PTC) implementation, there is little capital left to develop counter-terrorism capabilities.

Laws signed in 2007 required 100% scanning of US-bound containers at foreign seaports by 2012 through the use of non-intrusive and radiation detection equipment;[77] however, this has not been accomplished due to a lack of funding. Additionally, "second-generation radiation detection portals the US Domestic Nuclear Detection Office was tasked with developing never worked well enough to be deployed, and [subsequently], the program was cancelled in 2012."[78] The Department of Homeland Security (DHS) continues to look for ways to meet these requirements, but without additional funding, it will be pressed to reach full compliance.

INDUSTRY OUTLOOK

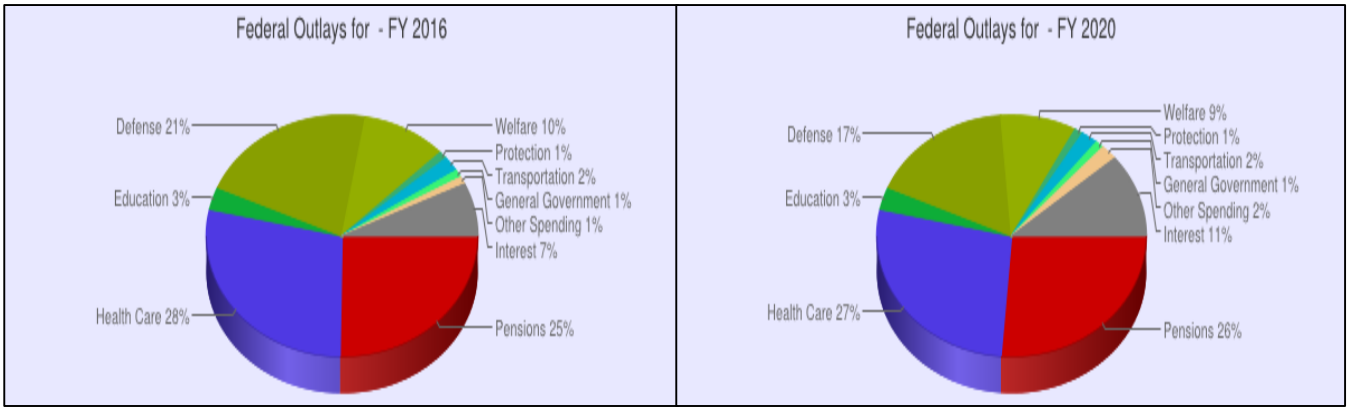
The overall industry outlook is healthy through 2019, mirroring projections for a recovering and expanding US economy. With capacity tight, pricing power over producers is in the hands of industry. While most portions of the industry are considered mature, industry growth is expected to be higher than domestic economic growth, with the exception of the maritime industry,[79] which still retains capacity but is hampered by domestic ports. Reduced fuel costs are likely to help even in industries with fuel surcharges. Due to the high barriers of entry for most modes and the slow pace of technical innovation, transportation is expected to remain stable in the

short-term, but expansion in intermodal implies that the rail industry is in a growth period.[80] An increased level of mergers and acquisitions is expected in the maritime industry, due to excess capacity, and in the trucking industry as bigger firms gobble up smaller firms.[81] The industry should keep a watchful eye on Third Party Logistics (3PL) firms that steal pieces of the value chain and can be competitors, complementors, or substitutes. Aside from infrastructure woes, 3PLs may be the biggest threat to the industry's ability to create value in the short-term; in response, many firms are likely to adopt their own supply chain business units.[82]

While short-term projections for the industry are generally positive, the challenges described in the previous section create concern that the industry could fall short of its potential. Given the capacity, environmental, and security issues facing some modes, portions of the industry run the risk of limiting further expansion of the US economy. Current innovations may be enough to overcome these challenges in the next five years, but industry has major hurdles to clear in the way of infrastructure issues to ensure both its short-term and long-term health.

Over the last 50 years, little has improved regarding transportation infrastructure. One of the primary culprits is the fact that the nation must fund the most critical infrastructure upgrades first (i.e. those impacting the economy), even though there is much that requires attention. As previously noted the FHWA estimates that $170 billion in additional capital investment is still required to solve highway issues. The President's Fiscal Year (FY) 2016 Budget attempted to address many of these challenges as it "provided a total of $94.7 billion in discretionary and mandatory funding in 2016 for the DOT to support infrastructure projects critical for long-term growth; improve America's roads, bridges, transit systems, railways, and aviation systems; enhance safety; spur job creation; and improve the way federal dollars are spent."[83] However, when compared to the percentages of federal outlays provided for other departments, such as DOD, it is apparent that this amount is not enough to solve capacity challenges.[84]

Figure 2: Comparison of Planned Federal Outlays



Finally, and to only compound this issue, it must be noted that the Presidential Budget plans to only dedicate "approximately $6 billion over six years for a competitive grant program designed to create incentives for state and local partners to adopt critical reforms in a variety of areas, including safety and peak traffic demand management."[85] This is a meager handout for state

and local partners, when "[f]ederal outlays for grants to state and local governments increased…to about $545 billion in fiscal year 2012."[86]

Despite federal funding challenges, there are several important steps that can be taken now to ensure the industry's long-term health**.** Initiatives in the DOT Moving Ahead for Progress in the 21st Century Act (MAP 21) are a partial answer,[87] but would be more effective if transportation was viewed through a wider lens. The freight transportation strategy is dominated by the trucking mode, but has opportunities to integrate with plans for rail and short sea shipping. The transportation industry must get the whole of government, to include federal, state, and local, as well as private sector partners, to understand that challenges are systemic across all modes. Whether the industry focuses on the truck driver shortage, the widening of the Panama Canal, slow port velocity, or rail congestion, each mode is greatly impacted by challenges facing the other modes. As such, stakeholders within each mode must begin collaborating now and support innovative solutions that will eliminate deficiencies across the entire supply chain. With the long-term outlook uncertain, the industry's future is dependent upon cooperation to increase capacity, environmental responsibility, and security. "Strategic thinking means looking at the bigger picture. Rather than immediately planning actions to deal with the practical issues right in front of them, a strategic thinker considers longer term and larger scope goals."[88] The industry has three areas of strategic focus that will impact its long-term outlook.

First, the industry and government must understand the impact of both competitors and substitutes across all modes of transportation. This does not simply mean switching business to a different mode, but exploring alternative forms of transport. Equally important, industry and government will need to consider what the future alternatives to transportation will mean for the industry's current business models and for the US economy. Advances in adaptive (3D) printing could revolutionize sectors of the freight transportation industry and high-speed transportation tubes would change passenger transportation forever.

Second, with competent planning the government and industry have the opportunity to encourage public-private collaboration to determine the best return on infrastructure investments. "[I]nvesting in infrastructure is essential to support healthy, vibrant communities. Infrastructure is also critical for long-term economic growth, increasing GDP, employment, household income, and exports. The reverse is also true – without prioritizing our nation's infrastructure needs, deteriorating conditions can become a drag on the economy."[89] Increased transparency between industry and government could be a major factor in the development of solutions for the described challenges, but it will require strategic initiatives that look beyond the five-year mark.

Finally, industry partners should focus on technological innovation as a solution to its challenges. There are a number of recent innovations applied to other industries – including automation, unmanned vehicles, big data, video recognition systems, laser technology, information technology, alternative energy sources, liquefied natural gas/compressed natural gas (LNG/CNG), and wireless technology – that have tremendous application in the transportation industry. These innovations, particularly when integrated across modes, have the ability to increase efficiency, expand capacity and spark new business models. While these changes could be expensive and timely upfront, the savings and competitive advantage the industry could build for the future are well worth the investment. The following sections will provide greater fidelity regarding specific innovations and technology.

Examples of Innovation to Increase Capacity

One of the easiest solutions to increase capacity in the aviation sector is achieved with bigger, more efficient airplanes (Boeing 777 and 787) that carry more passengers and freight. In the freight aviation sector, innovations in purchasing leftover passenger cargo space to move freight has become the norm, rather than the exception. Currently the limiting factor for aviation transportation, no matter the size of the plane or cargo capacity, is the safe management of traffic flow. This is a place where innovations in **global positioning systems, information technology, big data, and unmanned vehicles** have the potential to increase capacity.

There are several exciting initiatives that are beginning to transform aviation operations and efficiencies, the most prominent of which is the FAA **Next Generation Air Transportation System (NextGen)** effort. This major initiative will be implemented in gradual stages over the course of the next 15 years at a cost of over $29 billion, but is expected to harvest $133 billion in benefits to the National Aerospace System (NAS).[90] It is a major advance in technology and collaboration, but it is not the end all – it is just the beginning. In simple terms it is a "transition of air traffic control from radar-based to satellite-based, where controllers and pilots will have the advantage of increasingly sophisticated technology. . . Essentially, every controller in the US will be able to see the exact position of every aircraft flying in our airspace. . ."[91]

Several recent high visibility aircraft mishaps have illustrated the need to improve **tracking mechanisms** and the industry has been working on a solution. In conjunction with NextGen, **Automatic Dependent Surveillance-Broadcast (**ADS-B), a new form of transponder that broadcasts to ground stations more precise information than does radar, will help tracking using **GPS technology** and include the plane's trajectory. Other improvements include the ability to fix aircraft locations every second as opposed to once over 16 seconds.[92] This advance not only improves safety, but can increase capacity by providing more direct routing of aircraft. **Big data** is the vast information available to both the aviation industry and the FAA to collect information and use **information technology** for economic, safety and efficiency gains. But critics point out this is an area where aviation is falling behind other industries because it "is such a big concept that many airlines have trouble figuring out where to start."[93]

A most revolutionary and sometimes controversial future innovation is **autonomous systems.** To fully comprehend the increase in capacity that is possible, one must look beyond solely **unmanned aerial vehicles (UAVs)**. Autonomous systems also represent the use of computer technology to replace certain aspects of human air traffic control. Many other industries have had to confront this challenge; the aviation industry will need to do this as well if it is serious about economic growth and efficiency. It has the possibility to completely change the way air traffic control facilities are staffed, airspace is controlled, and duties are performed among the pilot-air traffic control community.

In the rail sector, the quick answer to increasing capacity could be reached through large capital investments in new track and trains. Over the last ten years, the nation's railroad companies have spent an average of $10 billion per year on capital expenditures.[94] Major railroads would need to invest an additional $162 billion in infrastructure over the next 20 years to address capacity issues on the primary corridors.[95] Even if the railroads gain access to the property required to build those new tracks, it is unlikely that private firms can absorb the financial risk of this sustained

level of capital investment. Another way to increase capacity is to double stack containers, but due to the height limitations of many bridges and tunnels this is not possible for older rail routes without significant infrastructure upgrades. An alternative to infrastructure investments is increasing volume through **Positive Train Control (PTC)**, an initiative that is similar to the aviation industry's NextGen initiative. PTC involves **wireless communication**, **global positioning satellites**, **data link**, **big data** and central control, all of which can be harnessed to improve routing, traffic flow and dynamic decision making. PTC informs the control unit of changing track/signal conditions, alerts onboard navigation systems and **track profile databases** to enforce speed parameters, uses **data link** to communicate with signaling equipment, and centralizes systems to issue movement authority to trains.

The result is the ability to control rail traffic and operations in a networked real-time manner at the federal "Big Picture" level to optimally control rail traffic flow and eliminate congestion through the primary corridors.[96] Analogous to air traffic control (ATC) centers, trains could be controlled by Rail Route Traffic Control Centers (RRTCC) which would enable efficient and safe train operations, especially when running mixed speed freight with faster passenger trains. Rail company representatives could sit with the Federal Railroad Administration (FRA) controllers to support most efficient timing and routing. Similar to ATC, during times of major crisis or national emergency, the rail system could be easily cleared of traffic, providing DOD or other federal assets an expedient, non-congested route.

The downfall of initiatives like NextGen and PTC is that despite their value added, they require large upfront investments. PTC was congressionally-mandated to be implemented by 2015, but is behind schedule and the cost of nationwide implementation ranges from $6 to $22 billion.[97] In the case of NextGen, it is no small venture for industry and government to match equipment upgrades and training in a timely manner. A successful outcome requires an element of trust between industry and government in implementation that is lacking. The situation then becomes the classic chicken and the egg debate. Industry will not obligate dollars until the government proves the decisions are final and ready to be implemented, and government does not want to spend taxpayer dollars on technologies that private industry is not ready to use.

Similar to the railroads, trucking struggles with barriers to capacity that involve infrastructure (Federal Highway System). It also must overcome a driver shortage and fierce competition for space on the roadways with passenger vehicles. In some large metropolitan areas, advances in **wireless technology** and **big data** processing have allowed paid express lanes and dynamic pricing to improve traffic congestion. These advances are limited to localities and do not begin to address the larger issues that freight carriers experience. As a result, the trucking industry is turning to technology to increase efficiency and capacity in the areas of telematics, which is the fusion of **wireless technology**, **big data,** and real time information on trucks.

Telematics increases both efficiencies and fuel savings (the highest cost). CR England put **in-cab telematics machines** in their vehicles that track a myriad of information from routing, hard braking/acceleration, location, and hours in service.[98] Analysis of this data is used to optimize routes, pickup real-time maintenance issues and improve driver performance. For example, it creates value when a truck transporting refrigerated produce experiences a maintenance issue. The on-board computer will notify the dispatch and driver about the refrigeration problem. The

company can take action to find a location for repair or make alternate plans/routes to "save" the load and time.[99] Furthermore, **electronic records** and **wireless technology** reduce administrative manifest requirements for truckers, allowing them to spend more time on the road.[100] Additionally, **electronic logs** reduce 50% of the mistakes generated when keeping paper copies, according to CR England Executives.[101] Finally, similar to CR England, UPS's ORION System (telematics) saved the company three million gallons of fuel between 2010 and 2012, driving down costs and reducing greenhouse emissions.[102]

Besides using **telematics** and **wireless technology** to save fuel and increase efficiency, carriers, shippers and logistics companies are turning to procedural innovation to improve capacity. According to the DOT, most long-haul trucks run 20% empty due to deadhead runs (repositioning after dropping off cargo).[103] To optimize capacity, companies are combing the forces of **GPS, wireless technology,** and the internet to find on-line shippers cargo space aboard trucks in real time. Two companies, BulkLoadNow.com and uShip.com, fuse this technology to increase capacity and provide flexibility for both carriers and shippers.[104]

Unlike the rail and trucking sectors that are physically constrained on routes, the maritime transportation sector experiences very little congestion. Thus, the maritime industry has a role to play in solving the capacity issues related to roads and rails. The growing need to expand the maritime freight network to relieve landside congestion led to an innovative solution already popular in Europe, America's Marine Highway (AMH) Program.[105] The DOT program promotes the utilization of **short sea shipping** as an integral component of a broader multimodal network with a variety of potential benefits, primarily increased capacity. Maritime Administration (MARAD)-commissioned studies concluded that roughly 4.7 million tons of cargo could be diverted to the AMH program. This equates to 4500 container or trailer loads per week of highway and intermodal rail freight along the I-95 corridor.[106] But this solution draws attention to the industry's bigger challenge – capacity near and in the port system.

With a desire to increase maritime shipping, innovations in **maritime domain awareness (MDA)** will be critical to increasing a port's capacity to receive ships. Multiple industry study visits have shown the private sector's ability to use **big data** to improve business performance and gain competitive advantage. A successful maritime Jones Act transporter described how the company built their own **information technology systems** to rely on data exchanges with their vessels, practically eliminating voice communications and automating reports by mining existing data; these process improvements saved significant time and associated labor costs and greatly improved accuracy and reduced errors, providing such a return on invested capital that a dedicated staff continues to innovate and identify additional opportunities.[107]

Even with these innovations in place, the biggest barriers to capacity in the maritime sector occur inside the port and are related to port size, water depth, infrastructure, organized labor strikes, and the ability to connect to other modes of transportation. While port size and water depth are natural barriers that are often financially and environmentally insurmountable, innovations in **automation** and **information technology** have the ability to increase both volume and velocity of throughput, better satisfying the needs of ever-increasing ship cargoes.

Thirty years ago the APM Terminal at The Port of Rotterdam leapt ahead of all the other world's ports by automating the majority of its container shipping operations. That

groundbreaking initiative was so successful that port **automation** has spread (and improved) throughout most of the world's major port facilities, except in the US. The Rotterdam operation proved so successful that a second fully automated port facility, to include the operation of the **ship-to-shore (STS) cranes, intra-port container carriers, container staging operations, inter-modal load operations**, and **gate procedures** opened in 2009.

One major constraint plaguing US ports is the inability to expand due to land constraints. This is problematic given that the Ports of Los Angeles and Long Beach collectively handle 40% of all US imports and have maximized their horizontal expansion. The use of technology and automation can increase their capacity 30% through vertical expansion. The majority of the world's advanced port facilities have introduced automated container stacking cranes capable of stacking seven containers vertically.[108] Not only are automated ports maximizing vertical expansion, they are doing it faster through unmanned systems equipped with **laser scanning, computerized position indicators, advanced optics, and programmable logic controllers.**

Efficiencies gained through automated container handling are also evident in STS crane operations. The state-of-the-art fully **automated STS cranes** employed at the APM Terminal in Rotterdam have an average discharge rate of over 60 lifts per hour. The most advanced manned STS cranes used in the US average 30 lifts per hour.[109] Moreover, systems integration of automated STS cranes enables one crane operator to operate multiple cranes, only limited by the size of the ship, from his cubicle in the port operations center.

A final critical component to increasing capacity is a port's intra-port container transport capability. In US port facilities, drivers perform this task with truck and trailer units (TTU) shuttling containers to various load or staging locations. The world's automated ports have introduced **automated ground vehicles** (AGVs), which are **computerized container carriers** that transport containers around the port facility via a **network of underground sensors**. The movement of AGVs is choreographed into the flow of containers being discharged from the ship simultaneously with the container staging operation through **information technology.** This enables port managers to establish vessel discharge plans days before a ship arrives in port.[110]

This last example is a key lesson for optimizing operations to increase capacity. Because the whole transportation system needs to provide a well-integrated multi-modal supply chain system that creates value for the national economy, efficiencies in capacity can no longer be thought of by individual modes. The game changer for the US transportation industry will occur when cooperation occurs amongst transportation modes and between government and private industry to integrate the previously mentioned advances in technology and innovation.

Examples of Innovation to Address Environmental Challenges

The environmental challenges to the transportation industry stem from its pervasive reliance on carbon-based fuel. Profit and efficiency in operations must be counter-balanced by the environmental impact of the activity. Some initiatives with application in this area have already been highlighted in the capacity section because innovations with increased efficiency provide environmental benefit. This section will address innovations that are more centrally focused on solving environmental challenges.

Each of the modes has their own particular challenges and solutions when it comes to reducing their "carbon footprint." In the maritime industry, there are three options for firms responding to global emission standards described in the challenges section: (1) use fuels with lower sulfur content, (2) reduce particulate levels emitted by exhaust systems, or (3) use alternate energy sources. The quickest compliance option is to transition from Intermediate Fuel Oil (IFO) to a more costly and refined Low Sulfur Marine Gas Oil (LSMGO). The second option is to install **exhaust gas cleaning systems (scrubbers)** that allow ships to continue to burn dirty fuels. The most capital and time intensive solution is to adopt propulsion systems that burn alternative fuels; LNG is the most popular because of its relatively low price, increasing availability, and growing acceptance as a cleaner form of propulsion in multiple industry sectors.

Although **LNG propulsion systems** have been around for 50 years, their adaptation to the maritime environment is recent. LNG has emerged as the preferred alternative fuel source due to its availability, ease of storage, and increasing infrastructure. Additionally, **LNG fuels** do not create sulfur emissions and avoid the maintenance, waste, and size concerns of scrubber systems; while reducing CO_2 emission by 35% and NO_X emissions by 80% compared to dirty fuels.[111] While not providing direct financial impact, there is also growing social pressure to adopt environmentally friendly business practices. Firms that are able to market themselves as "green" shippers create value through a differentiation strategy. DHL's "Go Green" program allows environmentally responsible practices to provide transporters a pricing premium.[112]

The combination of these advantages has spurred a new era of shipbuilding with 81 **LNG-powered ships** in operation or on order globally.[113] This number includes the first US-built LNG-powered vessels, two Marlin-class container ships on order from TOTE Shipholdings Inc.[114] These ships are significant because the $324.6 million loan that backs them are guaranteed by DOT, signaling a government-preferred response to sulfur emission regulations.

The potential for **LNG** to be the "next" energy source is an issue for all modes of transportation**.** Railroads have experimented with **LNG engines** and many trucking firms have switched portions of their fleet to **LNG trucks**.[115] In reality, policy decisions regarding LNG infrastructure go beyond transportation and intersect with national energy and environmental policies. While DOT commissioned a study regarding the current issues associated with US LNG marine bunkering,[116] this effort is only the starting point of broader work that should be accomplished. Ultimately, investments in a preferred energy infrastructure require a whole of government solution that exhibits a coherent strategy to stakeholders in all transportation modes, industries beyond the transportation sector, and concerns beyond the economy.

On the nation's highways, there are a number of innovative approaches toward reducing the environmental impact. For the trucking industry, that translates to an increased reliance on **"inter-modal" transport**, partnering with fuel-efficient rail lines to cover long distances. As one industry leader stated, "the driver shortage will accelerate the modal conversion from truck to rail as the definition of 'long haul' in the drayage business becomes shorter (less than 300 miles)."[117] As a result, **intermodal** transport is expected to grow 5.1% a year through 2018.[118]

Shifting freight volume onto waterways via **short sea shipping** will have an even greater impact on the environment. The capacity advantages of the AMH program have been described previously, but the utilization of marine highway routes will lower air emissions and noise

pollution from reduced vehicle-miles traveled (VMT) and train-miles. It can do this through more modern, fuel-efficient vessels subject to MARPOL standards.

There are also efforts to shift passengers off the highways and into more fuel efficient modes, thus reducing the heavy impact on the environment. Europe and Japan have provided examples of high-quality, **high-speed rail passenger service**, and many believe that a rail solution could relieve some of our busiest corridors. It is estimated that high-speed rail could reduce energy consumption and air pollution by as much as "2.8 million tons of CO_2 a year in the mega-regions of Los Angeles, Chicago, Albany, and Orlando alone."[119]

More promising changes are underway in short-haul passenger movements. To get people out of cars, communities are making ground-breaking investments in metro, light-rail, and **innovative community design**, eliminating strip malls with attractive walkable streetscapes. Although not technically a "mode" of transport, support for travel by bicycle is also increasing in the U.S markets[120] and is expected to continue its current trajectory through 2019.

One novel alternative to these efforts is **Cap and Trade** taxation. This approach proved successful in the reduction of acid rain by allowing power companies to purchase emission quotas from other less polluting companies.[121] In theory, all companies have an incentive to maximize returns by reducing emissions, and the government raises money by selling some of the permits. California is experimenting with a Cap and Trade system, and the European Union has had a program since 2005, but the market success of this approach is still undeterminable.

The **gasoline tax** was established to help fund roadway infrastructure, but a secondary effect of the tax is that it provides an economic incentive to reduce gasoline use and the pollution it creates. In Europe high taxes have transformed public driving patterns, with higher numbers of passengers per trip, more fuel efficient vehicles, and shifts to other modes of transport. By contrast, the US government has relied on regulations such as speed limits and fuel efficiency mandates with limited success. This highlights the central weakness of regulation – if market forces do not support it, it imposes artificial inefficiencies as manufacturers build to a standard, rather than the market. If market prices support the standard, the market does it more efficiently. One effect of high energy prices is that it spurs innovation. Ford recently introduced an **all-aluminum truck**, attracting buyers based on the fuel savings inherent in lighter materials.

In aviation, firms are exploring **lighter materials**, **new fuels** and **new propulsion systems** to improve their carbon scores. Sustainable aviation fuels can reduce life cycle CO_2 emissions by up to 80%.[122] Even though jets require unique fuels, there have been two major breakthroughs in the development of **jet biofuel**. The first is the **Fischer-Tropsch (FT) process** which involves "vaporizing a mixture of biomass and coal and converting the gas to synthetic liquid fuels."[123] The second method is **hydro-processing,** which takes vegetable oils, animal fat, waste grease and algae oil and distills them into jet fuel.[124] Down the road, **CNG** is another fuel that could replace oil in the aviation market as the shale fracking revolution has greatly increased domestic supply. With natural gas priced at $2.11[125] per gallon, compared to $2.66[126] for jet fuel, the savings would be significant. Additionally, **more efficient jet engines** are being designed with gear boxes that allow the fan and core turbine to spin at different speeds. Pratt & Whitney leads the way in this new technology, creating the **PurePower engine** that can cut fuel consumption by 16 percent.[127] Rolls Royce expects to have **Trent XWB engine** complete by 2020, with an estimated fuel reduction

of 20 percent.[128] Finally, the **NextGen** system discussed in the capacity section will reduce fuel consumption and emissions through **direct routing**.

An innovation that all transport modes share is maximizing their freight (or passenger) through **increased efficiency**. In aviation that means taking on freight in half-empty holds of commercial passenger flights. In the shipping industry, that drives the ever-larger container ships. For the rail industry, longer, **double-stacked cars** stretch the carrying capacity of one engine. And finally in the trucking industry, innovative **telematics** noted in the capacity section reduce "dead-head" empty return trips and the emissions generated per trip.

Examples of Innovation to Address Security Challenges

Ever since Timothy McVeigh's truck bomb, the horror of the planes on 9/11, and the explosions in the Spanish train system, transportation has become a tool for spreading terror. This new reality has required governments and industry to innovatively devise security measures that do not impede the work of transportation. One such innovation is the development of TSA, which is charged with "strengthening the security of the nation's transportation systems and ensure the freedom of movement for people and commerce."[129]

Although much of its highest profile work has been involved with commercial aviation, TSA's mandate covers all transportation modes. For example, rail security is critical to national and economic security, and rail volume is growing**.** "Industry freight volumes in the United States are projected to reach 88% above 2002 levels, according to the US Department of Transportation."[130] In addition to high levels of human patrols and automated vehicle location systems,[131] "the US government and railway operators have attempted to improve railway security. [TSA] inspectors, and rail operators, have conducted security risk readiness assessments; also various security measures have been considered and implemented, such as greater surveillance, public awareness campaigns, and general response planning."[132]

Further enhancement to security techniques is required because the current structure is not robust enough to prevent a terrorist attack on the vulnerable transportation system. It should be noted that ports outside of the US, specifically the Port of Rotterdam, have already successfully developed and implemented the necessary technology required to increase security without sacrificing efficiency and capacity. Specifically, the Port of Rotterdam has "trained operators [to] use **high-power X-ray scanners** to produce clear, unambiguous imagery of densely packed cargo in trains moving at speeds up to 60 kilometers per hour (35 MPH)."[133]

In the maritime industry, the integration of **vessel tracking systems, big data and information technology** have the potential to increase security. Vessel Traffic Services (VTS) provide active monitoring of vessels in confined and busy waterways, including 12 Vessel Traffic Centers (VTC) that cover critical ports such as Los Angeles/Long Beach and New York/New Jersey. The **Nationwide Automatic Identification System (NAIS)**, consisting of approximately 200 VHF receiver sites located throughout the coastal continental US, inland rivers, Alaska, Hawaii and Guam, is designed to collect AIS transmissions from local vessels. These systems provide real-time traffic information, as well as full database of information regarding the vessel, crew and cargo contents. The primary goal of NAIS is to increase MDA through data

dissemination to the Coast Guard and other government agencies,[134] which allows Coast Guard and customs officials to profile vessels and focus efforts on the security of ports.

The 9/11 attacks cemented the reality that the airline industry will always be more vigilant regarding security than other modes of transportation. Coupling **passive integrated screening technology** with the current security measures (i.e., visible police presence, random checks/screening, etc.) is the optimal solution to reduce checkpoint queue times and keep the skies safe. But innovations are still required. **Passive security** is the driver for the "checkpoint of the future." Still under development by a number of security companies, this approach leverages technology to integrate layered security checkpoints and facilitate throughput, decrease false alarms, and increase passenger comfort. Barbara Zanzinger, director of communications and marketing for Smiths Detection Inc., stated in a recent interview that, "industry and regulators have agreed to contribute jointly towards turning this vision into reality, with consideration for all relevant stakeholders. There are three important goals to be attained: strengthened security, increased operational efficiency and improved passenger experience."[135]

GOVERNMENT ROLES AND POLICY RECOMMENDATIONS

In general, the government role is to collaborate, oversee and assist industry in the interest of the nation and its population. Specific to transportation, the government has three distinct roles to include enhancing economic growth, protecting the environment, and ensuring security. Additionally, it has two roles common to every industry: verification of safe operations and creation of a level playing field amongst firms and industries. Strategically, government should define the ends for each role and employ effective ways and means to achieve those ends. This section will delineate the desired ends and highlight potential policy choices.

This paper has advocated that government's most important responsibility is to assist industry with enhancing economic growth through innovation and infrastructure. Government promotes innovation in collaboration with industry and trade groups. FAA support for the Mitre Corporation, a not-for-profit organization, is a positive example of government collaboration with both an independent consultancy company and industry. Mitre's work on NextGen is expected to harness technologies that will create dramatic increases in aviation capacity by 2020. However, those efficiencies will not be achieved without the appropriate government baseline resources. In the NextGen example, the government seeks to enhance innovation by providing direct funding to specific technologies for government-mandated outcomes. This policy choice is risky because it chooses distinct winners and losers and could stifle future innovation efforts.

One way to enhance innovation without funding specific technologies is through general research and development tax credits, as well as direct funding to basic and applied research. One form of this approach is support to industry education. This directly funds the efforts of those who will develop innovations, vice committing to specific technologies. The STC-Group Netherlands Maritime University is an outstanding example of such a partnership, which provides industry education,[136] as well as collaboration with industry, consultancy, and development of best practices. Government should enhance support to the Transportation Research Board (TRB) and other public university transportation industry programs. TRB recommendations have already proven their success in achieving efficiencies, exemplified by improvements in airport enplanement and accessibility in the densely populated Washington, DC-Baltimore metro area.[137]

Most directly, government assists industry by working with state and local agencies to fund infrastructure projects that enhance long-term growth. The federal government can learn from solutions offered by regional governments. One example is the Virginia Port Authority's Virginia Inland Port (VIP) in Front Royal, Virginia. The primary mission of this private enterprise, which is managed by state government employees, is to support the movement of goods to and from the Port of Virginia, in order to enhance local and state economies. The terminal is serviced by 17,820 feet of rail track that runs adjacent to Norfolk Southern's Crescent Corridor, moving intermodal rail cars to VIP for further transport.[138] The efficient movement of goods to an area 220 miles inland has attracted companies such as Home Depot, Kohl's, Rite Aid and Red Bull to open distribution centers in the area, providing lasting economic benefits to the region.[139] From a strategic level, it has shown the importance of integrating modes of transportation to increase capacity, reducing road traffic in the congested Norfolk area, and creating new businesses. The federal government could initiate similar projects to enhance economies across regions that currently lack the necessary planning and required infrastructure.

Government should also be prepared to apply lessons learned from private firms that are in the business of achieving efficiencies across all transportation modes, specifically 3PL firms. These firms have grown popular because of their ability to look across the system to determine the most efficient way to move products from point to point, "Many 3PLs describe themselves as the 'travel agents' of the freight system, as they are tasked with planning, overseeing, transporting, and storing their clients' goods and products from one end of the supply chain to the other.[140] One way for government to truly enhance the economy is to view the industry like a 3PL – as "travel agents" to the supply chain enterprise – rather than as individual transportation modes. Similar to the "joint mindset" that was mandated by the 1986 Goldwater-Nichols Act, DOT may be wise to look at the operational integration of modes in the same way DOD looks at the integration of service capabilities to provide Joint warfighting readiness.

Government's second responsibility is to ensure that industry's heavy reliance on fossil fuels does not create undue harm to the environment. In collaboration with the Department of Energy and the Environmental Protection Agency, this can be achieved by promoting innovative means of transportation that produce fewer emissions, taxing appropriately to incentivize reduced fuel consumption, and in some cases, establishing regulatory limits on emissions. The Clean Air Act and its associated regulations and emissions targets are the most common measures that government employs. When enforcing regulatory limits, government must understand that market forces will have the greatest impact on the industry. Government policies that are crafted with the market in mind offer the greatest chance of success and serve to share the cost burden more evenly amongst producers and consumers.

An equally important role for government is the regulation of the transportation of environmentally dangerous products. The shale oil and gas revolution has yet to reach peak production, but safe rail transport is gaining vigorous attention because of derailments. Much like government did in 1990 in response to tanker spills, government must be ready to work with the rail industry to implement measures that ensure safe transport. Promoting the safe transport of highly volatile substances via pipeline may be the proper response.

In its third role, government has a responsibility to ensure security in the transportation industry. This is really a two-pronged objective. First and foremost, government must ensure that

the transportation industry is secure from attack and this is done with limited impact on system capacity. It achieves this through collaboration with industry and government agencies (DHS and DOD) to develop protocols, share information and fund security initiatives. One example of a positive government role is the funding and support for TSA's Transportation Integration Facility (TIF) at Reagan National Airport. This facility houses experts who collaborate with industry to test security equipment and procedures for airports, but planners envision that it could also be used for rail and maritime initiatives.[141] This upfront government investment in testing procedures and equipment is vital, because it allows measures to be implemented that have the greatest effectiveness without sacrificing efficiency.

With funding tight for large projects like TIF, government should be prepared to support innovations that balance risk and cost through the use of big data. Researchers have examined alternate policy measures and potential security risks[142] that resulted in recommendations to modify established layers of security. The remedy was to double the budget of the Federal Flight Deck Officer (FFDO) program to $44 million per year, installing physical secondary barriers in all US aircraft at a cost of just $13.5 million per year and reducing funding for Federal Air Marshal Service (FAMS) by 75%. Government needs to be engaged with both consultants and industry to advocate these kinds of solutions. Development of passive systems previously mentioned is preferable to balance security, capacity, cost and risk.

Government also has the responsibility to ensure that the commercial transportation industry is ready and able to support the nation's security. It does this through its partnerships with industry in collaboration with DOD in programs like CRAF, MSP and VISA. While these programs have proven effective in supporting national security, these ways and means can also be controversial. Establishing legislation that protects one industry over other portions of the supply chain, or US firms over global competition (The Jones Act and MSP), is in direct conflict with the first role of government – enhancing economic growth. Government needs to determine which portions of the maritime industry are in the national interest, and which portions that support inland waterway transportation may not be worthy of protection through cabotage laws.

In its fourth role, government ensures safe operations through subject-matter experts and collaboration with industry to assist regulatory bodies. After determining that the overall percentage of truck crashes that were partially or completely attributable to fatigue was 56% and cost the nation an estimated $31.7 billion, the FMCSA created regulations to correct the problem.[143] In 2013, industry implemented limits on the hours of service for drivers, a positive step for highway safety, but the government must continue to collaborate with industry to understand the impact of its regulations and be prepared to refine follow-on regulations.

Finally, government has a responsibility to ensure that there is competition within the industry to achieve fair market pricing, that no one firm enjoys an unfair advantage, and that no sector of the industry achieves a monopolistic quality. Government achieves this through interaction with other government agencies, including the Department of Justice (DOJ) and the Federal Trade Commission (FTC), to enforce anti-trust and fair competition rules. With barriers to entry high throughout many sectors of the industry, deliberate study of these impacts is critical to ensure that the fruits of the first role of government – the economy – are not unfairly reaped by the producers at the expense of the consumers.

CONCLUSION

Despite the current strength of the industry, challenges remain, much of it due to a lack of capacity that stems from outdated infrastructure. The trucking industry is constrained by a lack of drivers and environmental impact of its operations. Freight rail's consolidation following deregulation has made the industry profitable, but may mean it will lack capacity as the economy expands. Air carriers, both freight and passenger, are also seeing limits imposed by an antiquated radar-based tracking system and crowded airports. Maritime traffic is hampered by outdated locks, shallow harbor depths and slow-moving freight at our nation's ports, especially in comparison to automated overseas operations. For much of this sector, the government is the logical and necessary agent to move forward with infrastructure improvements, but it also requires the cooperation of a range of other public and private stakeholders. The entire industry is faced with two additional challenges: the negative externalities caused by its total reliance on carbon-based fuel, and the security of the transportation network against terrorist attack.

Throughout all industry modes it was easy to observe how poor infrastructure limits growth. Interestingly, this barrier was often the driver for new technologies like automation, precise positioning services, and big data. Those savings reduced fuel consumption and abetted another industry trend, concerns about environmental impact. Ships that carry more containers, trains that stack containers, or trucks that run full on both legs of a trip save money and reduce emissions simultaneously. A carbon tax on gasoline would provide a permanent stimulus to further fuel those innovations. In parallel, technology is yielding less noxious fuels, more efficient engines, and leaner work patterns to further reduce emissions. The industry's last challenge arose from a very recent development: the use of transportation to carry out terrorism. Security measures have been traditionally focused on passenger airlines, but as has been noted, passenger and freight rail are extremely vulnerable to attack. Ultimately, innovations in security measures are still required to maintain the balance between safety and economic growth.

This paper highlighted the importance of government's contribution to the industry through infrastructure maintenance, coordinated standards, security oversight, and market equilibrium regulations. The great efficiencies and innovation released by the deregulation of the airline, rail and trucking industries show the power of the private sector, however, government can and should be the great instigator (the Interstate Highway system) and the great coordinator (standards for shipping containers). It should also facilitate collaboration amongst stakeholders, especially those that might compete with one another.

Collaboration across modes, especially on the core infrastructure from which all benefit, is the foundation for consistent economic growth. But it is the application of new technologies and innovation, like those which allow FloraHolland to succeed, that builds new business models and cause economies to flourish to unforeseen levels. This economic vitality is the base on which our national security rests. If we extend Mr. Churchill's observation from the introduction – that transport is the stem supporting the flower of victory – then perhaps infrastructure is the soil, and innovation the water, that allows them both to grow.

Endnotes

[1] FloraHolland website, accessed March 23, 2015, https://www.floraholland.com /en/about-floraholland/who-we-are-what-we-do/facts-and-figures/.

[2] "Kenya's Booming Flower Industry Bounces Back," *BBC News*, September 19, 2014, accessed March 23, 2015, http://www.bbc.com/news/business-29276515.

[3] Winston Churchill, *The River War* (London: Longman and Greens, 1899), 162.

[4] "Real GDP Growth Rate in the United States," Statista.Com, accessed March 15, 2015, http://www.statista.com/statistics/263614/gross-domestic-product-gdp-growth-rate-in-the-united-states/

[5] "GDP Real Growth Rate," Index Mundi, accessed March 23, 2015, http://www.indexmundi.com/g/g.aspx?v=66&c=us&l=en.

[6] R. Glenn Hubbard and Anthony Patrick O'Brien, Economics 4th ed. (New Jersey: Pearson Education, 2013), 45-46.

[7] *Transportation Services in the United States* (London, United Kingdom: Market line Industry Profile, 2015).

[8] "Transportation Services Sector Report Summary." Hoover's Inc, accessed March 22, 2015, http://www.hoovers.com/industry-facts.transportation-services-sector.1597.html.

[9] *Transportation Statistics Annual Report 2012* (Washington D.C.: Department of Transportation Research and Innovative Technology Administration, 2012), 1.

[10] Ibid., v

[11] Ibid., 1

[12] Ibid., 1

[13] *Pocket Guide to Transportation,* (Washington, D.C.: Department of Transportation Bureau of Transportation Statistics, 2015).

[14] "Transportation Services Sector Report Summary," 7.

[15] Ibid., 7

[16] Ibid., 12

[17] Ibid., 13

[18] Ibid., 15

[19] Ibid., 16

[20] Ibid., 16

[21] *Transportation Statistics Annual Report 2012*, 1-100, 50.

[22] Ibid.

[23] Ibid.

[24] Bureau of Transportation Statistics, "Economic Impact on Transportation," United States Department of Transportation: Office of the Assistant Secretary for Research and Technology, accessed March 1, 2015, http://www.rita.dot.gov/bts/programs /freight_transportation /html/transportation.html.

[25] Clifford Winston, "On the Performance of the U.S. Transportation System: Caution Ahead," *Journal of Economic Literature 2013* (September 2013), 773-824.

[26] "Transportation Services Industry Overview," Dale Carnegie Training, accessed March 1, 2015, http://sales.dalecarnegie.com/general/files/industry/Transportation.pdf.

[27] *Transportation Services in the United States*, 7.

[28] *The Maritime Administration and the U.S. Marine Transportation System: A Vision for the 21st Century*, Maritime Administration, US Department of Transportation, 5-6, accessed March 15, 2015, http://www.marad.dot.gov/documents/Vision_of_the_21st_Century_10-29.pdf.

[29] *Pocket Guide to Transportation* (Washington, D.C.: Department of Transportation Bureau of Transportation Statistics, 2015), 2-3.

[30] *Pocket Guide to Transportation* (Washington, D.C.: Department of Transportation Bureau of Transportation Statistics, 2015), 14, 36.

[31] *US Industry Reports (NAICS): Ocean and Coastal Transportation/Competitive Landscape* (USA: IBIS World, 2015).

[32] Ibid.

[33] *US Industry Reports (NAICS): Ocean and Coastal Transportation/Industry Outlook* (USA: IBIS World, 2015).

[34] "American Trucking Association: Reports Trends and Statistics." American Trucking Association, accessed March 24, 2015, http://www.trucking.org/ News_and_Information_Reports_Industry_Data.aspx.

[35] "American Trucking Association: Reports Trends and Statistics," American Trucking Association, accessed March 24, 2015, http://www.trucking.org /News_and_Information_Reports_Industry_Data.aspx.

[36] "Road Freight in the United States." *Road Freight Industry Profile: United States* 1-35. *Business Source Premier*, accessed March 24, 2015, EBSCO*host.*

[37] "Reports, Trends & Statistics," American Trucking Associations, accessed March 20, 2015, http://www.trucking.org/News_and_Information_Reports.aspx.

[38] Ibid.

[39] William B. Cassidy, "Building Capacity" *Journal Of Commerce* (15307557) 16, no. 4: 43-52, accessed March 2, 2015, EBSCOhost Business Source Premier.

[40] Wells Fargo, "Recent Transactions in the Transportation Sector," February 5, 2015.

[41] Amtrak, "News Release: Amtrak Sets Ridership Record And Moves The Nation's Economy Forward," October 14, 12013, accessed March 15, 2015, http://www.amtrak.com/ccurl/730/658/FY13-Record-Ridership-ATK-13-122.pdf.

[42] Association of American Railroads, "Industry Facts," Railroad Facts 2014 Edition, 2014, 3.

[43] Ibid., 1.

[44] Association of American Railroads, "The Economic Impact of America's Railways," *Railroad Facts 2014 Edition* (2014), 3.

[45] U.S. Department of Transportation, "National Rail Plan, Moving Forward," *Federal Railroad Administration*, September 30, 2010, 14.

[46] Association of American Railroads, "Carload Originated By Commodity," Railroad Facts 2014 Edition, 2014, 27.

[47] "Facts & Figures - Air Transport Action Group (ATAG)," Facts & Figures - Air Transport Action Group (ATAG), accessed March 24, 2015. http://www.atag.org/facts-and-figures.html.

[48] "Datasets: Science On a Sphere," Datasets Science On a Sphere, accessed March 24, 2015, http://sos.noaa.gov/Datasets/dataset.php?id=44.

[49] "RITA BTS Transtats," RITA BTS Transtats, December 31, 2015, accessed March 24, 2015. http://www.transtats.bts.gov/.

[50] "Facts & Figures - Air Transport Action Group (ATAG)," Facts & Figures - Air Transport Action Group (ATAG), accessed March 24, 2015, http://www.atag.org/facts-and-figures.html.

[51] "Transportation Section 23," NAICS Search, December 31, 2012, accessed September 24, 2014. http://www.census.gov/cgi-bin/sssd/naics/naicsrch?code=481&search=2012 NAICS Search.

[52] Ibid.

[53] American Society of Civil Engineers, "2013 Report Card for America's Infrastructure," accessed October 23, 2014, http://www.infrastructurereportcard.org/

[54] Ibid.

[55] Kim Cawley, "Testimony: Status of the Highway Trust Fund," Congressional Budget Office, July 23, 2013, 5.

[56] Neil Irwin, "The Trucking Industry Needs More Drivers. Maybe It Needs to Pay More," *The New York Times*, August 9, 2014, accessed January 29, 2015, http://www.nytimes.com/2014/08/10/upshot/the-trucking-industry-needs-more-drivers-it-should-try-paying-more.html?_r=2&abt=0002&abg=1.

[57] Ibid.

[58] House Committee on Transportation and Infrastructure, *Improving the Nation's Freight Transportation* System, (Washington DC, October 2013), 18.

[59] U.S. Department of Transportation, "Freight Facts & Figures 2013," *Federal Railroad Administration* (Washington DC, 2013), 3.

[60] Association of American Railroads, "Carload Originated By Commodity," *Railroad Facts 2014 Edition*, (Washington, DC, 2014), 27.

[61] Thomas Ward, "Port Congestion: To Strengthen Link, Re-forge the Chain," accessed January 23, 2014, http://www.porttechnology.org/images/uploads/technical_papers/PT27-36.pdf.

[62] *Ocean and Coastal Transportation Industry Outlook*, IBIS World, accessed March 29, 2015, http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/industryoutlook.aspx?entid=1138#IO.

[63] Scott Lincicome, "If you like Higher Prices, Enriched Cronies, and Weak National Security, Then You'll Love the Jones Act," *The Federalist* website, accessed Jan 22, 2015, http://thefederalist.com/2015/01/22/if-you-like-higher-prices-enriched-cronies-and-weak-national-security-then-youll-love-the-jones-act/.

[64] Ibid.

[65] International Maritime Organization, *Sulfur Oxides (SOx) – Regulation 14*, accessed January 3, 2015, http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Sulphur-oxides-(SOx)-%E2%80%93-Regulation-14.aspx.

[66] "Fact #819: April 28, 2014 Imports of Crude Oil Declining," Office of Energy Efficiency and Renewable Energy, February 12, 2014, accessed October 15, 2014. http://www.energy.gov/eere/vehicles/fact-819-april-28-2014-imports-crude-oil-declining.

[67] Angie Schmitt, "Drivers Cover Just 51 Percent of U.S. Road Spending," January 23, 2013, Streetblog USA, accessed February 7, 2015, http://usa.streetsblog.org/2013/01/23/drivers-cover-just-51-percent-of-u-s-road-spending/.

[68] Josh Mitchell and Amy Harder, "For Energy Policy Makers, Tough Lessons in Downside of Cheap Gas: Efforts to Improve Fuel Efficiency Fade Along With Pump Prices," *The Wall Street Journal*, accessed January 23, 2015, http://www.wsj.com/articles/for-energy-policy-makers-tough-lessons-in-downside-of-cheap-gas-1419873527.

[69] Federal Railroad Administration, "High Speed Rail Timeline," Department of Transportation, accessed January 24, 2015, https://www.fra.dot.gov/Page/P0140.

[70] Richard Bloom, Joyce Kirk-Moyer, and Norm Wrona, "Emergency Management and Business Continuity within Commercial Aviation," *TR News*, July/August 2013, 31.

[71] Henry Price, "Airline Passenger Travel to Nearly Double in Two Decades," FAA Press Release, March 8, 2012, accessed February 16, 2015, http://www.faa.gov/news/press_releases/news_story.cfm?newsId=13394.

[72] Pete Kasperowicz, "TSA's Budget Is about to Get Chopped by the House," *The Blaze*, May 28, 2014, accessed February 16, 2015, http://www.theblaze.com/blog/2014/05/28/tsas-budget-is-about-to-get-chopped-by-the-house/.

[73] Mike Ahlers, "Homeland Security Thins Air Marshal Ranks - CNN.com," *CNN*, February 26, 2014, accessed February 10, 2015, http://www.cnn.com/2014/02/25/us/air-marshals-cut/index.html.

[74] Veronica Strandberg, "Rail Bound Traffic—a Prime Target for Contemporary Terrorist Attacks?" *Journal of Transportation Security* (2013) 6: 271-86, accessed January 23, 2015.

[75] "Passenger Rail Security: Consistent Incident Reporting and Analysis Needed to Achieve Program Objectives." *U.S. GAO - Passenger Rail Security: Consistent Incident*, December 1, 2012, 43, accessed January 23, 2015, http://gao.gov/products/GAO-13-20.

[76] Veronica Strandberg, "Rail Bound Traffic—a Prime Target for Contemporary Terrorist Attacks?" *Journal of Transportation Security* (2013) 6: 271-86, accessed January 23, 2015.

[77] Allison C. Bennett and Yi Zhuan Chin. "100% Container Scanning: Security Policy Implications for Global Supply Chains." June 2008. Accessed March 30, 2015. http://web.mit.edu/scresponse/repository/Bennett_Chin_MIT_Thesis_June_08.pdf.

[78] Ibid.

[79] *48411, 48412, 48111b, 48311, 48321, 48211, 48551 Industry Outlook Reports*, IBIS World, accessed March 30, 2015, http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/home.aspx

[80] *48211 Industry Outlook Report*, IBIS World, accessed March 30, 2015, http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/default.aspx?entid=1133.

[81] *48412 and 48311 Industry Outlook Report*, IBIS World, accessed March 30, 2015, http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/home.aspx.

[82] *48551 Industry Outlook Report*, IBIS World, accessed March 30, 2015, http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/default.aspx?entid=1209.

[83] "FY 2016 Budget Fact Sheet," Department of Transportation, February 2, 2015, accessed March 25, 2015, http://www.dot.gov/mission/budget/fy-2016-budget-fact-sheet.

[84] "Budget of the United States Government," accessed March 25, 2015. http://www.gpo.gov/fdsys/browse/collectionGPO.action?collectionCode=BUDGET.

[85] "FY 2016 Budget Fact Sheet," Department of Transportation, February 2, 2015, accessed March 25, 2015, http://www.dot.gov/mission/budget/fy-2016-budget-fact-sheet.

[86] "Key Issues: Management of Federal Grants to State and Local Governments," accessed March 25, 2015, http://www.gao.gov/key_issues/management_of_federal_grants_to_state_local/issue_summary.

[87] "MAP 21 Overview," Department of Transportation website, April 3, 2015, accessed April 5, 2015, http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/home.aspx.

[88] Eva Botkin-Kowacki, "Business Strategy: Short-term Planning Is Key to Long-term Success," *The Tennessean*, March 23, 2015, accessed March 25, 2015, http://www.tennessean.com/story/sponsor-story/trevecca-nazarene-university/2015/03/23/trevecca-nazarene-university-business-strategy-short-term-planning-is-key-to-long-term-success/70323188/.

[89] American Society of Civil Engineers, "2013 Report Card for America's Infrastructure," accessed January 26, 2015, http://www.infrastructurereportcard.org/

[90] *NextGen: The Business Case for the Next Generation Air Transportation System* (December 2014), 1, FAA website, accessed April 3, 2015, http://www.faa.gov/nextgen/media/BusinessCaseForNextGen-2014.pdf.

[91] The FAA website, accessed January 28, 2015, http://www.faa.gov/air_traffic/briefing.

[92] *Seattle Times*, http://seattletimes.com/html/businesstechnology/2023134658_airplanesflighttrackingxml.html, accessed January 28, 2015.

[93] SKIFT--Travel IQ. http://skift.com/2014/07/28/airlines-struggle-to-take-advantage-of-big-data/, accessed January 28, 2015.

[94] Association of American Railroads, "Capital Expenditures," *Railroad Facts 2014 Edition*, (Washington, DC, 2014), 46.

[95] Lance Grenzeback, "National Rail Freight Infrastructure Capacity and Investment Study," Cambridge Systematics, Inc., September 17, 2008, accessed November 10, 2014, http://www.stb.dot.gov/stb/docs/, RETAC/2008/September/Cambridge%20Systematics%20briefing.pdf.

[96] Federal Railroad Administration, "Railroad Research and Development Program: Train Control," *Five-Year Strategic Plan for Railroad Research, Development, and Demonstrations*, (Washington, DC, 2002), 4-47.

[97] Eric Jaffe, "The Billion-Dollar Technology That May or May Not Prevent the Next Big Train Crash," *The Atlantic*, July 13, 2013, accessed March 25, 2015, http://www.citylab.com/work/2013/07/billion-dollar-technology-may-or-may-not-prevent-next-big-train-crash/6378.

[98] Erin Richey, "How Big Data Is Changing Long-Haul Trucking," *Forbes*, March 24, 2014, accessed January 24, 2015, http://www.forbes.com/sites/emc/2014/03/04/how-big-data-is-changing-long-haul-trucking/.

[99] Ibid.

[100] *Ryder White Paper: The Connected Truck - Fleet Efficiencies through Telematics*, 2012, accessed January 29, 2015, http://www.ryder.com/~/media/Ryder/Files/KnowledgeCenter/WhitePapers/The Connected Truck.

[101] Erin Richey, "How Big Data Is Changing Long-Haul Trucking," *Forbes*, March 24, 2014, accessed January 24, 2015, http://www.forbes.com/sites/emc/2014/03/04/how-big-data-is-changing-long-haul-trucking/.

[102] "UPS Press Release: ORION Fact Sheet," United Parcel Service, accessed January 20, 2015, http://www.pressroom.ups.com/Fact Sheets/ORION Fact Sheet.

[103] "Assessing the Effects of Freight Movement on Air Quality at the National and Regional Level," Emission Mitigation Strategies, August 12, 2014, accessed December 29, 2015. http://www.fhwa.dot.gov/environment/air_quality/publications/effects_of_freight_movement/chapter04.cfm.

[104] Gail Dutton, "The 3 Faces of Trucking's Future," *World Trade: WT100* 26, no. 4: 18-24, *OmniFile Full Text Select (H.W. Wilson)*, accessed January 23, 2015, EBSCO*host* .

[105] Parsons Brinckerhoff Strategic Consulting, *East Coast Marine Highway Initiative M-95 Study Final Report*, 2013, ES-1.

[106] Ibid., ES-3.

[107] Anonymous, November 21, 2014, *Transportation Industry Study Site Visit and Discussion.* Baltimore, MD.

[108] City of Los Angeles Harbor Department Planning and Economic Development Division, "Container Terminal Automation," March, 2014, 5.

[109] Andrew Rosenblum, "Megaport," *Popular Science*, May 2013, accessed January 18 2015, http://www.popsci.com/announcements/article/2013-04/may-2013-new-dawn-invention.

[110] Ibid.

[111] Muccin, Emil A., "New Rules, New Fuels," *U.S. Naval Institute Proceedings* 136, no. 12 (December, 2010): 24-29, accessed January 5, 2015 on Academic Search Premier EBSCO host.

[112] DHL website, accessed January 16, 2015, http://www.dhl.com/en/about_us/green_solutions.html.

[113] Claus Winter Graugaard, "LNG for Shipping – Current Status" (Det Norske Veritas, Inc. presentation, October 22, 2013), accessed January 16, 2015 http://www.golng.eu/files/Main/news_presentations/workshop/DNV%20221013.pdf.

[114] Paul Jaenichen, "With DOT Support, Maritime Industry Leans Forward on Environmental Stewardship," US Department of Transportation website, September 23, 2014, accessed January 2, 2015, http://www.dot.gov/fastlane/maritime-industry-moves-forward-environment.

[115] Kevin Bulils, "Cleaner Long-Haul Engines Guzzle Diesel or Natural Cleaner Gas," *MIT Technology Review* (October 8, 2013), accessed January 16, 2015, http://www.technologyreview.com/news/519641/cleaner-long-haul-engines-guzzle-diesel-or-natural-gas.

[116] Det Norske Veritas, *Liquefied Natural Gas Bunkering Study* (Katy, Texas: 2014), accessed January 4, 2015, http://www.marad.dot.gov/documents/DNVLNGBunkeringStudy3Sep14.pdf.

[117] "2015 Trucking Executive Commentary," *Journal Of Commerce* (15307557) 16, no. 1: 104-110, accessed January 20, 2015, EBSCOhost Business Source Premier.

[118] Meghan Walsh, "Why No One Wants to Drive a Truck Anymore," Businessweek.Com 9, August, 2013, accessed January 17, 2015, EBSCOhost Business Source Premier.

[119] The United States Conference of Mayors: "The Economic Impacts of High-Speed Rail on Cities and their Metropolitan Areas" (Washington D.C.: Economic Development Research Group Inc., 2010), 26.

[120] Melissa Imbruglia, *2014 IBISWorld Industry Report 44122b; Bicycle Dealership and Repair in the U.S.*, accessed January 31, 2015, http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/ataglance.aspx?entid=1009.

[121] "Acid Rain Program," Environmental Protection Agency website, accessed January 31, 2015, http://www.epa.gov/airmarkets/programs/arp/index.html.

[122] International Air Transport Association (IATA) website, http://www.iata.org/whatwedo/environment/Pages/alternative-fuels.aspx, accessed January 28, 2015.

[123] Niven Winchester, Dominic McConnachie, Christoph Wollersheim, and Ian Waitz. "Market Cost for Renewable Jet Fuel Adoption in the United States," *A Partner Project 31 Report*, no. PARTNER-COE-2013-001 (2013): 1-23.

[124] Ibid.

[125] "Average Prices Across the United States." *CNG Now*, September 24, 2014, accessed September 24, 2014, http://www.cngnow.com/average-cng-prices/pages/default.aspx.

[126] "Jet Fuel Daily Price," *Price Charts, Data, and News - Index Mundi*, September 23, 2014, accessed September 23, 2014, http://www.indexmundi.com/commodities/?commodity=jet-fuel.

[127] Ibid.

[128] Guy Derby, "Rolls-Royce Details Advance and UltranFan Test Plan," *Aviation Week & Space Technology*, August 25, 2014, 36.

[129] TSA homepage, accessed January 31, 2015, http://www.tsa.gov/about-tsa.

[130] Edward Rivera, "Rail Transportation in the US: On Track: Higher Production and Spending Will Bolster Demand for Rail Transportation." *IBISWorld Report*, 2014, 9, accessed January 28, 2015, http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/default.aspx?entid=1133.

[131] Ibid.

[132] Ibid.

[133] Andrew Goldsmith, "Port of Rotterdam's Ability to Scan Cargo on Trains Moving at 35 Mph Accelerates Screening with No Loss of Security," 2014, accessed March 30, 2015. http://www.gsnmagazine.com/article/41907/port_rotterdam's_ability_scan_cargo_trains_movin.

[134] *Coast Guard Navigation Center*, July 30, 2014, accessed February 9, 2015, http://www.navcen.uscg.gov/?pageName=NAISmain.

[135] Barbara Zanzinger, "Best Practices: Integration of Airport Checkpoint Security," *Homeland Security Today: Integration of Airport Checkpoint Security*, July 23, 2014, accessed February 9, 2015, http://www.hstoday.us/blogs/best-practices/blog/integration-of-airport-checkpoint-security/17eb7fd287df910cd0a87b135d80ffff.html.

[136] STC-Group website, accessed March 26, 2015, http://www.stc-group.nl/Pages/Education /1033/master-stcnmu-aboutnmu.aspx.

[137] Transportation Research Board website, accessed March 27, 2015, http://prp.trb.org /results.aspx?q=&subject=Aviation&datein=2years#.

[138] Port of Virginia website, accessed March 27, 2015, http://www.portofvirginia.com /facilities /virginia-inland-port-vip.

[139] Port of Virginia website, accessed March 27, 2015, http://www.portofvirginia.com/facilities/virginia-inland-port-vip.

[140] Special Panel on 21st Century Freight Transportation. *Improving the Nation's Freight Transportation System.* (Washington, DC: United States House of Representatives Committee on Transportation and Infrastructure, October 2013): 41.

[141] Rebecca Douglas, "New TSA Facility Provides Real-World Conditions for Equipment Testing," Airport Improvement Magazine, July-August 2009, accessed March 28, 2015, http://www.airportimprovement.com/content/story.php?article=00099.

[142] Mark G. Stewart and John Mueller, "Terrorism Risks and Cost-Benefit Analysis of Aviation Security." *Risk Analysis: An International Journal* 33, no. 5 (2013): 893-908, accessed March 27, 2015, EBSCOhost Business Source Premier.

[143] David E. Cantor, David E., Thomas M. Corsi, and Curtis M. Grimm, "Do Electronic Logbooks Contribute to Motor Carrier Safety?" *Journal Of Business Logistics* 30, no. 1 (2009): 203-222, accessed March 27, 2015, EBSCOhost Business Source Premier.