

NO CLASSIFIED INFORMATION FOUND

Feb 21, 2025

Spring 2017

Industry Study

Industry Report *Transportation*

The appearance of external hyperlinks does not constitute endorsement by the United States Department of Defense (DoD) of the linked websites, or the information, products or services contained therein. The DoD does not exercise any editorial, security, or other control over the information you may find at these locations.



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

TRANSPORTATION 2017

ABSTRACT: The transportation industry has long been the keystone of America's security, military strength, and economic prowess. Today, challenges besiege this vital industry, directly impacting its ability to meet national resourcing requirements and continued economic expansion. The most significant challenges are labor shortages, inadequate infrastructure, and barriers to automation (to include cyber security threats), each of which is impacted by burdensome regulation. The government, in coordination with industry stakeholders, must address these challenges by making strategic investments in infrastructure, reviewing, revising or rescinding current regulations, and implementing new policies to incentivize growth and industry efficiency.



Mr. Eric Chowning, Dept of the Navy

Mr. Shawn Clay, Dept of the Army

CDR Jeffrey Harris, U.S. Navy

Lt Col Gene Jacobus, U.S. Air Force

Col Larry Jenkins, U.S. Marine Corps

Ms. Patrice Jones, Dept of the Navy

LTC H. Clay Lyle, U.S. Army

Mr. Stephen Moree, Defense Security Cooperation Agency

LTC Eric Olson, U.S. Army

LTC Steven Putthoff, U.S. Army

COL Pablo Bruno Servat, Argentine Army

Mr. Kevin Slone, Dept of the Air Force

Lt Col Brett Sowell, U.S. Air Force

Ms. Elia Tello, Dept of State

LTC Christopher Warner, U.S. Army Reserve

CAPT Matthew C. Callan, U.S. Coast Guard, Faculty Lead

Ms. Valerie Belon, Dept of State, Faculty

Ms. Betty Hoapili, Defense Logistics Agency, Faculty

Mr. David Lemek, Dept of Homeland Security, Faculty

Industry Study Outreach and Field Studies

On Campus Presenters:

Management Essentials of the Railroad, Washington DC
 National Motor Freight Traffic Association, Washington DC
 National Pilot Sourcing Forum, Washington DC
 Atlas Air and Cargo, Purchase, NY
 Waterways Council, Inc., Washington DC
 FedEx Corporation, Washington DC
 Liberty Global Logistics, Washington DC
 Washington Metro Area Transit Authority (WMATA), Washington DC
 RAND Corporation, Washington DC
 U.S. Coast Guard, Office of Maritime Security Response Policy (CG-MSR), Washington DC
 American Association of State Highway and Transportation Officials, Washington DC
 American Short Line and Regional Railroad Association, Washington DC
 Toole Design Group, Washington DC

Field Studies – Domestic:

Federal Aviation Administration, Air Traffic Control Systems Command Center, Warrenton, VA
 Virginia Inland Port, Front Royal, VA
 American Trucking Association, Washington DC
 Norfolk International Terminal, and Virginia International Gateway, Norfolk, VA
 Norfolk Southern Rail, Richmond, VA
 UPS Freight, Richmond, VA
 Department of Transportation, Washington DC
 832d Transportation Battalion, Jacksonville, FL
 Port of Jacksonville, Jacksonville, FL
 LANDSTAR Systems, Jacksonville, FL
 Crowley Maritime, Jacksonville, FL
 CSX Railroad, Jacksonville, FL
 New Fortress Energy, Miami, FL
 U.S. Southern Command, Miami, FL
 DHL Express, Miami, FL
 U.S. Customs and Border Protection, Miami Port and Intl Airport, Miami, FL
 U.S. Senate Committee on Commerce, Science and Transportation, Washington DC

Field Studies – International:

Panama Canal Authority, Panama City, Panama
 U.S. Ambassador to Panama, Panama City, Panama
 Royal Flora Holland, Rotterdam, Netherlands
 Van der Vlist Special Transport and Logistics, Rotterdam, Netherlands
 Port of Rotterdam, Rotterdam, Netherlands
 Eurostar International, London, United Kingdom
 Royal Mail, London, United Kingdom
 International Maritime Organization, London, United Kingdom
 U.S. Embassy, London, United Kingdom

Our unity as a nation is sustained...by easy transportation of people and goods
- President Dwight D. Eisenhower¹

I. Introduction

The movement of people and materials has been the hallmark of strong and vibrant societies since the dawn of modern civilization. From mobilizing large armies, to moving people across vast distances, transportation has served as the core of societal strength and security. Today, the transportation industry continues to be the instrument through which the U.S. achieves security, drives global prosperity, espouses national values, and underscores international order. Moving forward, the government and key stakeholders must synchronize efforts to address critical challenges facing this vital industry.

Plagued by growing personnel shortages, deteriorating infrastructure, barriers to automation (to include cyber security threats), and burdensome regulation, the transportation industry requires action by the government and key stakeholders in order to remain a preeminent industry in the global marketplace, supporting a strong national defense. Current corporate strategies and government initiatives have been designed to confront these impediments; however, there are no comprehensive strategies to address the spectrum of industry challenges.

The focus of this report is to highlight the importance of the transportation industry to U.S. national security. It begins by clearly defining the transportation industry and outlining its current condition. This provides the basic framework for the research and analysis of challenges facing the industry across each of the primary sectors (maritime, air, rail, and trucking). It concludes with individual essays expounding on those core issues and offering recommendations for the government and key stakeholders to grow this critical infrastructure, and a thriving economy.

The methodology used in developing this report consisted of extensive research through a variety of mediums, to include literature review, foreign and domestic industry visits, and engagements with leaders from across government and industry. Further, each seminar member completed individual research projects that are reflected as essays on major issues in this report. In order to secure a sufficient level of understanding of the depth and breadth of transportation as an industry, it is essential to have a common understanding of the industry.

II. The Industry Defined

The transportation industry moves people and goods, and provides services through the principle modes of maritime, air, rail, and trucking, across private and public domains. Although the movement of people is a considerable element of the industry, this report primarily concentrates on the movement of freight across the different modes. The transportation industry drives the U.S. economy, as every business and industry depends on the transportation system to obtain needed materials and labor, and to get goods and services to customers. According to the Department of Transportation (DOT), “more than \$1 out of every \$10 produced in the U.S. is related to transportation activity.”² Millions of workers depend directly and indirectly on the transportation system for jobs. In 2014, employment in transportation and related industries accounted for 9.4 percent of all employment.³ Moreover, in 2014, the transportation industry added \$1.4 trillion in purchases and investments to the economy, or 8.9 percent of Gross Domestic Product (GDP).⁴ In 2014, the freight transportation industry employed 4.6 million people and comprised 9.5 percent of the U.S. economic activity as measured by GDP.⁵

The economic and social complexion of life in the U.S. reflects its mobility and its extensive transportation network. This enormous network consists of 4.2 million miles of roads, more than 19,000 public and private-use airports, about 140,000 miles of freight and passenger railroads, and 25,000 miles of navigable waterways.⁶ It connects people and businesses across the U.S. and with the rest of the world through a vast array of infrastructure, equipment, and supporting services.

In 2014, the estimated value of U.S. transportation assets was \$8 trillion, with the public owning 50.5 percent (highways, streets, publicly-held transit facilities, airports, seaports, inland ports and terminals), private companies owning 31.5 percent (railroads, trucks, planes, and ships), and the remaining 18 percent consisting of personal motor vehicles.⁷ In 2015, the industry moved 18 billion tons of goods, valued at more than \$19.2 trillion, representing a four percent increase from 2012.⁸

While the various modes compete with each other in some respects, they each have their own comparative advantage. While trucking provides the greatest flexibility, railroads and waterways provide the most efficient long-haul movement, and air provides the fastest movement over long distances. Projected growth of the U.S. economy and population, along with the increasing interdependence of the global economy, will bolster demand for movement of freight across all modes of transportation. This is reflected in the current condition of the transportation industry.

III. Current Condition

The transportation industry is a critical component of national security. Each of the four aforementioned modes has its own unique operating environment, organizational structure, and market. Throughout the industry, all modes are impacted by the increasing size, scope, and diminishing timeframe demands of globalization. The economic health of each mode is strong, with the industry modes employing similar business strategies. While most of the modes operate as oligopolies, each is positioned to take advantage of globalization. The Department of Defense's (DOD) reliance on an economically healthy transportation industry cannot be overstated. The U.S. military depends on the transportation industry to meet its national security responsibilities, such as enabling global power projection and maintaining the constellation of bases and operating locations worldwide.

This industry is dominated by the oligopoly market structure. The inland waterways maritime market is controlled by three companies accounting for 44 percent of market share.⁹ The air sector is subdivided into passenger and freight, with passenger air dominated by four airlines comprising 62 percent of the market and two freight carriers controlling 82 percent of their respective market.¹⁰ In rail, the top four Class 1 companies account for 88 percent of revenue.¹¹ The trucking sector, as the sole outlier, approaches perfect competition with 50 of the largest long-distance freight companies accounting for less than 30 percent of that sector's market share.¹² This reflects trucking's relatively low barriers to entry, compared to the other three modes.

Strong economic health, partially due to a high degree of concentration, is shared across the majority of the industry.¹³ Airline revenue has grown every year since 2011 and profit margins have increased two-fold to over 12 percent during that time. Employment has also increased by approximately two percent.¹⁴ Between 2011 and 2016, rail profit margins were estimated to have increased to 30.6 percent.¹⁵ Trucking has also seen modest increases, where the sector has realized consistent five to six percent growth in freight traffic and revenues since 2010 as manufacturing and consumer spending increased post-recession.¹⁶ However, this performance has not been matched by the inland waterways sector. Due to droughts and slumping coal demand, this sector

performed unevenly from 2011 to 2016, with industry revenue declining at an annualized rate of 1.1 percent.¹⁷

Within modes, companies employ similar business strategies. Within the maritime mode, few differences exist between strategies, offering similar services on a closed network. Air carrier strategies are also very similar, either focused on hub and spoke or point-to-point operations, and they generally compete on price and service. The most similar strategies are found in rail, due to its fixed network and similar assets that allow easy transition between company regions. Within trucking, due to the low cost of switching between companies combined with low concentration, strategies focus on cost and service differentiation.¹⁸

The transportation industry faces little threat from external competitors due to the high barriers to entry for international companies. Cabotage (domestic point-to-point shipping) laws protect U.S. companies, such as inland waterways and airlines, while the rail sector operates on a closed network. The trucking sector also has a low level of globalization, but this is changing in recent years as “large players have developed international networks to provide integrated door-to-door transportation services.”¹⁹ The most serious threat to transportation sector market share comes from within the industry itself, as the three surface modes compete with each other, and to a lesser extent with air.²⁰ Many producers could utilize any of the four modes, but the final choice comes down to cost, schedule, and efficiency. Companies are trying to hedge competition across modes by diversifying into a second mode, or developing strategic intermodal partnerships, especially in light of increased globalization.

International air travel and freight movement are growing, and U.S. air carriers support initiatives to keep the aviation sector viable. These initiatives include the Federal Aviation Administration’s (FAA) efforts to field the Next Generation (NextGen) Air Transportation System,²¹ and to address a growing pilot shortage in the next decade.²² Trucking is also primed to take advantage of increasingly globalized supply chains, and growing distribution within North America offers U.S. firms greater growth opportunities. Meanwhile, building networks by acquiring trucking firms in prime international markets could enable U.S. firms to capitalize on the expected seven to nine percent growth within Asian road freight industries.²³ Of notable exception is the U.S. international maritime industry, with only 169 U.S.-flagged vessels, representing a mere 0.4 percent of the global fleet.²⁴ This dearth of ship production is due to the high cost of producing ships domestically and the high operating costs of U.S.-flagged ships.²⁵

As an example, during the first Gulf War, the transportation industry moved over 293,000 personnel to Saudi Arabia, and shipped over 2,280,000 short tons of equipment.²⁶ This is comparable to moving the city of Richmond, VA, to the Middle East.²⁷ The U.S. depends on the transportation industry to serve as the backbone of a strong, vibrant economy. When the U.S. GDP grows, the economy is strong and able to support the global security enterprise. However, a weak economy with resultant low GDP reduces the federal government’s options for spending on military capabilities. A strong transportation industry enables the U.S. to project power across all instruments of national power. While the industry is performing at a strong level, many challenges and concerns remain which must be addressed to sustain national security and continue economic growth.

IV. Challenges

Numerous challenges face the transportation industry that impact its ability to meet the national resourcing requirements and expand to support a growing economy. The most significant

challenges are human resource shortages, inadequate infrastructure, and barriers to automation, each of which is impacted by regulation. Government and industry stakeholders must address these critical areas to ensure industry viability.

Personnel. Personnel shortages are a concern across all industry sectors, but particularly acute within the air sector, where demand for pilots is quickly outpacing commercial and military supply. Over the next five to ten years, approximately 20,000 to 30,000 pilots will reach mandatory retirement age.²⁸ Additionally, over the past decade, there has been a significant reduction in students interested in becoming airline pilots, due to high costs of training, reduced options for financial aid, low starting salary, and industry instability since September 11, 2001. The current requirement for 1,500 flying hours (a five-fold increase since 2012) necessary to complete commercial pilot certification exacerbates the challenge. The increased flight time requirement is a significant entry barrier and further impacts pilot shortages by increasing licensing costs and certification time. These factors are stifling the industry's ability to meet the forecast demand for 70,000 to 95,000 pilots over the next 20 years, resulting in critical national shortages.²⁹ The military, as a key component of the national source of pilots, is already experiencing a shortage of over 2,000 pilots as they increasingly transition into the commercial sector.³⁰

While not as immediate as the shortages in air, trucking is approaching a similar crisis with available drivers. Trucking associations, representing many trucking companies, anticipate capacity and capability shortages in meeting distribution demands over the next 20 years.³¹ Other barriers to attracting talent to a career in the trucking sector include the perception of the blue collar nature of the work, as well as the time away from home.³² In fact, driver availability is the leading challenge facing the trucking industry, with an estimated need for roughly 100,000 additional drivers, per year, through 2023.³³

Rail and maritime sectors face less threatening, albeit important, shortages that could negatively impact both the economy and national security. Within the railroad sector, personnel shortages are specific to locomotive operators. This shortage is due to an aging workforce, and decreased retention and recruitment due to work-life balance. Additionally, proposed labor regulations mandating two-man crews in each train adds additional labor force uncertainty. The rail sector's concern about this shortage is expected to increase as the economy grows and the demand for rail services increases.

The maritime sector is experiencing similar shortages in trained crews. Some argue that repealing, or significantly revising the Jones Act of 1920 could reduce the shortages, but may negatively impact U.S. jobs, further reducing American carriers and crews available for national security support. The Jones Act mandates the following requirements:

- 1) Ships to be owned by U.S. companies, controlled by U.S. citizens, with at least 75 percent U.S. ownership, and at least 75 percent U.S.-crewed;
- 2) Ships must have been built (or rebuilt) in the U.S.; and,
- 3) Ships must be registered in the U.S.

Opinions on the Jones Act vary, but many feel that while this act was intended to ensure U.S. national security support and safeguard American jobs, it actually limits competition, requires government subsidies, and passes on costs to the American consumer.³⁴ Many people in the maritime industry feel that economic efficiencies can certainly be gained by repealing or revising the Jones Act; however, a change in the regulations would further impact the U.S.' ability to support national security with U.S.-flagged vessels. The U.S.-flagged fleet in 1960 had 2,926 ships and 16.9 percent of the global fleet, while in 2016 only 169 U.S.-flagged vessels remained, or 0.4

percent.³⁵ The U.S. is already at the tipping point of not being able to man defense-related operations at sea.³⁶

Infrastructure. Regardless of individual challenges within each mode, inadequate infrastructure challenges all sectors of the transportation industry. Seaports are restricted in growth due to available land within congested metropolitan areas, airports are crowded by urban sprawl, railroads compete for finite tracking between passenger and freight demands, and trucking operates on deteriorated and increasingly congested interstate systems. Similar to personnel shortages, these challenges are further compounded by legislative oversight or regulatory requirements.

Investments in automation in the maritime sector have created efficiencies where maritime corporations are unable, or limited in their ability to physically grow. Ports and maritime firms across the U.S. are investing heavily in automation, improving capacity and revenue across the industry. However, supporting infrastructure investments are largely ignored. Inland waterways, a critical element of the economy that accounts for nearly 15 percent of all intercity freight, is in dire need of investment and improvement.³⁷ Roads leading into and out of ports have not kept pace with ports' improved efficiency.

Unique to the rail sector, railroad companies are responsible for their infrastructure, to include maintenance, extension and improvement of tracks, property, bridges, and signals; all of these elements are in need of capital investment. Yet Congress requires the rail industry to implement Positive Train Control (PTC), representing an additional financial resource burden that competes directly with rail's ability to grow and improve needed infrastructure. This circumstance could negatively affect rail's future ability to keep pace with a growing economy.

Infrastructure funding for federal highways continues to decline as the Federal Highway Administration estimates a \$10 billion annual shortfall in the funding needed to maintain current highway conditions.

Regulations. Just as the federal government is accepting risk in infrastructure investment, increased regulations are passing on additional costs to both trucking companies and customers. According to a 1988 Federal Trade Commission study, "federal and state regulation of trucking drove prices up and encouraged inefficient practices." Freight rates have increased by one-third to one-half and increased the freight bill to U.S. industries by \$5.5 to \$7.3 billion per year."³⁸ Despite deregulation, every aspect of the trucking sector is regulated to some extent. For a commercial driver's license and full certification, there are 16 separate endorsement and restriction codes, each requiring separate certification, even if the weight and size of the vehicle are the same.³⁹

Automation. Automation is inevitable, and overall a net positive on operations across the transportation industry. The challenge lies in controlling or keeping up with the pace of change and the cyber risk associated with automation. Society's discomfort with increased automation has also inhibited progress in this area. This comes at a time when automation could partially address many of the manpower issues across the industry. For instance, little research exists regarding the cost of automation versus the cost of a fully-trained human pilot in the air sector. Efficiencies can be gained as well from increased automation in the maritime sector, both at sea and in American ports. In 2016, fuel and personnel costs accounted for more than 40 percent of operating costs.⁴⁰ Further investments in maritime automation would increase overall efficiency and significantly increase profit margins for shipping firms. Initiatives like PTC, Electronically Controlled Pneumatic Brakes (ECP), and data analysis and digitization should be considered as the first steps towards the automation of railroad transportation. At the same time, with greater reliance on

automation comes the increased “technology-induced risk” that creates vulnerabilities in this critical infrastructure.⁴¹

Automation is significantly challenged by cyber security threats. In addition to the more publicized efforts of automation, such as autonomous vehicles, each sector is investing in information technology and automated systems that impact nearly every element of their day-to-day operations. Increased automation in the cockpit, the train engineer’s cabin, or the cab of a truck introduces opportunities for cyber-attacks that could have significant impacts on national security, both from a safety perspective as well as an economic perspective. Whether at the hands of cyber terrorists, criminals, or the multitude of simple hackers, attacks in the cyber realm are increasing in both likelihood and risk.

Efforts to address all of the aforementioned challenges by the government and key stakeholders are ongoing with uneven results. Several initiatives are being implemented; however, the efficacy of the proposed solutions remains to be seen. Many of these challenges, current initiatives, and proposed recommendations are addressed more fully in the essay section of this report. The future outlook of this vital industry depends on successfully addressing these challenges.

V. Outlook

The outlook for the transportation industry is marked by sustained growth as the U.S. and global economies continue to prosper. This growth is being built on the industry’s foundation of capacity and capability to meet the national security resourcing requirements. However, there are a number of impediments impacting its ability to achieve full surge and mobilization potential. Focused action to address the impediments of human resource shortages, infrastructure needs, and barriers to automation is required to sustain the industry’s ability to continue meeting national security resource requirements into the future.

The short-term outlook for the transportation industry is characterized by a continual growth of between 1.9 and 3.4 percent annually across the sectors.⁴² This growth is closely tied to the continued growth of the world economy through global trade, spending, and consumption. Over the next five years, projected headwinds of crude oil price volatility, growing human capital shortages, aging domestic infrastructure, and over-regulation will constrain growth potential. Additionally, exogenous events such as terrorism, global conflicts, and cyber-attacks have the potential to significantly impact the future outlook for the transportation industry.

The strong relationship between economic growth and related transportation needs will define the long-term outlook for the industry. The forecast positive growth of the U.S. and global economy will lead to continued growth in the transportation industry through each of its sectors. In addition to the positive economic outlook, other factors impacting the long-term outlook for the industry include crude oil prices, technology and innovation, regulatory reform and security. The ebb and flow of crude oil prices will remain one of the most impactful factors on the profitability of the transportation industry modes. However, other technology and innovation initiatives within sectors of the industry are expected to aid in the projected growth. Innovation efforts, such as the introduction of autonomous platforms across all sectors, NextGen air traffic control, and PTC will propel the transportation industry into the future. Another major factor for the long-term outlook of the industry is regulation. As the industry evolves to include additional levels of automation and initiatives designed to increase efficiency, regulatory reform is necessary to avoid suppressing the potential benefits. Finally, as previously indicated, physical and cyber security will be a limiting factor with respect to the industry’s growth.

Despite the impediments to future growth, the transportation industry is still positioned to maintain a preeminent position in the global marketplace. However, the challenges of labor shortages, poor infrastructure and barriers to automation will continue to plague the transportation industry unless properly addressed by key stakeholders across the industry and government. There are a number of initiatives designed to address the individual challenges by sector. Examples include the shipping sector's engagement with the International Maritime Organization (IMO) to address maritime law, the National Pilot Sourcing Forum's (NPSF) mitigation options to address the aircraft pilot shortages, the National Association of Manufacturer's proposal for U.S. transportation infrastructure improvements, and the Department of Homeland Security's creation of a new operation division (National Protection and Programs Directorate) to specifically address the cyber threat in the private and public sectors. While these individual initiatives may successfully confront impediments facing the transportation industry, there is no coherent strategy to address the spectrum of challenges facing the industry as a whole. Nowhere is this more evident than a lack of comprehensive public-private strategy, with an executable plan, to face the cyber threat. This has the potential to impact the transportation industry's ability to remain a preeminent force in the global marketplace into the future. The government must play an active role in securing the transportation industry.

VI. Government's Role

The role of the US government is to ensure safe, efficient, viable and environmentally sound modes of transportation today, and in the future. The government plays a vital role in: 1) developing and financing national infrastructure; 2) managing and planning the transportation system; 3) fostering a competitive playing field among firms in the industry; 4) developing and managing programs vital for supporting national security; and, 5) developing industry safety and security standards and regulations. The government's goal of national security and prosperity hinges on a strong and viable transportation industry.

The government has established various programs across the transportation industry to ensure support for surge and mobility requirements in peacetime, war, and emergency response. The Maritime Security Program (MSP) provides military access to modern U.S.-flagged vessel capacity, as well as the global intermodal transportation network. This network includes vessels, terminal facilities and U.S. citizen merchant mariners to crew the government-owned and commercial fleets. The Civil Reserve Air Fleet (CRAF) program supports defense airlift requirements when airlift needs exceed the capacity of military aircraft. The Railroads for National Defense program, in conjunction with Strategic Rail Corridor Network, ensures defense rail needs are identified, coordinated, and met. The national interstate system, created by President Eisenhower, facilitates trucking's efficient freight movement for DOD and private commerce throughout the U.S. The ability of the government to meet future defense mobility and emergency response obligations hinges upon how well it responds to the current industry challenges of human resource shortages, inadequate infrastructure, and impediments to industry automation now and into the future.

The government must make strategic investments in infrastructure, while also reviewing and revising current regulations to ensure they are value-added. Infrastructure investments will allow for increased capacity, improved passenger safety, and increased automation of all modes, thus reducing shortages by reducing demand. These investments in transportation infrastructure should be included in any major infrastructure plan the new administration pursues, recognizing that

budget trade-offs will be required in a fiscally constrained environment. These tradeoffs will become increasingly challenged as mandatory spending grows exponentially. With the absence of annual appropriations, discretionary spending opportunities such as infrastructure improvements are negatively impacted.

Furthermore, as the new administration conducts a thorough regulatory review, the administration should focus on close coordination with private sector stakeholders on regulations impacting the safety and efficiency across all modes. Specific examples include the Aviation Safety and Federal Aviation Administration Extension Act of 2010, which impacts the national supply of commercial pilots; the Jones Act of 1920, which impacts access to maritime assets; and the Railroad Safety Improvement Act of 2008 that directs PTC implementation. Further, the government must encourage and/or implement new policies that recognize the growing challenges associated with data and information security, and cyber threats to critical transportation and infrastructure assets. This includes improved infrastructure and ready access to commercial transportation for defense mobility and emergency response needs. Leadership at all levels of government must clearly understand the major issues impacting the transportation industry.

VII. Essays on Major Issues

The transportation industry faces major issues of labor shortages, inadequate infrastructure, and barriers to automation, each of which is impacted by varied levels of regulation. Each essay below further explores these major issues across the maritime, air, rail, and trucking modes.

Maritime

SECURING THE FUTURE OF THE U.S. MERCHANT MARINE

The U.S. merchant marine plays a vital role in enabling the U.S. to move its goods and military force anywhere in the world at any time. During the 1991 Gulf War, 10,000 mariners moved 220 shiploads of more than 2.1 million tons of cargo, with U.S.-flagged ships carrying 80 percent of the ocean-going cargo.⁴³ More recently, U.S. mariners moved 90 percent of the war supplies to and from Iraq and Afghanistan.⁴⁴ Twenty-six years after the Gulf War, many military leaders, to include the head of U.S. Transportation Command have expressed concerns about the state of the merchant marine, and the U.S. government's ability to meet sealift requirements.⁴⁵ Today, the merchant marine is a "tale of two fleets" facing serious challenges. On the one hand, the cabotage laws that restrict intra-U.S. shipping to U.S.-flagged ships ensure a relatively healthy domestic industry. On the other hand, the U.S. merchant marine is engaged in international trade, but in a state of continuous decline.

Critics of the Jones Act see the law as an unnecessary protectionist measure that drives costs up for U.S. consumers. However, a 1996 Government Accountability Office report disputes these claims, concluding that it is "extremely difficult to calculate both the actual costs of the Jones Act and the supposed savings that critics champion because there is no reliable data from which to make estimates."⁴⁶ Cabotage provisions such as those in the Jones Act are not unique, as the U.S. has similar restrictions in the aviation, rail, utility, and communications industries. Repealing the Jones Act would have a devastating impact on the maritime industry as well as the overall U.S. economy, as U.S. shipyards directly employ 107,000 people, support more than 402,000 jobs across every state, and generate \$24 billion in income and \$36 billion of the Gross Domestic Product.⁴⁷

The 2017 National Defense Authorization Act includes three measures to address the current issues/challenges facing the U.S. merchant marine, to include a \$5 million stipend for each of the 60 ships enrolled in the Maritime Security Program; the “Military to Mariner” initiative that maximizes service members' ability to apply qualified training and sea service toward obtaining a Merchant Mariner Credential and/or a Standards of Training, Certification, and Watchkeeping endorsement; and the continuation of the design of National Security Multi-Mission Vessels.⁴⁸

The following policy recommendations are made to improve mariner availability: 1) *Require certain U.S. exports (e.g., agricultural goods and liquefied natural gas) be carried on U.S.-flagged vessels, or include provisions in trade policies that would require a certain percentage of U.S. exports be carried on U.S.-flagged ships. U.S. exports of Liquefied Natural Gas (LNG) are expected to increase by 30 percent over the next 10 years.⁴⁹ Requiring U.S.-flagged ships to export LNG could mean 30 additional ships and thousands of U.S. mariners crewing those ships;⁵⁰* 2) *Provide tax incentives to U.S. carriers and potentially shipper tax incentives. Currently, the U.S. treasury does not benefit from foreign-flag operations, so providing similar tax breaks for U.S.-flagged ships would not significantly impact tax revenues; and* 3) *Hire additional mariners on the rolls of the U.S. Navy or the Maritime Administration. These mariners could man Military Sealift Command ships.*

Ms. Patrice Jones

THE U.S. MARITIME INDUSTRY: OVER-REGULATED AND UNDERFUNDED

The United States maritime industry is in decline due to the protectionist over-regulation of the 1920 Jones Act that closes the market to competition, and chronic infrastructure underfunding that threatens the viability of the inland waterways transportation sector.

In response to perceived threats from foreign shipping, the Jones Act enacted competition-killing provisions regulating the ships and crews engaged in U.S. domestic port-to-port commerce. The Jones Act contains the following key provisions: 1) Ships must be owned by U.S. companies that are controlled by U.S. citizens, with at least 75 percent U.S. ownership; 2) The vessel must be at least 75 percent crewed by U.S. citizens; 3) Ships must have been built (or rebuilt) in the United States; and 4) Ships must be registered in the U.S.⁵¹

These actions, coupled with the high cost of American labor and ship-building, have had a dramatic impact on the industry. In 1960, the U.S. flagged fleet of 2,926 ships made up 17 percent of the global fleet. In 2016, the 169 U.S.-flagged vessels made up 0.4 percent of the fleet.⁵²

While the U.S. government has over-regulated the domestic shipping industry, it has turned a seemingly blind-eye to the need for extensive inland waterway infrastructure requirements. According to the 2017 American Society of Civil Engineers Infrastructure Report Card, inland waterways and marine ports require \$37 billion in total funding by 2025 to meet the most critical infrastructure needs. Despite the 2015 increase in the diesel fuel surcharge (20 to 29 cents per gallon), only \$22 billion has been identified in new spending, producing a \$15 billion gap.⁵³ When the government is unable to properly maintain the inland waterways, transportation operators are unable to offer a reliable, predictable, cost-effective product to their customers. As a result, potential users of the inland waterways shift their business to rail and trucking, contributing to the stress on these networks, and driving up costs.

The government can remediate this situation by enacting a series of policy changes which will once again make the maritime industry a competitive part of the U.S. transportation network. **The following policy changes are recommended:** 1) *Eliminate the requirement for ships engaged in U.S. domestic maritime shipping to be U.S. built. This will reduce the cost of*

equipment and make shipping more competitive; 2) *Eliminate the requirement for 75 percent of non-licensed crew of ships to be U.S. citizens.* This will also lower operating costs and increase the available labor pool; 3) *Federal and state governments provide an infusion of funds to repair and enhance inland waterways infrastructure.* This will increase the capacity and productivity of the network; and 4) *Allow registered ships of allied nations to take part in the Department of Transportation Maritime Security Program.* This will expand the capacity of the Department of Transportation to support national security crises by providing a reliable source of maritime transportation to mobilize when needed.

Mr. Stephen Moree

AUTONOMOUS CARGO SHIPS: THE FUTURE IS NOW

The Global Deep-Sea, Coastal, and Inland Water Transportation industry is very dependent and reactive to four key factors: 1) global consumer spending; 2) the industrial production index of the 34 Organization for Economic Co-operation and Development countries; 3) total value of world trade; and 4) the world price of crude oil.⁵⁴ By far, the two largest operating cost drivers in the industry are fuel and labor (the ship's crew). In 2016, fuel costs accounted for 20 to 30 percent of all operating costs and wages accounted for 18 percent.⁵⁵ Other challenges facing the industry include a surplus of capacity, a sailor shortage, safety, piracy, and flat to slowly growing revenues.

Autonomous cargo ships will solve most of these problems, and they are just a few years away. Eliminating the crew would impact the design of the ship itself. "Without people on board, many constraints of the ship layout are removed. The removal of crew accommodations and the entire deckhouse saves costs, weight, and space, as well as enabling the ship to carry more cargo."⁵⁶ The next human shortcoming resolved by autonomy is that according to a 2012 report, "75 to 96 percent of marine accidents are a result of human error. Remotely controlled and autonomous ships would significantly reduce the risk of such mistakes"⁵⁷ The growing sailor shortage may make the need for automation a necessity. "The head of the U.S. Maritime Administration states that the U.S. could need 70,000 new sailors for the nation's maritime fleet by 2022. The United States Merchant Marine Academy and the six state maritime academies only graduate 900 per year."⁵⁸ Autonomous ships will be a deterrent to piracy, with sleeker designs almost impossible to board at sea and the capability to program or remotely control them to shut off engines and drop anchor or steer in a circle until the Navy arrives. The final anti-piracy deterrent is there is no crew to ransom!

Given the strength of the case for autonomous cargo ships, the biggest hurdle to overcome may be regulatory. There will also be federal and local regulations and policy to be revised, but the international law must be changed first. "The International Maritime Organization (IMO), the arm of the United Nations overseeing global shipping, prohibits ship operations without a crew. The International Convention for the Safety of Life at Sea (SOLAS) requires all ships to be "sufficiently and efficiently manned," the IMO said.⁵⁹ **Primary policy recommendations include:** 1) *The IMO must recognize autonomous ships and authorize their operations in international and territorial waters;* and 2) *SOLAS must address the safety and risk mitigation concerns through policy and regulation.* The case for autonomous ships is a compelling one and this innovation will progress rapidly because the economic and safety benefits are so strong.

LTC Clay Lyle

CYBER SECURITY IN MARITIME OPS: NEW THREAT TO AN OLD INDUSTRY

With the newly elected administration proposing massive infrastructure investment and other fiscal policy to expand gross domestic product up to a four percent goal, the economy is expected

to expand in the coming years. The U.S. transportation industry will play a key role in moving the country's goods while enabling that growth, yet the aging industry, particularly maritime ports, is struggling to expand in order to meet the growing demand. Port authorities are increasingly turning to technological innovation to optimize port operations. However, this type of innovation increases the risk from cyber threats. Despite increased investment in security, particularly following the 2011 terrorist attacks,⁶⁰ investments in cyber security have been minimal, and few ports across the U.S. have placed cyber security among their top concerns.⁶¹

The following recommendations are intended to address this “technology-induced risk” that comes from a reliance on technology and digital information and to ensure the continued security and resilience of this critical infrastructure:⁶² 1) *Revise/Update the Maritime Transportation Security Act (MTSA)*. The MTSA, implemented in 2002, must be updated to provide detailed guidance and requirements with respect to cyber security and ports' responsibilities for protecting critical infrastructure; 2) *Conduct Aggressive Inspections*. The Coast Guard, empowered through an updated MTSA, must take a much more proactive and aggressive role in specifically inspecting port cyber security and providing assessments on how best to recognize and mitigate threats;⁶³ 3) *Establish a National Level Council*. There is currently no established group at the national level to coordinate maritime issues and facilitate the sharing of information;⁶⁴ and 4) *Incentivize Ports*. Better sharing of information will help ports fully understand the threat and therefore incentivize them to action; however, there are other steps the federal government can take to increase investment in cyber security. For instance, the Federal Emergency Management Agency's (FEMA) Port Security Grant Program should be linked more closely to cyber security, or FEMA could waive the required 25 percent matching investment on any grant focused on cyber security.⁶⁵ As well, the federal government could incentivize ports through tax breaks on expansion investments that address cyber security.

Col Larry Jenkins

Air

PILOT SHORTAGE: WHAT CAN EDUCATION AND TRAINING FIX?

The Air Carrier sector is a critical piece of the national economy, and the U.S. government needs to assist by ensuring a continuous and viable pool of candidates is available to choose from in order to maintain and grow economic markets across the country. Regional airlines and the U.S. military have been dealing with a pilot shortage for years now. As of March 2017, the U.S. Air Force alone is short over 600 pilots.⁶⁶ According to a study by the University of North Dakota's Aviation Department, the commercial airlines will be short over 15,000 pilots (active pilots currently at 60,200) by the year 2026.⁶⁷ Reasons for this shrinking pool of pilots include: 1) the number of current pilots that will be retiring and 2) a smaller pool of incoming commercial pilots each year due to training requirements and the increasing cost of qualification (flying hours, etc.). Depending on the level of training and education attained, costs can range anywhere from \$150,000 to \$300,000 to qualify as a commercial pilot.⁶⁸

Traditionally, commercial airlines have recruited heavily from the military to find pilots, due to the experience and maturity those officers bring to the job. Military pilots are given credit for their flight hours obtained in service, and only need half of the Federal Aviation Administration's required 1,500 hours to be a commercial pilot. However, in today's environment when both are short on pilots, how can either the commercial airlines or the military increase their pools of available and qualified applicants? **The following recommendations are offered to offset the**

shortages: 1) *The Department of Defense and Department of Transportation join forces to form a Pilot Academy modeled after the U.S. Merchant Marine Academy;* and 2) *A Public-Private Partnership be established to provide for the funding of the academy.*

The purpose of the academy would be to provide the military with more pilots, as required in times of need (war/conflict), and to provide the airlines with additional pilots to help keep pace with and develop their routes/markets so the U.S. economy can continue to grow. Initially, there would be quotas for the number of cadets that would go into the military (versus how many become airline pilots), simply due to the urgency of the shortage in the military (for example, 50 percent to each). Cadets that are accepted to the Pilot Academy would know from day 1 that they are training to be pilots. This would create an enormous draw for applicants, competing for a spot at the Pilot Academy. Airlines that want to be able to recruit from the Pilot Academy would pay annually into a general pilot training fund.

LTC Chris Warner

THE NATIONAL PILOT SHORTAGE: REGULATORY BARRIERS

The air transportation industry in the U.S. accounts for over five percent of the nation's gross domestic product and provides almost 11 million jobs.⁶⁹ The enterprise is a vital component of U.S. national security, given its large economic impact and Department of Defense's reliance on civil aviation for movement of personnel and equipment in peacetime and war. However, a growing pilot shortage is beginning to have severe implications for commercial air carriers and the military.⁷⁰

Two regulatory barriers contribute to the pilot shortage. First, since 2010, U.S. law requires every commercial airline pilot to obtain an Airline Transport Pilot (ATP) certificate. This requirement was levied in response to the Colgan Air accident in Buffalo, New York, in February 2009 that killed 50 people, and increased flight hour requirements for new pilots by five hundred percent overnight, from 250 to 1,500 hours.⁷¹ As a result, regional carriers have seen the pool of pilot candidates decrease significantly due to the added cost and time one must invest to become a pilot.⁷² Pilot shortages have led some regional carriers to park airplanes, cancel routes, or even declare bankruptcy. Approximately seventy percent of major airline pilots come from regional carriers⁷³, so their shortages will rapidly become a major carrier problem absent any changes.

Second, the Congressionally-imposed cap on Aviator Retention Pay (ARP) for Air Force pilots is set to increase from \$25,000 to \$35,000 in FY17.⁷⁴ ARP (also known as the "pilot bonus"), incentivizes pilots to remain on active duty after their initial ten-year commitment expires. A 2016 RAND study found that the pilot bonus needs to increase to \$48,500 per year to meet the service's retention target. This figure is based on the best-known data and median industry forecasts in terms of major airline hiring, pilot compensation, and even civilian non-pilot pay, which has a statistically significant effect on pilot retention since not all military pilots pursue airline jobs.⁷⁵

This essay proposes two regulatory changes: 1) *The Federal Aviation Administration should allow new pilots with less than 1,500 hours to apply for a restricted ATP certificate so they can be employed by passenger airlines. The hours' requirement should be based on analysis of safety and training data through a government-funded study, rather than an arbitrary level of 1,500 hours that causes serious shortages in the regional carrier market;* and 2) *Congress should raise the pilot bonus cap in line with Air Force requests, backed by the RAND study. The recent increase to \$35,000 per year is a positive step, but it will likely only slow the growing pilot shortage. Implementation of these recommendations will only scratch the surface in terms of the national*

pilot shortage. However, the government can send a strong message that it recognizes the impact of the aviation industry on national security and the economy.

Lt Col Brett Sowell

NATIONAL PILOT SHORTAGE: RESPONDING TO A NATIONAL CRISIS

The significant growth of the commercial air industry is driving an insatiable demand for pilots that is quickly outpacing the available and projected supply, with shortages already being felt in the military and regional airlines. Over the next 20 years, the mounting pilot shortage will become one of the most critical issues facing the U.S., with projected impacts on the U.S. economy, global transportation, and national security. Recognizing the need for a collaborative approach to this national issue, the U.S. Air Force (USAF) and stakeholders from across the commercial airline industry established the National Pilot Sourcing Forum (NPSF). The NPSF has made measured progress in addressing the critical pilot shortage; however, changes to the forum are necessary to successfully solve this important national issue.

The NPSF began with the focus of producing and sustaining a national pilot force capable of meeting the demands of the USAF and U.S. airline industry through close collaboration.⁷⁶ Over the past three years, the forum has had success in the initial phase of identifying the pilot shortage and producing possible solution options. However, in order to successfully prioritize these options and take necessary action in the next phase, the NPSF must address its current challenges of organizational complexities created by forum members' underlying divergent interests, a lack of assigned responsibilities and authorities, and significant strategic messaging issues.

The NPSF is at a critical juncture where several areas must be considered in order to move forward toward resolving the current shortage. **The most significant recommendations include:** 1) *The immediate need for a comprehensive communications strategy*; 2) *Targeted growth codified in a renewed charter*; and 3) *A long-term organizational evolution*. The comprehensive communications strategy should include a coordinated strategic message, targeted engagement opportunities, and implementation timeline. Further, the NPSF must target growth to formally include all organizations impacted by the pilot shortage, or who have a direct impact on resolving the shortage. They must also revise the NPSF charter to establish the roles, responsibilities, and authorities of each member more clearly. Finally, the forum must evolve into a new, whole-of-government organization via a National Pilot Sourcing Program under the leadership of an Executive Working Group, modeled after the Civil Reserve Air Fleet program. The national pilot shortage is here, and the NPSF must take action *now*...U.S. national security depends on it!

Lt Col Gene Jacobus

FLYING THE PILOTLESS SKIES

The future of commercial and military aviation is facing a crisis significant enough to be a national security concern, as the current and projected number of pilots fall severely short of the requirements. Traditionally, the military services and regional airlines are feeder systems for major commercial airline pilots. However, in recent years demand has far outstripped supply in the military, and a crisis is looming for both military and commercial aviation.

Supply-side solutions include paying bigger bonuses to pilots, increasing the education and training pipeline throughput, and changing regulations to reduce the time and cost of becoming a pilot. However, as the National Pilot Sourcing Forum (NPSF) concluded in their 2016 annual report, “none of the near-term and mid-term options can fully address what is a strategic problem set,” and “our nation simply does not have enough pilots to fulfill all military and airline industry

requirements, now and in the future.”⁷⁷ It is time to have the hard conversation about how to address the demand-side of the problem.

Full aircraft automation will reduce the demand for pilots, get the nation closer to pilot equilibrium, and strengthen national security. However, the infrastructure investment necessary to make full automation feasible in the future needs to begin now to prevent the pilot shortage from becoming a national security emergency. The military services are already testing autonomous aircraft. The Navy is headed down the path of using fully autonomous aircraft in what some pilots may consider less desirable aircraft with the carrier-based air-refueling system. Its predecessor, the X-47B, demonstrated the ability to autonomously take off and land on an aircraft carrier and conduct autonomous aerial refueling. The Air Force has demonstrated autonomous capability in a fighter using the F-16 in what is known as the “loyal wingman” program. Although the technology is not ready to be implemented everywhere today, these examples provide proof that fully autonomous aircraft are a possibility.

The military and civil aviation pilot shortage the United States is facing is significant enough to affect national security, but can be **addressed in part through several recommendations**: 1) *Implement fully autonomous aircraft*. The technology has been proven by both the Navy and the Air Force, and further enabling technologies are being implemented by the Federal Aviation Administration in the NextGen system; and 2) *The path to automating the skies should include gaining buy-in from the labor force and the public, a permissive regulatory framework, and most importantly, a strong cyber defense*.

The solution to the pilot shortage is a combination of supply and demand adjustment that will maintain the nation’s military air dominance, improve economic strength, and keep the U.S. ahead of its adversaries on the forefront of technology.

Mr. Eric Chowning

Rail

RAIL’S POTENTIAL LABOR SHORTAGE

Without freight railroads, American industry and consumers could not participate in the global economy at the level they do today.⁷⁸ Class I Railroads’ operations and capital investment support approximately 1.5 million jobs (1.1 percent of all U.S. workers), \$274 billion in output (1.6 percent of total U.S. output), and \$88.4 billion in wages (1.3 percent of total U.S. wages).⁷⁹ However, the railroad sector is facing a locomotive operator shortage due to an aging workforce and potential new labor regulations.

According to the Bureau of Labor Statistics, the median age for railroad workers is 42.5 years⁸⁰, significantly higher than the United States median age of 37.7 years. The age of locomotive engineers and operators is further skewed to the right to 49.1 years.⁸¹ With no statutory retirement age, many railroad employees have decided to prolong their careers and push retirement to a future date.⁸² To attract new hires, railroads must overcome the obstacles of work-life balance and the general public’s perception that railroads are slow and an outdated mode of transportation.

In April 2014, the Federal Railroad Administration (FRA) announced its intention to issue a Notice of Proposed Rulemaking that would most likely require a minimum of two-person crews on all freight and passenger trains.⁸³ The major railroads object to this ruling, stating that it potentially ties their hands during labor negotiations and would stifle innovative technologies, such as Positive Train Control (PTC). The rail labor unions support the legislation, citing safety for not only crews, but also the general public. Although the FRA cannot provide reliable or conclusive

data to show that one-person crew operations are any less safe, or safer than two-person crew operations, it does have statistical data to show benefits from a second crewmember, and qualitative studies show that one-person train operations pose increased risks by potentially overloading the sole crewmember with tasks. It must also be noted that PTC is not a substitute for all the tasks performed by properly trained conductors.⁸⁴ **The following recommendations are submitted for the issues identified above:** 1) *Institute crew management systems* to track duty hours and crew rest in order to improve safety of operations; 2) *Increase promotion of rail's contribution to society*; 3) *Increase retention and attract new hires* through improved work-life balance; 4) *Invest in PTC and related technologies* to capitalize on potential efficiencies and benefits; and 5) *Delay implementation of FRA's two-man crew legislation* until a joint safety study is completed on single-person operations verse two-person operations.

The railroads are vital to the prosperity of the nation; and for national security, through its ability to move equipment efficiently and cost effectively. The U.S. cannot afford to let trains sit idle due to a lack of foresight in workforce management, or due to a self-inflicted, legislation-induced labor shortage.

CDR Jeffrey Harris

INCREASE RAILROAD COMPETITION AND CAPACITY

To keep pace with the nation's increasing demands for both freight and passenger high-speed rail, the industry must find ways to increase the market and operating efficiency, and broaden competition. The four largest Class 1 railroads are oligopolies with a concentration ratio 4 (CR4) of 88 percent of the market.⁸⁵ The rail infrastructure is owned by the railroads and tightly guarded against competitor use by lobbying Congress against open access or reciprocal switching mandates.⁸⁶ The extensive railroad networks owned by the railroads were enabled by extensive federal land grants, permissive rights-of-way next to government lands and taking possession of private lands through the use of eminent domain cases for economic development.⁸⁷ As such, there is a high barrier of entry into the current market, which precludes competition.

Roadways and airports are heavily congested in many mega-regions and the Department of Transportation projects this trend will significantly worsen in the next 30 years.⁸⁸ Railroads could help reduce much of this congestion by increasing capacity and expanding intercity passenger and commuter rail services. Intercity passenger rail services are limited today to the National Railroad Passenger Corporation (Amtrak), which was established by Congress under the Staggers Act of 1980 to deregulate railroads. The Staggers Act enabled railroads to shed mandated passenger transport and focus solely on freight rail services. As a result, passenger rail services nearly vanished throughout the U.S. Due to deregulation, the freight rail industry consolidated and recovered from near bankruptcy, and is now deemed very successful.⁸⁹ Separating infrastructure from rail operations by breaking existing railroads into two businesses will lower the cost of entry and enable new train operators to enter the market and improve competition.

Railroad capacity hampers many routes. An increase in the number of dual tracks and sidings are needed in order to support the mix of low-speed freight rail and high-speed passenger services. Positive Train Control will improve rail efficiencies and safety, but it won't improve capacity for many routes until more rail infrastructure is added. New routes within the U.S. are needed as demographics continue to change nationally. To support this, there is a need for both public and private investments to modernize and expand the railroad infrastructure.⁹⁰ **The following recommendations are provided:** 1) The U.S. should *break up Class 1 railroad operators into two companies: infrastructure, and operations* in order to lower the barriers to entry for new

competition and market growth; 2) Once the infrastructure is separated from operations, *privatizing Amtrak should be done* to improve passenger rail performance, investment, and expanded services; and 3) The U.S. must *invest in the rail infrastructure by establishing a national infrastructure bank* and address infrastructure funding by increasing revenues.

Mr. Shawn Clay

RAILROAD INDUSTRY: POSITIVE TRAIN CONTROL (PTC) IMPLICATIONS

The US Railroad System has been overshadowed in recent years by safety failures that have led to avoidable accidents. In 2008, Congress passed the Rail Safety Improvement Act containing a series of measures that included the implementation of a system called PTC. The conclusions of this research indicate that the PTC system is a right measure promoted by the federal government needed to reduce train accidents and increase efficiency. However, the way it is being implemented has generated some setbacks that are a consequence of delegating to the railroad companies the major responsibility for its implementation.⁹¹

PTC consists of an integrated wireless network that connects the On-board System, the Wayside System, and the Back-Office Server. Based on a set of data such as train weight, length, composition, speed, type of cargo, etc., this system is capable of detecting and preventing potential problems, and, if necessary, to adopt autonomous measures to avoid a catastrophe. According to the Association of American Railroads, up to the end of 2016 the implementation of PTC reached 38 percent of route miles, 63 percent of locomotives, and 87 percent of trackside signal systems, representing for the companies an investment of more than \$7.9 billion for development and deployment, and an additional \$100 million a month for testing and installation.⁹²

The implementation deadline for PTC was originally scheduled for December 2015, but was soon deemed unrealistic, so Congress was forced to pass the Surface Transportation Extension Act that, provided three more years to finish the project by 2018, and another two years for testing and full implementation. PTC presented two main challenges: an imprecise definition and immature stage of technology, and the uncertainty and poor financial support from the federal government. The expression of Matt Burns, from Burns Engineering Inc., very eloquently stated, “PTC and rail signal systems are sometimes viewed by skeptical rail operators as mysterious black boxes requiring unending time and capital resources to install.”⁹³ Considering performance, cost and schedule, the problem can be summarized as a complex and undeveloped technology, with prohibitive and increasing costs, to be implemented in a short and unrealistic period of time.

PTC implementation is causing serious challenges for companies, which must overcome financial, technological, legal and operational obstacles with their resources. **The following recommendations are made to take advantage of this great opportunity for the safety and efficiency of the railroad industry, to include implementation of:** 1) *a more efficient financial assistance program* to help companies cope with the project; 2) *a major centralization in the management of the technological development*, releasing the companies from that additional task; and 3) *a better coordination and synchronization of efforts between the Agencies at the Federal, State and Local level and the Companies*, among others.

These measures can contribute to achieving this national goal quicker and better, allowing the country to have a safer and efficient railway system.

Col Pablo Martin Bruno Servat

MODERNIZING RAIL TOWARDS AUTONOMY

Technology can create immense efficiencies, spur new life, increase profits, and make the railroad industry the industry of choice for the transportation of goods. Technological advances in other modes of transportation are threatening the market share of freight rail; innovations in trucking, air transport, and maritime modes, along with the drop in fuel prices, are eroding the benefits of freight rail. The large Class I rail operations are looking to diversify their portfolios by expanding their intermodal operations to hedge against fluctuations in commodities. The Class I railroads are making significant investments in the intermodal portions of their business. This intermodal capitalization includes substantial investments in technology to allow customers to access freight data as it moves through the system, as well

Experts caution that “Self-driving technology will damage the railway sector unless the latter can significantly reduce its costs and considerably improve its quality in time”⁹⁴ IBM challenges one to rethink rail as “optimized efficiency, differentiated service, real-time decisions, shared knowledge, and adaptive and autonomic responses.”⁹⁵ Experts in rail predict: “Automation will not be confined to those aspects of the railway which have a direct and immediate bearing on the operation of the railway (traffic management, signaling, train driving, traction energy management etc.). It will also pervade other areas such as asset management, long-term operational planning, which will make extensive use of intelligent information derived from data about asset condition, actual operational performance versus planned.”⁹⁶ Programs such as Positive Train Control (PTC), Electronically Controlled Pneumatic Brakes (ECP), data analysis, and digitization provide current and future opportunities for innovation.

The industrial Internet of Things (IoT) is an opportunity for the rail freight industry. Information generated from IoT elements such as PTC, ECP, sensors along tracks, locomotives, and the actual freight, can be leveraged to help railroads increase efficiencies, boost productivity, and improve processes.⁹⁷ Arguably, there are significant benefits from the continuous, accurate, real-time information from PTC in terms of shorter train running times, improved running time reliability, improved track capacity, and improved asset utilization.⁹⁸ ECP will reduce braking distances between 40 and 60 percent. Experts suggest ECP technology, coupled with a robust PTC system, sets the stage for autonomous trains in the U.S.

The Federal Railroad Administration is reviewing a rule to mandate crew size to two in a freight locomotive at all times. This rule could infringe on technological advancements including that of train autonomy. Train autonomy in some form would assist in the increased efficiencies of rail whether at the yard, utilizing the data on freight cars and locomotives, or the autonomy of rail’s intermodal efforts. The Department of Transportation needs to find the balance to spur innovation, refrain from the appearance of safety in lieu of actual safety, and look for ways to induce research and development to help the U.S. economy as a whole. **Two specific policy recommendations are:** 1) *Do not mandate crew size and;* and 2) *Do not overregulate technological innovation and advancement.*

Ms. Elia Tello

Trucking

PREPARING THE TRUCKING INDUSTRY FOR THE FUTURE

The Department of Defense (DOD) uses third party trucking companies to support all aspects of national defense, to include the movement of household goods and unit training supplies, to the movement of equipment to support contingency operations. There is very little consistency

in how the DOD tactically executes the contracted logistic operations at the local level, leading to increased costs and delivery times. The standard operating procedure to allow contracted truck drivers entry into a military base varies by service, specific base, and geographic location, as well as the daily force protection level determined by various levels of command. This lack of standardization to expedite drivers onto bases costs the U.S. economy approximately \$21 million a year in lost productivity and congestion at entry points, with the expense passed back to the DOD by charging higher rates than what are charged a comparable customer.⁹⁹

By establishing a DOD-sponsored base access system, companies enroll drivers and receive a background clearance check using existing national databases to confirm the credentials of a driver and determine risk for access to a DOD facility. An example of a similar service is the Transportation Worker Identification Credential that is used for maritime workers to access port facilities.¹⁰⁰

Due to the hardship of being a truck driver (long hours and up to 200 days away from home over a year) there is a very high driver turn-over rate in the industry (100% annually in some companies) and a shortage of approximately 50,000 drivers nationwide.¹⁰¹ Regulation also exacerbates and restricts entry, such as age requirement for drivers, hours driven per day and specific driver endorsements necessary to drive specific commodities. A driver must be 21 years old to obtain a commercial license to cross state lines. The Department of Transportation (DOT) mandates 16 separate endorsement and restriction codes that limit what a driver can carry, each requiring separate certification regardless of whether the weight and size of the vehicle are the same.¹⁰²

Vehicle safety improvements and technology are leading to much safer vehicles, and should also lead to lower regulation of drivers. Working with industry, DOT should determine how to keep the highways safe, as well as the industry profitable, by reviewing and modifying regulations that limit productivity and prevent drivers from entering the industry. As new vehicle technology emerges, leading to safer vehicles, the trucking industry would benefit from having the DOT consult with economist and industry experts in updating trucking regulations and policy to understand what the impact is on the transportation industry, as well as what will benefit the overall national economy and not stifle it. **Two specific recommendations are made to address these issues:** 1) *Establish a DOD standardized base entry system for commercial truck drivers operating under government contract;* and 2) *Review restrictive DOT regulations, determine which are barriers to entry and not safety related or outdated due to technology improvements and repeal them.*

LTC Eric Olson

A U.S. HIGHWAY TRANSPORTATION NETWORK FOR THE 22ND CENTURY

President Eisenhower's Interstate Highway System provided the required infrastructure to support U.S. growth and reach its 20th-century potential. Now the U.S. has reached a new point where the U.S. transportation infrastructure is "inadequate for the nation's growing needs"¹⁰³ to meet the transportation demands of the 22nd century.¹⁰⁴

In 2014, the average person spent 40 hours a year in congestion, up from 14 hours in 1982,¹⁰⁵ costing an estimated \$27 billion a year to people and businesses in fuel and time lost.¹⁰⁶ Between 1980 and 2000, vehicle miles traveled (VMT) on the U.S. highway system grew by 80 percent with large-truck VMT growing even faster, while lane-miles increased by only 4 percent.¹⁰⁷ The Federal Highway Administration projects that about 46 percent of the National Highway System will be at, or exceeding capacity during peak periods in 2020, compared with 28 percent in 1998.¹⁰⁸

Also, despite slow but steady decreases in fatal accidents,¹⁰⁹ in 2010 vehicle accidents cost the country an estimated \$850 billion.¹¹⁰

To address increasing congestion and accident costs, and to capitalize on the benefits of vehicle automation, the U.S. needs to develop “smart” interstates and highways that communicate with vehicles, other infrastructure and public works systems, and report on their own condition. Sensors embedded in traffic signals, intersections, and even rural interstates which communicate across transportation networks would enable highway managers to better manage traffic and road maintenance through full situational awareness of traffic and road conditions.¹¹¹ Car companies are currently integrating Vehicle to Infrastructure (V2I) technology into new cars, however current highway infrastructure does not provide the capability to fully realize the efficiency and safety benefits of emerging technology. **The following recommendations include:** 1) *Mandate and resource states to integrate V2I technology into all roads rated as high congestion areas by 2025 and all roadway upgrades after 2025;*¹¹² and 2) *Implement an integrated transportation network of “smart” highways that requires a nationally integrated system for highway management, monitoring, and maintenance, much as the National Air Traffic Control Coordination Center provides for the National Air Space.* A National Highway Coordination Center developed around a system of municipal, state, regional, and national highway control centers would provide a holistic view of the highway network and allow managers to respond to emergencies or adjust traffic flows to prevent congestion.

As President Eisenhower said, “action, comprehensive and quick and forward-looking, is needed”¹¹³ to provide an efficient, resilient, and adaptive “smart” transportation network that embraces and integrates emerging technologies to meet the country’s looming transportation demands and propels the U.S. into the 22nd century.

LTC Steven Putthoff

KEEP THE WHEELS TURNING TO MOVE AMERICA’S ECONOMY

The trucking sector fuels the American nomadic lifestyle, a feeling of freedom that many drivers must carry with them as they endlessly navigate the open road. Trucking is the driving force behind the nation's economy, moving 11 billion tons of freight yearly. Trucking’s viability in the 22nd century requires government investment in infrastructure, autonomous technology, and operator recruitment and training.

Occupational Safety and Health Administration regulations govern the safety and health of the workers; and the responsibilities of employers to ensure their safety at the warehouse, dock, construction site, and in other places truckers go to deliver and pick up loads throughout the country.¹¹⁴ These regulations could be mitigated with autonomy. Citing American Trucking Association (ATA) figures, Phil Byrd Sr., President of Bulldog Hiway Express, told attendees at a Commercial Carriers Journal Symposium that to keep up with demand, trucking companies would need to add roughly 100,000 drivers per year through 2023.¹¹⁵ That figure seems to be substantiated by ATA forecasts that the driver shortage will be about 239,000 by 2022.¹¹⁶ Initiatives being undertaken to improve transportation, and trucking, particularly in the 21st century, includes “platooning”. Peloton, a tractor-trailer automation company, and Omnitacs, a fleet management company are collaborating to integrate a vehicle-to-vehicle communications and state-of-the-art, radar-based collision avoidance system.¹¹⁷ Secondly, autonomous vehicles (AVs) may fundamentally alter freight transport. AV technology has the potential to avert deadly crashes, increase road and load capacity, save fuel, and lower harmful greenhouse gas emissions.¹¹⁸

Finally, there are clear examples where AVs can be effective today with little regulatory or social impact, such as the World Food Programme's planned use of AV trucks to deliver aid to starving populations.¹¹⁹ **Several actions by the government can proactively manage this development:** 1) *Fund innovative AV research investment* to spur growth in AV technology and implementation; 2) *Create federal guidelines for AV licensing* to ensure consistent regulatory implementation across all states; 3) *Offer government incentives or tax deferments* to firms who upgrade their fleets with AV technology; 4) *Fund infrastructure* to designate AV traffic lanes in future highway projects; and 5) *Standardize liability, security, and data privacy policies* regarding autonomous vehicles.

Trucking moves freight into 80 percent of the nation's cities that do not otherwise receive service by other modes. Autonomy can alleviate regulation, safety concerns, driver shortages, and congestion with bigger, safer tractor trailers, however, public acceptance of autonomous vehicles on the interstate must be addressed in infrastructure upgrades, such as dedicated lanes, etc.

Mr. Kevin Slone

VIII. Conclusion

The transportation industry is a critical enabler of U.S. national security and global economic standing. Although it is currently strong, and moderate growth is expected in the future, the industry faces significant challenges of growing personnel shortages, inadequate infrastructure, and barriers to automation. These challenges not only limit growth and profitability within the industry, but also risk national economic growth and support to national security into the future. Moreover, varied levels of regulation continue to threaten industry health and constrict overall growth moving forward. Specific examples include a lack of regulation with respect to cyber security standards across the industry, and overregulation with respect to industry certifications (i.e. 1,500 flight-hour requirement, commercial drivers' license certification, etc.), that impede the industry's overall efficiency and effectiveness. To overcome these challenges, the government, in close coordination with key industry stakeholders, must take decisive action. Consideration must be given to reviewing, revising, or repealing specific legislation (i.e. The Jones Act of 1920 and Aviation Safety and Federal Aviation Administration Extension Act of 2010) to successfully address these and other challenges to promote the future health of the transportation industry. Additionally, the industry requires strategic infrastructure and innovation investments across all transportation modes. These investments will be the catalyst for advancing efforts towards automation to increase efficiencies, potentially resolving personnel shortages and increasing overall capacity across the industry segments. Finally, the government must implement new policies to promote industry growth and develop a comprehensive strategy to address emerging cyber security threats to transportation assets and infrastructure. The problems facing this vital industry are real and the time for cooperative action is now...U.S. security and prosperity depend on it!

End Notes

¹Eisenhower, Dwight D. "39 – Special Message to the Congress Regarding a National Highway Program." February 22, 1955, The American Presidency Project, accessed May 10, 2017, <http://www.presidency.ucsb.edu/ws/?pid=10415>.

²"The Nation's Freight", Freight in America, U.S. Department of Transportation — Bureau of Transportation Statistics, accessed May 5, 2017, https://apps.bts.gov/publications/freight_in_america/html/nations_freight.html.

³"2016 Transportation Statistics Annual Report – Introduction, U.S. Department of Transportation - Bureau of Transportation Statistics, accessed May 5, 2017, https://www.rita.dot.gov/bts/sites/rita.dot.gov/bts/files/publications/transportation_statistics_annual_report/2016/introduction.

⁴Ibid.

⁵Ibid.

⁶Ibid.

⁷Ibid.

⁸"2016 Transportation Statistics Annual Report: Chapter 3 – Moving Goods," U.S. Department of Transportation, Bureau of Transportation Statistics, accessed May 5, 2017, https://www.rita.dot.gov/bts/sites/rita.dot.gov/bts/files/publications/transportation_statistics_annual_report/2016/chapter_3.

⁹IBISWorld, Inland Water Transportation, "Major Companies," accessed Feb 2, 2017, <http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/majorcompanies.aspx?entid=1144>.

¹⁰IBISWorld, *IBISWorld Industry Report 48811*, "Domestic Airlines in the U.S.," September 2016, accessed May 5, 2017, <http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/default.aspx?entid=1194>.

¹¹IBISWorld, *IBISWorld Industry Report 48211*, "Rail Transportation in the U.S.," November 2016, accessed May 5, 2017, <http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/competitivelandscape.aspx?entid=1133>.

¹²IBISWorld, *IBISWorld Industry Report 48412*, "Long Distance Freight Trucking in the U.S.," December 2016, accessed May 5, 2017, <http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/default.aspx?entid=1150>.

¹³Economic health evaluates employment, revenues, profits, profit margins compared to the cost of funds, leverage/debt ratios, etc., both at the current point in time and trends over the previous five years. Overall positive performance across elements indicating financial health and considering the operating environment of the industry indicates economic health. [The Staff of Entrepreneur Media, Inc. "8 Factors That Determine the Financial Health of a Business." Entrepreneur. Entrepreneur Media, Inc, 29 Jan. 2015. Irvine, CA. <https://www.entrepreneur.com/article/240611> (accessed 16 May 2017); Eisenhower School Academic Year 2017 Industries Studies Handbook (rev 1). Washington, D.C.: National Defense University, November 2016]

¹⁴IBISWorld, *IBISWorld Industry Report 48412*, "Long Distance Freight Trucking in the U.S.," December 2016, accessed May 5, 2017, <http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/default.aspx?entid=1150>.

¹⁵Ibid.

¹⁶Road Freight in the United States. Industry Profile, London, UK: MarketLine, October 2015, accessed May 5, 2017, <http://advantage.marketline.com.nduezproxy.idm.oclc.org/Product? ptype= Industries& pid=MLIP1750-0014>.

¹⁷IBISWorld, *IBISWorld Industry Report 48231*, "Industry Performance," Inland Waterways Transportation, accessed May 7, 2017, <http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/currentperformance.aspx?entid=1144>.

¹⁸IBISWorld, *IBISWorld Industry Report 48412*, "Long Distance Freight Trucking in the U.S.," January 2017, accessed May 7, 2017, <http://clients1.ibisworld.com/reports/us/industry/default.aspx?entid=1150>.

¹⁹Ibid.

²⁰IBISWorld. *IBISWorld Industry Report 48211*, "Rail Transportation in the U.S., November 2016, "Competitive Landscape", accessed May 5, 2017, <http://clients1.ibisworld.com.nduezproxy.idm.oclc.org/reports/us/industry/competitivelandscape.aspx?entid=1133>.

²¹Federal Aviation Administration, "NextGen", accessed May 5, 2017, <https://www.faa.gov/nextgen>.

²²"Current and Future Availability of Airline Pilots." GAO Report 14-232, February 28, 2014, i-56. Military & Government Collection, EBSCOhost, accessed April 16, 2017, <http://eds.a.ebscohost.com.nduezproxy.idm.oclc.org/eds/pdfviewer/pdfviewer?vid=1&sid=9839dfff-ef7f-4a25-babf-fb137394c175%40sessionmgr4009&hid=4205>.

²³IBISWorld, *IBISWorld Industry Report 48412*, "Long Distance Freight Trucking in the U.S.," accessed May 7, 2017, http://www.researchandmarkets.com/research/gwkvsf/2014_worldwide.

²⁴"Table 1-24: Number and Size of the U.S. Flag Merchant Fleet and Its Share of the World Fleet." Bureau of Transportation Statistics, accessed April 12, 2017, https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_24.html_mfd.

²⁵"If You Like Higher Prices, Enriched Cronies, And Weak National Security, Then You'll Love The Jones Act." The Federalist, 2017, accessed April 16, 2017, <http://thefederalist.com/2015/01/22/if-you-like-higher-prices-enriched-cronies-and-weak-national-security-then-youll-love-the-jones-act/>.

²⁶"Operations Desert Shield and Desert Storm: A Logistics Perspective," Association of the U.S. Army: Sept, 1991, 5, accessed May 7, 2017, <https://www.ausa.org/sites/default/files/SR-1991-Operations-Desert-Shield-and-Desert-Storm-The-Logistics-Perspective.pdf>.

²⁷Ibid.

²⁸Mary Schlangenstein and Michael Sasso. "Shrinking Pool of Future Pilots Keeps Major Airlines on Edge." Bloomberg.com. June 29, 2016, accessed April 10, 2017. <https://www.bloomberg.com/news/articles/2016-06-29/shrinking-pool-of-future-pilots-keeps-major-airlines-on-edge>.

²⁹*2016 Pilot & Technician Outlook*. Boeing Report. 2016, accessed April 13, 2017. <http://www.boeing.com/resources/boeingdotcom/commercial/services/assets/brochure/pilottechnicianoutlook.pdf>; *Aviation Workforce. Current and Future Availability of Airline Pilots*. GAO Report to Congress. February 2014. accessed April 01, 2017. <https://www.gao.gov/assets/670/661243.pdf>.

³⁰*House Armed Services Subcommittee Hearing on Military Pilot Shortage*, 9 (2017) (testimony of Lt Gen Gina M. Grosso);

McGee, Michael. *Air Transport Pilot Supply and Demand: Current State and Effects of Recent Legislation*. RAND Corporation. 2015, accessed April 16, 2017. https://www.rand.org/pubs/rgs_dissertations/RGSD351.html.

³¹Related from visits and briefings by various agencies with the Eisenhower School Transportation Study. Agencies include the American Trucking Associations, International Maritime Organization, Federal Railroad Association, and Department of Transportation.

³²Jeff Crissey, *Trucking Outlook: 4 Key Challenges facing trucking industry growth*, accessed April 12, 2017, <http://www.cjdigital.com/1-driver-availability-49-3/>.

³³Jeff Crissey, *Trucking Outlook: 4 Key Challenges facing trucking industry growth*, accessed April 12, 2017, <http://www.cjdigital.com/2014-trucking-outlook-feeling-the-squeeze/>.

³⁴“The Jones Act.” *Transportation Institute*, accessed April 15, 2017, <https://transportationinstitute.org/jones-act/>.

³⁵“Table 1-24: Number and Size of the U.S. Flag Merchant Fleet and Its Share of the World Fleet.” *Bureau of Transportation Statistics*, accessed April 12, 2017, https://www.rita.dot.gov/bts/sites/rita.dot.gov/bts/files/publications/national_transportation_statistics/html/table_01_24.html_mfd.

³⁶Charlie Papavizas, “Last Port of Call for the U.S. Merchant Marine?” February 6, 2017, MarineLink, accessed April 11, 2017, <https://www.marinelink.com/news/merchant-marine-call421701>.

³⁷“Waterways System.” *Waterways Council, Inc.*, accessed April 16, 2017, <http://waterwayscouncil.org/waterways-system/>.

³⁸Diane S Owen, Federal Trade Commission, Bureau of Economics, *Deregulation in the Trucking Industry* (1988)

³⁹Federal Motor Carrier Safety Administration, accessed April 17, 2017, <https://www.fmcsa.dot.gov/registration/commercial-drivers-license/drivers>.

⁴⁰IBISWorld, *IBISWorld Industry Report H4821-GL: Global Deep-Sea, Coastal, and Inland Water Transportation*, “Competitive Landscape” tab, accessed April 13, 2017, <http://clients1.ibisworld.com/reports/gl/industry/default.aspx?entid=1540>.

⁴¹Joseph Kramek, *The Critical Infrastructure Gap: U.S. Port Facilities and Cyber Vulnerabilities* (Foreign Policy at BROOKINGS, July 2013), 13-18.

⁴²IBISWorld, *IBISWorld Industry Report H4821-GL: Global Deep-Sea, Coastal, and Inland Water Transportation*, “Industry Performance” tab, accessed April 13, 2017, <http://clients1.ibisworld.com/reports/gl/industry/default.aspx?entid=1540>; IBISWorld Industry Report: Domestic Airlines, IBISWorld in the “Industry Performance” tab, accessed April May 1, 2017, <http://clients1.ibisworld.com/reports/us/industry/ataglance.aspx?entid=1125>.

⁴³Darren W. McDew, “Losing Our Sea Legs,” *Norfolk Virginian Pilot*, 17 January 2016, accessed April 16, 2017, http://pilotonline.com/opinion/columnist/guest/darren-w-mcdew-losing-our-sea-legs/article_04a74527-645e-58f8-8dc1-f464c94e0069.html.

⁴⁴Ibid.

⁴⁵Ibid.

-
- ⁴⁶US Government Accountability Office, "Maritime Issues: Assessment of the International Trade Commission's 1995 Analysis of the Economic Impact of the Jones Act," March 6, 1998, accessed April 15, 2017, <https://www.gao.gov/assets/90/87426.pdf>.
- ⁴⁷MARAD, "The Economics Importance of the US Shipbuilding and Repair Industry," MARAD policy paper, November 2015, accessed April 11, 2017, https://www.marad.dot.gov/wpcontent/uploads/pdf/MARAD_Econ_Study_Final_Report_2015.pdf.
- ⁴⁸American Maritime Officers Union, National Defense Authorization Act addresses key issues for U.S. maritime industry, merchant fleet.
- ⁴⁹Chris Dupin, "MARAD Executive Director says concern exists over mariner shortage," American Shipper.
- ⁵⁰Ibid.
- ⁵¹"The Jones Act." *Transportation Institute*, accessed April 15, 2017, <https://transportationinstitute.org/jones-act/>.
- ⁵²"Table 1-24: Number and Size of the U.S. Flag Merchant Fleet and Its Share of the World Fleet." Bureau of Transportation Statistics, accessed April 12, 2017, https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_24.html_mfd.
- ⁵³"2017 Infrastructure Report Card." *American Society of Civil Engineers*, accessed April 17, 2017, <http://www.infrastructurereportcard.org/the-impact/economic-impact/>.
- ⁵⁴IBISWorld, *IBISWorld Industry Report H4821-GL: Global Deep-Sea, Coastal, and Inland Water Transportation*, "Industry Performance" tab, accessed April 13, 2017, <http://clients1.ibisworld.com/reports/gl/industry/default.aspx?entid=1540>.
- ⁵⁵Ibid.
- ⁵⁶Matt Hickman, "Autonomous Cargo Ships May Set Sail by 2020." MNN.com, November 8, 2016, accessed April 14, 2017, <http://www.mnn.com/green-tech/transportation/blogs/remote-controlled-cargo-ships-may-sail-seas-2020>.
- ⁵⁷Oskar Levander, "Autonomous ships on the high seas." *IEEE Spectrum* 54, no. 2, February 2017, 26-31, accessed April 14, 2017, <http://eds.a.ebscohost.com.nduezproxy.idm.oclc.org/eds/results?sid=a6434f2b-2440-e9ca53dede1fed5e375%40sessionmgr4008&vid=0&hid=4103&bquery=Oskar+Levander%2c+%22Autonomous+ships+on+the+high+seas.%22&bdata=JmNsaTA9RIQmY2x2MD1ZJnR5cGU9MCZzaXRIPWVkcylsaXZlJnNjb3BIPXNpdGU%3d>.
- ⁵⁸Lauren Young, "Autonomous Cargo Ships are arriving Just in Time for the Sailor-poor U.S." *Inverse.com*, March 25, 2016, accessed April 15, 2017, <https://www.inverse.com/article/13335-autonomous-cargo-ships-are-arriving-just-in-time-for-the-sailor-poor-u-s>.
- ⁵⁹Robert Wall and Paris Costas. "Ship Operators Explore Autonomous Sailing." *Wall Street Journal Online*, August 31, 2016, accessed April 15, 2017, <https://www.wsj.com/articles/ship-operators-explore-autonomous-sailing-1472635800>.
- ⁶⁰Michael D. Greenberg et al, *Maritime Terrorism: Risk and Liability* (Santa Monica, CA: RAND Corporation, 2006), 2.
- ⁶¹Joseph Kramek, *The Critical Infrastructure Gap: U.S. Port Facilities and Cyber Vulnerabilities* (Foreign Policy at BROOKINGS, July 2013), 13-17.
- ⁶²Henry Willis and David Ortiz, *Evaluating the Security of the Global Containerized Supply Chain* (Santa Monica, CA: RAND Corporation, 2004), 18.

⁶³Gregory Wilshusen, *Maritime Critical Infrastructure Protection: DHS Needs to Enhance Efforts to Address Port Cybersecurity* (Washington, DC: United States Government Accountability Office, October 2015), 7-8.

⁶⁴Ibid, 8.

⁶⁵Jim Romeo, "The Safe Passage of Goods," *Security Magazine* (October 2016): 28, accessed March 25, 2017, <http://www.securitymagazine.com/articles/87455-ensuring-the-safe-passage-of-goods>.

⁶⁶Scott Maucione, Air Force meeting with airlines on pilot shortage in March 17, 2017, <https://federalnewsradio.com/air-force/2017/03/air-force-meeting-airlines-pilot-shortage-may/>.

⁶⁷Bloomberg News, Shrinking Pool of Pilots on the Horizon, July 11, 2016, accessed May 15, 2017, www.omaha.com/eedition/sunrise/articles/shrinking-pool-of-pilots-on-horizon/article_ab19211e-ae89-5e0c-ad44-5d92795bbb1e.html.

⁶⁸Sarina Houston, The Top 4 U.S. Aviation Universities, Aviation and Aerospace, August 1, 2016.

⁶⁹Federal Aviation Administration, "The Economic Impact of Civil Aviation on the U.S. Economy." Nov 2016, 3, accessed April 16, 2017, https://www.google.com/?gws_rd=ssl#q=aviation+industry+economic+im.

⁷⁰National Pilot Sourcing Forum Annual Report 2016, 10 Apr 2017, 5.

⁷¹Airline Safety & Federal Aviation Administration Extension Act of 2010, Public Law 111-216, Title II Section 217, Airline Transportation Pilot Certification (c)(1).

⁷²Ely Portillo, "Who Will Fly the Planes? Regional Airline CEO Warns of Pilot Shortage." *The Charlotte Observer*, 11 May 2016, accessed April 15, 2017, <http://www.charlotteobserver.com/news/business/article77052957.html>.

⁷³"Current and Future Availability of Airline Pilots." GAO Report 14-232, February 28, 2014, i-56, Military & Government Collection, accessed April 16, 2017, <http://eds.a.ebscohost.com.nduezproxy.idm.oclc.org/eds/pdfviewer/pdfviewer?sid=72ca2b41-729e-4ffd-af60-a4b575dc9d89%40sessionmgr4006&vid=0&hid=4103>.

⁷⁴Christopher Woody, "The Air Force May Pay Pilots Nearly a Half-Million Dollars to Stay in Uniform." *Business Insider*, 30 Mar 2017, accessed April 19, 2017, <http://www.businessinsider.com/air-force-pay-pilots-bonus-incentives-to-stay-in-uniform-2017-3>.

⁷⁵Michael G. Mattock, et al "Retaining U.S. Air Force Pilots When the Civilian Demand for Pilots is Growing." *RAND Corporation*, RR-1455, 2016, xiv-xvii.

⁷⁶National Pilot Sourcing Forum Annual Report 2016, 10 Apr 2017.

⁷⁷*National Pilot Sourcing Forum Annual Report 2016*. Report. 2017. 2-11.

⁷⁸Association of American Railroads. "Freight Railroads & International Trade." March 2017, accessed May 4, 2017, <https://www.aar.org/Documents/AAR%20Freight%20Railroads%20%20International%20Trade%20Report%20FINAL.pdf>.

⁷⁹Daraius Irani, et al, "Economic and Fiscal Impact Analysis of Class I Railroads." Towson University Regional Economic Studies Institute. May 16, 2016, accessed May 4, 2017, <https://www.aar.org/Documents/AAR%20Towson%20Freight%20Rail%20Economic%20Report%20June%202016.pdf>.

⁸⁰Bureau of Labor Statistics. *Labor Force Statistics from the Current Population Survey*. United States Department of Labor, accessed April 14, 2017, <https://www.bls.gov/cps/cpsaat18b.htm>.

⁸¹Data USA: Locomotive Engineers and Operators, accessed April 4, 2017, <https://datausa.io/profile/soc/534010/#growth>.

⁸²Federal Railroad Administration. *Railroad Industry Modal Profile: An Outline of the Railroad Industry Workforce Trends, Challenges, and Opportunities - Update*. United States Department of Transportation. April 2016.

⁸³Oliver Wyman. *Analysis of North American Freight Rail Single-Person Crews: Safety and Economics*. Association of American Railroads. February 3, 2015.

⁸⁴Federal Railroad Administration. "Train Crew Staffing." *Federal Register: The Daily Journal of the United States Government*, March 15, 2016, accessed April 20, 2017, <https://www.federalregister.gov/documents/2016/03/15/2016-05553/train-crew-staffing>.

⁸⁵IBISWorld, *IBISWorld Industry Report* 48211, "Rail Transportation in the U.S.," Market Analysis, November 2016, accessed May 8, 2017, <http://clients1.ibisworld.com/reports/us/industry/default.aspx?entid=1133>.

⁸⁶Jeff Berman, "STB Rolls Out Proposed Reciprocal Switching Regulations." *Logistics Management*, July 28, 2016, 1-2, accessed April 20, 2017, http://www.logisticsmgmt.com/article/stb_rolls_out_proposed_reciprocal_switching_regulations.

⁸⁷Pamila Baldwin and Aaron M. Flynn, "Federal Railroad Rights of Way" (Washington, DC: Congressional Research Service (CRS), May 3, 2006, 1, accessed April 20, 2017, <http://congressionalresearch.com/RL32140/document.php>.

⁸⁸Anthony Fox, "Beyond Traffic 2045", Washington, DC, Department of Transportation, 2015, 214–37, accessed April 20, 2017, <https://www.transportation.gov/BeyondTraffic>.

⁸⁹Staff, "Chronology of Railroad in America," Freight Rail Association, *Association of American Railroads*, (July 2015), accessed April 20, 2017, <https://www.aar.org/BackgroundPapers/Chronology%20of%20RRs%20in%20America.pdf>.

⁹⁰Staff, "Rail Infrastructure Report Card," Series, Infrastructure Report Card, *American Society of Civil Engineers*, 2017, 1-3.

⁹¹ Federal Transit Administration, "*Rail Safety Improvement Act of 2008 (RSIA)*", <https://www.fra.dot.gov/Page/P0395>, (Accessed Apr 11, 2017)

⁹² Ibid.

⁹³ Burns, Matt, "*Positive Train Control: Why it's Taking So Long to Get Rail Safety On-Track*", Burns Engineering Inc., June 16, 2016 <http://www.burns-group.com/blog/2016/06/positive-train-control-why-its-taking-so-long-to-get-rail-safety-on-track/>

⁹⁴Thomas Steffens, "Will the driverless truck derail the freight train?." *UIC Global Rail Freight Conference*. Rotterdam, 2016.

⁹⁵IBM. "Think beyond the rails: Leading in 2025." Global Rail Innovation Center, IBM, n.d. Intermodal Association of North America. *Data & Statistics*, accessed April 3, 2017, <http://intermodal.org/resourcecenter/statistics.php>.

⁹⁶Francis How, "Signalling The Future." Railway Industry Association, UK, The Institution of Engineering & Technology, 2012.

⁹⁷Jeff Stagl, *Internet of Things: Freight railroads are elevating efforts to collect, analyze and merge information from many sources*. March 2016, accessed April 10, 2017,

http://www.progressiverailroading.com/rail_industry_trends/article/Internet-of-Things-Freight-railroads-are-elevating-efforts-to-collect-analyze-and-merge-information-from-many-sources--47509.

⁹⁸Steven R. Ditmeyer, *PTC vs. Legacy Train Control Redux*. July 8, 2016, accessed April 4, 2017, <http://www.railwayage.com/index.php/ptc/ptc-vs-legacy-train-control-redux.html>.

⁹⁹Trucking company interview with author, February 10, 2017.

¹⁰⁰Transportation Security Administration web page. TWIC <https://www.tsa.gov/for-industry/twic>.

¹⁰¹Trucking Company office visit during off site curriculum, April 3, 2017.

¹⁰²Federal Motor Carrier Safety Administration, accessed April 17, 2017, <https://www.fmcsa.dot.gov/registration/commercial-drivers-license/drivers>.

¹⁰³Dwight D. Eisenhower, *Message to the Congress Regarding Highways*. Press Release, (Washington, DC: The White House, Office of the Press Secretary), February 22, 1955.

¹⁰⁴Derived from visits and briefings by various transportation agencies with the Eisenhower School Transportation Study.

¹⁰⁵Volpe. *Shaping America's Transportation Future; Annual Project Accomplishments*. Cambridge, MA: Volpe, The National Transportation Systems Center, 2016.

¹⁰⁶Richard J. Hillstead et al, *Fast Forward: Key Issues in Modernizing the US Freight Transportation System for Future Economic Growth*. Arlington, VA: RAND Corporation, 2009.

¹⁰⁷ Volpe. *Shaping America's Transportation Future; Annual Project Accomplishments*.

¹⁰⁸Robert W. Poole Jr. and Peter Samuel. *Corridors for Toll Truckways: Suggested Locations for Pilot Projects*.

¹⁰⁹Fatality Analysis Reporting System (FARS) Encyclopedia. National Highway Traffic Safety Administration. <https://www-fars.nhtsa.dot.gov/Main/index.aspx>. Accessed April 19, 2017.

¹¹⁰Fatality Analysis Reporting System (FARS) Encyclopedia. National Highway Traffic Safety Administration, accessed April 19, 2017, <https://www-fars.nhtsa.dot.gov/Main/index.aspx>.

¹¹¹Robert Arnold and Jonathon B. Walker. *V2I Deployment Guidance Presentation*. Washington D.C.: Federal Highway Administration, US Department of Transportation, 2014, accessed May 5, 2017, https://www.tn.gov/assets/entities/tdot/attachments/WalkerV2I_DeploymentsAndGuidance_PresentationRev.pdf.

¹¹²While this essay does not recommend a best funding mechanism for road infrastructure restructuring (i.e. user fees, fuel taxes, public-private-partnerships, tollways). Infrastructure funding needs the ability to change with inflation, usage, and technology, while providing stable, multi-year funding to allow long-term projects at lower risks and costs.

¹¹³Dwight D. Eisenhower, *Message to the Congress Regarding Highways*.

¹¹⁴General regulatory authorities and items covered, US Department of Labor, Occupational Safety and Health Agency, accessed April 20, 2017, https://www.osha.gov/SLTC/trucking_industry/index.html.

¹¹⁵Jeff Crissey, *Trucking Outlook: 4 Key Challenges facing trucking industry growth* accessed April 12, 2017, <http://www.cjdigital.com/2014-trucking-outlook-feeling-the-squeeze/>.

¹¹⁶Ibid.

¹¹⁷Platooning Lets Trucks Get by With a Little Help from Their Friends, Feb 24, 2017, Material Handling and Logistics, accessed April 8, 2017, www.mhlnews.com.

¹¹⁸The Economist, Technology Quarterly, Q3, 2012: *Look, No Hands*, 17-19, accessed April 14, 2017, <http://www.economist.com/node/21560989>.

¹¹⁹Nadia Papasidero, World Food Programme, *How WFP is Steering the Future of Self-Driving Trucks Toward Zero Hunger*, 18 April 2017, accessed April 20, 2017, <http://innovation.wfp.org/blog/self-driving-trucks-zero-hunger>.