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Transportation Industry Study

SEMINAR 19

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I. INTRODUCTION

A. "Nothing Happens Until Something Moves!"

The transportation industry is critical to the National Security Innovation Base (NSIB) and the Defense Industrial Base (DIB). A diverse industry with multiple markets and sectors, some segments are on the verge of significant change; all are impacted by challenges and opportunities involving infrastructure, human capital, and automation. **Private firms and the government should accept and engender change in the transportation industry to improve the ability for the United States of America to mobilize industry and the military for the 21st Century.** The timing for this paper, which will showcase the importance of disruptive technology / innovation, human capital, regulations, and resourcing in accelerating or impeding that change, is critical given President Donald J. Trump Administration's $1.5 trillion infrastructure plan recently released in February 2018.[1] The current Administration, Congress, and Industry have the perfect opportunity to resource the U.S. Transportation Industry, which is the backbone upon which American industry mobilizes for war, projects power globally, and sustains forces worldwide in accordance with the National Security Strategy.

B. Methodology

Throughout the second half of the academic year, 2017-2018, Seminar 19 developed a comprehensive approach to analyze the transportation industry as a whole, in particular its role in supporting the NSIB and the DIB, its segments, the public-private interplay and cooperation (or lack thereof), the role of human capital as well as its shortage, the possibility of change due to disruptive technologies, the importance of innovation, the rise of automation, the impact of regulation, and the overall health of its markets, sectors, and firms. Fourteen students, with five faculty advisors assisting, studied these diverse aspects of the transportation industry. As will be

evident from below, the industry is broad and deep, encompassing four major sectors and numerous markets.

The students conducted their analysis of the industry through in-class study, day field trips from the Washington, D.C. area (Transportation Security Agency Headquarters, et al.), overnight couplets to firms in the U.S. (UPS, GE Aviation, e.g.), domestic trips to conferences and a government agency (Customs and Border Protection – Miami office), and international travel to major ports and conferences (the Panama Canal, Singapore, and Malaysia). An Industry Analytics class focused on a corporation representing each of the major sectors: J.B. Hunt (trucking), Atlas Air (air transport), Kirby Corporation (waterways), and Union Pacific (railroads). Additionally, a Strategy and Acquisition course helped tie in the impact of the "iron triangle" as well as the demand for resourcing. Knowledge gained by the students was instrumental in the development of this paper.

The first section of the paper provides an overview and definition of the industry as a whole. This is general knowledge gained by the report's authors in the course of their semester study. It concludes with a SWOT analysis (strengths, weaknesses, opportunities, threats) of the industry. Section two of the report is a snapshot of current conditions in the four major sectors of the industry – trucking, rail, maritime, and air transport. It provides a brief analysis of these sectors based on the students' work during the Industry Analytics course on a particular firm project. The third section of the paper delves into challenges affecting the industry – these mostly come in the context of infrastructure and human capital, but also include threats to innovation. The future outlook is the theme of the next section. This is all about innovation to include mass transit, autonomous vehicles, and port operations. The penultimate section covers government regulations and recommended changes in areas such as seaport operations, autonomous vehicles,

air traffic control, and human capital. The last section discusses three independent but tangential topics to the transportation industry: the role of a corporation such as Navistar to support the industry, an alternative forms of energy (solar) for use by the industry, and the role of interoperability in the industry amongst the U.S., allies, and partners.

II. INDUSTRY DEFINED

Distilled to its basic components, the transportation industry involves the movement of all types of goods, services, and people from one location to another, domestically and internationally. The flow of these goods is the essential substance of trade. It is also critical to the national security of the U.S. The industry is essential to the industrial and innovation bases as well as mobilization; it has a number of sectors along with unique markets; and it presents strengths, weaknesses, and opportunities – not without threats.

A. Industrial & Innovation Bases and Mobilization

The transportation industry serves a dual role as both part of the NSIB and DIB and the means by which these bases support the rest of the critical and essential security related industries. Transportation itself needs to be mobilized, organized, resourced, and sustained as an industry in order for it to accomplish its historic mission of moving the products, output, and manpower of the U.S. to the sea and air ports of embarkation to deploy and project force around the world. Once deployed, this power needs to be sustained by that same transportation industry along these lines of communication. The 20th Century was the birth of the modern American transportation industry. The First and Second World Wars saw the mobilization of the Armed Forces and the development of the U.S. as the arsenal of democracy.[2] The fruits of this arsenal were moved along rails, inland waterways, and overseas on the merchant marine fleet. The Vietnam War set the paradigm for the massive transport of troops and materiel via air for the

first time – not supplanting rail and sea cargo movement but adding another dimension to the base. That war also witnessed and accelerated the rise of the shipping container. This now ubiquitous twenty-foot box (the genesis of the modern day twenty-foot equivalent unit, or TEU, standardized intermodal shipping container) revolutionized world trade and truly ushered in the intermodal segment of the transportation industry.[3] Today, the transportation industry stands ready to support the mobilization of America's assets through airlift, sealift, inland waterway operations, long-haul trucking, rail, and intermodal operations.

B. Underlying Sectors and Markets

The transportation industry is massive, but as the reader will see in the section on firm analysis, it can be subdivided into a number of sectors, sub-sectors, and markets. The seminar assessed four major sectors of the industry: trucking, railroads, airways, and maritime. The industry has both international and domestic markets (with the exception of trucking which remains continental) as well as sub-markets. It contains private firms (e.g. J.B. Hunt), public-private partnerships / authorities (e.g. the Panama Canal), and government owned entities (e.g. Singapore Airlines). What links these disparate firms, corporations, entities, and authorities together is trade – the flow of goods, services, and people. Intermodal trade is the concept which fuses many of the different corners of the industry into a non-stop moving machine. Intermodal trade allows items manufactured in the heartland of America to be placed in a container or containers, moved by truck to a railhead, railed to the port of Oakland, loaded onboard a container ship, sailed around the world, delivered to another port, and trucked to a final destination.

The trucking sector represents firms which provide final delivery as well as those which deliver long haul tractor trailer service. The trucking sector is a major part of the intermodal

chain. The rail sector is primarily long haul freight but does include passenger transportation as well as urban mass transit. In recent years, the rail sector has also become a player in the intermodal chain of the industry. Rail is one of the oldest parts of the industry in America but remains vibrant and essential for national security as well as a healthy economy. In contrast, the airlines sector, moving not only vast numbers of passengers but large amounts of cargo, is a relative newcomer to the industry – taking off after the Second World War. Air travel has eclipsed rail and maritime in the long-distance movement of personnel but the latter two move relatively more cargo. Air movement also can form part of the intermodal chain (as seminar students learned during their class trip to the United Parcel Service, Inc.) Finally, maritime is the movement of trade along lakes, rivers, canals, and the oceans. In the U.S. there is still an extant inland waterway system but a seagoing merchant marine cadre has been eclipsed by foreign flagged vessels since its heyday during the mid-20th Century. The industry, divided into four major sectors and a number of niche segments across both domestic and international markets, remains essential for the national security of the U.S. It will be assessed below.

C. Strengths, Weaknesses, Opportunities, Threats – SWOT Analysis

The industry and its underlying markets lends itself easily to a holistic assessment through a traditional SWOT analysis. While not inclusive of all facets of transportation, this succinct analysis below was shaped by the students' assessments, visits, interviews, and studies through the course of the semester.

Strengths are readily apparent in the U.S. Transportation Industry. The industry can draw on centuries of experience and a long culture of innovation. American engineers built the Panama Canal and constructed the Transcontinental Railroad. The interconnected freight rail system engendered by the latter remains one of the core strengths. Additionally, since the advent

of flight at Kitty Hawk, the U.S. dominates the airplane manufacturer business (a key supplier to transportation). Americans travel more now than ever and that is clearly self-evident in the nation's airports and highways. These advantages in flight, rail, and highway have been crucial in projecting power worldwide and in moving forces domestically (one thinks of Jomini's emphasis on internal lines of communication). Science and technology remain a major contributor as well.

Weaknesses certainly exist within the industry. Challenges with maintenance and upkeep of infrastructure abound (as will later be discussed in this paper). Competitors are present in the airline and maritime sectors. Weaknesses and opportunities are present in human capital. Members of the work force are underemployed or lack the right skillsets and education to be employed in appropriate positions.

Opportunities are extant and should be acted upon today. Some, like human capital, are both a weakness and an opportunity. Appropriate immigration and education strategies have the ability to transform the work force. Where there are strengths, there exists hidden opportunities as well. The U.S. airline and aircraft manufacturing industries are robust and could continue to grow. Science and technology offer incredible avenues to innovation through research and development. Public-Private partnerships continue to improve autonomy and other innovative products which are critical to both national security and the economy. Finally, Schumpeterian change will offer radical disruptions but provide radical opportunities. One can think easily of the crushing effect of the internal combustion engine on the buggy-whip manufacturing industry contrasted with its enabling effect on the automobile industry.

Threats are self-evident … but can be avoided. These are both internal and external. Much like weaknesses, they exist in infrastructure, competitors, and complex regulation.

Infrastructure costs are an opportunity cost for governments at all levels. The question to invest or not to invest in transportation infrastructure should be championed by and for the industry. Besides challenges from resourcing or regulations, threats exist externally from international competitors. In a world where national security should remain critical, some elements of the U.S. Transportation Industry must remain organic. The threat to the latter will continue to engender dialogue around such things as government regulation and intervention (e.g. the Jones Act) while balancing the threats to national security against the threats to economic efficiency.

III. CURRENT MARKET CONDITIONS – FIRM ANALYSES

According to the U.S. Department of Commerce International Trade Administration, spending on logistics services and the four transportation industry sectors (freight rail, maritime, trucking, and air and express delivery services) totaled $1.48 trillion in 2015, or eight percent of annual GDP.[4] The following section will briefly explain the economic and military implications for these transportation sectors and highlight the outlook for select firms in each mode.

A. Trucking – J.B. Hunt

Over the road truckers are the lifeblood of the U.S. economy. Trucks receive and deliver goods and services from business to business and business to consumer. They are the "bridge" between multiple modes of transport – such as railheads, airports, seaports, and inland distribution centers. Trucks offer the most exact way to move cargo the final mile to the destination point and are not tied to fixed infrastructure nodes. This ground mode offers mobility, speed (for close distance locations), ease of adjusting cargo, and a host of other valuable aspects to the sector. Trucks don't offer an economy of scale like railroads or shipping lines until they merge into large companies. One of those is J.B. Hunt.

A leader in truck transportation with annual revenues of nearly $7 billion, it currently employs over 22,000 employees and operates more than 12,000 trucks. Over 100,000 trailers and containers can be found in the company's fleet as well. J.B. Hunt is divided into four business units: Intermodal (JBI), Dedicated Contract Services (DCS), Truck [Full-load dry-van] (JBT), and Integrated Capacity Solutions (ICS). J.B. Hunt's fleet of tractors covers the entire U.S. domestic market (North America including Canada and Mexico). This is not the truck company of 1950; this is a company focused on transportation services. Nearly seventy-five percent of its profits stem from the intermodal business where it rents out it unique tractor-trailer-container combination to the rail lines for true intermodal success. Twenty percent of the profits come from running other companies transportation / internal trucking businesses (DCS). The traditional over the road business (JBT) generates only a paltry three percent while the logistics services it provides other companies (ICS) generates five percent. J.B. Hunt focuses on a number of areas of competitive advantage: intermodal refinement, a strong rail partnership, and a final mile critical delivery. One challenge that J.B. Hunt is facing along with the rest of the trucking industry is the need for skilled, qualified drivers to fill a growing delta between requirements and assets. This is explained in more detail in the human capital challenge section later in this paper and has similarities to other human capital problems (e.g. pilot shortage). Finally, J.B. Hunt is a leader in transportation innovation. Whether in concepts or technology it realizes that innovation is a key to success for the future. This is also covered in more detail in the outlook section.

Truck transportation is an essential sector of the American transportation industry. Unlike rail, air, and inland waterway – all essential and all covered in subsequent sections – trucking provides the arteries and capillaries of the logistics system in the U.S.[5]

B. Rail – Union Pacific

Perhaps no American transportation mode embodies adaptation and change better than the freight rail industry, which supports the U.S. economy by moving both finished goods and raw commodities throughout North America. U.S. railroads are key to global trade, hauling goods to and from ports as well as across international borders to Canada and Mexico. Railroads have a long history in the U.S. economy, opening up westward expansion as daring private investors started building the nation's railroad infrastructure in the 19th Century. The rail industry has changed as highways, trucking, and pipelines have become commonplace economic forces. Today there are fewer total railroads, less track, and fewer passenger moves on trains, but nevertheless, freight rail is critical.[6]

The strategic importance of this freight rail cannot be overstated. Rail is often the only viable mode for moving essential bulk commodities such as mined resources and agricultural products from inland regions of the nation's core to ports and throughout the continent. Rail also plays a very critical role in mobilization – moving heavy military cargo from forts to ports of embarkation. Rail is integral to moving containerized intermodal cargo and automobiles. Railroads both compete with one another and work together to collectively be the mode of choice for moving large quantities across North America. Trade policy can have a significant impact on freight rail competitiveness. Although the freight railroads are privately owned and maintained, they are also subject to federal oversight from the Federal Railroad Administration (FRA) to ensure safety and the Surface Transportation Board to ensure fair economic trade. Today's freight rail industry is dominated by a few major railroads. Class I railroads cover most of the country and are supported by many other smaller, local Class II and Class III railroads in regional areas. However, most of the privately maintained tracks connect as a single, standard network.

Seminar 19 studied the Union Pacific Corporation (U.P.), which like most Class I railroads is publicly traded on the New York Stock Exchange. In 2015, Fortune Magazine referred to U.P. as "the railroad with better profit margins than Google."[7] Further, the firm's CEO Lance Fritz told his Board of Directors in February of 2018 that, "We are optimistic the economy will favor a number of our market segments leading to another year of positive volume growth. Increased unit volume, combined with inflation plus core pricing and G55-0 productivity initiatives, should result in another year of revenue growth and improved margins."[8] Still, as the firm highlighted in its 2018 Annual Report, heightened regulation from multiple federal agencies, implementation of safety-aimed technologies such as Positive Train Control, and market forces such as competition, mergers, and global trade flows all present risk factors to the financial performance of U.P.[9] Figure A summarizes U.P.'s operating landscape and relatively equal revenue distribution across six different commodity groups, which – in addition to exemplifying freight rail's economic influence – likely protects the industry to an extent from adverse impacts of economic volatility in a particular sector. Notable among U.P.'s revenue mix is that intermodal business grew nearly 40% for U.P. between 2010 and 2014, an indicator that railroads are a key stakeholder in the increased connectedness of global transportation networks fueled by containerization.

While economy-supporting freight movement is the primary business of the U.S. rail network, railroads also host scheduled Amtrak passenger train service and work closely with the Department of Defense (DoD) and other federal agencies for military movements from interior bases and for emergency contingencies. Together and in coordination with states and the Association of American Railroads (AAR), the FRA, and the U.S. Army's Transportation Engineering Agency under the Military Surface Deployment and Distribution Command, they

established the Strategic Rail Corridor Network (STRACNET), an interconnected rail network of more than 36,000 miles and protocols to facilitate movement of heavy military equipment from more than 120 defense installations to seaports when needed.[10] In short, the nation's rail network is a critical resource for both the U.S. economy and the military's ability to mobilize defense forces. Sound federal oversight that ensures the vitality of the nation's rail infrastructure is a critical priority when assessing the nation's transportation needs.

C. Maritime - Kirby Corporation & American Roll-on Roll-off Carrier Group

Given America's deep seafaring heritage and extensive access to navigable waters, it should come as no surprise that U.S. transportation relies heavily on maritime routes. Of course, global commerce and Mahanian naval dominance are facilitated by deepwater ports on the U.S. Pacific, Gulf of Mexico, and Atlantic Ocean Coasts. Seminar 19 focused amply on global shipping challenges, so much so that an entire section later in this compendium is devoted to port issues. This section focuses specifically on the nation's inland waterways and maritime shipping cadre, which like railroads, play a unique and indispensable role in America's interconnected transportation network. The waterways not only facilitate our national economic engine through transporting one-sixth of the nation's intercity cargo, but they also provide critical national defense value by supporting the mobilization and sustainability of the U.S. military.

The inland waterways network stretches 12,000 miles and includes 191 lock sites and 237 active lock chambers that, according to the Army Corps of Engineers, have a replacement value of over $125 billion. The network serves as a cost-effective means for moving major bulk commodities such as grain, coal, and petroleum. A single fifteen-barge tow used on an inland waterway is equivalent to about 225 rail cars or 870 tractor-trailer trucks. If the cargo transported on the inland waterways each year had to be moved by another mode, it would take an additional

6.3 million rail cars or 25.2 million trucks to carry the load. The ability to move more cargo per shipment makes barge transport both fuel efficient and environmentally advantageous. On average, a gallon of fuel allows one ton of cargo to be shipped 59 miles by truck, 202 miles by rail, and 514 miles by barge. As evidenced by the numbers above, inland navigation also serves as a key element of state and local government economic development and job-creation efforts and is essential in maintaining economic competitiveness.[11]

The operations and maintenance costs that support the inland waterway infrastructure are substantial. It is widely understood in the industry that the periodic capital improvements required to sustain the system have not been made. For example, more than half of the locks and dams are over fifty years old and have not been modernized or replaced. There are many reasons for this, but ultimately, they were not a budget priority compared to all the other needs of the nation. As a result, the infrastructure has decayed at a rate that makes full repair of the system cost prohibitive in the short-term, but possible with a long-term plan that includes dedicated and dependable funding. Two monetary issues that policy makers should consider for apportioning funds are increased user fees and privatization of the 191 lock sites that make up the inland waterways. There are positives and negatives to both, but both warrant strong consideration. Overall, the inland waterway system is a national treasure that drives the nation's economy and provides for its national defense. Any conversation that involves the mobilization of the U.S. military must include the capabilities and robustness of the inland waterways system.

Seminar 19 closely evaluated the Kirby Corporation, America's largest domestic barge operator with a fifteen percent share of the market. Overall, the domestic barge industry is volatile, having undergone several consolidations over the past five years due to an oversupply of barges and operators. Kirby has been a relative standout among its peers, leveraging its size to

acquire several smaller competitors and adaptability to reconfigure barges as petroleum demand increased and grain and coal business waned. Its competitors struggled to match Kirby's success in modernizing its fleet, digitizing business processes, and sustaining operational diversity through a business unit that maintains the engines in not only Kirby's fleet of tug boats but many other firms using similar equipment.[12] Government regulation and protection is of great interest to Kirby and the domestic barge industry as a whole. Any discussion involving changes to the century-old Jones Act, which among its many protections restricts maritime transportation of goods loaded in one U.S. port and discharged in another domestic port to U.S. companies operating U.S.-built vessels, is of the utmost concern to the protected barge industry. Should the Jones Act be repealed, domestic firms could be squeezed out of the industry by foreign barge operators that can often operate with less restriction and lower costs.[13]

There is another importance as well. The viability of commercial maritime firms is not just economically critical: the industry also supports the U.S. Government in wartime with vessels, seafarers, and shipbuilders. As testified by Eric C. Ebeling, President and CEO of American Roll-on Roll-off Carrier Group (ARC) on behalf of USA Maritime before Congress in January of 2018, the domestic commercial shipping industry is committed to:

> "Investing in the U.S—flag fleet and U.S. Merchant Marine, to operating the most military-useful and economically viable ships to support our armed forces around the world…The U.S.-flag fleet has been at a crossroads in recent years. Declining cargoes resulted in a shrinking fleet, which led to a shortage of qualified mariners, and these factors in turn impacted national defense readiness in terms of sealift and logistics support available to support the needs of the Department of Defense. Congress has passed smart new maritime policies in recent years, and the fleet has now started to stabilize."

ARC, itself, owns foreign-built, ocean-going ships that have been transitioned into U.S. flag vessels to participate in the U.S. Government's Maritime Security Program (MSP). Working with the DoD Transportation Command (USTRANSCOM) and the Maritime Administration

(MARAD), ARC's Roll-on/Roll-off (Ro-Ro) ships – vessels which can accommodate nearly all wheeled equipment and breakbulk cargo that can be trailered – have for many years transported much of the U.S. Government and military rolling stock to and from Europe and as well to Middle Eastern ports in support of Operations Enduring Freedom and Iraqi Freedom. Mr. Ebling was speaking to Congress in support of extending the MSP beyond 2025 so that companies have time to maintain and invest in the strong U.S. flag international fleet that preserves U.S. military sealift capability in both peacetime and during conflict. He closed his strong testimony by quoting USTRANSCOM commander Gen. Darren McDew from October 2017, saying "We don't know when, but someday the nation is going to come calling. When she does, she will need us, she will need our ships, she will need our mariners… if we do nothing now, the strength of the maritime fleet that brought the nation to war throughout history… that strength will not be here. It's already in decline." To which Ebling added, "It is incumbent on all of us as Americans to stay that decline and ensure that this crown jewel capability continues to be available to USTRANSCOM, and the nation."[14] Seminar 19 could not agree more with General McDew and Mr. Ebling that maintaining a stable cadre of mariners and ships to support national security needs is absolutely a core value.

D. Air Transport – Atlas Air

The innovation of flight transformed global transportation and advanced America's military power throughout the 20th Century. No other mode can quickly cover as much distance as the aircraft industry that continues to modernize with increasingly larger capacity and longer-range planes like the Boeing 787 Dreamliner. Without question, the evolution of the global economy and military power projection would not exist without airlines, airports, and related infrastructure. Today's predominant mode of choice for long-distance passenger travel is also

critical for time-sensitive freight. Seminar 19 had the opportunity to analyze both of these markets through Atlas Air Worldwide Holdings (AAWW), Inc., a provider of outsourced aircraft and aviation operating services.[15] The company offers cargo and passenger aircraft charter services, ACMI contracts (Aircraft, Crew, Maintenance and Insurance), and dry leasing services, i.e. aircraft and engines without CMI (Crew, Maintenance, and Insurance). The company also offers aviation services to include flight simulator training (for pilots of Air Force One and the E-4B National Airborne Operations Center) and administrative management support services (to schedule analysis/management, route and traffic rights management, fuel procurement / administration, ground-operations support, and 24-hour customer service).[16]

Atlas Air was founded in 1992 with one Boeing 747-200 aircraft. In 1993, it leased freighter aircraft to other airlines on an ACMI contract basis. During the rest of the 1990s, Atlas experienced substantial growth through long-term leasing. In November 2001, it acquired Polar Air Cargo, Inc., an all-cargo, scheduled-service carrier. In 2004, it emerged from bankruptcy. The services it provided continued uninterrupted during restructuring.[17] In 2007, its subsidiary, Polar Air, closed on a strategic transaction with DHL Express. This transaction provides DHL Express guaranteed capacity while AAWW gained a valuable long-term customer, securing a strong revenue stream and further reducing commercial risks through a long-term ACMI agreement. In February 2008, the company formed Titan Aviation Leasing Ltd., a wholly owned subsidiary, to dry lease aircraft and engines – this showcased the extension and diversification of the company's activities. From 2011 to 2015, Atlas Air took delivery of new aircraft, the next-generation Boeing 747-8 freighters, and initiated new 767 and 777 operations. In April 2016, AAWW completed the acquisition of Southern Air, Inc., a premier provider of intercontinental and domestic CMI services. This acquisition provided Atlas immediate market entry with 777

and 737 aircraft. In May 2016, a strategic, long-term relationship with Amazon was concluded. AAWW was to provide and operate twenty Boeing 767-300 converted freighters in support of the continuing expansion of Amazon's e-commerce business and the enhancement of its customer delivery capabilities. The new service began in August 2016 and is expected to ramp up to full service through the end of 2018. Twelve aircraft are currently in service. To align interests and strengthen the long-term relationship, AAWW granted Amazon warrants to acquire up to twenty percent of AAWW's common shares at a certain price per share until 2021. These agreements also provide for future growth of the relationship as Amazon may increase its business with AAWW.

In the same way that primarily economy-driven maritime firms bolster the DIB in times of need, so too passenger and freight airlines provide mobilization contingency to DoD. The Civil Reserve Air Fleet (CRAF) program is an invaluable asset for the Nation that consists of commercial aircraft from private industry that augment DoD airlift, in various stages during peacetime or wartime, on a contractual "as needed" basis. The CRAF is a vital and major component of passenger and cargo charter airlift and directly contributes to national security and prosperity. As of April 2017, an Air Mobility Command Fact Sheet stated that "24 carriers and 434 aircraft are enrolled in CRAF. This includes 397 aircraft in the international segment and 37 aircraft assigned to the national domestic services segment…"[18] The CRAF is an exceptional public-private partnership with the dual-purpose of protecting and promoting national security and prosperity around the globe. One of the key CRAF partners is Atlas Air.

Atlas Air relies heavily on DoD airlift contracts to maintain profitability. Sequestration, constrained defense budgets, and decreased deployments have significantly decreased the use of CRAF aircraft over the last five to ten years. In turn, budgetary and profitability uncertainty has

significantly decreased the number of air carriers and those willing to participate in the CRAF program. To ensure program viability, the DoD has encouraged participation for airlines like Atlas by mandating that only carriers that are members of the CRAF are eligible to compete for peacetime government air transport and air travel contracts.[19] Due to changes in both national strategy and the air carrier/air charter industry structure, the CRAF framework has significantly changed. In the Air Force Magazine, John Tirpak writes:

> Because the US military depends so heavily on CRAF, and because so many carriers depend on US government business, the Congressional Research Service dubbed the relationship "symbiotic" in a 2006 study of the program. In exchange for getting to buy only as much additional airlift as it needs, the government gives preference and steady work to those who commit to the program. The government doesn't want to be the sole source of revenue for any company, however, and sets limits on how much of a carrier's overall business can be government contract work. That's because TRANSCOM and AMC want those carriers to be viable during downtimes, so they'll be available and can be called on for the next contingency.[20]

Atlas Air and the air charter service market as a whole are vital to national security and prosperity. CRAF is the bedrock that enhances and ensures that the Nation's air mobility resources are ready, willing, and able to meet any defense mobilization requirement, no matter how big or small.

The above section has outlined the major sectors within the transportation industry as well as their most significant accompanying firms. The next section defines the major problems encountered, often common, throughout these sectors and markets.

IV. CHALLENGES

There are a number of challenges facing the transportation industry, not all of which can be given full critical assessment in a single paper. Instead, Seminar 19 identified prevailing issues by asking cross cutting questions across the industry and codifying the emerging themes into three key areas. Probably the most well-known and acceptable challenge involves

"crumbling infrastructure" – or at least an older degraded one. A healthy and resourced infrastructure is critical because it truly forms the backbone upon which the transportation industry operates. A second challenge is human capital, i.e. the relative (compared to decades past) decrease in available or potential members of the labor force. This particularly impacts commercial truck drivers and airline pilots. A final challenge to the industry is represented in barriers to innovation. Dire consequences could result from these barriers blocking or impeding legitimate healthy change.

A. Infrastructure – Roads and Highways

Infrastructure is the foundation for the U.S. Transportation Industry. Solid, quality roads, rail, water, and aviation infrastructure provide an effective and efficient means to move goods from one location to another via truck, train, ship, or plane and therefore provide the platform for economic growth and activity. The American Society of Civil Engineers (ASCE) graded the U.S. infrastructure with a cumulative letter grade of a D-.[21] Having a low infrastructure grade stifles productivity and decreases access to labor, therefore impeding economic growth. Due to the current state of U.S. infrastructure, the U.S. economy projects a loss of almost $4 trillion in GDP and a loss of 2.5 million jobs by 2025.[22]

The trucking industry relies on roads; in 2016 alone, all registered trucks traveled 450.4 billion miles.[23] However, ASCE graded U.S. roads with an overall grade of a D. Currently, twenty percent of rural and urban roads are in poor condition while thirty-nine percent are in mediocre or fair condition. Some communities such as San Diego, California and Concord, Massachusetts live with seventy percent of their roads in poor condition.[24] In 2015, poor road conditions "Cost motorists $120.5 billion in extra vehicle repairs and operating costs, or $533 per

driver."[25] Maintenance and repairs also cause downtime for trucks in the industry and the cost of this downtime gets passed to the consumer, negatively impacting the economy.

It is not just poor road conditions stifling economic growth within the trucking industry. Lack of investment in road infrastructure creates traffic congestion. Traffic congestion interferes with on-time deliveries and increases fuel consumption. These inefficiencies within the industry increase the cost of doing business and in turn increase the cost of goods to the consumer, which negatively impacts the economy. In 2014, the U.S. work force wasted 6.9 billion hours delayed in traffic and 3.1 billion gallons of fuel that totaled more than $160 billion.[26] Future forecasts expect commercial truck travel to increase by seventy-two percent by 2030, increasing congestion and fuel consumption.[27] To improve the grade and support a growing economy, the U.S. must invest in infrastructure to improve road conditions and decrease congestion through proper planning and funding.

As mentioned in the opening, President Donald J. Trump's Administration unveiled a $1.5 trillion infrastructure plan in early 2018. $100 billion of the proposal is shared between the U.S. Department of Transportation (DoT), U.S. Army Corps of Engineers (USACE), and U.S. Environmental Protection Agency (EPA) while another $14 billion is shared among infrastructure programs to include the Transportation Infrastructure Finance and Innovation Act (TIFIA). The president's proposal identifies $50 billion for a new Rural Infrastructure Program that would split the $50 billion between states and Tribal infrastructure. In addition, he proposes $20 billion for another new program, the Transformative Projects Program promoting innovation in infrastructure.[28] $6 Billion is proposed to create flexibility and broaden eligibility to facilitate using Private Activity Bonds (PAB).[29] The allocation of funds for innovation and PABs introduces the Trump Administration's initiative to encourage public-private partnerships in

funding mutually beneficial projects at the state and local level; thereby reducing the burden of the U.S. Government to secure funding for infrastructure projects. State and local governments, possibly in partnership with private industry, will fund the remaining portion of the plan.

Currently, funding for both federal and state government infrastructure projects is provided through taxes on vehicle fuel purchases, commonly called the gas tax. The federal government funds much of its road infrastructure projects through the Federal Highway Trust Fund (FHTF), which gains its revenue from the gas tax. Since 1993, the fuel tax on gasoline has remained at 18.4 cents for gasoline and 24.4 cents for diesel. However, the tax did not keep up with inflation, which has increased by over 65%, cutting the FHTF purchasing power by 40%.[30] But it gets worse. The FHTF is expected to run out of funding in the year 2021 with a $139 billion shortfall by 2027.[31] This is in addition to the $836 billion backlog of highway and bridge capital investment projects that is expected to grow to $3.2 trillion by 2040.[32,33]

States are stepping up to pay their share of road infrastructure costs. In 2014, state and local governments spent $48.3 billion while the federal government spent $43.5 billion on capital costs for highway infrastructure. States also spent $70 billion on operations and maintenance of roads with the federal government spending just $2.7 billion.[34] In addition, by 2017, twenty-six states increased the gas tax, providing additional funding to support much needed infrastructure improvements.[35] Most of these states also increased the cost for vehicle registration and licensing, yet another way to increase revenues in order to fund infrastructure projects. Even with the increase in gas taxes, registration and licensing, most states still fall short of funding 100% of projects. An even larger problem is state and local debt. It is estimated that states and local governments currently face a combined debt of $3.1 trillion.[36] This proves that states require

additional funding sources to reduce the debt burden of financing transportation infrastructure programs.

Instead of a gas tax, many states are considering a user-based tax due to the eventual decrease in vehicles using gas or diesel. Volvo recently announced they will no longer produce combustion engines by the year 2019 with all vehicles coming off the assembly line in either a hybrid or fully electric configuration.[37] Other auto makers are following closely behind and some states, such as Oregon, are testing mileage-based user fees options. With many in the younger generations wanting greener solutions coupled with advancements in technology, planning for tomorrow starts today. A user fee based on mileage should phase-in over time as combustion engines phase-out.

A dearth in allocated funding could hurt the U.S. economy. It is imperative to act now in order to change course and implement an increase to the gas tax that keeps up with inflation, implement a mileage user fee system for hybrid and electric vehicles, reduce regulations and policies that waste time and money, support sensible public-private partnerships, and provide an appropriate portion of the federal budget focused on improving U.S. infrastructure.

B. Infrastructure – Ports & Harbor Operations

Ports and harbors in the United States offer value propositions since they confer economic and social benefits. They provide cost effective modes of transportation, driving global trade and the U.S. economy. The increase in port activities, especially in the containerized industry, increases pressure for the development of new infrastructures of ports on the existing facilities to increase capability and capacity. The onset of globalization and the economies of scale in shipping provided a consistent trend in containerized shipping. The early container ships were modified bulk vessels and tankers with limited capacity for carrying containers on

converted decks. These were self-sustained vessels (crane onboard) which carried approximately 500 to 800 TEUs and could service any ports.[38] Ports and harbors were and are expensive infrastructures that are closely related to economic impacts. The U.S has vast interconnected transportation networks, composed of highways, railways, and inland waterways, connecting the interior of the country to these maritime ports.

The demand for improvements in ports and harbors has increased recently in the U.S. due to improving economic conditions. Consumer spending has facilitated global trade. As a result, the trade index has consistently improved in previous years, increasing the buying power of consumers and companies. Industry operators are forecasted to experience steady improved revenues due to increasing trade volumes, a growing level of disposable income and increased consumer spending in the U.S. These factors have bolstered the demand for port and harbor industry services. International trade accounted for thirty-two percent of the U.S. GDP in 2015 and is expected to reach sixty percent by 2030.[39]

Maritime transportation is essential to the U.S. and world economy. Maritime trade is the most cost-effective transportation of mass goods and raw material, 90% of the world's trade is carried by sea. Healthy ports and harbors drive economic growth in the U.S. through imports and exports. Exports have continued to be a growing percentage of the GDP. Foreign and domestic trade depend on ports and harbors that handle almost all commerce by weight. This waterborne transportation of all products is about two billion tons, which is about half of the global trade.[40]

The volume of goods through U.S. and international ports has significantly increased with container ships, bulk carriers, and Ro-Ro vessels. The volume of throughput is adding mounting pressure on the creation of new port facilities due to limited space, congested truck routes, and limited rail access. The profitability of the port and harbor industry is closely

associated with shipping volumes. However, some existing ports in the U.S. are inadequate to handle heavy workload due to capability and capacity limitations. Some U.S ports operate on technology which is slow and inefficient. Therefore, they need renovation or acquisition of new technologies to remain competitive, efficient, and not over-reliant on an expensive labor force. Economic theory often refers to U.S. ports as significant factors for economic developments, especially from the historical point of view where they promote trade and welfare of the U.S. There are some signs of neglect among the U.S ports and harbors. This disrupts the view as the country competes in an increasingly dynamic world economy. Many aspects of port management are relics from mid-century. Most European and Asian ports are becoming modern and productive, putting U.S. ports farther behind due to the absence of innovation, automation and investment. This could be a troubling scenario for the U.S., especially if freight movement by sea increases in the next few years.

Some U.S. ports have narrow channels, shallow harbors, and congested rail access routes.[41] For example one major New Jersey harbor has shallow-dredged channels, making it prone to siltation. This forces large ships to unload some of their cargos elsewhere, raising shipping costs, and making ports less competitive. The maintenance and expansion of U.S. ports are often hindered by delays in granting permits, environmental regulations, and disagreement about the disposal of dredge refuse.

In contrast to the condition of the U.S. ports, the Dutch port of Rotterdam is one of the most important around the globe in terms of megacarriers (large container ships with carrying capacity of over 15,000 TEUs). The Rotterdam terminals have an elaborate waterways management system that track vessels as well as managing traffic, thus reducing disruptions significantly. The handling of cargoes is automated with state-of-art cranes that can load and

unload thirty containers per hour. Also, the Rotterdam terminals have robot-stacking cranes that are capable of moving containers in and out of the terminal at a faster rate. The average container handling per hour in U.S. ports is 28 containers. This may seem equivalent, but the small difference in productivity can lead to major economic effects over time. Similarly, the Port of Yokohama in Japan includes vessel berths which are over 49 feet deep with a modern container terminal, sample storage areas and an access road.

C. Human Capital – Commercial Truck Driver Shortage

Much has been researched and written about human capital issues facing the transportation industry. These range from recruiting, to developing, to retaining a qualified workforce needed to meet the industry's current and future requirements. Estimates that "Forty-to-fifty percent of the existing workforce is nearing retirement" exacerbate these challenges.[42] These issues have been especially pronounced in the Over The Road (OTR) trucking industry where by the year 2025 there will be a shortage of nearly 175,000 drivers, according to the American Trucking Associations (ATA).

The driver shortage is becoming more critical because the weight of domestic shipments by truck compared to other shipment methods is projected to continue to grow. In 2007, for example, the total was almost sixty-eight percent; that number grew to seventy-four percent in 2012 and is expected to be over seventy-eight by 2040, according to the DOT Bureau of Transportation Statistics. It is clear that the driver shortage issue must be addressed now, through driver recruitment and retention, a review of government regulations, and a focus on innovation in order to ensure there is no negative impact on the U.S. economy.

The first factor impacting the shortage of drivers is the high OTR truck driver turnover – currently this is approaching a ninety-five percent annualized rate according to the ATA. It has

been an issue for the trucking industry for many years and has now become the top issue according the American Transportation Research Institute (ATRI).[43] There are a myriad of reasons contributing to the OTR shortage, namely lifestyle, job alternatives, and government regulation.[44] Regarding lifestyle, new drivers to the industry "Are assigned routes that put them on the road for extended periods of time before they return home, typically a week or two. Therefore, it is not just a career, but a lifestyle that does not fit with everyone's desires or needs. Eventually, drivers that wish to can move into regional or local driving positions with tenure."[45]

A second factor contributing to higher turnover is more job alternatives, primarily due to historically low unemployment rates. In years past, "The trucking industry was one of the few industries hiring people" compared to today where "There are more job alternatives available for current drivers and would-be truck drivers."[46]

A third factor impacting the shortage of drivers is the workforce demographics of the OTR labor pool. This is another area that needs to be better analyzed to address the driver shortage. Chief among the demographic factors is the age of OTR drivers. According to the ATA, the median age of OTR drivers is forty-nine, seven years older than the average U.S. worker overall.[47] In fact, in 2014 ATRI found that in the trucking industry fifty-five percent of the workforce was forty-five or older (this is largest cohort employed by the truck transportation industry) and less than five percent of the workforce was between twenty and twenty-five years of age.[48]

Another key demographic-related issue is the inability of the trucking industry to attract segments of the broader U.S. population. Women, for example, make up about forty-seven of the U.S. workforce but only six percent of all truck drivers; this percentage has ranged between four and six percent over the past fifteen years.[49] Much work needs to be done in the area of

ergonomics for women drivers, mainly due to height differences between men and women. Ryder System Incorporated has been a leader in this area; it offers a custom vehicle design that includes fifteen unique specifications intended to meet the needs of female drivers. Overall, the industry has done a better job attracting minorities than women; over thirty-eight percent of drivers are minorities, an increase of twelve percent since 2001.[50]

The first recommendation in providing a long-term solution to the OTR driver shortage is to examine the recruiting process. This process must begin by targeting potential candidates who will have a higher probability of pursing and accepting a driver position and, more importantly, are the types of individuals who will stay in the OTR sector of the trucking industry.

A 2016 National Center for Intermodal Transportation for Economic Competitiveness study of high school and recent college graduates found that "Self-efficacy, occupational values, and social support were significant predictors of study participants' interest in working in transportation."[51] More specifically, the study found three results. First, women were more likely to accept a job in transportation if there was potential for significant financial reward or flexible work hours. Second, a good indicator of accepting and succeeding in a position in the transportation industry is whether a family member has worked in the industry. Third, individuals who have a high degree of self-confidence often possess the skills that are of value and that will be successful in the transportation industry and are therefore more likely to accept a position as OTR drivers.

D. Human Capital – Aviation Pilot Shortage

Aviation is essential to national security and prosperity, two main pillars of the National Security Strategy (NSS). The current pilot shortage in the U.S military and the airline industry is growing at an alarming pace. The U.S. Air Force, which reports a shortage of nearly 2,000 pilots,

consistently sees pilots leaving the military for civilian airlines are in a that hiring boom and offer a large increase in pilot compensation.[52] The airlines are also feeling the human capital pinch. “Over the next ten years, about 22,000 pilots at the largest airlines are expected to retire. That’s more than forty-two percent of the pilots currently working at those companies…some projections indicate that this country could experience a shortage of as many as 35,000 pilots over the next fifteen years or longer.”[53] Pilot incentives/compensation, government regulations, and aviation related deployment/commerce demand are the major challenges. The U.S. must enhance its ability to effectively recruit and retain pilots, sensibly reform pilot qualification regulatory guidance, and substantially develop innovative solutions for the growing pilot demand in order to prevent detrimental impacts to national security and prosperity resulting from insufficient incentives and compensation, excessively conservative regulations, and inadequate technological breakthroughs.

There were a number of interrelated facts which shed light on this issue. First, in 2009, FAA raised the mandatory retirement age of airline pilots from age sixty to sixty-five; however, a decade of below average airline compensation, post-9/11 airline pilot furloughs, and a major financial recession, created an extended period of minimal pilot hiring at the major airlines. Second, in 2009, the crash of Colgan Air Flight 3407 drove the 2013 FAA mandate that increased the airline First Officer requirements from 250 hours and a Commercial Pilot license to 1500 hours and an Airline Transport Pilot (ATP) license (Restricted Airline Transport license allows 750-1250 hours). Third, the demand for civilian passenger and cargo air commerce, combined with decades of significant Air Force deployments has exponentially increased. International trade growth and aviation related globalism has created an expectation of affordable air travel, cheap goods, and rapid delivery. The NSS, National Defense Strategy (NDS), and

National Military Strategy (NMS) are heavily reliant upon Air Force pilots to provide peerless air superiority, long range strike capability, and global mobility. These expectations drive demand for pilots and contributes to the pilot shortage.

There are salient points which support these key contributors to the dearth of pilots. A 2015 RAND dissertation on Air Transport Pilot supply and demand found that, "In 2009, civil aviation accounted for 5.2 % of the U.S. GDP...produced $1.3 trillion in related goods and services…generated 10 million jobs…generated earnings of $394 billion."[54] The same RAND study stated that "A shortage of the U.S. pilot supply, or available stock, could have significant effect on a number of issues, including route limitations, economic viability for certain airlines, economic effect on cargo and the travelling public, and stress on military pilot manning."[55]

Fortunately, there exist a number of potential solutions. First, analysis of the Part 121 Scheduled Air Carrier age sixty-five limitation is necessary. The age sixty-five retirement does not apply to Part 135 Charter Operations or Part 91 General Aviation Operations. Civilian airlines and the FAA must work closely with Congress to raise the retirement age for Part 121 Scheduled Air Carriers from sixty-five to seventy, or eliminate it all together (like Part 135 and Part 91 Charter and General Aviation Operations), and institute decreased interval FAA flight physicals to meet safety requirements and concerns of the American public. Second, age limit efficacy for Air Force pilot training should be reevaluated. The current age thirty limit significantly limits recruiting, training, and retention of older personnel in the Air Force pilot force. The Air Force must raise the age to enter pilot training from thirty to thirty-five, create post active duty career airline flow through job guarantee opportunities, and increase the number of flying squadrons and pilot billets with the Air Force Reserve Component. Third, due to high civilian flight training costs, decreased ATP flight time requirements and Government-based

subsidies/incentives for civilian pilot training must be considered. The FAA must work closely with Congress to lower ATP flight time requirements from 1500 to 1000 flight hours and decrease the Restricted ATP flight time requirement range from 750-1250 to 700-900 for pilots with military backgrounds and aviation degrees. The government should add a small tax to each airline ticket in order to create pilot production subsidies for flight training schools, university aviation programs, and small regional air carriers. Fourth, civilian airlines must increase hourly pay rates, provide profit sharing, and provide 401K contributions with regional and charter air carriers. Fifth, financial caps placed on Air Force pilot monthly Aviation Continuation Incentive Pay (ACIP) and the yearly Aviation Continuation Pay (ACP) must be removed. Sixth, the Air Force must focus on allowing pilots to fly and maintain a high level of readiness while decreasing pilot deployments and eliminating non-flying/non-warfighting administrative/staff duties by authorizing retired Air Force pilots or contract personnel as the primary pilot training instructor solution. The Air Force must also focus its marketing efforts among high schools, colleges, flight training schools, and the Civil Air Patrol. Offering monetary and non-monetary incentives / compensation combined with recruiting / retention initiatives is critical for the Air Force. Seventh, the civilian airlines must develop and employ a large number of autonomous air cargo aircraft and semi-autonomous long-haul passenger aircraft to meet the increasing air transport demand. Eighth, the Air Force must develop / employ a large number of autonomous fighter and bomber aircraft to meet air superiority and long-range strike mission requirements. Threats to innovation such as this is the subject of the next sub-section.

E. Threats to Innovation

Yet another challenge facing the transportation industry are the regulatory barriers that threaten innovation and the adoption of new technologies. As an example, autonomous vehicles

will likely transform the transportation industry and provide numerous benefits to society. Despite the benefits, many threats to widely adopting autonomous vehicles still exist. Specifically, current automotive safety laws and regulations as well as liability ambiguity threaten to stifle autonomous innovation.

One of the major challenges facing law makers is the construct of the existing regulatory framework. Under the present automobile regulatory framework there are two basic aspects being regulated, the safety of the driver and the safety of the vehicle. Currently, individual states are primarily responsible for ensuring the safety of the driver. The regulating of the safety and behavior of the driver is typically implemented through individual specific state statues.[56] However, ensuring the safety of the vehicle itself is generally regulated at the federal level through the Federal Motor Vehicle Safety Standards (FMVSS).[57] The FMVSS is responsible for specifying how vehicles must be designed before they can be sold in the U.S.[58] The introduction of highly autonomous vehicles (Level 4 and 5 see Figure C for an explanation of the differing levels of autonomy), significantly complicates this regulatory framework as the "driver" will no longer be a person residing in a state and challenges the effectiveness of the current regulatory structure.

Additionally, the variation among individual states creates challenges for autonomous vehicle manufacturers. In certain circumstances state laws directly contradict one another. For example, in New Jersey an outdated traffic law requires drivers to honk their horn when passing vehicles and bicyclists.[59] Despite the fact that the law is rarely enforced it is still in effect.[60] In Pennsylvania, however, a traffic law mandates that drivers must not honk their horn at bicyclists to keep from startling them and causing an accident.[61] While this may seem like trivial example, should autonomous vehicle manufacturers design to specifications for each individual state?

What should manufacturers do with state laws that are rarely enforced? The variations in laws and legislation create many challenges for autonomous adoption.

Many individual states have attempted to enact legislation regarding autonomous vehicles in order to facilitate innovation. In 2011, Nevada was the first state to provide legislation and regulation for autonomous vehicles.[62] Numerous states have followed Nevada's lead realizing the value and impending need for autonomous legislation, however, the autonomous vehicle laws are not common across state lines (see Figure B).[63]

The inability for regulators to rapidly react to the changing vehicle environment creates a significant barrier to innovation. An additional challenge for autonomous vehicle manufacturers and regulators is the question of liability. In 2015, Volvo issued a press release stating the biggest barriers to autonomous vehicle adoption were "Regulatory, not technical."[64] The technology exists, but the regulatory framework does not. Under current liability law the driver is responsible for operation of the vehicle. However, in highly autonomous modes (Level 4 and 5) it does not make sense for the "driver" to assume the liability. In fully autonomous vehicles the vehicle is also the driver. Fully autonomous vehicles will only have passengers, or potentially no passengers at all. Therefore, the current liability construct must be revised. In 2015, Volvo CEO Hakan Samuelsson stated that Volvo, "Will accept full liability whenever one of its cars is in autonomous mode."[65] Automakers taking on full responsibility for accidents will require them to assume complete liability when their vehicles are operating autonomously. This is a huge liability, but necessary for widespread autonomous adoption. Without the liability when operating autonomously the incentive to ensure the appropriate level of safety does not exist. If automakers are responsible for their vehicles they have a significant financial and moral incentive to ensure their safety before they introduce them in the marketplace.

V. OUTLOOK

Addressing the nation's transportation infrastructure, human capital, and regulatory challenges will undoubtedly require forward thinking to both modernize existing systems and introduce innovative technologies. The nation once at the forefront of transportation innovation now finds itself trailing others across the globe. The good news is that despite falters, government and private sector leaders have not given up on improving the transportation infrastructure. Many solutions, both conventional and disruptive in nature, span the spectrum from theoretical to final stages of development. Some improvements have even been implemented. Later, this paper will assess and recommend government goals and roles in the transportation industry. Government has long talked about public-private partnerships, but the concept seems to be gaining steam with private firms leading the charge. The following section will highlight recent examples of industry-inspired solutions for future prosperity.

A. Innovation – Mass Transit

Where people choose to live and work has a significant impact on global economics and transportation needs. Before the period of the industrial revolution, the majority of the population was spread across rural areas according to reports by the U.S. Census Bureau.[66] By 2045, the DOT predicts the U.S. urban population will grow nearly forty percent to 270 million, blossoming regional clusters of major cities called megaregions. In the growing South Florida megaregion, private firm Florida East Coast Industries is capitalizing on this trend with mixed use community developments along the firm's Brightline rail service—the nation's first privately-funded passenger rail line in decades—which was introduced in 2017 with frequent service between multimodal terminals in Miami, Fort Lauderdale, West Palm Beach, and ultimately Orlando in a future phase. The corridor also enhances the firm's freight rail business,

yielding greater economic impact for the region and increased connectivity to global shipping in the ports of Miami and Fort Lauderdale. [67] Numerous other proposals are in earlier stages of development. Planning is underway for similar megaregion rail connections between Dallas and Houston, Texas. The plan uses a high-speed bullet train led by Texas Central and employs Japan's proven Shinkansen train technology.[68] Further-forward on the innovation scale, Northeast Maglev LLC is in discussions to bring magnetic levitating train technology in use in China, South Korea, and Japan to Northeastern U.S. megaregion.[69] These proposed projects still face numerous funding and regulatory hurdles, but if nothing else are encouraging examples of private firms improving current rail transportation systems.

Disruptive technologies are worthy of the attention of transportation officials, as they could revolutionize travel and infrastructure. At the forefront of disruptive transportation efforts is Elon Musk, the entrepreneur behind the transformative Tesla automobiles and SpaceX rockets pioneering private space exploration. In the surface transportation arena, Musk in 2013 introduced Hyperloop, a frictionless system where vehicles would move within tubes or tunnels at speeds over 700 miles per hour. Musk has proffered that the conceptual system could cost much less and be much faster than conventional rail systems, inviting criticism from skeptics across the transportation industry. Undeterred, Musk's challenged industry experts and academics to validate the idea. The global response has yielded five years of progress, including millions of dollars in venture capital investment, successful test track trials, and promises of operational hyperloop systems in 2021 by the Richard Branson-backed Virgin Hyperloop One venture with competing firms not far behind.[70] In support of not only Hyperloop implementation but also infrastructure revitalization at large, Musk has also started The Boring Company, which he claims can quickly and efficiently dig tunnels at far less cost than modern methods.[71]

Challenges remain in implementing and integrating these technologies into the existing transportation landscape in a meaningful way, but the potential is promising. While it is easy to dismiss innovative, unproven technology as risky, it is the sentiment of the 2018 Transportation Industry Students that officials would be unwise to dismiss these forward-thinking ideas, especially given the need for urban transportation improvements and the successes Musk, Branson, and others have bestowed to global transportation. That the idea was spurred in the U.S. and could parlay with groundbreaking engineering improvements at a time when infrastructure is of vital bipartisan interest makes it that much more exciting. Further encouraging, the Trump Administration appears open to innovate ideas from industry, having created a Strategy and Policy Forum that included leaders like Musk to advise Administration leaders with private industry perspective. The Boring Company even reportedly received high level Administration permission to begin construction of possible Hyperloop tunnels in the Washington, D.C. region, a momentous, albeit provocative offer that would almost certainly require far more formality to be brought to fruition.[72]

B. Innovation - Autonomous vehicles

Autonomous vehicles are poised to disrupt the transportation industry by improving the safety and efficiency of transportation throughout the world. Transportation innovators have been ardently working on improving the driving experience. As noted earlier, Musk's Tesla business has developed the most advanced cars in the world, leading the revolution for electric vehicles and autonomous systems that—despite recent high profile accidents—data suggests are safer.[73] Safe, environmentally friendly automobiles could prove significantly important in light of likely capacity challenges in megaregions. For example, integrating autonomy and efficiency into intercity motorcoach buses – which are by far the least subsidized form of rural

transportation – could provide viable supplemental service to link megaregion transportation systems and airports to smaller communities.[74]

The recent surge in autonomous vehicle technology was spurred by the Defense Advanced Research Projects Agency (DARPA) Grand Challenge in both 2004 and 2005. Since then, the field of autonomous vehicle technology has made incredible progress. Many major technology companies and automobile manufacturers are currently testing self-driving systems. In 2015, Google's autonomous vehicle program passed the one-million-mile mark and boasted the successful navigation of 200,000 stop signs and 600,000 traffic lights.[75] Also in 2015, Tesla introduced its autopilot mode and planned to introduce fully autonomous vehicles in late 2018.[76] It is not only fully autonomous vehicles entering the automobile market, many high-end conventional vehicles feature autonomous capabilities such as self-parking and emergency braking systems. These differing levels of autonomous systems are making our roadways more efficient and safe. See Figure C for a description of differing levels of autonomy.

In 2016 over 37,000 people were killed in motor vehicle accidents.[77] Of those, distraction related deaths accounted for 3,450.[78] Additionally, over 90% of motor vehicle accidents are caused by human error.[79] Technology plays a critical role in mitigating and reducing the impact of human error and fatalities on our roadways. A RAND study, suggesting that autonomous vehicles should be introduced to the market as soon as they are "slightly safer" than a human driver predicts that autonomous vehicles could save over 1.1 million lives by 2070.[80] See Figure D for additional details.[81]

While fully automated vehicles will clearly save lives, there are many systems in use today that provide differing levels of autonomy and improve safety. An example of a driver assistance autonomic technology (Level 1) includes automatic emergency braking (AEB)

systems. An AEB system detects an impending accident with another vehicle and attempts to avoid or mitigate the crash.[82] If the system detects an upcoming accident it alerts the driver to respond, even if the driver does not respond certain AEB systems will automatically apply the brakes and avoid or reduce the severity of an accident.[83] Even though the AEB is only providing "minimal assistance" this incremental improvement in automation can drastically improve the safety of our roadways. Additional technologies such as forward collision warning, lane departure warning, lane keeping and blind spot detection are becoming more widely proliferated and are improving safety. These new technologies, incorporating differing levels of automation, continue to address common errors on our roadways and mitigate the potential for human error.

In addition to making transportation safer, autonomous vehicles will increase efficiency and reduce costs. In 2016 it was estimated that the economic impact of car accidents was $836 billion.[84] The increased safety provided by automation and technology will drastically reduce these costs.

Not only will autonomous vehicles reduce costs, fully autonomous vehicles will revolutionize how we spend our time. The average American spends more than 17,000 minutes on the road every year.[85] That equates to more than seven forty-hour work weeks. By utilizing the time on the road for sleeping, reading, surfing the internet, watching T.V., exercising or working we can significantly improve how we spend our time. By eliminating the need to mitigate distractions and the requirement to focus on driving, autonomous vehicles will allow people to choose what activity they want to do. For the average American, they would have an additional hour every day to be productive.

Additionally, fully autonomous vehicles, that do not require a driver, will also provide disabled, older, and younger members of society efficient means of transportation. The blind, the

old, the young, the handicapped will now have the same means of transportation as the most able-bodied people. Parking lots will no longer need handicapped spaces since passengers can be dropped off and the vehicle can self-park. Crowded urban centers may become more decentralized as autonomous transportation makes daily commutes more enjoyable and predictable. Autonomous vehicles are also likely to reduce the total number of vehicles on the road. With the evolution of on-demand transportation services like Uber and the additional carpool and ridesharing options researchers expect the total number of vehicles on the road to significantly decrease.[86] The decrease in traffic volume will have beneficial effects on traffic congestion, infrastructure costs and further contribute to our overall well-being.

Society will clearly benefit from the increased safety and efficiency provided by autonomous vehicles. Added benefits will include the decreased cost to consumers and the improvements in global transportation. Autonomous vehicles are likely to be the most disruptive technology in the transportation industry in decades. The inclusion of automated vehicles will not necessarily eliminate the need for humans in the logistics chain, but according to trucking expert, Bill Meahl, it will "make their lives easier and the highways safer."[87]

Autonomous vehicles may also revolutionize the "last mile" in delivery. The last mile to an individual's doorstep, is considered to be the most expensive and complex portion of the global shipping effort. To address this issue, in October 2017, DHL committed to outfitting their German fleet of electric light trucks with a self-driving system.[88] DHL representatives expect the autonomy of their electric fleet to ensure, "deliveries can be made with greater accuracy and safely, and at a lower cost."[89] By decreasing costs while increasing accuracy and safety autonomy will provide benefits to industry. Decreasing the costs of delivery is a critical aspect of continued e-commerce growth. As more and more people turn to Amazon and other web services

for retail products the importance of ensuring a cost effective, safe and reliable delivery method for the "last mile" is critical to continued success.

Another area of innovation in the trucking industry is platooning. Platooning involves "Several trucks with a driving support system closely following one another to form a platoon. The trucks have smart driving technology and mutual communication between the trucks (vehicle-to-vehicle communication)".[90] Advantages of platooning include increased road capacity, improved traffic flow, reduced traffic congestion, and improved fuel efficiency. One test on platooning trucks showed that "The decreased wind resistance improved fuel efficiency on the lead truck by 4.5 %, while the rear truck saw an improved rate of 10%."[91]

C. Innovation – Ports

International trade accounted for 32% of the United States Gross Domestic Product (GDP) in 2015 and is expected to reach 60% by 2030.[92] In order for the United States to remain competitive in a dynamic global trade market, innovative technologies must be considered to maximize economies, increase terminal productivity, and reliability, while concurrently cutting labor costs.

Post Panamax vessels are expected to make up 62% of total container ship capacity by 2030. [93] This change in vessel mix and the advent of Neopanamax and megacarriers, provides concentrated freight activity to maritime ports. Autonomous technologies such as Automated Stacking Cranes (ASCs) and Automated Guided vehicles (AGVs) allow maritime ports to operate autonomously while using interchangeable equipment for handling and storage while increasing throughput.[94] Autonomy can reduce the amount of time vessels spend in port, improve production by as much as 30%, and reduce longshore labor by as much as 50%.[95] The United

States has been slow to adopt autonomy into its' port infrastructure, mainly due to the resistance from labor unions and infrastructure costs.

An additional tool to increase operational efficiency, customer service and decrease errors is through the use of big data analytics. Big data analytics should consider metrics that predict problems at maritime ports, to include details regarding gate moves, inventory levels, container dwell time, and trouble tickets. By analyzing data on a weekly basis, the port can better predict, assess and act upon changing variables to increase efficiencies and decrease cost.[96]

The mixture of Neopanamax and megacarriers provides concentrated freight activity to ports. The high density has negatively impacted trucking transportation, often slowing productivity to a grinding halt. The Truck Arrival Management System (TAMS) provides "truck appointments that allow terminals to calibrate the flow of trucks into their facilities and match truck demand with capacity, at the entrance gate in each area of terminal."[97] In order for TAMS to be successful, maritime ports should extend gate hours and gain efficiencies of their facilities through big data analytics. The incorporation of TAMS into big data analytics will enable the terminal to match truck flow with maritime port equipment, reducing the wait time. In parallel, the trucking industry should provide estimated arrival times to the Maritime Port for TAMS to be successful. The ability to share information will ease truck driver frustration while concurrently improving the utilization of maritime port's infrastructure.

In sum, autonomy presents the transportation industry with numerous solutions that address megaregion congestion, safety, and human capital challenges on the horizon. Incumbent upon stakeholders at all levels of government is the need to balance regulatory oversight of innovative solutions in a way that does not discourage the creation of new ideas but fosters positive change.

VI. GOVERNMENT GOALS & ROLES

In recent years, the federal government has voiced priorities for U.S. transportation systems and invested in projects through the America's Reinvestment and Improvement Act of 2009 (ARRA), annual Transportation Investment Generating Economic Recovery (TIGER) grants, and the Fixing Americas Surface Transportation Act of 2015 (FAST) with some success.[98] During the second administration of President Barack Obama's, DOT prepared an extensive "Beyond Traffic 2040" report that then-DOT Secretary Anthony Foxx called a non-partisan conversation starter to determine what transportation offerings the U.S. needs and why. Among the many themes in this report, which was released just before the inauguration of President Trump, are three elements relevant to this paper: first, promotion of new technology with appropriate federal governance that incentivizes innovation; second, seeking best value return on investment; and third, securing necessary funding for projects through public private partnerships and innovative funding mechanisms. The report also reminds the reader that America was once the global leader in transportation engineering feats, including the Erie Canal, Transcontinental Railroad, Interstate Highways, and global aviation standard — all systems on which we still heavily rely and that are in dire need of extensive capital infusion.[99] As mentioned in the introduction, President Trump delivered on his campaign promise to send a transportation infrastructure package to Congress, which was passed on January of 2018. While not linked to the "Beyond Traffic" report, President Trump's proposal does hit the same key tenants, including funds apportioned for direct federal spending to spur additional local and private investment, as well as improving the value of transportation systems.[100] The following section addresses specific solutions identified by the students of Seminar 19 that the transportation officials should strongly consider to bring current infrastructure to a state of good repair and infuse innovative

technology that combine to create a network that supports both economic and national security priorities for decades to come.

A. Government efforts to support seaport vitality

The U.S. has a uniquely distributed system of over 180 seaports that exist to service a vast country with multiple coastlines, islands, and territories. [101] Complicating the system is the fact that there is no standard model for operating port facilities and port authorities exist at several different levels to include state, local, and private ownership.[102] As a result, the federal government is relied on to create a level playing field across all seaports. The purpose of this section is to provide an analysis of U.S. government programs and policies related to U.S. seaports.

The Committee on Marine Transportation System (CMTS) and the Department of Transportation's Maritime Administration (MARAD), two governmental entities responsible for seaport related policy and oversight, updated their strategic plans in 2017. Highlighting maritime system performance, safety, security and innovation, these plans will guide the Marine Transportation System for the next four to six years, ensuring the economic vitality of our critical seaport infrastructure. While we cannot guarantee that each seaport can or will take maximum advantage of the economic benefits of global trade, recent attention on the Maritime Transportation System by the CMTS, the MARAD, the U.S. Army Corps of Engineers (USACE) Institute for Water Resources (IWR) and Federal Maritime Commission (FMC) gives seaports a renewed fighting chance.

Federal funding mechanisms for seaport projects were also examined, in particular the Harbor Maintenance Trust Fund (HMTF) and Transportation Investment Generating Economic Recovery (TIGER) grants. The Water Resources Development Act of 2016 guaranteed that by

2025 all HMTF revenue will be appropriated solely for maritime projects where only a fraction had been in the past.[103] While this phased-in method is promising, additional proposals to redirect all funding immediately have stalled in Congress.[104,105]

In March 2018, the Department of Transportation announced the winning forty-one recipients for its next round of TIGER funded projects. However, out of forty port-related applications, only five made the list and of those only two were awarded to seaports. $500 million was allocated across all projects with seaports receiving only $73 million, or 14.5 % of the total.[106] In order to ensure the MTS is properly funded to maximize the economic potential of the shipping industry a greater commitment on funding seaport projects is necessary; the funds collected by the shipping industry for the shipping industry need to be put into maintaining and advancing U.S. seaports.

Key seaport modernization projects identified by USACE (IWR) prior to widening of the Panama Canal have been completed or are nearing completion today. President Obama's 2012 "*We Can't Wait"* initiative lit off the seaport modernization engines and President Trump's infrastructure initiative (Executive Order 13766) is providing quality fuel, but it may place too much emphasis on state and local activities rather than federal involvement; the federal government has a responsibility to act to support our decentralized maritime industry and keep the seaports running at maximal efficiency.[107,108] More study on the delegation of current federal responsibilities to the state and local level would be appropriate.

Achieving economic growth and prosperity through a healthy seaport infrastructure will require a whole of nation effort. State and Federal regulatory policy should provide enhanced funding to modernize maritime ports for increased efficiencies. They should work to create less port competition and increase collaboration across port users, workers, managers, and within the

United States' Government. Increased collaboration would allow multiple ports to cooperate by finding novel ways to prevent congestion and cargo delays and further the economy. While the nation's seaport system will remain decentralized, the Trump administration and Congress must continue make sustained investments in U.S. seaport policies, projects, and programs.

B. Air Traffic Control

Privatizing the nation's air traffic control (ATC) system is the most effective step the U.S. government can take to safely, effectively, and efficiently manage the expected exponential growth of air traffic over the next ten years. It will ensure consistent predictable funding, allow for greater labor flexibility, and bring online the much-delayed Next Generation Air Transportation System (NextGen) aircraft routing system. NextGen is the critical U.S. National Airspace infrastructure component that will increase airspace capacity for commercial, military, and general aviation operations.

The current ATC system, run by the Federal Aviation Administration (FAA) as a division of the DoT, is too bureaucratic and over-regulated to bring NextGen online. Its funding is also too unpredictable to implement meaningful long term financial commitments that are required to upgrade the system. Just as airlines, rail, and other industries have been deregulated, it is time to privatize ATC. Southwest Airlines CEO Gary Kelly stated in February 2017, "We want the government out of managing the air traffic control system so that it can be adequately managed, adequately financed."[109] The National Air Traffic Controllers Association, which represent more than 19,000 air traffic controllers, also supports some version of privatization.[110] The Association's only request of a privatized ATC system is that it "Maintains the existing work protections, pay levels, retirement benefits, and health care benefits."[111]

Despite a phenomenal safety record, the current ATC system still relies on 1950's methodology and infrastructure and that comes with a cost. The Airlines for America (A4A) trade group states that "Flight delays cost the economy $25 billion last year (2016) and our antiquated ATC system is responsible for almost half of those delays."[112] The lack of steady and secure funding for the ATC system has prevented it from making the necessary long-term investments required to bring the system into the modern era. Steady and secure funding allows ATC to make incremental modernization improvements, keeping it ahead of the demand curve, as well as postures itself for generational leaps in technology and capability such as NextGen. In summary, funding outside the government appropriations process enables implementation of long term strategic plans. For example, Congress directed the FAA to transition to NextGen in 2003, yet the program is still not fielded and is $2.6 billion over budget.[113]The Government Accountability Office (GAO) did an audit of the NextGen program and found that "appropriation levels have been consistent with agency (FAA) requests, but uncertainty over the length and amount of appropriations makes it more difficult to deliver long-term projects like NextGen."[114] In total, a private organization has the freedom to maneuver and adjust to "real-world" events that a government entity does not. The FAA is no different.

Today, the FAA performs both a regulatory and an operations function. It is the safety regulator of the airline and aircraft industry and also the operator of all air traffic. Privatizing ATC eliminates the inherent conflict of interest by separating the safety regulators from the operators. In addition, privatizing "Would take nearly two-thirds of its workforce (FAA)—including thousands of technicians and over 13,000 air-traffic controllers—off the government payrolls."[115]

The aviation industry is an economic driver that accounts for 5.4% of GDP.[116] The national airspace system is unrivaled anywhere in the world not only for its economic benefits, but for its contribution to national security with its designated military operating areas and Air Defense Identification Zones (ADIZ) that encircles our border. The way to ensure its continued success is through privatization of the ATC system. House Bill 2997, the 21st Century Aviation Innovation, Reform, and Reauthorization Act, is set for a vote in the U.S. House of Representatives this year.[117] Passage of the bill puts American airspace and ATC system on the right course for the future.

C. Autonomous Vehicle Regulation

The impact of autonomous vehicles on the future of global transportation will be enormous. Ensuring that the regulatory framework exists to provide autonomous vehicle manufacturers with an environment to foster innovation while ensuring the safety of the public is of utmost importance. The following recommendations aim to spur innovation while incentivizing the early adoption of autonomous vehicles.

The first solution is to provide federal regulatory guidance. The variation in state laws creates many challenges for autonomous innovators. The federal government must provide a regulatory environment that creates the opportunity for seamless adoption across state lines. Both the House and the Senate have introduced bills attempting to achieve this goal, however, they must be passed and implemented. The SELF DRIVE Act was introduced in the House in June, 2017 and passed in September, 2017.[118] Yet this bill has not passed in the Senate and has not been implemented. It is currently with the Senate committee on Commerce, Science and Transportation. Additionally, in the Senate, Sen John Thune of South Dakota has introduced the AV START Act. This bill was introduced in Sep 2017 and was intended to support the

development of highly automated vehicles.[119] Unfortunately this bill has yet to be voted on. Despite the delays in providing clear regulation and guidance, the technology for autonomous systems continue to develop.

Additionally, to spur autonomous implementation, the U.S. government should incentivize early adoption in select "sanitized" environments. Autonomous vehicle manufacturers continue to utilize public roadways as "test-beds" for autonomous vehicles. While this method for testing is valuable in gathering information, it jeopardizes autonomous adoption. On the night of 18 March, 2018, a self-driving Uber vehicle struck and killed a pedestrian in Tempe AZ.[120] The vehicle was operating in "autonomous mode" with an "operator" at the wheel.[121] This was the first known pedestrian fatality involving an autonomous vehicle. As a result of this accident, Uber has halted its test programs and the state of Arizona has suspended the testing of autonomous vehicles. Tragically, this single accident will undoubtedly invoke fears of autonomous adoption and is likely to provide significant setbacks. However, most unfortunate, is the fact that in 2016 there were almost 6,000 pedestrian deaths, 16 each day.[122] In two months, more than 1,000 pedestrians die from car accidents, yet one autonomous vehicle strikes a pedestrian, at night, crossing outside a crosswalk and it halts autonomous testing. Since autonomous vehicles are so highly visible and scrutinized, autonomous vehicle manufacturers must look for incremental adoption methods to prove the technology. The American public needs to become comfortable with autonomy. Manufacturers must look for opportunities to implement autonomous vehicles and gain the trust of the public. These options include, golf courses, theme parks, airports, master planned vacation or residential communities. Creating incentives for adoption in controlled environments will limit the "negative press" associated with autonomous vehicle fatalities as well as introduce the public to the future of transportation.

The transportation industry needs to adopt this technology as soon as possible. Creating the appropriate regulatory framework and promoting autonomous adoption in sanitized environments will speed the adoption of autonomy throughout society. Road traffic is the fifth leading cause of death in the world.[123] Delays in autonomous vehicle adoption will cost millions of dollars and thousands of lives.

Autonomous automobiles are just the beginning. Autonomy in automobiles will quickly spread to boats, submarines, aircraft, tractors, trains and any other form of transportation that can benefit from improved safety and efficiency. Autonomous vehicles are the future of transportation, creating an environment conducive to their rapid adoption and implementation of autonomous vehicles will have far reaching benefits to society.

D. Human Capital – Commercial Truck Driver Shortage

The trucking industry like most other transportation-related industries is well regulated by the government at the state and federal level. This regulation can be interpreted positively or negatively. From the trucking industry perspective, regulation is costly, and drivers generally do not like it. In a 2010 study in which drivers were asked to a provide a single aspect (other than pay) that would most improve their quality of life the most common response was to reduce the number of state and federal governmental rules and regulations.[124] One driver's comment in the study sums up the general feeling among truckers on government regulation of the trucking industry:

> I do not like the federal government telling me when I can drive and when I have to sleep. This is "big brother" in action. Someone who sits at a desk in Washington, DC dictates to me how I run my life. They write these laws and they have never driven a truck and they don't have a clue what my job entails.[125]

Of note, this study was conducted about five years before the introduction of the Electronic Logging Device (ELD) mandate, which has garnered much negative attention in the trucking industry as being too restrictive.

Related to the age issues discussed earlier in the demographics section of this paper is the federal regulation that requires an individual to be 21 years old before obtaining a Commercial Driver's License (CDL) to operate across state lines. This regulation has helped contribute to the fact that "Drivers 20 to 24 years of age represent approximately five percent of individuals employed in the truck transportation sector, while for all industries this age group comprises 9.8% of employees."[126] Thus, 18 to 24 years of age population is a largely untapped resource for the trucking industry. The FMCSA in 2016 introduced a pilot program as part of the Fixing America's Surface Transportation (FAST) Act that would allow individuals under 21 years of age with military driving experience to operate a commercial vehicle across state lines. In 2017, legislation entitled Waiving Hindrances to Economic Enterprise and Labor (WHEEL) Act, H.R. 3889, was introduced to ease the regulatory burden on interstate trucking, including removing the military experience requirement for those with a clean driving record and an appropriate DoT-approved training certification.[127] To date, the bill has not passed. These several areas of government regulation that need to be addressed given the persistence and severity of the trucking industry's OTR driver shortage.

VII. OTHER MAJOR RELATED ISSUES

Transportation is connected to every other industry in one form or another throughout the domestic and global marketplace. As such there are issues which affect the industry, are tangential to it, or a supplier for it. To truly understand the industry, one needs to see how a supplier provides support, goods, and services to it. One excellent example is the firm Navistar in

the heavy trucking sector. The entire industry runs on energy – primarily in the form of gasoline, diesel, aviation gasoline, or electricity. Alternative fuels may change this and solar power is one possibility. Lastly, massing transportation assets are both a principle of war (mass) and a principle of economics (economies of scales). One way to accomplish this is through transportation interoperability amongst the U.S., allies, and partners. These are fitting topics for this section on other major related issues.

A. Navistar & The Heavy Vehicle Sector

Navistar International Corporation, a supplier in the heavy machinery and vehicle industry, has similar challenges and opportunities as the other businesses within the transportation industry. They are heavily involved with technology and innovation, leveraging alternatives, such as autonomous technologies and electric vehicles. These innovations and technologies are imperative to the future of the trucking industry, with potential upgrades in the infrastructure and an increased demand for truck drivers, the trucking industry must be able to close the gap on human resource shortages. The significance of the heavy machinery and vehicle industry will continue to remain a vital cog in the transportation manufacturing sector that will drive commerce, automotive safety, and support national security interests.

Being in the supply chain of the trucking industry, and as a whole, the transportation industry, Navistar's successes and failures are extremely dependent on the global economy, energy, commodities, NAFTA (North American Free Trade Agreement), and steel – with the recent tariffs, to name a few variables. Beyond the factors listed, there are several others to consider when thinking about challenges or threats to the supply chain of the trucking sector. Some of these other factors include: infrastructure, the gas tax, which hasn't been raised since 1993, and forecasted driver shortages for long haul trucking.

On the flip side, there is an opportunity to exploit technology to leverage electrically powered vehicles, and potential autonomous vehicle technology – even though autonomous trucks may be several years away from being a legitimate resource of the trucking industry, according to the following passage. The author of the article cited below, sat down with Darren Gosbee, Navistar's Lisle-based, Director of Advanced Technology and Scott Smay, Director of Vehicle Integration. They both think about innovation and technology, as one might imagine:

> Driverless trucks, just like driverless cars, will be here within 10 years, Gosbee said. He noted that much of the technology already exists, but laws and the driving public will have to adjust. "I don't know how society will react to seeing a truck driving down the road without a driver, or a truck driving down the road with a truck driver who's doing something else," he said.[128]

Navistar is also partnering with critical suppliers and developers in the technology industry that will enhance their vision regarding electric vehicles. In addition, as reported in Navistar's 10-K, they are serious about leveraging technology to advance their products further:

> We are well positioned to participate in the three emerging technology themes impacting the North American transportation industry. These include Advanced Driver Assistance Systems ("ADAS") autonomous driving, the digital supply chain, and electrification. We have emerging relationships with first movers in all of these areas. We have announced the planned introduction of the series of electric vehicles in the medium duty and school bus classes.[129]

One of the major challenges for electric vehicles is range. It is still the biggest drawback to electric vehicles, as explained in the passage below:

> Long-haul truckers typically cover 400 to 600 miles a day, something hard to do with batteries alone—unless you're packing a mighty big one. "I imagine they'll use a 600-kWh battery, possibly up to 800-kWh," says Nikola CEO Trevor Milton. (The Model S sedan sports a pack that tops out at 100 kilowatt-hours). With a little math, Milton figures "Musk's truck will get around 200 to 300 miles range." Not much, which explains why Nikola uses a hydrogen fuel cell generator to boost range to 1,000 miles.[130]

Global commerce, domestic trade, and national security are dependent on companies like Navistar. Without a robust and reliable trucking industry, U.S. national security is threatened, as well as its contribution to global trade. It is up to the trucking sector to maintain this segment and

ensure they harness technology. Technology is the greatest opportunity to hedge against the driver shortage, while continuing to drive the economy towards innovation and autonomous vehicles.

B. Alternative Energy for Transportation – Solar

The potential for solar energy is great, and the sunlight can offer much more energy than needed. Sooner or later, the electric power produced by renewable energy sources will lead activities including transportation, changing the current predominant use of fossil sources of energy. Among all renewable energy sources, solar energy, has the highest growth in consumption. Between 2010 and 2018, due to technological improvement, mainly in the photovoltaic systems, the solar energy consumption in the U.S. increased ten times.[131] Even if the use of solar energy in 2017 in the transportation sector was insignificant – less than 1%,[132] solar energy still has great potential and will play a more important role in the future of the transportation industry.

Several successful projects proved that solar energy can be used for the transportation industry's benefit. As technologies evolve, cost efficiency for using solar panels increase significantly. Replacing the conventional sources is no longer a solution only for remote sites, where grid power lines could not be extended, or the cost efficiency would impede such extension. The grid parity – considered when the prices of the electricity generated by the photovoltaic system and that of conventional technologies electricity production are equal – is becoming a reality, proving the economic viability for solar generated electricity. Transport infrastructure facilities are already using solar panels. First applications envisaged navigation horns and lights, ensuring the security of maritime transportation. The development on solar energy use on road infrastructure is significant and adoption of new technologies is rapid and

widespread. Solutions include off grid electricity produced using photovoltaics that could be stored and used to power electric vehicles as well as automatic de-icing and snow removal from roads, and of course lighting. In India, an international airport completely operates using solar power. Its photovoltaic power plant produces more energy than the airport's needs. All transportation vehicles could someday use solar energy for movement. Current photovoltaic technologies can assure the required energy for a plane to fly, a boat to sail, a train or a car to drive. They cannot compete yet with the classic vehicles at the production costs or performance, but they have proved their viability. The speed of technology development will narrow the discrepancy in the near future.

Energy is vital in transportation, and the needs for energy are increasing. Trends are in favor of using the solar generated power – decreasing price and increased efficiency – creating economic opportunities that didn't exist a few years ago. Supportive government regulations for manufacturers and for consumers of solar energy are key elements in facilitating innovation and development in the photovoltaic domain. Some technologies might not be implemented whereas some technologies need more development. The research in this field must continue in order to increase the efficiency, decrease the costs, and provide commercial solutions. Solar energy is clean and available. It evolved from a green dream to an economic reality. Solar energy will play in the future a more important role in the transportation industry.

C. Interoperability & Multinational Operations

Changing security environment and the need to address current and primarily asymmetric threats and risks, wherever they occur, force specific requirements on the development of national capabilities. Armed forces are required to be fully deployable and sustainable in operations in austere conditions for an extended period. In NATO-led operations, currently many

nations of different sizes, force structures, equipment, training, and capabilities participate. The only way to approach operational goals while achieving economies of scale is cooperation of all involved participants. An essential prerequisite for such collaboration is interoperability.[133] However, the reaction time for the possibility of potential conflict is rapidly decreasing and there is no guarantee of success in combating contemporary threats. Logistics interoperability, as a part of the transportation industry, is one of the essential capabilities guaranteeing ultimate success. It is necessary to conduct a mutual dialogue and to develop and share capabilities, interoperable weapon and information systems, training, technological advances, and service capacities.[134] The purpose of this effort is not only collective defense, but also for reducing the costs of defense while simultaneously improving security among Alliance partners.

Sharing Transport Capacities (STC) is not a new approach, especially in the context of joint military operations (e.g. NATO, EU), or during the joint military exercises. However, from a global perspective, this technique can also be the international community's responsibility to ensure that timely and decisive required transportation capacity is available. This is conducted through a specific management process of transport resources against different tasks. In this manner, transportation tasks and transportation capacity sharing are processed parallel to each other, although there could be some variation in efficiency.

Funding is an essential element in the implementation of STC. Financial resources always present a critical point in the implementation of acquisition programs. This can be demonstrated by the U.S. Air Force, which is actively pursuing autonomous capability. This could be a case where the process of interoperability, joint operations, and sharing of capabilities within the Alliance states can be a solution for the future.[135]A major advantage of this solution and possible targeted reform of acquisitions within the armed forces can be the adoption of the concept of

military construction along with simultaneous mobilization of the armed forces. A positive aspect of this solution may be the fact that the area of defense and national (collective) security should be subject to regular review while the development and approval of defense / mobilization plans must be treated as part of a national defense management. Jointness, or the collective responsibility for the management and maintenance of the individual parts of the system, will undoubtedly bring significant financial savings and a greater control over the whole system.[136] A unified security and access system will greatly accelerate all processes associated with STC. Ultimately, the proposed concept could have an effective impact on the military operations of Alliance countries in the areas of national interest and security. Headed by the U.S., this has a primary role in collective security.

VIII. CONCLUSION

The transportation industry has been the backbone of the defense industrial base and the national security innovation base. It has formed the system upon which America mobilized its forces and then railed, sailed, and flew to war. Throughout the course of the seminar study, the students researched, analyzed, and assessed the transportation industry through coursework, domestic field trips, guest speaker engagements, and international travel. The industry is divided into four major sectors: trucking, rail, airlines, and maritime. It is separated into both domestic and international markets as well as niche markets and segments. Overlaying all of this and linking disparate elements of the transportation system together is the concept of intermodal trade.

There were a number of common themes identified by the seminar students. These include disruptive technology, rapidly accelerating innovation changes, human capital issues, government regulations, private-public resourcing, and infrastructure challenges. These

percolated to the forefront of discussion throughout the year and can be found as trends within this report. The first section of the paper defined the industry and covered its current strengths, weaknesses, opportunities, and threats. The second section analyzed the sectors of the industry along with a major firm (or more) represented within that sector. Challenges to the industry were discussed in the third section. This was followed by an outlook section which focused on many of the themes above and how they could be implemented. Next, the roles of government goals and regulations were discussed, to include recommendations (see below as well). Lastly, tangential but important topics related to the industry were included as a means to showcase the tie-in between transportation and other mobilization related industries.

To summarize, there are a number of recommendations from the report. The transportation industry will need the government's help in the area of regulation. First, the WHEEL Act must be passed and implemented and the FAST pilot program expedited, especially given the undetermined time before autonomous trucks and platooning are fully operational and integrated into the industry. These two pieces of legislation could have an immediate impact on the driver shortage by expanding the labor pool. Second, industry and government must work together on legislation to accelerate the safe integration of autonomous trucks and platooning technology. The government should maintain its goal of releasing the third iteration of the Federal Automated Vehicle Policy which is scheduled for late summer 2018. Besides efforts to adjust and improve regulation, governments at the federal, state, and local level should engender innovation. This can be accomplished through tax incentives and thoughtful planning. It is only through creating a positive, supportive climate for innovation that the U.S. will maintain the viability of the National Security Innovation Base and the productivity / efficiency of the Defense Industrial Base. Finally, resourcing and repair of the American infrastructure is critical.

This cannot be afterthought in future federal budgets but must be a critical item supported at the federal level and assisted by state and local governments.

In conclusion, these solutions require a concerted effort, along with collaboration and cooperation, on the part of industry and government. They will undoubtedly involve risks; however, these are risks that can be managed and are well worth taking to ensure the vitality and readiness of the industry as well as its ability to support U.S. mobilization efforts in times of need. The U.S. Transportation Industry forms the backbone for other critical domestic industries and for the mobilization of the U.S. Armed Forces. Thus, if and when the time comes, it needs to be ready to be mobilized … and be a driving part of the overall mobilization process.

APPENDIX

FIGURE A

Operations – UPRR is a Class I railroad operating in the U.S. We have 32,122 route miles, linking Pacific Coast and Gulf Coast ports with the Midwest and eastern U.S. gateways and providing several corridors to key Mexican gateways. We serve the Western two-thirds of the country and maintain coordinated schedules with other rail carriers to move freight to and from the Atlantic Coast, the Pacific Coast, the Southeast, the Southwest, Canada, and Mexico. Export and import traffic moves through Gulf Coast and Pacific Coast ports and across the Mexican and Canadian borders. Our freight traffic consists of bulk, manifest, and premium business. Bulk traffic primarily consists of coal, grain, soda ash, ethanol, rock and crude oil shipped in unit trains – trains transporting a single commodity from one origin to one destination. Manifest traffic includes individual carload or less than train-load business involving commodities such as lumber, steel, paper, food and chemicals. The transportation of finished vehicles, auto parts, intermodal containers and truck trailers are included as part of our premium business. In 2017, we generated freight revenues totaling $19.8 billion from the following six commodity groups:

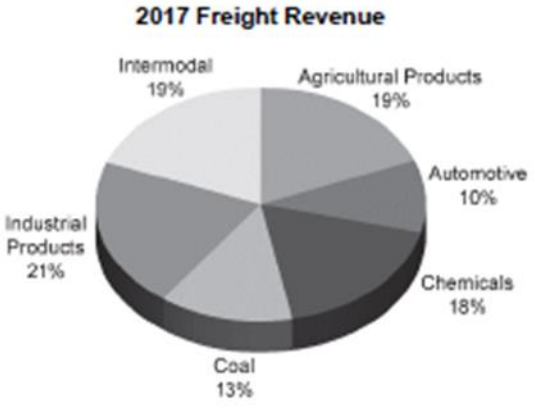


FIGURE B

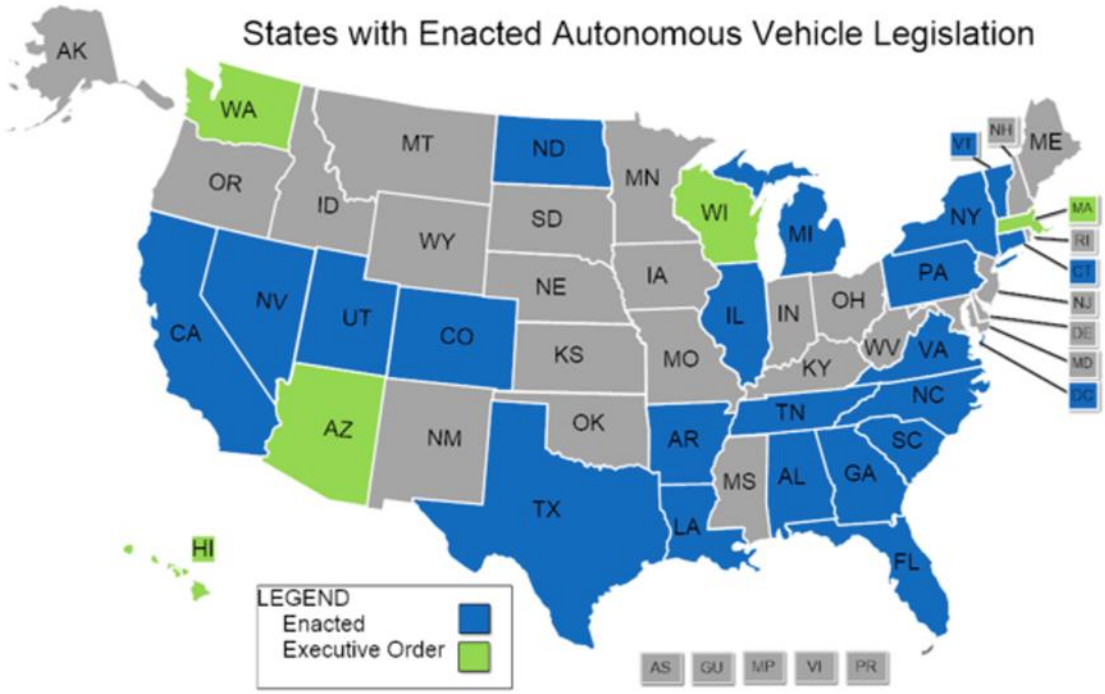


FIGURE C

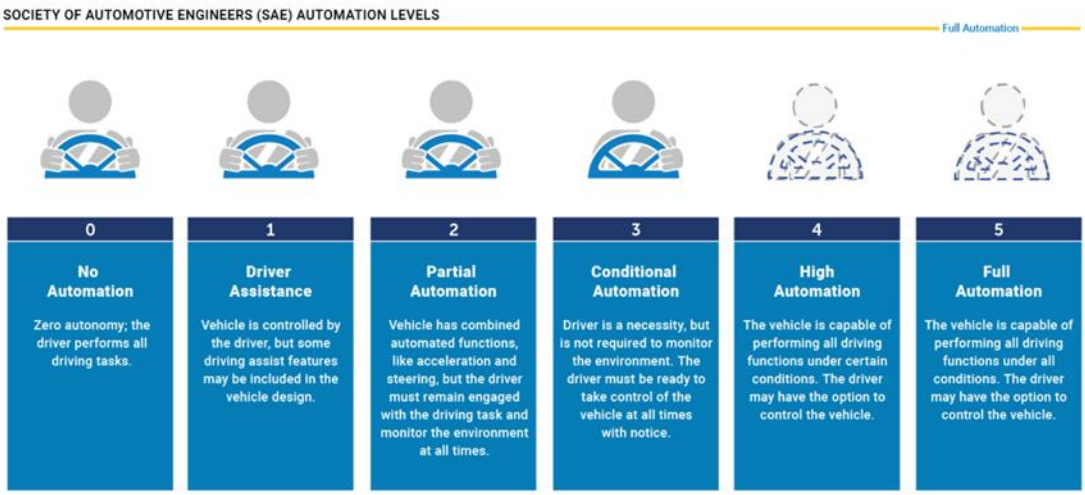
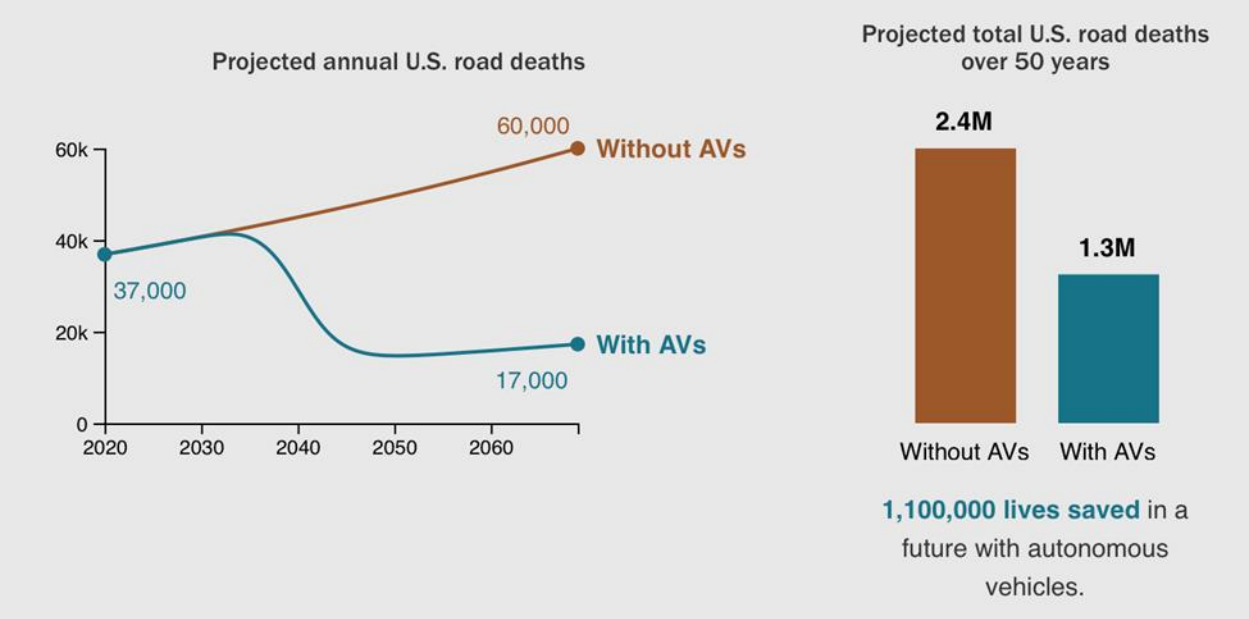


FIGURE D



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