Freight Automation

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Introduction: Speaker Perspective

Transportation economics consultant with 30 years of consulting experience supporting planning and strategy for public and private sector freight transportation and trade infrastructure owners and operators.

Very active in Freight Systems Group research within National Academies of Science Transportation Research Board. Past Freight Systems Group Chair.

Follow research and development efforts in all modes of freight transportation, from a market and policy impact perspective.

Have worked for a large management consulting firm, a civil engineering planning design firm and currently for a transportation economic analysis firm.

For public agencies, regularly contribute to planning scenario development and assessments. Provide alternative economic forecasts for these scenarios.
Growth In U.S. Freight Demand Is Coming From the Growth in U.S. Consumption

- Freight activity is derived demand from goods demand.
- U.S. economic growth driven the most by consumption.
- Business and consumer spending in the long recovery from the Great Recession has driven freight demand to surpass pre-recession volumes.
- Freight growth rate remains above overall U.S. GDP growth, though shifts in modal demand and network use continue as distribution practices and technology evolve.
- There is short-term excess capacity in some freight industry sectors due to over-investment in equipment (though not in infrastructure.)
The key to the U.S. economy and freight demand is consumer spending.

Source: IHSMarkit
Economic and Policy Context for Freight Automation

- Economic conditions are key to freight automation. Technology and productivity gains yield lower costs due to automation, speeding adoption compared with rising labor costs and scarce skilled labor.

- U.S. consumer demand is still key to freight demand where consumer product growth is faster than bulk commodity transportation growth rates.

- Policy factors (regulatory, government spending, trade, security, environmental) significantly constrain freight automation and not equally across modes.

- Increasing importance of automation to industry economic growth will lead to adoption pressures
"Digital Transformation" is broadly the application of new technology for improving freight logistics through factory, distribution, transportation, inventory/demand, and procurement operations; as well as smart connected equipment, infrastructure, products and related services.

- includes the entire “technology stack” - covering cloud and analytics - not just device or asset connectivity.

Terms for this broad digital transformation include the Industry Internet of Things (IIoT), Industry 4.0, and Smart Manufacturing. Freight automation is part of this scope.
Manufacturing Supply Chain Changes

- Design using in-transit / in-service product performance data
- New smart connected products with new features / capabilities
- Software-defined functionality and interaction with environment
- Add-on connectivity solutions for products already in the field
- Improved product functionality / quality
- Improved replacement parts / supplies & returns management
- Reduced energy consumption and environmental impacts
Benefits of Digital Transformation

- New services based on smart connected products
- New business models and revenue streams
- More attractive environment for workers
- Growing existing markets
- Creating new markets and new jobs
- Increasing market shares
- Improving business responsiveness and agility

There are losers (e.g. old jobs) from such transformation too
MANY Challenges Remain for Supply Chain Technology Advances

- Cybersecurity, data security & privacy, confidentiality
- Risk and uncertainty management, risk averse organizational cultures
- Budget constraints
- Lack of agency / industry standards
- Complexity of multiple potential tech options: where to focus?
- Momentum / “sunk costs” in legacy systems and equipment
- Business process opportunities cross multiple organizational silos
- Management vision and buy-in; willingness to lead
- ROI or business case for specific technology adoption
- Bandwidth issues for change: 'we're running lean and we're all busy'
- Limited analytics skills in, or training for the organization / division
Generally this means autonomous freight equipment loaded with sensors and computing power usually with good communications and extensive safety features. Can be connected to the network.

Technology exists today and has been live tested in controlled environments. (Think scaled-up high-tech connected robots.)

Push for this comes from large potential system efficiencies in capacity utilization, lower labor and other operating costs, reductions in emissions plus increased safety and security.

Laws, risk management and public understanding are lagging but likely to follow passenger transport into eventual acceptance and wide deployment. Many possible scenarios of how this happens.

Not all freight modes will see automation advance at the same time, creating cost imbalances that will affect modal competition.
Maritime Cargo Automation

Remote-control or autonomous vessels can be crewless. Technology exists; Rolls Royce is testing in Europe now. Laws and risk management haven’t kept up.

Large potential operating cost savings and increased safety from designs for no humans onboard.

Source: Rolls Royce
Maritime Cargo Terminal Automation

Early phase of U.S. marine cargo terminal automation

Technology exists: fully automated terminals in Europe.

Labor agreements and implementation costs make them expensive now but few regulatory or risk management barriers. This automation will happen

Large potential for capacity throughput increases, increased safety / security, lower environmental footprints

Could interface with automated trains and trucks too.
Air Freight Automation

Unmanned cargo aircraft development is led by the military (e.g. delivering rockets to terrorist cars.)

Technology exists but safety barriers and ancient U.S. air traffic control system make commercial U.S. deployment unlikely for a long time.

More automation in cargo loading/unloading likely

Giant air-ships for slow heavy cargo in prototype.

Ironically automated delivery of cargo to outer space is generations old and the industry default.
Rail Freight Automation

Technology is many generations old in short-distance rail transit (e.g. airports)

Safety issues are key barrier to adoption for freight rail, whose network tech lags

U.S. PTC (Positive Train Control) roll-out delayed until 2018; Sets stage for additional automation technology later

Automation of rail freight terminals moving faster due to fewer regulations, lower cost
Trucks Evolving Towards Automation

Autonomous trucks are driverless trucks. Technology exists today and has been live tested in controlled environments. Don’t require but benefit from smart roadways.

Laws and risk management are lagging but likely to follow passenger vehicles into eventual acceptance.

Large potential cost & emissions savings and increased safety. Could induce modal shift to truck and increased truck VMT.
NHTSA Levels of Truck Automation

Level 0: Driver in complete & sole control of vehicle; braking steering, throttle

Level 1 Function Specific: One or more systems that automatically assists driver with a primary vehicle control function

Level 2 Combined Function: Two or more primary control functions combined to work in unison to relieve driver of control of these functions

Level 3 Limited Self Driving: Enable driver to cede full control under certain conditions. When necessary, system automatically transitions control back to driver

Level 4 Full Self Driving Autonomous Trucks

Today’s well-equipped large trucks are at Level 1

Source: Meritor Wabco
Trucks traveling at highway speeds with reduced following distances to decrease aerodynamic drag (improve fuel economy) and increase road capacity

Following driver reaction times eliminated through:

- Vehicle to Vehicle connectivity
- Radar based Adaptive Cruise Control
- Collision Mitigation Systems
Freight Automation: Freight Shuttle

Electric driverless guideway for fixed route network
Conceptually between automated truck and train

Source: Texas A & M
Infrastructure for Truck Automation

Dedicated, tolled truck-only highway network could help
Agencies will have to consider BIG costs, even with P3s
Mercedes has ‘Vision Van’ autonomous local delivery electric vehicle with 168 mile range feeding 2 drones. Uses driver/operator initially but not needed.

Source: Mercedes Benz
Conceptual Last-Mile Delivery with Automated Vans and Drones

Matternet M2 drones operate up to 12 miles from Vision Van, handle up to about 4 pound parcels.

Automated robot internal parcel and battery handling.

Source: Mercedes Benz
Drones in Delivery Automation

Amazon grabbed attention first but DHL, UPS and Dominos Pizza are all experimenting with live test drone product delivery. Virginia Tech has drone burrito delivery.

Now only small shipments delivered expensively to one-off recipients willing to pay for the service.

Likely to scale-up and be much cheaper over time with multiple drone “swarms”.

Less labor, faster than humans, and fewer mistakes, able to work essentially continuously and have a smaller energy footprint than humans for same work.
Drones in Freight Automation

Drones are less well known in other roles in automating freight transportation:

1) Automation in tracking large assets and freight in inventory or in transit. (Identifying trailers in a yard; containers on a train, etc.)

2) Automated counting inventory in warehouses / distribution centers.

Now used in controlled environments such as intermodal yards and warehouses/ Distribution Centers.

Scaling up quickly: Walmart is less than a year from using drones inventory counting. Older floor-traveling warehouse robots are old-school already.
The Future of Network Infrastructure in Freight Automation

- Supporting the integrated traffic data stream with environment & infrastructure information
- Incorporate cyber security with standards
- Agencies contribute to freight V2I initiatives
  - Wireless inspection
  - e-parking
  - e-tolling
  - weigh in motion
- Agencies plan infrastructure for future demands
How Does a DOT Prepare for This?

- What is the role of DOTs in supporting freight automation?
  - Provider and operator of road infrastructure, intermodal planning for entire state freight system;
  - Regulatory and financial framework for operations and payments

- What are the most likely scenarios DOTs will face in the future?
  - Baseline forecast scenario of technology evolution towards automation
  - Define in detail for the state via a combination of technology, economic, demographic and environmental factor-driven possible alternative scenarios
  - Dimensions of a baseline vs. slower or faster adoption of technology
  - Objective is to capture risk and uncertainty in agency planning

- How can/should a DOT prepare in the face of uncertainty?
  - Define the Potential Needs Under Alternative Scenarios
  - Build Understanding of Each Scenario for the State
  - Take Action Preparing for Range of Potential Futures
  - Confirm and Sustain Results on a Recurring Basis
How Does a DOT Prepare for This?

- How does a DOT track and monitor the future scenario trajectories in order to accommodate in-progress change?
  - Extend performance management indicator process to indicators of technology and other dimensions of scenario definitions
  - Collect and assess indicators on a recurring basis
  - Refine scenarios definitions with new information
  - Modify plans to address updated range of outcomes

- What do agencies need in order to prepare for impending changes in the use of the transportation system – monitoring data, software programming skills, strategic analysts, analysis tools, …?
  - Performance data, asset management data, network analysis
  - Multi-criteria analysis tools for assessing scenario options
Thank you!

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