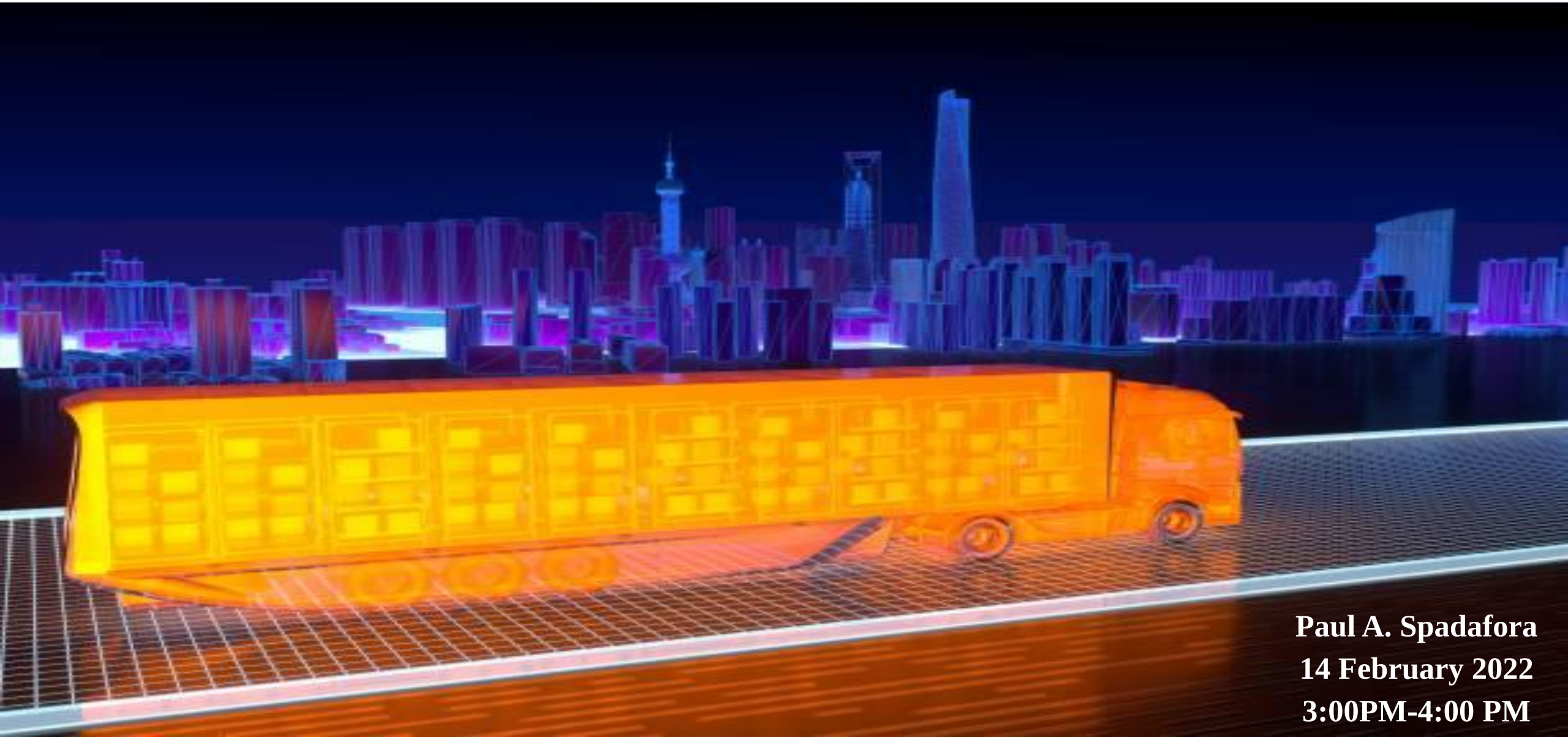
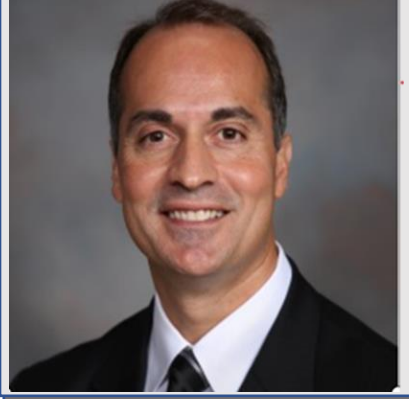
CALSTART WEBINAR



Paul A. Spadafora
14 February 2022
3:00PM-4:00 PM



Paul A. Spadafora

Director of Professional Engineering Programs & Industry Executive

University of Detroit Mercy's College of Engineering & Science.

CEO - Avante Global Consulting

Paul is a member of the University of Detroit Mercy Engineering & Science Board of Advisors & an accomplished leader in Industry

He is CEO of Avante Global Consulting utilizing his knowledge and experience within the global automotive market by engaging in topics such as merger & acquisitions, reorganization, restructuring, strategy, and functional expertise.

Paul has also served as Global Vice President for Magna International and NBHX-Trim, leading areas of Engineering, Research & Development, Innovation, Advanced Sales, Product Development, Program Management and Manufacturing.

Paul began his professional career at General Motors, where he has held positions of increasing responsibility in Engineering, Purchasing and Manufacturing. He maintained the executive position of Vehicle Chief Engineer for over a decade launching multiple full vehicle programs throughout the world, including residing in Shanghai, China for four years.

Paul has an MBA from Oakland University, a Master degree in Engineering from University of Detroit Mercy and a Bachelor degree in Mechanical Engineering from University of Detroit.

He also holds two automotive patents, multiple President's and Chairman's Awards, Six Sigma Black Belt and was a General Motors Scholar from the University of Detroit.

Overview of Electric Trucks

McKinsey: Electric Truck adoption will exceed 30 percent by 2030 across different vehicle classes:

- Light commercial vehicle (LCV)
- Medium-duty truck (MDT)
- Heavy-duty truck (HDT)

Volvo AB, Daimler Trucks and VW subsidiary Traton expect 35-60% of their global sales to be electric and /or fuel cells by 2030.

Positive Electrification Trends

1. Lowered costs from technology improvements

Battery prices have decreased by about 80 percent since 2010, bringing an estimated pack cost down to around $227 per kilowatt.

2. Shifting consumer demand

30 to 45 percent of vehicle buyers in the United States and Germany, respectively, consider an EV purchase.

3. Increased urbanization

1.1 billion new urban residents by 2030 are expected to have created greater demand for e-mobility solutions.

4. Accelerated regulatory forces

Stricter emissions and fuel-economy targets at national, state, and city levels are expected to continue.

Statistics: McKinsey Center for Future Mobility
https://www.mckinsey.com/features/mckinsey-center-for-future-mobility/overview/electrification

Challenges to Electrification Trends:

1. **Developing charging infrastructure**

   An automotive supplier creates and prioritizes a suite of charging use cases to assess revenue potential from physical hardware and new business models.

2. **Establishing an investment plan across the value chain**

   A private equity firm runs a series of market scans for emerging electrified vehicle technologies.

3. **Assessing impact on electricity grids**

   A national utility company determines potential impact from electric car uptick on national and local electricity demand.

Shared Cross-Industry Perspectives

1. **Automotive**

   There will be emerging use cases and business models around charging infrastructure, supplier changes across the powertrain value chain, and greater development of fully electrified platforms.

2. **Travel, transport, and logistics**

   Emerging use cases for electrified trucks (medium duty and heavy duty) and last-mile delivery with electrified vehicles will gain prominence.

3. **City, state/region, national governments**

   There will be greater emphasis on partnership models and investments for charging infrastructure.

4. **Utilities**

   Changes to local and national grid loads from electrified vehicle rollout will be seen, along with new business models related to grid storage and load balancing.

Electric Vehicle Usage Varies

1. **Light commercial vehicles making last-mile deliveries**
    - These routes are typically short—under 100 kilometers per day.
    - Batteries in these vehicles can easily support these routes without the need for in route charging.

2. **Medium-duty vehicles distributing dry goods**
    - Usually have a defined and fixed daily route and a known average daily distance traveled of about 200 kilometers.
    - Can be charged at the beginning and end of their journeys.

3. **Heavy-duty vehicles doing point-to-point long haul**
    - This use case covers large heavy trucks—class 7 and class 8—that drive long distances to deliver goods from ports or production facilities to large distribution centers or warehouses.
    - The exact routes and distances remain highly predictable and fixed, with a range of 400 kilometers +.
    - Will likely require in route charging at predetermined stops.

Five Charging Strategies for Electric Trucks

Characteristics of charging strategies

	Overnight only	Overnight and mid-route[1]	Mid-route[1] only	Battery swapping	Overhead catenary
Location	Operator's hub	Operator's hub and private or public mid-route charging station	Private or public mid-route charging station	Operator's hub or public swapping station	While driving, using catenary
Cost	Low capex[2] if only Level 2; opex[3] can be lower if charging when electricity cost is lowest at night	Potentially lower capex for chargers and smaller battery; higher opex if using public mid-route charging	Potentially lower capex for chargers and smaller battery; higher opex if using public mid-route charging	High capex for swapping infrastructure and battery storage; high opex for swapping labor	Considerable cost for building catenary infrastructure
Feasibility	Viable today	Limited availability of mid-route charging infrastructure	Limited availability of mid-route charging infrastructure	No pilots for commercial sector	Some pilot projects announced
Flexibility	No flexibility for externalities or total route length	Option to extend stops if needed	Needs predictable routes	Possible only where swapping station available	Possible only where catenary available

[1]Mid-route charger owned by operator or public/third party.
[2]Capital expenditures.
[3]Operating expenditures.

McKinsey & Company

US Level 4 Autonomous Driving Truck Adoption

1. **TuSimple:**

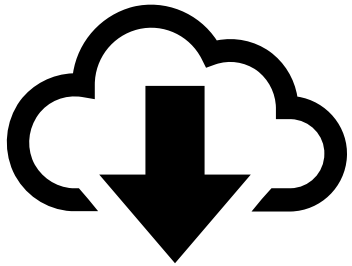
   A self-driving truck company, plans for AV freight deliveries in 2024, said CFO Cheng Lu during the ATA's Management Conference & Exhibition last year.

2. **Daimler’s Freightliner Inspiration Truck:**

   Company has been approved for autonomous driving in Nevada.

3. **Other companies that have announced pans for fully automated trucks include:**
   - Navistar
   - Volvo
   - Peterbilt Motor Company
   - Tesla
   - Waymo

"DOD, Industry, and Academia co-developing technologies for quantifiably enhanced vehicle cyber resiliency."



ECM Security

- **New engine control module calibration codes now use industry standard encryption.**
- **Follows NHTSA Best Practices for cyber security**
- **Secured on DVD or Web Portal**
- **Calibrations used with OEM diagnostic software to reflash an ECU**

University of Detroit Mercy

Also Focused on Training Courses in Vehicle Cyber – can customize to meet your Team / fleet needs.

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Questions?

Questions?

Automotive Status & Concerns of Electrification

1. **Edmunds Status Report:**
    - Estimates EV Market share in the US climbs to 4% in 2022
    - US Lags China and Europe in EV implementation

2. **Consumer Concerns:**
    - Vehicle Range
    - Affordability (EV average price $56K in October 2021 – $10K + higher than non EV at $46,000)

3. **Industry Concerns:**
    - Infrastructure Charging stations
    - Battery Capacity (Rare Earth materials)
    - Industry Expertise
    - Conversion Costs from ICE
    - Standards

Acceleration of Electrification

AlixPartners LLP Report:

Consumer study of % people ready to buy an all electric vehicle

- Globally from 2019 to 2021: 11-25%
- US from 2019 to 2021: 5-19%

Global Industry (5 year rolling) Investment (Electric & Autonomous): $330B

- General Motors $35B
- Ford $22B
- Stellantis $35.5B
- 30 new EV Launches in 2022 (Ford F-150 at $40K)

US Target and Laws:

- 50% New Sales being EV's by 2030
- Fuel Economy Target by 2026 to 40 mpg
- Infrastructure Package:
  - $7.5 B for EV Charging
  - $7B for Battery MFG & Recycling
  - Current Consumer Rebates of $7,500 (discussing going to $12,500)

Reasons for Growth of Electric Trucks

1. **Regulatory:**
   - Electric Trucks contribute 3 to 5 percent of global CO2 emissions.
   - European Union, require new trucks to reduce CO2 emissions by 30 percent by 2030.
   - 40 cities+ Globally ban diesel & gasoline internal combustion engine (ICE) trucks in their city centers.

2. **Supply:**
   - Major OEMs have announced new models across different weight classes, resulting in the potential for more than 30 models by 2040.

3. **Technology Improvements:**
   - Increasing vehicle range
   - Battery costs are also falling.
   - Over the next decade, they should decline to the point where the total cost of ownership (TCO) for many eTruck models will be similar to or better than the TCO for ICE trucks.

Graduate Certificate & Master of Science Vehicle Cyber Engineering (VCE)

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