Ten Trends in Surface Mobility: 2023

John Moavenzadeh
Executive Director, MIT Mobility Initiative
MMI Vision Day, November 3, 2023
Trend #1
Geopolitical Bifurcation: Shifting Global Value Chains

Context / Description:
• Chinese automotive OEMs have shifted from imitator to innovator, leading in critical technologies such as EV batteries and advancing in automation
• China exerts influence / control over critical battery minerals: cobalt, nickel, graphite and lithium
• US (Trump-imposed, Biden-continued 25% tariff, IRA EV tax credit restriction) and Europe (EC investigation) react

Headlines:
• How China Is Quietly Dominating the Global Car Market (Bloomberg, Jan. 26, 2023)
• EU to investigate ‘flood’ of Chinese electric cars, weigh tariffs (Reuters, Sept. 13, 2023)
• Ford halts work on $3.5B EV battery factory with China’s CATL (Tech Crunch, Sept. 27, 2023)

“Global markets are now flooded with cheaper Chinese electric cars. And their price is kept artificially low by huge state subsidies. This is distorting our market.

So I can announce today that the Commission is launching an anti-subsidy investigation into electric vehicles coming from China.

Europe is open for competition. Not for a race to the bottom.”

- Ursula von der Leyen, President, European Commission, September 2023


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Trend #2
Autonomous Backlash: AVs Drive into Headwinds

Context / Description:
- Automated mobility has passed through the Gartner hype cycle
- A serious public dialogue has emerged as to why we want this technology and how it should be deployed
- Shift to “driverless” (no test operator) in cities across the US and China raises the stakes on safety and liability

Headlines:
- Baidu, Pony.ai Start Driverless Robotaxi Tests in Beijing (Reuters, Dec. 30, 2022)
- Protesters, Armed with Traffic Cones, Are Immobilizing Driverless Cars (NPR, August 28 2023)
- Citing Safety Concerns, DMV Suspends Cruise’s AV License (SF Inquirer, Oct. 24, 2023)

AV Public Companies Performance are Plummeting, and the industry is going through consolidation

<table>
<thead>
<tr>
<th>Company</th>
<th>Valuation at IPO</th>
<th>Valuation Today</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aurora</td>
<td>$14,000M</td>
<td>$4,900M</td>
<td>-65%</td>
</tr>
<tr>
<td>TuSimple</td>
<td>$8,500M</td>
<td>$310M</td>
<td>-96%</td>
</tr>
<tr>
<td>Luminar</td>
<td>$7,000M</td>
<td>$2,080M</td>
<td>-70%</td>
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<tr>
<td>Embank Technology</td>
<td>$5,160M</td>
<td>$70M</td>
<td>-98%</td>
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<tr>
<td>Velodyne Lidar</td>
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<tr>
<td>Aeva</td>
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<tr>
<td>Ouster</td>
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<tr>
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<td>Otonomo</td>
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<td>$40M</td>
<td>-97%</td>
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<tr>
<td>Quanergy Systems</td>
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<td>$16M</td>
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<tr>
<td>Arbe</td>
<td>$722M</td>
<td>$361M</td>
<td>-50%</td>
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<tr>
<td>CYNGN</td>
<td>$198M</td>
<td>$32M</td>
<td>-84%</td>
</tr>
</tbody>
</table>

Total $50,880M $9,609M -83%

Average Decline

Trend #3
Automotive Architecture: The Rise of Software Defined Vehicles

Context / Description:
- The personal car emerges as another connected personal device (with the phone, tablet, laptop …)
- Vehicle architecture has shifted from mechanical-led platform to software-forward design
- Automotive OEMs are challenged to take on the role of lead software architect
- Just like batteries, SoC (System on a Chip) is increasingly viewed as “core business” for auto OEMs

Headlines:
- How OTA Updates Will Change Your Life for Better – and Worse (Motor Trend, March 9, 2023)
- Why Your Car Will Become Even More Like an iPhone (Wall Street Journal, Nov 4, 2021)
- Your Car Is Spying on You: How to See What Data It's Collecting and Delete It (USA Today, May 21, 2023)
Trend #4
Urban Micromobility: Two Steps Forward, One Step Back

Context / Description:
• Micromobility (bikes and scooters) hold tremendous opportunity to decarbonize urban mobility
• Shared micromobility has evolved from “competition in the market” to “competition for the market”
• Infrastructure needs to adapt to maintain safety: protected lanes, speed segregation, etc.
• Once the “darlings of venture capital”, micromobility companies have seen valuations plummet

Headlines:
• Paris Becomes the First European Capital to Ban Rented Electric Scooters (New York Times, Sept. 1, 2023)
• Scooter Company Bird Delisted from NYSE After Stock Collapse (CNBC, Sept. 23, 2021)

Trend #5
Capturing Externalities: Progress Toward Dynamic Pricing

Context / Description:
- Our mobility system often fails to capture the full economic cost of mobility consumption – e.g. supersized single-occupancy SUVs consuming precious street space during downtown rush hour
- Dynamic pricing based on the current (actual) level of demand can be used to drive mode shift (decarbonization), congestion management and revenue collection
- Congestion pricing, the Godmother of dynamic pricing, has been implemented in Singapore, Stockholm, London and many other cities

Headlines:
- Officials Mark Full Opening of I-66 Express Lanes (Nov 30, 2022)
- Congestion Pricing Plan in New York City Clears Final Federal Approval (New York Times, June 26, 2023)
Trend #6
Mobility Demand Patterns: Hybrid Is Here to Stay

Context / Description:
• Levels of Working From Home (WFH) and Working From a 3rd Place (WF3P), such as a café or friend’s house, stabilized in 2023

Headlines:
• Hybrid Working Schedule ‘Here to Stay,’ Littler Survey Shows (Bloomberg, May 10, 2023)
• Global Air Traffic Rebounds to 95.6% of Pre-Pandemic Levels (The National News, Sept. 7, 2023)
Trend #7
EV Hesitation: Charging, Battery Supply, Cost

Context / Description:
- Securing the supply of battery materials continues to challenge global OEMs and drive cost
- Battery production capacity is being added – but it takes time to build and ramp gigafactories
- Public charging reliability continues to be a challenge – but with some interesting developments

Headlines:
- US EV Market Struggles with Price Cuts and Rising Inventories (Reuters, July 11, 2023)
- Hyundai Follows Volvo, Ford, Honda to Adopt Tesla’s EV Charging Ports (Forbes, Oct. 5, 2023)

Source:
- https://www.forbes.com/sites/brianbushard/2023/10/05/hyundai-follows-volvo-ford-honda-to-adopt-teslas-ev-charging-ports-here-are-the-others/?sh=20ee60f374d8
Rising US Infrastructure Costs: Finding Bang for the Buck

Context / Description:
- By many measures, infrastructure delivery in the United States costs more than comparable advanced nations (e.g., Germany, Japan, South Korea, United Kingdom).
- As the United States makes a massive $1 trillion investment in infrastructure, how can we ensure maximum “bang for the buck”?

Headlines:
- Why Public Transportation Is Especially Expensive to Build in the US (NPR, July 21, 2023)
- Why Is US Infrastructure So Expensive – And What Can We Do About It? (Wall Street Journal, July 24, 2022)

Source:
Trend #9

The End of the Froth: Capital Sloshes Out of Mobility Tech

Context / Description:
- Unprecedented levels of capital were invested in mobility technology (eVTOLs, EVs, LIDAR, battery tech, etc.) during the “SPAC wave” of 2020-2021
- Raising capital in mobility ventures is now more challenging

Headlines:
- Flying Car, Anyone? Inside the Perilous Quest to Get Battery-Powered Aircraft Off the Ground (FT, Jan. 12, 2023)
- The Collapse of the EV SPACs: Another One Goes Bankrupt, Others on the Verge (Wolf Street, August 23 2023)
- VC Investment in Mobility, Still Down from Last Year, Appears To Be Leveling Off (Automotive News, Sept 22, 2023)

[https://www.ft.com/content/87b1ee8b-e856-40a5-aa57-62340ff3d8c8](https://www.ft.com/content/87b1ee8b-e856-40a5-aa57-62340ff3d8c8)
Trend #10
Future of Work: Rethinking the Social Contract

Context / Description:
• Global transportation system – from services to manufacturing – is still highly labor intensive, and many industries are struggling to hire, re-train, and retain workers at multiple skill levels
• Automotive companies struggle to reskill their engineering talent from mechanical focus to software focus
• US public transit, long-haul trucking, and other transport sectors struggle to find workers

Headlines:
• Software is Now as Important as Hardware in Cars (The Economist, April 14, 2023)
• MBTA Contract Calls for 18% Pay Hike Over Four Years (Boston Globe, August 2, 2023)
• UAW Strikes at Automakers Highlights Skyrocketing US CEO Pay (Reuters, Sept. 20, 2023)

Source: https://www.reuters.com/business/autos-transportation/uaw-strikes-automakers-highlight-skyrocketing-us-ceo-pay-2023-09-20/
https://www.bostonglobe.com/2023/08/02/metro/mbta-contracts-calls-18-percent-pay-hike-over-4-years/
https://www.economist.com/special-report/2023/04/14/tech-wars
China’s Top 100 Firms: By Ownership Share

China’s state vs. private company tracker: Which sector dominates?

MIT Mobility Initiative

Jinhua Zhao
Professor of Cities and Transportation
Ever since the first hominids left Africa, human beings have been on the move. The canoe was invented in 8,000 B.C., and the first form of public transportation was a stagecoach operated in Paris in 1662. Fast forward to today’s self-driving car prototype, and it’s clear just how far we’ve come.

Morning traffic on the Southeast Expressway in Dorchester. (David L. Ryan/Globe Staff)
We are confused
AV debate:

How safe is safe enough?
When 42,915 people died on the road in 2021, who took responsibility?
Q1: What is success?
Technology Themes in Mobility

1. Mobility Decarbonization
   - To reduce carbon emission by transitioning from fossil fuel to sustainable alternatives:
     - Electric vehicles
     - EV charging
     - Battery technology
     - Fuel Cells
     - Hydrogen

2. Autonomous Driving
   - To enable vehicles to operate without or with minimal human intervention, aiming to replace or assist human drivers, including:
     - Sensors & processors
     - Localization & Mapping
     - Perception software
     - Full-stack players

3. Connected Vehicle and Infrastructure
   - To enable real-time data exchange with other vehicles, infrastructure, and external systems.

4. Next-Gen Aviation & Space Tech
   - Sustainable aviation fuel; autonomous flights; eVTOL; hydrogen aircraft:
     - SpaceX, BlueOrigin; launch, satellite, manufacturing, in-space services

For each theme, we will cover the following content:

A. The Opportunity
B. Investment Activities
C. Trends
D. Market Landscape
E. Highlight Startups
Different framings of transportation

As a congestion problem
As a sustainability problem
As a social justice problem
As an urban creativity problem
As a public health problem
Q2: What defines the future of mobility?
Behavior + Computation
Behavioral thinking

is travel social?

is travel emotional?

is time absolute?
Business Decision

- EV range anxiety
- Ridesharing Pricing
- AV adoption
- Congestion charge
- Ownership vs access
- Car profit margin
- ...

Behavioral Thinking

- Emotional $\rightarrow$ rational
- Preference of sharing
- Risk preference
- Price salience
- Option value
- Car pride
- ...
Behavioral Thinking
- Emotional
- Social
- Perceptual

Transportation Technology
- Electrification
- Automation
- Connectivity
- Sharing

Computational Foundation
- Representation
- Explanation
- Prediction
- Control
- Creation
Q3:
How can MIT contribute?
Transportation Faculty and Researchers (Sample)

Jim Alsdin
Professor of Architecture and Transportation
Research Interests: Urban and Regional Policy and Planning

Saurabh Amin
Professor of Mechanical Engineering
Research Interests: Fluid Dynamics, Aerodynamics, Heat Transfer, and Energy Systems

Steven Barrett
Professor of Aeronautics and Astronautics
Research Interests: Aeronautics, Astronautics, and Fluid Dynamics

Charlie Fink
Professor of Operations Research
Research Interests: Operations Research, Operations Management, and Supply Chain Management

Daniel Freund
Professor of Operations Research
Research Interests: Operations Research, Supply Chain Management, and Business Analytics

Jason Jackson
Assistant Professor of Mechanical Engineering
Research Interests: Materials Science and Engineering, Nanomaterials, and Nanotechnology

John Leonard
Professor of Aeronautics and Astronautics
Research Interests: Aerospace Engineering, Astronautics, and Space Systems

Elisabeth Reynolds
Professor of Architecture
Research Interests: Architecture, Urban Design, and Urban Planning

Cathy Wu
Assistant Professor of Architecture
Research Interests: Architecture, Urban Design, and Urban Planning

Jeniiklae Tranik
Professor of Architecture
Research Interests: Architecture, Urban Design, and Urban Planning

Chris Zegras
Professor of Urban Planning and Transportation
Research Interests: Urban Planning, Transportation, and Public Policy

Bill Aulet
Professor of Engineering and Applied Sciences
Research Interests: Engineering and Applied Sciences

Dimitris Bertsimas
Professor of Management and Operations Research
Research Interests: Management and Operations Research

Alexandre Jacquillat
Assistant Professor of Management
Research Interests: Management and Organization Theory

Fabio Duarte
Assistant Professor of Aeronautics and Astronautics
Research Interests: Fluid Dynamics, Heat Transfer, and Energy Systems

John Attanasi
Professor of Management
Research Interests: Management and Organization Theory

David Mindell
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Research Interests: Aeronautics, Astronautics, and Space Systems

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Director of the MIT Senseable City Lab
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Sajij Sarma
Assistant Professor of Architecture
Research Interests: Architecture, Urban Design, and Urban Planning

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Professor of Electrical Engineering
Research Interests: Electrical Engineering

Harl Balakrishnan
Professor of Electrical Engineering
Research Interests: Electrical Engineering

Sietse Karaman
Professor of Aeronautics and Astronautics
Research Interests: Aeronautics, Astronautics, and Space Systems

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Research Interests: Aeronautics, Astronautics, and Space Systems

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Sarah Williams
Professor of Architecture
Research Interests: Architecture, Urban Design, and Urban Planning

Sandy Pentland
Professor of Media Arts and Sciences
Research Interests: Media Arts and Sciences

Nigel Wilson
Professor of Media Arts and Sciences
Research Interests: Media Arts and Sciences
Our Mission

The MIT Mobility Initiative (MMI) is a global platform to accelerate a safe, clean and inclusive mobility system through research, education, entrepreneurship and engagement.

**Research**
Catalyze cross-disciplinary research that provides insight to strategic challenges for industry and society.

**Education**
Manage and enhance MIT’s transportation degree programs and expand the executive education offering.

**Entrepreneurship**
Leverage MIT’s innovation ecosystem to spin off mobility tech startups and support existing startups.

**Engagement**
Foster direct interaction with leaders from business and government on the “front lines” of the mobility revolution.
How is MIT contributing?

Solve short-term technical problems
Develop medium-term platforms and capacity
Catalyze strategic, institutional, and social changes
MIT serving the public
Q1: What is success?
Q2: What defines the future of mobility?
Q3: How can MIT Mobility Initiative contribute?