Autonomous Vehicles Reality Check Part 3: Robots Moving Freight

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I first rode in a self-driving vehicle in 1991. Haven't looked back.

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Trucking is a key driver of our economy. What are the prospects for a transition to driverless ... [+] BISHOP CONSULTING

There was a time when "AV trucks" were discussed as a singular thing, i.e., driverless long-haul trucking. Those days are now in the rear-view mirror. Trucking use cases suitable for automated driving are rapidly proliferating. In this last installment of my Autonomous Vehicles Reality Check series, I'll stretch wide to wrap my arms around it all, aiming to provide some perspective. Rather than an in-depth company-by-company review, this article is more about automated trucking use cases that are showing various degrees of momentum.

Buckle your seat belt. I'll start with off-road use cases which are very much here and now, as are some surface street operations. Then we'll examine the classic long haul trucking world, in which there are various use case subdivisions for driverless operations (also known as "Level 4" or "L4"), that will be important to defining success in the long run.

Off Road Use Cases

Given unpaved terrain, the off-road use case may not be a simple operational environment but at least there's no public traffic to deal with, nor vehicle safety regulations. Mining, construction, agriculture, and similar industrial operations are seeing a boom in application of automated driving, although the first commercial automated trucks were introduced over a decade ago by Caterpillar and Komatsu, offering monster mine-hauling trucks. In recent years, Pronto.ai, SafeAI, and RRAI have become active in this space to address other hauling needs across a variety of vehicle types and sizes. Thus far, only SafeAI has announced customers, such as Japanese construction company Obayashi.

The truck and heavy equipment manufacturers have been in this game for some time. Nils Jaeger, president of Volvo Autonomous Solutions (VAS), a Volvo Group subsidiary, recently outlined their multi-vertical strategy for automated trucking. VAS's first foray is in providing off-road autonomy for the quarry and mining industry. Since 2018, VAS has been providing autonomous trucking at the Bronnoy Kalk mine in Norway, so far with a safety driver in the cab. Another similar operation is underway in Switzerland.

The timing dynamics create business opportunity. While OEMs are likely to take their time in bringing new products to market, there is demand for industrial autonomy now.

SafeAI has already entered the off-road market by retrofitting customer's existing vehicles with autonomy capability.

Trailer Shifting: On Pavement But Off Road

Another aspect of automated off-road operations is "trailer shifting" at logistics centers. In this use case, automated tractors autonomously link up with trailers to move them between loading dock doors and onsite storage areas. These vehicles operate 100% "inside the gate" and never see a public road. Fernride, ISEE, Outrider, and RRAI are the main companies active in this space to my knowledge. Fernride has an ongoing pilot with DB Schenker in the Netherlands. ISEE has announced pilots with Maersk and Lazer Spot. Outrider has run extensive trials with Georgia-Pacific and other large companies in the package shipping, retail/eCommerce, and manufacturing industries. RRAI is currently building a new logistics and distribution autonomy facility to support product development, customer demonstrations, testing and training specific to automating yard trucks, class 8 vehicles and advanced trailers for warehouse, drayage, ports and other last-mile/first-mile environments.

I've spoken to truck fleet executives who prefer to try out yard tractors first, as a way to dip their toe into the AV waters before going "full bore" on the public highways. My sense is that there are a few dozen automated yard tractors operating now in late-stage pilots with customers, which are likely to transition into production buys.

The Role of Remote Driving and Support

Depending on the specifics of a deployment, remote driving can be considered for both off-road and trailer shifting operations, but to my knowledge the majority of developers are focused on on-board autonomy. With or without remote driving, a "remote support" function can allow for human overseers to provide operational inputs as needed to ensure optimal efficiency.

Running On Public Roads: Surface Streets

The public's image of truck automation has typically been the robot big rigs barreling down a desert highway somewhere in the southwestern USA. But wherever trucks are operating on public roads, there's a business case for automated operations.

Trucks move containers from seaports or rail terminals to warehouses and distribution centers. In some cases, these "drayage" moves occur within massive logistics facilities which are contained private environments. In most other cases, trucks are moving containers short distances on local roads. A similar use case exists in moving goods between a parts plant and the main production facility within a manufacturing region, as is typical in automotive manufacturing. Moving mined material from the extraction point to a job site may entail short on-road runs as well. These use cases are technically

feasible for implementation now, potentially without much needed in the way of regulatory clearance. Einride recently announced operations of this type in Tennessee, shuttling goods between facilities of their customer General Electric. VAS's Jaeger notes these types of operations are the focus of the second vertical within their strategy. In this use case, remote driving can be considered if the vehicle speeds are a match with communications latency to the remote center.

The most active trucking use case on local streets are repetitive runs between distribution centers and local stores, driven by the boom in e-commerce. Gatik has championed this use case, taking their offering past development and pilot phases into fully deployed revenue-producing driverless goods movement. Walmart was their first customer, with fully driverless operations starting in 2021 in Arkansas. This year Gatik announced Georgia-Pacific, KBX and Pitney-Bowes as new customers in the Texas market and began fully driverless deliveries with Loblaw, Canada's largest retailer, with whom they have been operating since 2020 in Ontario. Isuzu supplies L4-ready medium-duty trucks to Gatik. The company has stated that their funding picture provides them "three to four years" of funding runway, during which they expect "aggressive growth" in customer operations. I asked Gautam Narang, Gatik's Co-Founder and CEO, what "aggressive growth" really means. He said they "expect to have hundreds of trucks deployed in commercial operations by the end of next year."

Udelv is another street-level autonomy player, which is developing a "cab-less autonomous delivery EV for multi-stop, last- and middle-mile delivery routes." Early in 2022, Belgian logistics service provider Ziegler Group placed an order for ten Udelv Transporters.

Running on Highways: Highly Automated Driving

When it comes to over-the-road trucking, autonomous driving takes several forms. The use cases being pursued vary across the levels of driver support, operational design domain, and multi-truck operations.

An interesting interim step in applying autonomy to highway driving is known as Highly Automated Driving (HAD). In early 2021, autonomous driving developer Plus introduced a product called PlusDrive which employs L4-intent hardware and software

to perform essentially all driving tasks during freeway driving (in-lane driving, lane changes, accommodating merging traffic, etc.) while the system is supervised by a driver employed by the fleet customer. Thus, in terms of its manner of operation, it is a Level 2 implementation. "PlusDrive is built using our autonomous driving software, which we have constrained to operate under the supervision of a professional driver for this commercial product to improve safety, fuel economy, and driver comfort," said Shawn Kerrigan, COO and Co-Founder at Plus, adding that PlusDrive "looks to assist drivers, not replace them." Key benefits also accrue to Plus's L4 development and validation process, given the high mileage accumulated by each PlusDrive equipped truck. The first customer for PlusDrive was Amazon; deliveries started in 2021 and have continued through 2022.

Driver support systems of this type go far beyond the Advanced Driver Assistance Systems on the late model trucks, in that AI algorithms in L4-intent systems are continuously getting smarter and expanding features via over-the-air updates. Tesla's Autopilot would be a similar AI-powered HAD offering if it is enabled on the Tesla Semi.

I have no doubt that the truck OEMs will field similar HAD products, but they will take a step-by-step approach spanning quite a few years. However, when PlusDrive was introduced, I was curious to see whether other highway-focused truck AV startups would take a similar path, as a way to get more quickly to market and generate revenue, and, to satisfy the appetite of truck fleets to get at least a preliminary version of automated trucks into their hands.

This month Embark announced that they have provided automated trucks to their partner and investor Knight-Swift (KS), one of the largest trucking fleets in North America. Like PlusDrive, the trucks are operated by fleet-employed drivers who supervise the automated driving. Embark CEO Alex Rodriguez related that "the functions will turn on progressively: first in-lane operation handling merges and cut-ins, later transitioning to full multi-lane capability where regulations permit." KS was the initiator here, as they wanted to evaluate the vehicles in their daily operations. This also gave Embark the opportunity to harden the system, for example enabling a boot-up process that doesn't require an engineer in the loop. Regarding KS, Rodriguez notes "this is a last step for being ready to go with L4 upon commercial deployment of our

technology." He stresses that, unlike Plus, their HAD system is not a product and is being offered to potential customers in very low volume.

Running On Highways: Automated Convoying

Using technology to convoy (or platoon) trucks was pursued with vigor during the last decade. Locomation is the dominant player now. According to the Locomation website, their Autonomous Relay Convoys (ARCs) are two-truck convoys with a lead truck and a follower truck and two drivers. Both trucks are equipped with an autonomy system and are electronically tethered so that they move together. One driver drives the lead truck while a second driver rests "off the clock" in the follower truck. Periodically, the trucks swap places to allow each driver to take turns either leading the convoy or resting. This allows greater utilization of both the trucks and available driving hours. Several fleets including Wilson Logistics, Stevens Trucking, and Christensen Transportation have signed up for deliveries of ARC systems. Seeing ARC as an interim business model prior to extensive solo-truck L4 deployment, Locomation has stated that the first units will be delivered to Wilson Logistics in late 2023.

Running On Highways: Level 4 Autonomy

L4 autonomy on the open road is being pursued by startups Aurora, Embark, Kodiak, Plus, TuSimple, Waabi, and Waymo, as well as virtually all traditional truck OEMs. Let's take a quick look at these L4 highway-focused players.

Aurora expects its self-driving technology to be "feature complete" by the end of the first quarter 2023. With an extensive final validation phase occurring next year, they plan to start driverless commercial operations in 2024. Aurora works with the likes of FedEx, Uber Freight, Schneider, Werner and US Xpress. The company currently hauls freight 22 times a week for these customers and that number is expected to increase to 100 per week by the end of next year. Aurora is under the microscope due to being publicly traded. In response to recent skeptical press as to their future, CEO Chris Urmson stated that "Aurora plans to remain independent and has the capital that allows us to ride out the current storm in the capital markets."

Also publicly traded, Embark has been called "less than worthless" by Crunchbase News. Ouch! I'm not a market-savvy guy, but to me this appears to be an artifact of the

awkwardness of a company that has yet to introduce a product being traded on a public stock exchange. Looking at their strengths, Embark is in an enviable position given their tight partnership with Knight-Swift. When Embark's tech proves to be solid and ready-to-go, it is reasonable to expect that KS will deploy it in driverless operations. As a major investor, KS can play a nurturing role in the journey to profitability. Their assessment of value could mean a lot more than the noises coming from Wall Street.

Kodiak is running extensive freight operations in Texas and Oklahoma as they mature their L4 system. Kodiak trucks are moving goods for Werner, IKEA, Pilot, U.S. Xpress, CEVA Logistics, and 10 Roads Express. A significant boost comes from a $50M award from the U.S. Defense Department to automate Army Robotics Combat Vehicles. This funding will prove helpful as they approach commercial launch "within the next couple of years," as stated by CEO Don Burnette at this month's TTNews Automate online forum.

TuSimple is a gothic novel all its own. The company has capable technology but severe management challenges. Their flagship OEM partnership with Navistar/Traton, much ballyhoo'd when it was originally announced in 2020, is no more. Given time, they can potentially climb out of the hole they've dug.

There has been extensive chatter on the web about TuSimple's crash earlier this year, with many voices asserting that the incident proves TuSimple was essentially faking self-driving all these years. But dig deeper and this assertion doesn't hold up. The TuSimple crash was the result of a procedural error in activating the autonomy. Such an error should never have even been possible, and TuSimple has been rightly condemned in that case. Given that this lapse — and crash — occurred, I've heard armchair referees speculate that all of TuSimple's capability is sub-par. Hold on, though: a procedural lapse tells us nothing about how the automated driving system itself performs while running on the road. Colleagues who have extensive experience with the TuSimple system on the highway tell me it is a very high performing driver. They also remind me that TuSimple's L4 system has driven millions of highway miles without an incident. At this point, I'm not taking sides, but I'm also not dismissing TuSimple completely.

Waabi is the new kid on the block. Although a late-comer, they insist that their AI-infused simulation-based development approach will get them to first product relatively

quickly. They are quietly courting trucking fleets while the rest of us wait and see.

Waymo Via is in a very strong position due to consistent backing by Alphabet. Their partnership with dominant freight broker C.H. Robinson will create a powerhouse once Waymo's initial L4 product is released. A similar Uber Freight partnership adds more strength. Waymo's L4 ready trucks built for them by Daimler have been delivered. Waymo hasn't given hints as to the timing and sizing of a production buy from Daimler, nor regarding a full commercial launch date. Waymo Via also indicates on their website they'll target any type of truck-based goods movement; thus, they could enter the surface street use cases I've discussed here if they see business potential.

What About Truck Makers?

Unlike the startups, OEMs are unlikely to be in a fundamental cash crunch; their revenue stream comes from selling regular trucks. Of course, their budgets for autonomy programs must be sold upwards within the organization, and available cash for productizing autonomy depends on other internal investments in electric powertrains and a myriad of other priorities.

Truck-makers Daimler, Iveco, PACCAR, Traton, and Volvo are highly active in automated trucking. These companies comprise the majority of large truck suppliers for North America and Europe. And there are significant up-and-comers in the electric powertrain space such as Nikola and Tesla, who are likely to offer some form of driver assist or automated driving to be relevant in today's industry.

Daimler Trucks is laser-focused on highway operations. Martin Daum, CEO of Daimler Trucks North America, states that their approach to long haul autonomy has a reasonable time frame which he expects to scale up "within a decade." Daimler has traditionally been the trucking industry leader in introducing high tech systems. Significantly, they have two strong horses to ride when it comes to AV: Torc and Waymo.

Partnerships with the startups have been the norm.

Traton is evaluating options after ending the TuSimple relationship; more on this below.

Iveco is partnered with Plus. At the IAA event last September in Europe, a joint press release noted that PlusDrive has been integrated into the S-WAY truck in preparation for public road testing, which "paves the way for IVECO and Plus to produce a semi-autonomous product as a first step and to prepare for ultimately manufacturing fully autonomous vehicles."

PACCAR is planning to introduce autonomy with the Aurora Driver. For Volvo Group, on-highway autonomy is the third of the three verticals VAS's Jaeger has discussed; their horse is also Aurora.

This month, Volvo Group made a major announcement that they are partnering with Uber Freight "to pilot its hub-to-hub autonomous offering in which Volvo will provide autonomous freight capacity to Uber Freight shippers." If I'm reading this right, the implications of this move are very significant, i.e. that a truck manufacturer will become a freight mover rather than just a truck seller. The potential impacts of doing so have been debated since the first AV prototype trucks hit the road. As noted above, Volvo has a toe in the water already with transporting mining material at operations in Europe. Will Volvo's on-road customers come to see their supplier as a competitor? Even though this move may make business sense for Volvo, customer relations could be very tricky to navigate.

What's On My Radar?

For anyone wanting to keep tabs on this space, here are some key issues and questions.

Walmart, Loblaw, and other shippers operating repetitive surface street runs are the first in the world to be gaining benefits from automated trucking. It's natural that any promising vertical would have multiple offerors; indeed, the end-customer always seeks to gain better terms via competition. So, I'm watching for competitors to enter the space that Gatik now inhabits exclusively. Gatik has significant first-mover advantage, having forged deep customer relationships with these types of trend-setting shippers across North America. This would not have occurred unless both the business model and the tech were successfully challenged by a rigorous validation process. Still, it's a "big pie" so I keep watching for who else will show up. The robotaxi players certainly have strong capability in street driving, although their current people-carrying operations would

have to be adapted to the specifics of local freight hauling. Part One of this series highlighted that Amazon wants to begin autonomous operations for local freight with a yet-to-be-announced partner. And, Part Two of this series noted that Waymo and Aurora are developing an automated driver for cars, which can be adapted to box truck operations on city streets. No doubt, these and similar companies are analyzing the pro's and con's of entering this potentially lucrative use case; there's a lot of local hauling going on out there.

Almost all of the on-road focused startups have strategic partnerships with shippers and/or freight carriers. Aurora, Gatik, Plus, and Waymo have strategic partnerships with major truck OEMs as well. Will we see truck OEMs take the stance of offering multiple options to their customers for automated driving capability? They do this now with engines and other major components. If they go with a la carte autonomy, this provides an opening for further OEM-startup partnerships. In the background, there's always the possibility of an acquisition happening as a means to the same end.

In the highway space, what role will Highly Automated Driving play in terms of revenue for those offering it? Being available now, will HAD play a role as a steppingstone to adoption of full L4 systems? And, if HAD has strong uptake, will it motivate the truck OEMs to accelerate their own rollout of such systems?

In the near term, it will be fascinating to see what transpires with Traton and their U.S. subsidiary Navistar, now that their technology partnership with TuSimple is kaput. I'm quite certain they aren't sitting on their hands; they seek to have a strong play in the AV truck market as a strategic necessity.

For highway operations, current efforts aim to automate the "ramp to ramp" long haul, augmented by transferring the load to human driven trucks for the last mile. Some AV developers have also asserted they have the capability to move loads "dock to dock," i.e. running driverlessly for both the long haul and the last mile. This "dock to dock" capability is the Holy Grail; shippers don't want to adapt their operations to the tech, they want the tech to adapt to their current operations. TuSimple's messaging has touted coming to market with a dock-to-dock solution. The other startups are focused on ramp-to-ramp for initial system introductions. Long haul AV players who can offer dock-to-dock will gain significant competitive advantage.

What's Coming Down The Road?

Compared to people transport, the freight side is much more definitive. If the tech works perfectly and fits into freight operations perfectly, deployment will expand. Consider Walmart — if they are seeing improved customer service at less cost by deploying Gatik vehicles, they can rapidly expand AV operations across the 20+ countries they operate in. The same is true for giants like Amazon and the other shippers mentioned above. I expect to see substantial expansion of the street B2B delivery use case in 2023.

If there are regulatory bumps along the way, I expect these shippers will play an ever-expanding role in advocating for a supportive regulatory regime. To be clear, driverless operations occur now in many jurisdictions, given that the U.S. Federal government is essentially silent on the matter and state governments have explicitly allowed it. But the industry seeks a more definitive approach for the long term. Consider Walmart, Loblaw, Georgia Pacific, Knight-Swift, and all the other large shippers and freight carriers mentioned here: together they constitute a significant voice at the table with regulators and legislators. They will make a strong case that driver jobs are not in danger, and an improved supply chain and more sustainable movement of goods is supported by automated driving. The shippers won't be alone; the vehicle manufacturers will also be active in advocating for full AV regulatory support.

Every new retailer and trucking fleet that starts moving goods driverlessly on public roads adds to the credibility of AV's. Therefore, for any one of the use cases discussed here, I train my lens on customer uptake as the main indicator of progress. In addition to running driverless, to what extent is this integrated into daily logistics operations? Is it applied across the full enterprise, or if not, what stands in the way? When a deployment partnership is announced, many hoops within the customer organization have already been jumped through to ensure the validity and safety of the self-driving system, as well as the fit with real-world logistics needs. For retailers in particular, their brand is at stake if a driverless truck emblazoned with their logo makes a dangerous maneuver or inconveniences motorists with glitchy driving. However, with this potential downside comes the upside of reduced operating costs, thus enhancing their profits.

2024 appears to be the launch window for commercial driverless on highways, if statements by Aurora and Kodiak play out according to plan. Therefore, 2023 will see a substantial portion of driverless operations in conducting final on-road validation testing. OEMs will keep their launch dates close to the chest, but I'd be very surprised if they made a move sooner. Waymo marches to their own drummer, and if I had to place a bet, I'd put my money on them to be the first mover here, maybe even during the coming year.

No doubt you've noticed that this article series is not focusing strongly on the very challenging financial conditions within this industry. My colleagues remind me that "cash is everything" when it comes to startups. In Part Two, I asserted that "the deployment phase of people-carrying AV's will be achieved by players with deep pockets who can play the long game. Companies with cash, solid technology, and patient ownership can stay in the game. Companies lacking any one of these pieces have an uncertain future in today's economic climate." This statement applies equally to driverless trucking.

Historically, the typical Deep Pocket Long Gamers in trucking have been the vehicle manufacturers, the major trucking fleets, and the shippers. You can see from the information presented here that each type of mover-shaker is in the game for their own business reasons. These folks are not starry-eyed about cool robots; they have stuff to move and it must be moved more efficiently, more quickly, and with less cost than today.

Economic uncertainty aside, what storm clouds might appear on the horizon for AV's? Generally, I see the tech progressing. Strange moves by Congress or USDOT could have a negative effect, but I don't see any serious prospects of this happening. More significantly, a serious crash or a series of minor crashes will be a setback for individual developers. Even worse, if there are crashes across the board, or other occurrences that cause the public to feel unsafe, the industry will have to step up to remedy the situation. Such a retrenchment phase would imply implementing technology tweaks, further testing, and extensive public polling and education campaigns. If such a scenario occurs, I do not see this as stopping the industry, I see it as a slowdown in product introductions based on an abundance of caution. Current USDOT crash reporting

requirements for AV's enable all of us to keep tabs on safety performance. So far, the safety record of those already running driverless has been good.

Reality Check: Wrap Up

Having looked at both people and goods transport in this Reality Check series, we are seeing driverless operations in both domains occurring now, but with a very small geographic footprint. The expansion of the footprint and/or intensity of operations in particularly high-demand areas will be key to scaling up which, if all goes to plan, is the pathway to profitability. Profitable operations lead to vast expansions of service.

My bottom line? At a gradual but steady pace, across wide swaths of modern society we're still on track for a transition to driverless operations which address the mobility needs of people and the logistics needs of businesses. A strong industry overall is continuing to mature, amidst significant uncertainty for individual tech developers.

Disclosure: I am an advisor and/or shareholder with Gatik, Outrider, Plus, and RRAI.

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