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Navya: Steering Toward a Driverless Future

In May of 2022, Sophie Desormière (HBS PMD '75) sat in standstill traffic on her way to Orlando Airport. She had just visited a partner who operated a fleet of her company's autonomous vehicles (AVs). Desormière was the CEO of French AV company Navya, which designed both the autonomous software and the 12- to 15-person electric shuttles it plugged into. Amid the cacophony of honking by frustrated drivers, she could barely hear the notification on her smartphone. Lisa Kuehl, Navya's U.S. marketing manager, had received an inquiry from a residential community in White Bear Lake, Minnesota, interested in renting two shuttles for one year and having Navya manage all the operations.

While companies such as Waymo were designing AVs to replace personal transportation in complex urban settings, Navya designed roboshuttles for first and last mile transport use cases at controlled speeds (less than 25 miles per hour), with multiple passengers, and fixed routes, like planned communities (e.g., service between a residential area and a town center) and campuses (e.g., hospital sites, universities, nuclear facilities, and army bases). Since its founding in 2014, the company had deployed 200 of its electric roboshuttles in 25 countries. Yet, after a premature IPO in 2018, its stock faltered, and it ejected two CEOs. Turbulence had also affected two of its competitors, Local Motors and Optimus Ride, which exited the market in early 2022, one amid a highly publicized crash incident. Although Navya was still in operation, it was burning through cash reserves fast, and the hype around AVs was beginning to fizzle as the technology had not matured as quickly as hoped.

Desormière momentarily forgot the traffic around her as she considered the White Bear Lake inquiry. Historically, Navya sold its shuttles and worked with third parties to offer on-the-ground service. Should Navya take this opportunity, even if it meant disintermediating operators like Beep, and fully service end customers? Should it agree to rent out vehicles and, if so, at what monthly price? Her CFO, Pierre Guibert, pushed the company to sell its shuttles rather than rent them for short periods and have to deal with their depreciation. Yet, the company's U.S. contingent had been fielding steady requests for rentals, as many customers sought to first try out the new technology for a limited time.

Before she could dwell on this further, a bus in the adjacent lane reminded her of Navya's recent decision to partner with electric bus maker, Bluebus, to integrate Navya's software into a larger, bus-like form factor. Was this a wise decision, or should Navya have stuck to making shuttles in a vertically integrated manner, designing both the hardware and software? Desormière sought to rapidly scale the

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business by collaborating with hardware manufacturers. On this front, Navya had also forayed into goods transportation, working with tractor company Charlatte Manutention to create an autonomous tow tractor to operate on industrial sites and in airports. But Desormière was unsure how much to prioritize transportation of passengers versus goods. Finally, she needed to figure out how to allocate her limited sales effort across the geographies Navya operated in.

As her cab finally started moving, Desormière recognized that all of these decisions were linked to the prospect of achieving Level 4 (L4) autonomy, which depended on both technical and regulatory progress. Navya's vehicles operated at Level 3 (L3) autonomy, meaning that they still needed to have a safety attendant on board, which customers paid for on top of all the smarts of an autonomous vehicle; the advent of L4 would allow for the removal of all on-board human supervision, which had significant economic and social appeal. Desormière wondered how long Navya could keep selling customers on the promise of L4, and how much the company would be able to increase prices once L4 became a reality. She was uncertain exactly when this would be. If she could just keep the company moving until then, a driverless future for Navya looked bright.

Autonomous Vehicles

The Vision of Autonomous Vehicles (AVs)

Thierry Morin, a board member at Navya, highlighted the changes he had seen in the public perception of the automotive industry over the past 30 years, "For many years, the car was man's best friend—it gave you freedom to go where you wanted when you wanted. But today, it is public enemy number one. There are two major reasons: number one, cars kill fast when an accident happens, and two, cars kill slowly due to the pollution they emit." Each year, globally, motor vehicle crashes killed 1.25 million people and injured another 20 million. In the U.S. alone, around 40,000 people died each year. (See **Exhibit 1** for U.S. annual motor vehicle fatalities). Human error was responsible for at least 90% of these crashes.[1] With one fatality every 23 seconds,[2] solving the safety problem was literally a matter of life and death. The hope was that fully automated vehicles without human drivers would alleviate these statistics. AVs would react faster[3] and would not speed, get distracted, nor be drunk.

The transportation sector was also the largest contributor of greenhouse gases (27% of emissions in 2020), as 90% of fuel was gasoline and diesel.[4,5] (See **Exhibit 2** for car emissions). Though autonomous software was compatible with several drivetrains, including internal combustion engines (ICEs), the advent of AVs was an opportunity to shift to electric vehicles (EVs) that did not emit greenhouse gases.

Because AVs could pick up passengers at their starting points at any time, they promised to increase transport accessibility for disabled people and those living in remote areas, as well as remove the need to own a car, thus reducing traffic congestion and demand for parking. AVs could also make riding more pleasant, freeing up attention to chat, conduct meetings, ride when tired or inebriated, and consume content displayed on screens within the vehicle. AVs were expected to lead to efficiencies from not having to employ millions of drivers, resulting in cost savings that could be passed on to consumers. Finally, AVs had the potential to offer new revenue streams, such as advertising. However, some questioned whether AVs would create new jobs at the same rate they displaced existing ones.[6]

Technology

Significant investments in AV tech began in 2004, when the Defense Advanced Research Projects Agency (DARPA) launched a competition encouraging academic and industry teams to develop an AV capable of traversing a 150-mile course in the Californian Mojave Desert.[7] No contestant vehicles

completed the course, but the competition kickstarted the imaginations of engineers across the globe, spurring research developments that extended beyond defense applications. By the mid-2010s, major car, ridesharing, and technology companies were all investing in AV tech.

As of 2022, AVs used artificial intelligence (AI) and other critical tools to perceive and navigate road environments. The vehicles had several sensors—e.g., cameras, radar, ultrasonic, infrared, and light detection and ranging (LiDAR), as well as computers that ran algorithms on input from these sensors. Many AVs combined real-time sensor and GPS-location data with pre-existing map data, in order to classify objects in their surroundings and predict how they would behave. Given these predictions, an AV planned its path from points A-to-B, executing steering-wheel maneuvers at a determined speed.

Although developers shared a vision of full autonomy, most AVs were not yet fully autonomous, so the Society of Automotive Engineers created a taxonomy of levels for classifying vehicles based on the extent to which they were capable of automated driving tasks, ranging from no automation (L0) to full automation (L5). (See **Exhibit 3** for the automation levels). As of mid-2022, while L1 and L2 vehicles were already on the market, L3 and L4 vehicles were being actively tested by several companies. L5 vehicles, that could perform all aspects of dynamic driving in all conditions, did not yet exist.

L3 deployments required a human safety attendant on board and were usually also supervised by a human in a remote center, who resolved issues as they arose—for example, advising if it was safe for a vehicle that had stopped to resume driving, or communicating with a passenger who felt sick and calling for medical help. Given the concomitant costs over and above human-driven vehicles (HDVs), the economic potential of L3 vehicles was at best hazy. Moreover, the economic viability of both L3 and L4 depended on the ratio of vehicles on the road to remote supervisors. For these reasons, the advent of L4 vehicles as part of managed fleets was anticipated to be a major economic milestone.

Myths and Hype

In the early years of AV development, the industry was plagued by misplaced optimism and misconceptions. These misconceptions were often based on information supplied by self-interested developers, who suggested the technology would very soon to be commercially ready. As one expert quipped, "AVs were 20 years away from the late 1930s until the early 2010s and have been about five years away ever since."[8] For example, electric vehicle company Tesla dubbed the lane centering and adaptive cruise control software in its vehicles "Autopilot," which could have been interpreted as performing L5 autonomy, when in fact it was L2. In 2016, the German minister of transportation instructed Tesla to cease using the "Autopilot" term in its sales pitches.[9] Similarly, the autonomous truck company, TuSimple, called its 80-mile drive across highways in Arizona "fully autonomous" without qualifying that it was testing L4 on a specific route in a highly controlled scenario.[10]

In reality, no company was anticipated to be able to deliver L5 anytime soon given the variable settings these vehicles were expected to operate in, which posed an inordinately complex technology challenge. Yet several players were actively working toward L4 capability, with vehicles designed for specific use cases like highways, fixed routes, or neighborhoods with predictable driving conditions.

Safety, Consumer Perceptions, and Regulation

In March 2018, one of Uber's autonomous vehicles was on a test run when it struck and killed Elaine Herzberg, a resident of Tempe, Arizona, who was walking her bicycle across the road.[11] The safety attendant, who was watching a video on her phone moments before the crash, was charged, and Uber suspended AV testing.[12] The incident, and several that followed involving other AV companies, raised questions around whether AVs were indeed safer than HDVs, and what the implications would be for

their regulation, insurance, and diffusion. It was generally accepted that safety would be a social and legal prerequisite for adoption. In fact, AVs were expected to be safer than HDVs, because they would limit the opportunity for human errors, such as inattention, distraction, inadequate surveillance, excessive speed, incorrect assumptions, misjudgments, illegal maneuvers, and falling asleep.[13] AVs were expected to follow the letter of the law and collect enough data to rapidly identify and fix errors.

Because of this safety expectation, AVs were projected to be cheaper to insure, which would in turn lower their operating price and hence increase their adoption. Experts noted that it was still too early to say if AVs were *already* safer than HDVs, as existing AVs were closely supervised, drove in controlled conditions, and had not yet been involved in enough crashes to afford statistical comparisons. Also, some speculated that consumers might be more inclined to sue AV companies in the event of accidents, as vehicle performance was closely 'tethered' to the companies responsible for the technology, making them more culpable in the eyes of the public.[14] Depending on their level of automation and connectivity, AVs could be vulnerable to cyberattacks.[15] Specifically, some companies were pursuing tele-operations technology, which presented the risk of hackers taking full control of the vehicle.

Consumers might further be less forgiving of AV failures. As Kevin Reid, Chairman of the Board at Beep, noted, "In my opinion, AVs are already significantly better than human-driven vehicles. The unfortunate thing is, because it's new technology, every single incident, whether it's a passenger car OEM or some AV specific testing where there was a fatality—it almost doesn't matter what the reason is—it weighs so heavily, and people are looking for a reason to be scared or to validate their fear."

Similarly, the public appeared to be preoccupied by macabre hypotheticals in which an AV may face a dilemma requiring it to choose whom to kill versus save, e.g., a young child versus an elderly person or a pedestrian versus passengers in an oncoming car, suggesting that they should be programmed with a 'moral compass'. One article poured skepticism on these ideas, "These arguments are too contrived to be of practical use […] and should not be used to inform engineering or policy."[16]

Finally, most AV companies were selling short-term experiments of 6 to 12 months and required government approval, which took 2 to 3 weeks in the U.S. and 1 to 2 months in Europe. The U.S. Director of Sales at Navya, Jacob Giehl, reflected on the U.S. approach:

> The EU model is about creating guidelines and regulations. But the U.S. model is more about putting a product out there and proving it works. My European colleagues ask what the criteria for approval are in the U.S. There are no set criteria. It is about working with the NHTSA [National Highway Traffic Safety Administration] waiver team to get approval for specific projects. With L4, we can put something in front of NHTSA, and they might say, "Let's start with L3. Report to us every month on your disengagements,[a] and in six months we'll reevaluate and see if it's possible to move forward with L4."

Business Models

The industry was carved up by three visions of AV mobility: robotaxis, roboshuttles, and freight.

[a] Disengagements were when the AV was switched from autonomous to manual mode, either because the software stopped working or the safety operator intervened. They typically occurred during a potentially dangerous action or omission by the AV.

Personal Transport: Robotaxis

Robotaxis catered to individual mobility and aimed to transport one to four people in an "on-demand" (aka ride hailing service) model. By eliminating the need for a human driver, robotaxis were projected to be an affordable transportation solution for consumers. This was reinforced by data suggesting that Millennials and Gen Z were less interested in driving,[17] and that by 2030, one in five Americans would be over 65.[18] Existing ride-hailing companies like Uber expensively relied on four to five million drivers worldwide in 2022,[19] paying them $0.83 per mile in the U.S.[20] while charging consumers a little over $1 per mile, on average.[21] (See **Exhibit 4** for Uber financials). Under a service model, robotaxis were expected to lower individual ownership of cars, which sat idle 95% of the time.[22]

The costs associated with an average robotaxi were declining. Chinese company Baidu estimated that each unit cost $37,000 to produce,[23] and expected this figure to fall as production scaled from about 600 units in 2021 to 1.5 million units in 2030.[24] Similarly, whereas the most expensive sensor on these units, LiDAR, used to retail for $75,000, Waymo indicated its price could soon drop below $7,500.[25]

Robotaxi companies had to manage large fleets and invest in their AVs' ability to perceive dense urban settings. Alphabet's Waymo led the market. Former Waymo CEO John Krafcik explained, "In terms of robustness and accuracy […] our sensors are orders of magnitude better than what we see on the road from other manufacturers."[26] In 2017, Waymo began testing L4 minivans within a 100-square-mile area outside Chandler, Arizona,[27] followed by a similar service in San Francisco in 2021.[28]

Waymo and many robotaxi companies did not produce the hardware themselves, relying instead on vehicle-manufacturing partners (such as Jaguar Land Rover), which were fitted with Waymo's sensors and computers. Many traditional automotive firms were partnering with AV startups. In 2021, Ford announced a partnership with Argo AI, a U.S. AV tech company, and its intention to launch self-driving vehicles on the Lyft ride-sharing network.[29] Volkswagen invested $2.6 billion in Argo AI,[30] and Mercedes-Benz partnered with self-driving sensor maker Luminar Technologies.[31]

Some critics doubted that robotaxis would reduce inner-city congestion, as they believed most people would replace their HDVs in a like-for-like swap with AVs, with individual owners sometimes renting out their AVs in an Airbnb-style model.[32] They were also critical of companies which had repeatedly failed to deliver on their promises of L4-L5 autonomy while continuing to burn through cash investments. Uber's AV division was described by some as a "cash-burn machine,"[33] and in 2021 the company sold this division to AV company, Aurora, for half of its original valuation.[34,35]

Public Transport: Roboshuttles

Roboshuttles were developed to capitalize on existing public systems that transported multiple people at a time, and could be operated on public roadways for city residents or on private sites for company employees and visitors. They often operated on "first and last mile" routes, i.e., the distance from one's starting point to a transportation network (e.g., from home to the nearest metro station), and from a transportation network to one's final destination (e.g., from the metro to work). Many roboshuttle companies sought to capitalize on a tightening bus driver labor market, as existing drivers entered retirement and younger people found the job unappealing.[36] Public transport operators (PTOs) had difficulty finding drivers for existing services, let alone considering new routes for the future.

Companies in this space worked towards medium-sized fleets (10 shuttles or fewer at a time per use case), with supervision and strong AI capabilities. Roboshuttles were expected to reach the market earlier than robotaxis due to the less complex challenges of microtransit as compared to the dense, less predictable urban settings that robotaxis had to navigate. Many believed that L5 automation would be

needed for the safe operation of robotaxis but that L4 would suffice for roboshuttles. U.S.-based May Mobility announced intentions to deliver L4 shuttles in the U.S. and Japan by 2023,[37] and French-based EasyMile won contracts with French PTOs like RATP to run services in Paris;[38] it was also making steady progress in the U.S. despite temporary license suspensions following two safety incidents.[39,40,41]

Despite this progress, two prominent firms had exited the market. In 2022, Local Motors closed due to lack of demand for its vehicles.[42] Navya's Giehl noted that the company had only made the hardware, while working with Perrone Robotics for the software, "I think the software is vital. It's the core of the whole industry. Local Motors never owned what ran the vehicle." That same week, U.S. rival Optimus Ride was acquired by Magna International, a Canadian mobility tech manufacturer.[43]

Roboshuttles were projected to be cheaper to operate than robotaxis on a per-rider basis, but less convenient.[44] Critics noted that only 5% of Americans commuted by public transit[45] (versus 49% of Europeans).[46] As Tesla CEO, Elon Musk, quipped, "Why do you want to get on something with a lot of other people, that doesn't leave where you want it to leave, doesn't start where you want it to start, doesn't end where you want it to end? And doesn't go all the time.... That's why everyone doesn't like it. And there's like a bunch of random strangers, one of who might be a serial killer, OK, great."[47]

Freight: Trucking, Tract, Delivery Bots

AVs were also expected to disrupt the logistics market, especially delivery networks over highways and urban arteries. There were over 3.5 million truck drivers in the U.S. alone, yet in 2018 there was already a shortage of drivers. (See **Exhibit 5** for trucking industry information). In large part, this was because of the grueling nature of the job, with drivers often working for days on end with little sleep.

Major AV companies like Waymo, TuSimple, and Aurora were all investing in autonomous freight solutions, boasting that their trucks would operate 24/7 and therefore lead to fewer vehicles on the road. Fuel efficiencies were also expected because the autonomous trucks would be able to better control speed, road position, and drive in fleet formations, all of which minimized fuel-consumption.

Similar developments were occurring in the urban goods delivery sector. In 2020, Amazon acquired robotaxi startup Zoox, with the intent of building L4 delivery vehicles.[48] Nuro, a Silicon Valley startup, received an exemption from the NHTSA to transport goods.[49] Between 2018 and 2021, it partnered with Kroger Groceries, Domino's Pizza, CVS Pharmaceutical, and Walmart to test the autonomous delivery of their products.[50] Consumers had to leave their homes to pick up the goods from the Nuro pods.

Autonomy was also expected to benefit logistical operations in enclosed settings, like baggage transfers at airports. However, human-driven tracts operated faster than current roboshuttles and were expected to arrive perfectly on time. Service interruptions resulted in penalties for vehicle providers.

Navya

A Startup in the Shoes of a Public Company

In 2014, private equity fund Robolution Capital purchased French software company Induct in liquidation. Induct then launched Navya, a self-driving electric van prototype, unveiled for the first time at the 2014 Consumer Electronics Show in Las Vegas. In 2016, the start-up gained two additional shareholders—Keolis, a French public transportation company, and Valeo, a French automotive supplier[51]—and over the next year launched pilot schemes in Lyon, France, and Las Vegas.

From the beginning, the company strategically invested in creating electric-powered roboshuttles capable of carrying 15 to 20 people at L3 on slow, fixed routes, and made both the hardware and software in a vertically integrated model. Morin explained, "In 2014, there were barely any electric shuttles, and especially not ones that could be made autonomous. Navya was almost obligated to manufacture them itself." Navya opened its first facility in Lyon in 2014. In 2017, it opened another in the U.S. to capitalize on public funds for companies manufacturing their products domestically.

Buoyed by the optimism surrounding the AV space, in July 2018, Navya completed an IPO on the Euronext Paris exchange, raising €38 million.[52] Charles Beigbeder, President of the Supervisory Board, reflected, "The CEO and co-founder at the time was ambitious and believed, like the market, that L4 and even L5 was achievable in a short-term horizon. There were customers in many parts of the world willing to test the shuttles Navya was developing. And so, there was a nice attraction to the company that prompted the IPO. However, the IPO turned out to be a mistake. We were too early." Navya was unable to meet 2018 revenue targets,[53] and the CEO left the company with the original vision largely intact and having made strides in developing the technology. But optimism had been punctured.

Product

Navya made two types of vehicles—the *Autonom,* capable of L3, and the newer *Autonom Shuttle Evo,* designed to support L4. (See **Exhibit 6** for Navya's vehicles). Each was equipped with an onboard computer and various sensors, including cameras, LiDAR, GPS, and odometry, which were integrated seamlessly with the vehicle's hardware (the sensors and hardware were supplied by OEMs).

Navya Commissioning entailed an initial technical feasibility study at the customer's site and project validation, after which Navya created a 3D map of the site, including a virtual path, and trained the customer's on-site workers. *Navya Drive* included proprietary software that enabled the vehicle to operate autonomously. *Navya Operate* covered remote supervision, which included remote monitoring personnel, technical support, and both hardware and software analysis.

Navya typically sold its shuttles and software as a package, although more sophisticated customers could choose to cover parts of the supervision and commissioning themselves. Navya had designed the vehicles so that the software and hardware were tightly integrated, making it almost impossible for the vehicles to operate with any software other than *Navya Drive*, unless stripped to the wires. The newer *Autonom Shuttle Evo* sold for a list price of €300,000, and *Navya Drive* and *Navya Operate* were charged to customers as monthly recurring fees. (See **Exhibit 7** for pricing details).

Value Chain

Navya was in essence a B-B-B-C company: its main direct customers were PTOs, corporations that specifically managed multiple vehicles and day-to-day operations for end customers like universities or hospitals; end consumers were the people who rode on shuttles (students, residents, employees, etc.). Most end customers were not set up to operate Navya's shuttles, and needed someone to supervise the vehicles, map an area, ensure a safety attendant was on board, and maintain the vehicle. Although Navya could perform these functions itself, it preferred to let PTOs provide the turnkey solution to end customers, for which PTOs charged an additional, healthy margin. Reid explained:

> The industry norm falls into three categories. The first is selling hardware, where a 10% to 15% margin is normal. The second is performing services, like providing a safety attendant and handling maintenance, where margins are around 45% to 65%. The third is offering software solutions, where margins are 70% to 95%. Navya has both hardware and

> software components, so they'll blend on average lower than the software number. Beep develops software so that we can run the overall autonomous service.

PTOs typically charged end customers an additional 15% margin for the package they bought from Navya. As for the appetite to shift to AVs, Beep CEO, Joe Moye, described the role of the push to EVs:

> Every public transit group is looking to either modify their existing vehicles to become electric or procure all new electric vehicles at significant expense. We utilize that as an important aspect of how we're positioning the Navya shuttles—as they are electric. Ultimately, public transit priority number one is going to be upgrading shuttles and buses to electric platforms over the next 5 to 8 years. How do we factor in that incremental cost that they're going to have to incur with the substitution of vehicles when we price the AV shuttle service? It's not just about comparing the current ICE model to the future.

Although operators like Beep and Keolis paid Navya's recurring SaaS fees, they typically did not buy the vehicles themselves. Instead, they either had the end customer purchase the vehicles upfront, which was often the case with public entities, or worked with financial partners called leasing agents, who bought the vehicles and leased them at a 4% to 5% interest rate to operators. In these arrangements, the operator accounted for all the expenses in a single, seamless contract with the end customer.

A Change of Gear?

In June 2020, with permission from the European Commission, Navya debuted its first pilot L4 shuttle service in Châteauroux, France, under remote human supervision. In 2021, Navya partnered with Valeo to bring an L4 driving system to market within three years, pending regulatory approval.[54] It also began offering shuttles, via operators, to end customers in the U.S., such as the residential communities of Lake Nona, Florida,[55] and Peachtree Corners, Georgia. The latter had three miles of roadway that the state had cleared for an AV service connecting hotels, restaurants, and retail outlets.[56]

Yet in 2021, Navya's board was again unhappy with the company's financial performance and fired the CEO, replacing him with Desormière, who brought with her 25 years of management experience, including 17 years in the automotive and mobility industries at Valeo. Desormière's first points of order were to educate the company on what it meant to trade publicly and to transform Navya into a profit center. She reflected on the situation when she joined Navya, "We were really a big startup: hundreds of engineers dedicated to software, AI, and neural networks. There was a gap between being traded and being a big industrial start-up that went for an IPO without preparation, education, or training. We were a cost center everywhere. It was just about creating new software, functionalities, and building blocks. It's a lovely spirit, but there was unconsciousness about burning cash. Any growth, any scalability, and any commercialization needs financing, and there was no structure for that."

By 2022, Navya had 280 employees in France, the U.S., and Singapore. Thanks to heavy R&D investments since its founding in 2014, it had sold more than 200 units of its *Autonom Shuttle Evo* in 25 countries. (See **Exhibits 8 to 10** for Navya's financial performance metrics**)**.

Caution: Road Work Ahead!

Selling a Promise

As L3 vehicles drove themselves 95% of the time, the service prepared customers for when L4 would be rolled out. Giehl explained:

> We are not selling an innovation, but an experiment. True L4 mobility will not hit the road overnight. If you're not already in that business, or if you have not experienced an L3 operation for at least two years, you will not be the first to deploy L4. There is a learning curve where the end customer can see how it works on their site, what needs to be done in terms of social acceptance, infrastructure work, quality of service, and more. Operators, too, must learn about the technology to be ready for when they take out the safety attendant and replace them with a remote supervisor. It's not an easy technology to access.

Navya generated demand for its services by relying on operators, who in turn generated demand from end customers. Navya had a vested interest in facilitating these efforts and hence would also try to find end customer leads and then transfer them over to an operator.

About 80% of Navya's customers were subsidized by the public sector (e.g., cities, governmental departments), which wanted to proactively invest in newer and greener mobility solutions. Reid explained that the public investment often paid for itself by driving higher consumption, "A lot of people think charging the $1 to the end consumer is what pays for public transit. But the reality is a lot of the time it's consumption taxes. The more you can move people in and out very efficiently, the more you activate consumption within that area, which helps fund the pool of money." At the same time, the high cost of Navya's vehicles made it hard to sell even to customers with public subsidies. Giehl conceded, "When operators get a tender from a city to address the full mobility service, they always add a chapter on 'innovative services' under which AV technology can be accounted for. However, unfortunately for us, this chapter is the first one to disappear when negotiations on pricing start."

Navya also had several private-sector use cases (e.g., campuses, hospitals, resorts, and theme parks). Yet ROI concerns for L3 were pronounced in these cases, due to the combination of paying for the software services as well as a safety attendant. Beigbeder often heard from prospects, "Let's wait Navya until you have progressed to L4. Come back when I can get the safety attendant out of the shuttle and have someone in my plant supervising a dozen AV shuttles online. Then I would have huge savings and be ready to order a large number of them." Notably, employing a human driver in the U.S. or Europe made up about 40% to 60% of the total cost of operating a typical (non-AV) shuttle. While Navya was technically exempt from requiring regulatory approval to operate L4 on enclosed private properties, it did not believe its technology was fully L4 ready. Even so, it had already made an exception once to deliver COVID-19 test kits at the Mayo Clinic in Jacksonville, Florida in 2020. As for when Navya might be able to deploy L4 vehicles, some executives pointed to a potential loosening of EU restrictions during the summer of 2022, whilst the CTO of Navya, Olivier Le Cornec, assessed that, despite its great strides, Navya was unlikely to achieve true L4 capacity before the summer of 2023.

As of 2022, insurance for a non-automated EV shuttle was $16,000 to $19,000, which was paid by whoever operated the vehicle. Many insurers used similar rates for AVs, while others charged more, given the lack of existing AV insurance claims data and cybersecurity risks that arose uniquely for AVs.

Navya was flexible on commissioning and supervision rates to encourage adoption, but was unwilling to negotiate the price of *Navya Drive*. In pricing the current Navya software components, in particular *Navya Drive*, management factored in the reality that customers were only getting L3 capability, requiring them to pay for a safety attendant. In order to recoup investments and chart a path to profitability, Desormière planned to increase the price of *Navya Drive* when L4 became commercial, given the expected operational savings. To provide operators enough time to prepare, she asked her management team to flesh out what the new price should be. Tim De Bree, Head of Special Projects, indicated that Navya could go for a skimming strategy, which focused on end customers with an acute pain point or readiness to adopt, and extract the surplus generated by shifting to L4; or a penetration strategy, which cast a wider net of adoption, thereby leaving much of the surplus with end customers.

The White Bear Lake Opportunity

Navya preferred to sell, rather than rent, its vehicles, as this covered the hefty manufacturing costs of each shuttle upfront and helped manage cash burn. Moreover, selling usually meant longer, larger contracts. Yet, Navya was receiving more and more demand for leasing and rentals at its U.S. office. A recent example was the inquiry sitting in Desormière's inbox from White Bear Lake, which wanted to directly rent several vehicles from Navya for one year without involving an operator. Giehl remarked, "Minnesota is trying to be innovative and has the funds. It's a state-funded, lucrative project with plenty of revenue. But in the end, under a rental model, we'll get the vehicles back. We're going to keep the asset on the books and the liability. What do we do with it then?" Typically, when the company received or generated demand from an end customer, it would direct the prospect to a local operator. A Navya executive said, "We should refrain from playing the role of the operator; it is not our core competence and would require a different kind of execution." Yet Kuehl had other ideas, "Our CFO's preferred mode is to sell. I don't know if that should be our only mode. I'm okay with the monthly rental, and then the next customer rents the same vehicle again. From a marketing perspective, it's good to encourage as many customers as possible to get the different use cases accustomed to AVs. I think it also makes economic sense. We are behind Europe, so we need to get the vehicles on the road."

Because the industry was not yet mature, most operators were not willing to carry extra vehicles to provide as rentals. As for Navya's ability to operate and service end customers, for Kuehl the only limit was hiring staff, "If we had enough safety attendants, we could be our own operator. We could quickly develop the skills." Beep's Moye disagreed, explaining his company's role in the value chain:

> Everything we do from how we communicate to end customers, how we help them participate in the design and expansion of routes, how we work within the communities we serve, how we service them day in and day out, that's a big piece of what has been critical to our business success. If we left it to Navya or other suppliers, the end customer experience would be incomplete. That's been a big emphasis of ours. And frankly, one we learned the hard way. Initially, we figured, I'll just turn this thing on, and it'll go from here to there and all is good. It wasn't that easy. We had to build an entire services model around it to ensure a great rider experience. I don't know how easy it would be for vehicle suppliers to replicate this without a partner ecosystem.

Similarly, Beep's Reid thought that Navya should not get into rentals, "If I were Navya I wouldn't rent. The effort you're going to go through to train your people and to get these routes established and AV-ready, to certify the safety and longevity of these vehicles, you're typically doing all of that for a long-term contract; whereas a rental is short-term by definition."

Navya's U.S. team believed that a benefit of renting directly was the ability to get closer to the end customer. Kuehl realized the importance of this after a recent incident, "All of a sudden, the vehicle was stopping, going, stopping, going. Peachtree Corners, the end customer, was frustrated. Eventually, we were informed and sent our chief of operations to program the route properly and add leeway." Giehl nodded, "It took so long to detect the incident because the operator wasn't keen on us talking to their end customer. We had to tread lightly, but we also needed to ensure our vehicles were performing as expected. I want the end customer to at least know who we are by introducing myself at conferences. Sometimes it's the first time they learn that the software is ours." Moye characterized Beep's view, "By default, people call them the 'Beeps'. Navya's brand is displayed on our vehicles together with our brand, it's not like we cover them up, but we promote our brand as the service provider." (See **Exhibit 11** for Beep's shuttle branding). Reid thought Beep's proximity to the end-customer was one of its main

advantages, "When you're going after a nascent market, the best way for you to be successful is to have customers tell you what they need. Get in front of the customer, bring a solution."

Desormière had to decide whether to take the White Bear Lake opportunity and serve the customer directly. If so, what price should she quote? She realized that the answer depended on whether her objective was to simply cover Navya's hardware and software costs or capture as much surplus as she believed White Bear Lake was willing to pay, given that no other operator was willing to offer rentals.

Collaborating with Bluebus

Having done the costly work of designing both the shuttle and the software, and using data from deployments to continuously improve, Navya had an advantage in understanding how to develop AV driving intelligence and sensors (referred to as the AD pack), build shuttles, and seamlessly integrate hardware with the AD pack. This had helped secure partnerships with Bolloré, a French conglomerate that supplied vehicle mechanics (e.g., steering, acceleration), and Valeo, which supplied AV sensors.

As management looked to scale faster, it began to question whether Navya needed to remain vertically integrated. Morin summarized the dilemma, "Should Navya do everything? Should we design the shuttle, should we assemble it, should we do the software? I'm not so sure." Giehl, for his part, noted that Navya ought to be less concerned with manufacturing hardware because, at the end of the day, different form factors could be complementary to Navya's software, "There's a reason why trucks, sports cars, and sedans exist. They all have a purpose. It's the same thing here. I think larger and smaller form factors that are autonomous are going to exist. Instead of battling over the same pool of investment money, we have to work together to function like a transportation sector."

After looking into several form factors, in 2021 the team partnered with Bolloré to integrate Navya's software into Bolloré's 6-meter Bluebus, thus increasing Navya's passenger capacity to 35 people.[57] Under this arrangement, Navya would only be responsible for the AD pack and just sell the software service to customers rather than the bus itself. Desormière noted, "In this model, we are platform agnostic. It allows us to deliver either a 15- or 35-person transportation solution." For Bolloré, working with Navya was also an opportunity to learn about the software, which was typically an inscrutable 'black box' to outsiders. Desormière contrasted Navya with Waymo, "Waymo knows very well what is in its black box, but they don't want to share the contents. We are triggering the minds of some OEMs with the thought, 'If I go with Navya, I will be able to understand what is in the black box.' They perceive Navya as a building block in their technological road map."

The Bluebus collaboration not only went against the founders' vision but also that of successes like Tesla and Zoox, who considered vertical integration a competitive advantage. The CEO of Zoox, Aicha Evans, explained, "We believe that designing from the ground up is the right way to combine AI and a purpose-built vehicle that combines and makes it easier to optimize to achieve the best results."[58] Giehl had a different view, "Think about Tesla. Get rid of the dealerships, sell the vehicles and the chargers yourself, sell the solar panels, own the entire industry. On paper, it makes a lot of sense. And on the operational end, at some level it's just hiring people and training them. But, in execution, there is capital that's needed, and then it's a lower margin business. It's not as easy as it seems on paper."

Despite the allure of collaborating to introduce additional form factors, some argued that Navya should concentrate on shuttles and invest more heavily in developing its third generation, fully L4 shuttle. Giehl noted, "We should focus on being the first in L4 deployments, and the shuttle is our best path to reach that goal. It would be much more difficult to achieve that with a bus that has to drive 60 miles-an-hour on complex road routes. It's two different products altogether." Several executives supported the emphasis on shuttles but believed that Navya should stop making them. Because Navya

had limited production capacity, it was not yet as efficient as some of the larger industrial players who had been manufacturing vehicles for decades, making its costs higher for a given quality standard.

However, if Navya only integrated its software into other players' vehicles, the end-customer might think that the software was also, say, provided by Bolloré rather than Navya. Desormière weighed in:

> We can be like "Intel Inside," becoming "Navya Inside." We need to develop the technology and be able to deliver the highest quality, performance, and feeling because when you are on board and this kind of thing is running, you create sensation, emotion, and comfort. I'm fine with the consumer not seeing Navya on the signature of the vehicle. I care much more about delivering the best performance. It's like ADAS, the driving assistance in a passenger car. Today, when you drive a car, you have blind spot detection, lane departure warning, traffic jam assisted braking, you don't care if it's Valeo or Bosch.

At the same time, De Bree noted that the AD pack was not just 'plug-and-play', "You can't just put software and sensors on an existing vehicle. You need to robotize it and make it autonomizable. So, there is some development work to be done on the vehicle platform, which we are rare experts in."

Aside from the vertical integration issue, there were debates on the bus form factor itself. Some at Navya who supported the move noted that 12- to 15-person shuttles did not generally form a central part of current transport networks, while moving up to a bus model with more riders would be an attractive proposition that slotted more easily into existing practices. The economics were also expected to be more attractive for end customers if they could serve many consumers at a time. Others countered by noting that big buses often operated half-empty and were too big to navigate more flexible routes.

For his part, Le Cornec felt that the move to buses neglected the reality of what was technologically possible, "If you're looking at big buses, the vehicle is so wide that you will be just 5 cm from each side of the road or lane delimiters. You would have to be very precise for localization, for movement determination, and for pass tracking. It would be a nightmare." Le Cornec assessed that smaller pods on transport networks carried some advantages, "The small vehicles are better able to integrate with other users on the road—better able to move between pedestrians, other vehicles, and e-scooters. But the tradeoff is that for this kind of vehicle, you would only be able to have very few people inside."

Desormière started to wonder if the Bluebus collaboration was wise, and whether Navya should continue on this route or adhere to the founders' approach of vertically integrated shuttles.

Moving People versus Moving Goods

Although Navya had initially focused on transporting passengers, in 2018 it collaborated with Charlatte Manutention, a French OEM, to retrofit Charlatte's vehicles with Navya's AD pack, calling it the *Autonom Tract*.[59] The AV tract, which was 50% more expensive than a regular tract, debuted in 2019 at Toulouse-Blagnac airport in Southern France,[60] where it transported luggage between the airport terminal and airplanes without an on-board attendant (Navya supervised it remotely).

De Bree thought that moving goods had pluses over moving people, "First, if you don't have people in the vehicle, the level of service you need to provide is lower. Second, the environment you operate in is often more structured. Third, especially in public transport, drivers don't just steer, brake, and accelerate. They do many other things." Le Cornec added, "A famous study by a major car maker found that there are up to 48 things that the driver does besides driving. When you are an AV intended for passengers, you must be able to start the vehicle, stop the vehicle, and be sure that everyone is seated properly. You have to be sure that the door is closed. That no one is standing in the middle, and so on."

There were also dangers associated with transporting passengers, as Morin noted, "Even at 25 km/h, which appears to be a low speed, if you need to engage the emergency brake, and not everyone is seated, if the deacceleration is too high, this might cause injuries. Furthermore, the lack of a driver could cause some people to feel uncomfortable and create real safety risks in a locked shuttle in transit."

While some believed L4 would be launched in industrial settings to move goods before it would be approved for passenger transport, Desormière noted operational challenges in the former settings:

> Airports and logistic centers, like FedEx and DHL, are looking for just-in-time, around the clock operations. And if you are not delivering on time, you can incur penalties. A lot of penalties. If performance is poor, you can kill not just the business case, but the entire company. They want a 99.99% trustworthy solution. At the moment, it's difficult to reach that level. If a passenger shuttle stops for any reason, that's okay. The passengers wait for a few minutes or walk the remaining 500 meters until the issue is resolved by the supervision team. But if you have tow tractors with parts to bring to the assembly chain, customers cannot accept waiting for 15 minutes and holding up the entire production line.

As end customers would structure contracts so that Navya paid penalties for delays, the company had been cautious in pursuing these opportunities. However, in light of the pros pointed out to her, Desormière had to determine how much to invest in "people" versus "goods" applications.

Geographic Focus

Navya's shuttles were deployed in 25 countries. (See **Exhibit 12** for Navya's active markets). But for a small company with 280 employees, the majority of whom were engineers, identifying leads and converting customers was a costly, time-consuming process. It was also difficult for Navya to develop regional expertise to find new clients and use cases. Navya typically partnered with local PTOs to find new opportunities. Even so, it had to build and maintain contact with regional players, including end customers. To bring focus to Navya's global presence, Desormière had to consider how geographies differed in terms of economics, safety, cultural norms about drivers, public appetite for roboshuttles, and driver salaries. (See **Exhibit 13** for comparative driver salaries). De Bree illustrated, "Take Japan, where you have an aging population. It's not that people are scared of AVs. It's that older people expect to be helped. We have areas in Japan and Korea where operators are telling us, 'These safety attendants are doing a lot of services, like helping people carry their luggage.' Then there are other places where we worry more about safety. It's 10 p.m. The shuttle stops. I am alone. Who will make me feel safe?"

There were also cultural differences in how much consumers feared autonomy, which would require education. Moye noted, "Currently, our safety attendants also serve as ambassadors to educate on the technology: 'Here's how it works. Here's what just happened. Here's what you can expect.'" On the other hand, Desormière noted that clients in Saudi Arabia tended to be less concerned, "If they have their smartphone, if they have good connectivity, they don't care if there is no driver." Fortunately for Navya, its vehicles had not been involved in any serious crashes to date, which was encouraging.

De Bree noted that geography mattered for the kind of customer Navya appealed to, "In Europe, it could be municipalities; in Asia, we operate on military sites. In the U.S., we have interest from master-planned communities and universities." He sought customers wishing to avoid tight labor regulations while facing driver scarcity. (See **Exhibit 14** for a driver shortage survey). De Bree also considered a region's relationship with cars, e.g., if it banned (or planned to ban) ICE vehicles in city centers. Another question was whether Navya should adapt to existing infrastructure or focus on joining projects at their genesis, where it could mold infrastructure design. For example, Saudi Arabia had plans for smart cities, such as Neom, backed by a $500 billion investment by Crown Prince Mohammed Bin Salman.[61]

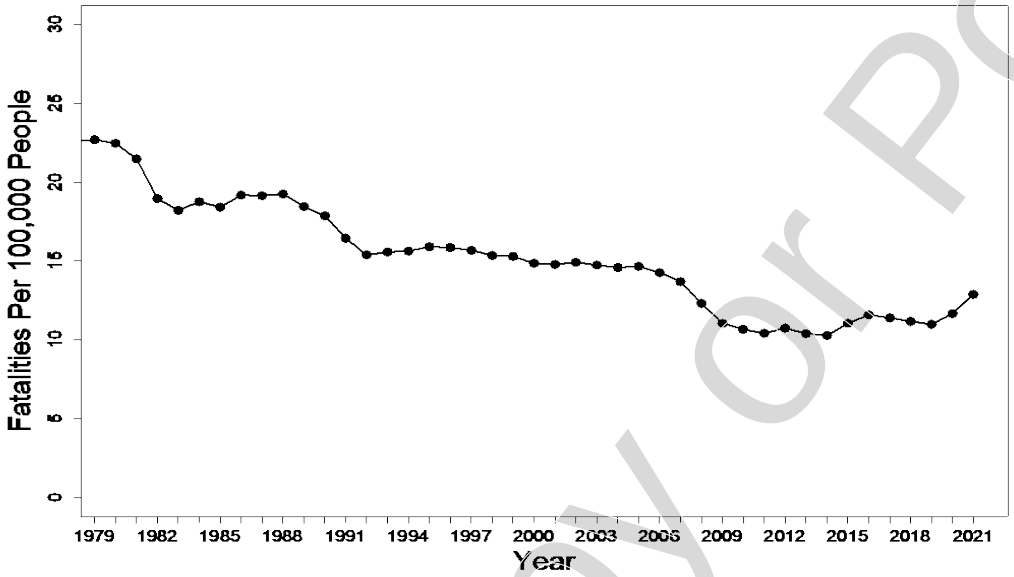
Desormière also had to consider different regulations and purchase patterns in the U.S. versus the EU. Government exemptions permitted Navya to run multiple L4 demonstrations in France. However, EU legislation, which seemed to be on the verge of accepting the rollout of more L4 projects, had been repeatedly delayed.[62] Still, there were encouraging developments, such as the EU pledging to finance two-thirds of a €50 million AV project (ULTIMO), buying up to 45 Navya shuttles outright.

Navya's Driverless Future: Pedal to the Metal

A loud honk jostled Desormière from her reverie as she arrived at the airport, barely in time to catch the red eye to Paris. She resolved to reach decisions on how to respond to the White Bear Lake inquiry, how to alter pricing when L4 was ready for primetime, whether to vertically integrate in hardware and software, how much to prioritize moving people versus goods, and where to focus geographically.

She tried to accelerate Navya's growth by bringing a collaborative spirit to a competitive, secretive industry, "There is Perrone Robotics, EasyMile, and Navya. We perceive each other as competitors. You are in competition when you are worth billions of euros. You are not in competition when you are so small. There is no way to accelerate but by working together." (See **Exhibit 15** for Navya's competitors). Yet, she was also cognizant that collaboration might jeopardize Navya's hard-earned advantages in the long term. Desormière believed Navya could become a global leader in autonomous vehicles, but could not lose sight of the company's cash burn position. If necessary, she might have to find alternative financing opportunities, whether it be a majority share investment from an OEM or public investments in impact technology. With any luck, she would also get some sleep on the flight.

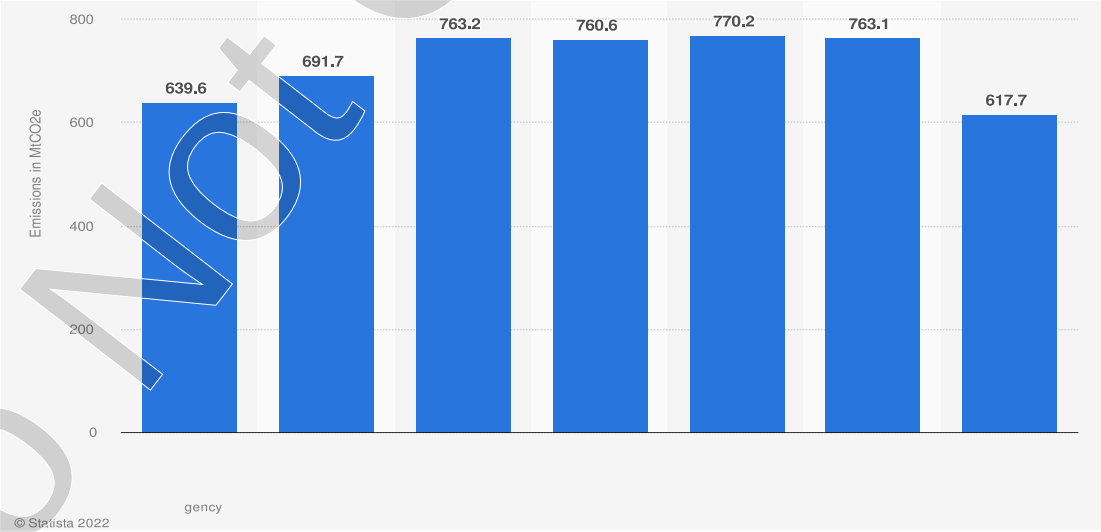
Exhibit 1 U.S. Annual Motor Accident Fatalities per 100,000 People Over Time (1979–2021)



Source: Adapted by the casewriters from "Motor vehicle fatality rate in U.S. by year," Wikipedia, August 22, 2022, https://en.wikipedia.org/w/index.php?title=Motor_vehicle_fatality_rate_in_U.S._by_year&action=edit&section=1, accessed September 2022.

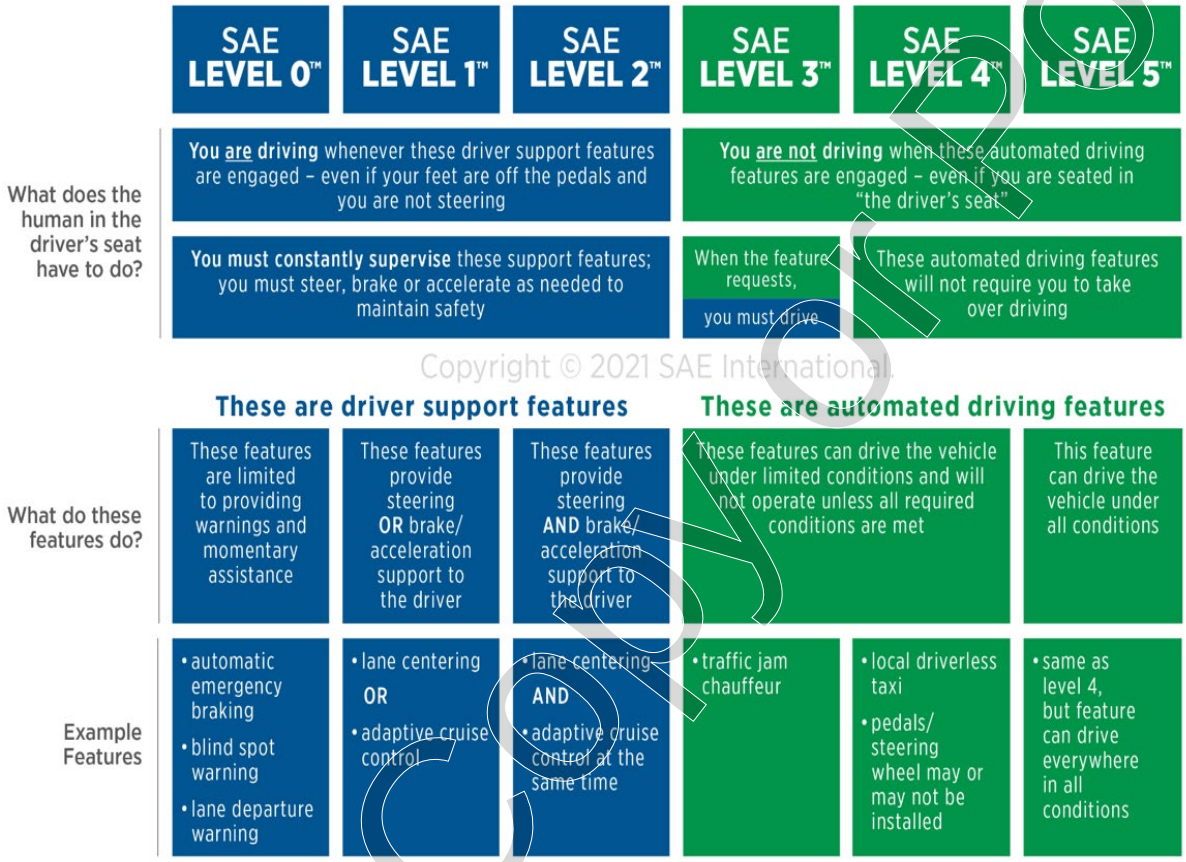
Notes: Accident causes: 30% involved alcohol impairment, 29% involved speeding, and 13% involved driver distraction.

Exhibit 2 U.S. Greenhouse Gas Emissions from Passenger Cars from 1990 – 2020 (in Millions of Metric Tons of CO2 Equivalent)



Source: Statista, "GHG emissions from passenger cars in the United States 1990-2020," EPA, https://www-statista-com.ezp-prod1.hul.harvard.edu/statistics/1235091/us-passenger-car-ghg-emissions-by-vehicle-type/, accessed August 2022.

Exhibit 3 SAE Levels of Automation



Source: SAE, "SAE Levels of Driving Automation Refined for Clarity and International Audience," May 3, 2021, post on blog "SAE Blog," www.sae.org/blog/sae-j3016-update, accessed August 2022.

Notes: In AVs of L3 and above, sensor data was used to construct 2D and 3D perception maps of the environment to enable precise vehicle positioning and obstacle detection; camera data was used for enhanced perception of the environment (e.g., road signs, traffic lights); GPS sensors received signals from a base station to determine the precise position of the vehicle at any moment; and odometry measured the displacement and speed of each wheel to estimate the velocity of the vehicle and change in position.

Exhibit 4 Select Uber Financials **(In Millions)**

$m	FY 2021	FY 2020	FY 2019	FY 2018	FY 2017
Mobility	6,953	6,089	10,745	9,437	7,278
Delivery	8,362	3,904	2,510	1,460	587
Freight	2,132	1,011	731	356	67
Other	8	135	161	17	--
Revenue	17,455	11,139	14,147	11,270	7,932
Cost of Revenue	9,351	5,154	7,208	5,623	4,160
Operations and Support	1,877	1,819	2,302	1,516	1,354
Sales & Marketing	4,789	3,583	4,626	3,151	2,524
R&D	2,054	2,205	4,836	1,505	1,201
General & Administrative	2,316	2,666	3,299	2,082	2,263
Depreciation & Amortization	902	575	472	426	510
Total Costs and Expenses	21,289	16,002	22743	14,303	12,012
Income (Loss) from Operations	(3,834)	(4,863)	(8,596)	(3,033)	(4,080)
Interest expense	(483)	(458)	(559)	(648)	(479)
Other income (expense), net	3292	(1625)	722	4,993	(16)
Loss Before Income Taxes	(1025)	(6496)	(8433)	1,312	(4575)
Provision for (benefit from) income taxes	(492)	(192)	45	283	(542)
Loss from equity method investments	(37)	(34)	(34)	(42)	--
Net loss incl. non-controlling interests	(570)	(6788)	(8,512)	987	(4033)
Net loss to non-controlling interest	(74)	(20)	(6)	(10)	--
Net Loss	(496)	(6,768)	(8,506)	997	(4033)
Gross Bookings ($m)	90,415	57,897	65,001	49,799	34,409
Monthly Active Platform Users (m)	118	93	111	91	68
Trips (m)	6,368	5,025	6,904	5,220	3,736
Mobility Adjusted EBITDA	1,596	1,169	2,071	1,541	388
Delivery Adjusted EBITDA	(348)	(873)	(1,372)	(601)	(355)
Freight Adjusted EBITDA	(130)	(227)	(499)	(537)	(543)
Other EBITDA	(11)	(461)	(750)	(587)	(544)

Source: Adapted by casewriters from Uber, Annual Report 2021 (pdf), downloaded from https://s23.q4cdn.com/407969754/files/doc_financials/2022/ar/2021-Annual-Report.pdf, and Uber, Annual Report 2020 (pdf), downloaded from https://s23.q4cdn.com/407969754/files/doc_financials/2021/ar/FINAL-Typeset-Annual-Report.pdf, and Uber, Annual Report 2019 (pdf), downloaded from https://s23.q4cdn.com/407969754/files/doc_financials/2019/ar/Uber-Technologies-Inc-2019-Annual-Report.pdf, all accessed August 2022.

Exhibit 5 U.S. Trucking Industry Fast Facts 2021

- There were around 3.6 million truck drivers in the U.S. (6.7% women).
- The average truck driver's annual salary ranged from $41,960 (light or delivery service trucks) to $46,370 (trucks tractor-trailer or semi-trucks).
- Autonomous tractor-trailer trucks were expected to cost $200,000; $50,000 more than non-automated ones.
- Trucking related costs included driver wages (32%), fuel (26%), truck/trailer payments (14%), driver benefits (10%), and other expenses (18%).
- Insurance for a truck cost from $12,000 to $14,000.
- In 2021, there were around 2.9 million tractor-trailer trucks operating on U.S. roads.

Source: Adapted by casewriters from "Trucking Industry Trends & Statistics," Cloud Trucks, August 8, 2022, https://www.cloudtrucks.com/blog-post/trucking-trends#toc-6, accessed September 2022. Jacopo Prisco, "There's a shortage of truckers, but TuSimple thinks it has a solution: no driver needed," CNN, July 15, 2021, https://www.cnn.com/2021/07/14/world/tusimple-autonomous-truck-spc-intl/index.html, accessed September 2022.

Exhibit 6 Navya's Roboshuttles and Tract Vehicles

Source: Company documents.

Notes: Dimensions of length, width and height were 15'8" (4.8m), 6'11" (2.1m), 8'9" (2.7m), with capacity for 15 passengers. Vehicles required 6 hours charging time for 9 hours of operation.

Exhibit 7 Navya Vehicle Purchase and Recurring Services List Pricing Parameters

Onetime Fees	
Vehicle	$300,000
Additional Sensors	$ 17,325

Annual Fees	
Commissioning	$30,310

Monthly Fees	
Navya Drive	$2,500
Navya Operate	$2,500

- A non-automated EV shuttle cost about $200,000
- Depreciation for current Navya L3 shuttles was 40% per year and would likely be 15-20% per year for the next-generation L4 shuttles (as well as for EVs). These percentages depended on vehicle lifetimes
- Each vehicle required monthly maintenance at a cost to the provider of $700 per EV or $900 per AV.
- While some end customers operated only one shift a day (up to 8 hours; e.g., with the operator paying a shuttle driver an average of $46,305 a year in the U.S.), others operated 2-3 shifts (16–24 hours; with prorated driver costs). The White Bear Lake opportunity involved one fixed route and a single daily shift
- If end customers did not buy the vehicle, operators often leased it on their behalf, typically for 3 years, at a 4-5% interest rate charged by the leasing agent on the vehicle price. For their involvement, operators expected a 15% margin on the interest charged.
- An L3 AV safety attendant was 70% to 80% the cost of a fully licensed shuttle driver
- Navya commissioning was performed annually per site, and each Navya Operate license covered supervision of up to five vehicles (regardless of the number of hours per day)

Source: Company documents and casewriter estimates.

Note: True pricing values have been slightly masked.

Exhibit 8 Navya's Stock Performance 2018-2022

Source: Capital IQ, Navya Stock Price, accessed September 1, 2022.

Exhibit 9 Key Statistics from Navya's 2021 Annual Report

Navya Financials

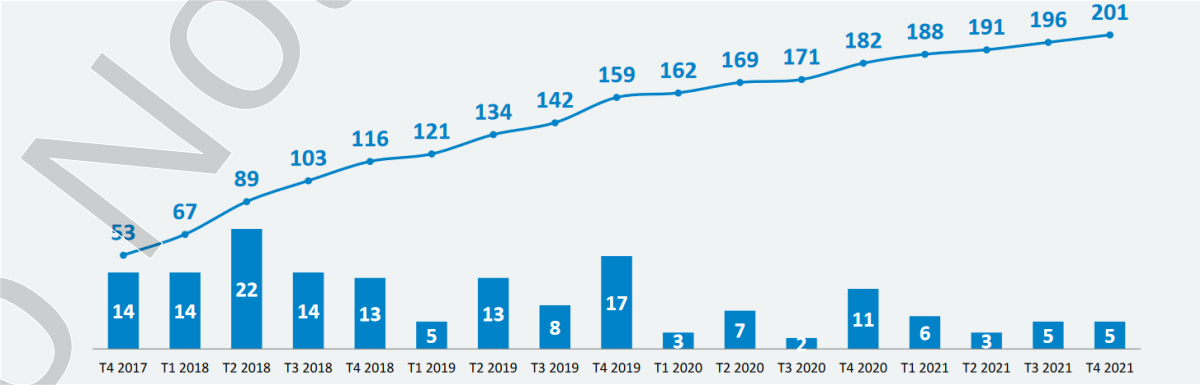
€K	May-22	FY 2021	FY 2020	FY 2019	FY 2018	FY 2017
Revenues		10,163	10,668	15,016	19,012	10,280
Gross Margin		(1,997)	31	(180)	3,416	1,338
R&D		(9,434)	(8,129)	(8,852)	(4,706)	(1,855)
Sales & Marketing		(3,584)	(4,122)	(5,422)	(5,225)	(4,314)
General and Administrative Expenses		(6,751)	(7,170)	(8,625)	(7,542)	(3,247)
Operating Expenses		(19,769)	(19,422)	(22,899)	(17,473)	(9,416)
Recurring EBIT		(21,765)	(19,390)	(23,079)	(14,057)	(8,078)
Other Expenses		(723)	(1,011)	(8,094)	(4,123)	(3,258)
EBIT		(22,488)	(20,401)	(31,174)	(18,180)	(11,336)
Financial Result		(1,559)	(3,286)	(1,145)	33	(145)
Net Result		(24,047)	(23,687)	(32,321)	(18,147)	(11,481)
Cash Position	7,800	15,685	27,985	18,999	19,449	4,325

Navya Revenues per Product

€K	FY 2021	FY 2020	FY 2019	FY 2018	FY 2017
Vehicles (one-off revenues)	6,041	7,313	12,096	16,692	9,292
Services (recurring revenues)	4,122	3,355	2,920	2,320	988
Total	10,163	10,668	15,016	19,012	10,280
Share of Services in total revenues	41%	31%	19%	12%	10%

Source: Adapted by casewriters from company documents.

Exhibit 10 Trajectory of Navya Vehicle Adoption



Source: Company documents.

Exhibit 11 Example of Beep-Navya Co-Branding

Source: Company documents.

Note: The shuttle depicted was from the Lake Nona deployment; operating for over two years with 8 shuttles on 5 routes.

Exhibit 12 Navya's Geographic Presence

Source: Company documents.

Note: Segment breakdown: 50% of customers were cities and planned communities, 30% were campuses (e.g., hospitals, universities), and 20% were private sites. Potential deployment use cases included: theme parks in Orlando; London Heathrow Airport; a Singapore military base; and a Paris convention center. Navya projected it could have 10-15k units deployed in 2025, with a regional split: 40% North America, 25% Europe, 25% Asia-Pacific, and 10% Middle East.

Exhibit 13 Base Salary of Bus Drivers in Selected Markets

Country	Average Base Salary
France	$31,555
Japan	$28,623
Saudi Arabia	$22,339
South Africa	$13,431
U.S.	$46,305

Source: Adapted by casewriters from "Bus Driver Salaries by Country," Salary Expert, August 31, 2022, https://www.salaryexpert.com/salary/browse/countries/bus-driver, accessed August 2022 and casewriter estimates.

Note: Currency conversion rates as of September 2, 2022. Conversion rates do not account for purchasing power parity.

Exhibit 14 Driver Shortage Survey (2021): Demographics (as of 2020) and Causes

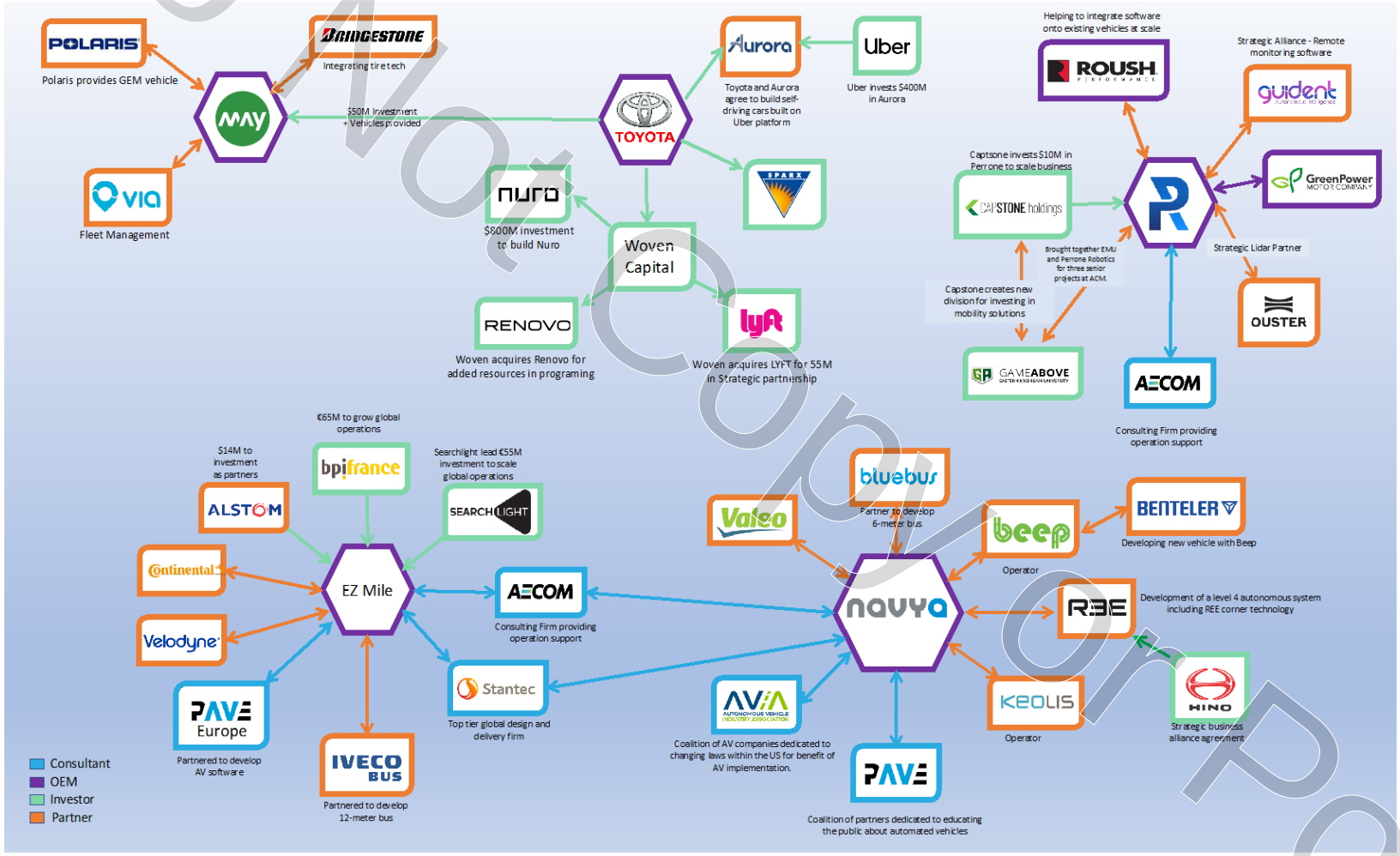
Country	Average Age	% Drivers <25 years	% Women
Europe (mobility)	50	3%	10%
Europe (logistics)	44	5%	1.8%
Russia	44	5%	0.3%
Turkey	46	7%	1%
Mexico	41	6%	2%
China	41	0%	0.1%

Driver shortage causes: Main reasons (for each country, top three ranked reasons noted)

Country	The Lack of skilled drivers	Poor Image of the Profession	Difficult Working Conditions	Difficulty to Attract Young People
Europe (mobility)	2	1		3
Europe (logistics)	1		3	2
Russia	1	2		3
Turkey	2	1		3
Mexico	1	2		3
China (Not available)				

Source: Adapted from "New IRU survey shows driver shortages to soar in 2021," IRU, March 8, 2021, https://www.iru.org/news-resources/newsroom/new-iru-survey-shows-driver-shortages-soar-2021, accessed September, 2022.

Exhibit 15 Competitor Relationships in the Roboshuttle Industry



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