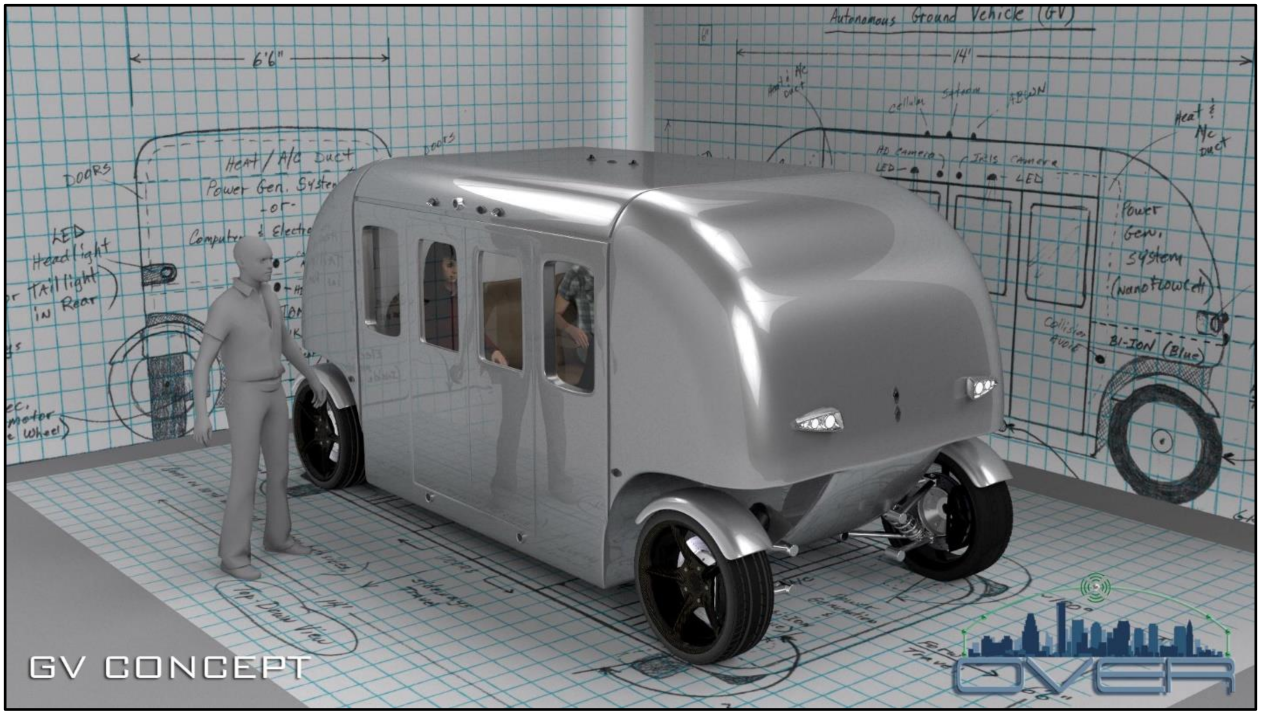
5.0 The Ground Vehicle (GV) Concepts



Autonomous (self-driving) technologies and vehicles are being developed worldwide at a phenomenal rate. Virtually every major auto, truck and aircraft manufacturer, as well as component manufactures, are developing products that support the autonomous vehicle industry. Below is a selection of some of the largest investments in self-driving technology[1].

- Intel $15.3 billion to buy Mobileye
- Ford $1 billion investment in Argo AI
- Toyota $1 billion investment in Toyota Research Institute
- Uber $680 million to purchase Otto
- GM $581 million to acquire self-driving car start-up, Cruise Automation
- GM $500 million investment in Lyft
- Volvo $300 million joint venture with Uber
- Intel $250 million over the next two years to make fully autonomous driving a reality.

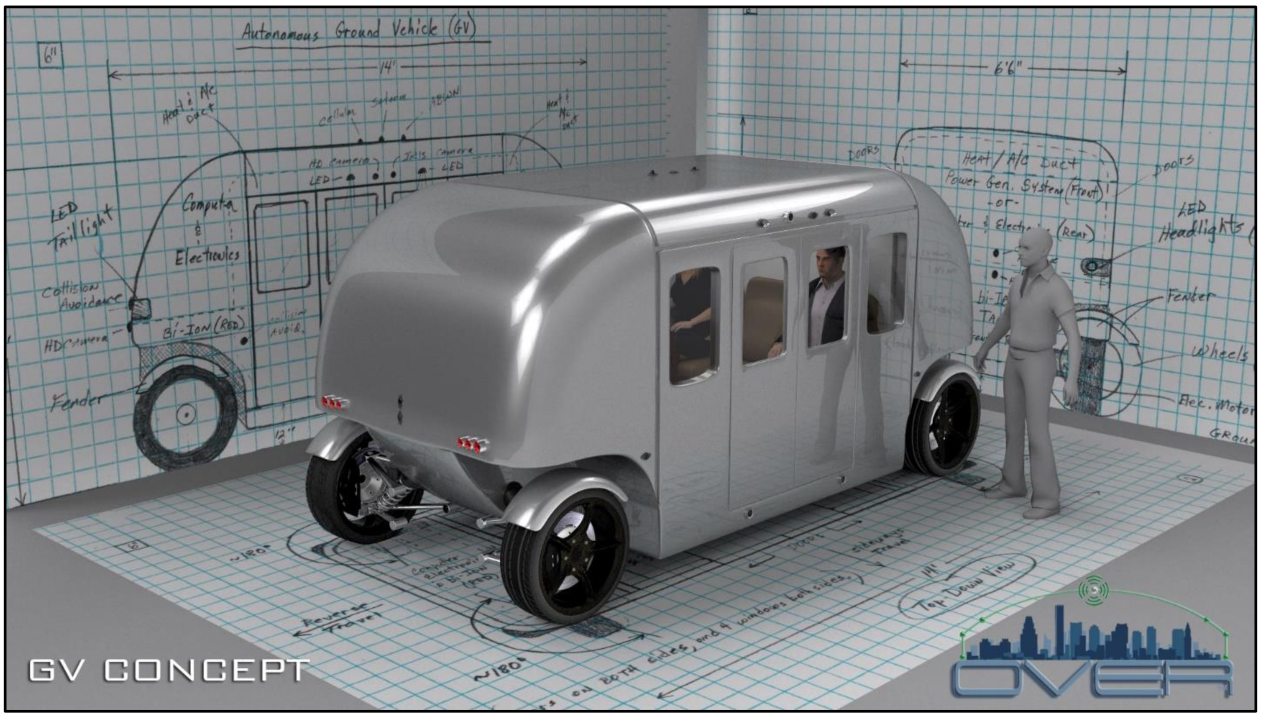
The proposed OVER Ground Vehicle (GV) concept is configured with various systems and components, developed by various companies around the world, which appear to meet the proposed ATS standards. The specific systems and components that are eventually determined to be the best choice for the final designs are TBD. It is anticipated that the companies holding patent to those accepted "best-of-the-best" systems and components (of which OVER anticipates being a party), would each enter into a licensing agreement with the multi-corporation, joint venture manufacturer, referred to as the "JVLLC". The agreement would allow the JVLLC and any Subsequent LLC (SLLC) to scale, modify, refine, improve, manufacture, operate and maintain their product(s), in exchange for a fixed Return on Investment (ROI) generated by each GV in

[1] https://emerj.com/ai-adoption-timelines/self-driving-car-timeline-themselves-top-11-automakers/

operation, containing their product(s). OVER's Business Approach is that the JVLLC and SLCC manufactured GVs will ***never be sold*** to any individual, company, or government agency, but rather owned, operated and maintained by the JVLLC or applicable SLLC - *perpetually*. The JVLLC Business Approach is addressed in detail in Chapter 7 of this white paper.

5.1 Overview.

The OVER concept GV is designed first and foremost to provide customers with convenient, easy-to-use, speedy, affordable, on-demand, cargo and passenger taxi-fare services. The concept GV will be networked with GM Control and other GVs in the area, and operate with full (Level 5) autonomy. The concept GV has no steering wheel, gas or brake pedals, or other controls at all, and is therefore never susceptible to human (driver) error. They are basically "robots" which follow approved ground-level time-paths autonomously (normally the quickest route), driving from one GPS position to another, through various waypoints (turns at intersections) as required.



In order for the GVs to be used to their full capacity, they must provide customers with *convenience, ease-of-use, sufficient speeds, and affordability*. As with the AVs, the concept GVs provide a *level entry/exit* design, which will easily accommodate wheelchairs, strollers, walkers, rolling luggage, and various rolling cargo devices, when docked at a ramp/platform assembly. The GVs are designed with other features and functionality, similar to the AVs, including the easy-to-use ATS APP, iris recognition system for access and payment, door opening size, bus-type sliding doors, seats, windows, lighting, grab bars, and free Wi-Fi. The quantity of available GVs must be sufficient to minimize wait times to acceptable levels. Lastly, the customer's price for taxi-fare (e.g. cost-per-kilometer) must be low enough to ensure repetitive/continued use. Providing convenience, ease-of-use, sufficient speeds, and affordability must be considered and solutions integrated into all GV designs, regardless of manufacturer, from the very beginning.

OVER proposes only one GV size for initial production, having approximately 6.7 m^3 (~240 ft^3) of interior space. The passenger model (GP-7) has six fixed seats to carry up to six walk-in customers, plus space for one wheelchair, for a maximum of seven occupants. The passenger model has eight windows, four on the starboard (right) side and four on the port (left) side, all the same type/size as the AV windows (SPD-Smart EDW) – which simplifies manufacturing, logistics and maintenance. The cargo model (GC-6.7) is the same size but has no windows or seats. Its anticipated that both GV models will be able to carry payloads up to 1,000kg (~2,200lbs). Manufacturing and maintenance are simplified, since the GVs use systems similar to the AVs, including nanoFlowcell power generation system and motors, computer, electronics, cameras, sensors, doors, windows, etc. Both GV models have 2'W x 5'H bus-type sliding doors, very similar to the AV doors, but *on both the starboard and port sides* to facilitate loading/unloading on either side of a one-way street.

Similar to the AVs, the concept GV is configured with a proprietary nanoFlowcell power generation unit, four powerful yet lightweight electric motors (one per wheel), and state-of-the-art communications and electronics. It is expected that the GVs would travel at speeds of at least 100km/h (~62mph), with a goal of eventually achieving speeds of 160km/h (~100mph) or more. Regardless of speed, it will be able to operate continuously, for *at least three hours*, at the maximum-allowable speed, while carrying the maximum payload, using no more than 90% of the available fuel. This will leave 10% remaining to travel to a refueling facility. (*The duration of travel is limited only by the amount of bi-ION electrolyte "fuel" that can be carried*).

The concept GV is also designed with the integrated pin/slot connection design (*previously addressed in Section 4.6*) with common mounting HW which will speed GV assembly, as well as enable rapid and cost-effective removal and replacement of components in the field. The curved exterior covers, doors and walls, as well as interior partitions and components would be constructed of strong, lightweight, honeycomb sandwich panels[2] (or similar). The GV is designed to ensure reliability, durability, and longevity, and also minimize weight where appropriate.

The concept GV design is expected to meet or exceed the proposed standards for motor power and torque, fuel/power source capability, speed, duration, payload capabilities, communications, and electronics. Although the concept design includes proposed operational systems, the specific and eventual power source, fuel, motors, wheel assemblies, electronics, communications, etc. are TBD. However, any approved GV design would meet or exceed all proposed standards.

5.2 Safe, Secure, Reliable and Swift

As with the AVs, the *four key objectives* of the concept GVs are to provide *safe, secure, reliable and swift* autonomous ground transportation for business and the general public.

5.2.1 Safe

A safe GV will contain redundant collision avoidance systems and sensors, along with swarm technology, to ensure collision free operation - even if one system fails. Redundant collision avoidance systems and sensors will significantly reduce the risk of injury or death to passengers, pedestrians, and occupants of other vehicles (whether networked or not), as well as reduce the

[2] http://www.stressebook.com/honeycomb-sandwich-panels/

risk of transport damage to cargo. Further, the GVs will contain multiple safety-related features including front and rear crumple zones, side impact protection beams, high strength cabin/occupant structure, safety/tempered window glass, seat belts, wheelchair anchoring/ fastening system (TBD), a variety of exterior lights and reflectors to include daytime running lamps, auto-horn, traction control, stability control, anti-lock braking, tire pressure monitoring, and automated parallel parking capability. It is expected that over time, the ATS and the GVs themselves will prove to be *the safest form of transportation in the history of mankind, for both occupants and pedestrians*.

5.2.2 Secure

In addition to being safe, GVs and the ATS must also be secure from all threats, both physical and electronic. Threats may come from inside or outside the organization. Physical threats include vandalizing or damaging a GV, attempting to access a GV's components or systems, attempting to approach or enter a GV without authorization, or attempts to hijack or steal the entire vehicle. Electronic threats include sabotage, hacking, malware, ransomware, over-clocking, reprogramming, etc. As stated earlier in this document, the U.S. has some of the most brilliant engineers in the world, who will ensure, perpetually, that the ATS and GVs are secure from these and all other threats. Electronic communication threats can be overcome by implementing high-security network communication protocols, such as 2048-bit encryption and randomly generated, multi-character passwords. If necessary, the ATS could use communication protocols similar to those used by our government and military such as the Secret Internet Protocol Router Network (SIPRNET) used for "Secret" communications, or the Joint Worldwide Intelligence Communications System (JWICS) used for "Top Secret" communications. The American taxpayers paid to develop these technologies and protocols, and should be able to incorporate them into the ATS, if at all possible. Additionally, OVER proposes a "Bug Bounty" reward-based program to encourage anyone, anywhere to continually seek to identify and report ways that the system/software could be hacked (*addressed fully in Section 6.7*).

5.2.3 Reliable

The design of the concept GVs, as well as their systems, components, and materials; and the quality control of the manufacturing process all contribute to the reliability of the concept GVs. Selecting mature, proven systems and components will contribute to implementing a *very reliable form of transportation*. If certain systems or components prove to not be as reliable as desired/necessary, the JVLLC will rapidly redesign/modify the system/component, in-house (normally), and make the needed manufacturing changes with little delay. Additionally, to ensure continuously improved GVs over time, the JVLLC will perpetually evaluate new systems and components for potential integration/upgrade to operating GVs, and/or for revisions to subsequent GV designs and manufacturing processes.

5.2.4 Swift

Relative swift travel is a necessity to develop and maintain customer demand. It is expected that the GVs would travel at speeds of at least 100km/h (~62mph), with a goal of eventually achieving speeds of 160km/h (~100mph) or more. The development and implementation of a standard ATS which accommodates both networked GVs as well as non-networked vehicles, will be key to enabling swift and concurrent operations, initially and perpetually. Development, testing, and implementation, including grouping vehicles into platoons (*flocks)* to increase road capacity, is being conducted by multiple companies, worldwide. Examples of companies testing/using proprietary highway systems and various navigational protocols include Mobileye, WAYMO, and others. However, as with the AVs, *all GVs* should be manufactured to operate within a standard networked system (the ATS), regardless of manufacturer.

5.3 Basic GV Operation

Cargo operators and passengers will both make request for their desired GV via cellular or Wi-Fi, using the ATS APP (computer or mobile device). Cargo operators are typically employees who are authorized to order and dispatch a GV, to deliver a product to customers, retail stores, or otherwise. Passengers would be ordering a GV to transport themselves or their party to a desired destination. Destinations would be entered as a physical address, selected on a map, or chosen from a list of previously entered destinations – hence the "customer profile". As a customer uses the GVs (and AVs) his/her profile is updated with every destination entered, and the customer can assign names (e.g. Work, Home, School, etc.), change them, or delete them.

GM Control processes the request automatically by selecting and directing the closest/quickest available GV to the pick-up location. The time of arrival appears on the customer's mobile device or computer. Upon arrival, passengers see their name on a "heads-up" display on each door window on the side being used, their identity is confirmed via iris recognition, and the passenger enters. Cargo models do not have windows and therefore do not have the "heads-up" display, but their identity is confirmed via iris recognition, doors open, and the operator loads the cargo.

Once loaded, the GV autonomously calculates the quickest time-path to destination along roads and highways using the MAP, based on real-time traffic. The time-path typically contains waypoints at intersections where turns are required. The time-path and cargo/passenger manifest are transmitted to GM Control via the same wireless network as the AVs (e.g. ABWN), or via the backup cellular network. GM Control recalculates the time-path, and if identical to the GV's calculation sends approval to the GV. The GV then departs at the approved time.

If, during the trip, the GV determines that it cannot maintain sufficient speed on the approved time-path, due to traffic congestion, accident, or otherwise, or if the passenger/operator wants to change destination, the GV calculates a revised or replacement time-path, and transmits it to GM Control for approval. GM Control recalculates the requested time-path, and if identical, sends approval to the GV. Once approved, the GV travels the new approved time-path to destination.

Throughout the trip, each GV will transmit/receive data via the dedicated wireless (primarily) or cellular networks (backup), every few seconds. The data consists of Ground Vehicle Identification Number (GVIN), current position-in-time (PIT) data (longitude/latitude/time), and future time-path data at key points along the route. All GVs receive the data from other GVs in transit, but only process and plot GVs into their MAP whose PIT will come within approximately 0.5km (~0.31 miles) of them, anywhere and at any time along the route. The location and time-path of these GVs are plotted to the GV's MAP, updated each time new data is received, and tracked throughout the trip.

Once the last cargo or passenger unloads from a GV, and if the GV has no further assignment, the GV will typically remain, parked at the unload location until the next assignment. The GV will use its internal Li-ion batteries to provide power to the computer, communication systems, LED lights, HD Cameras, and door window “heads up” displays, as required. If the batteries become depleted, the GV can “idle” the nanoFlowcell system to generate enough power for all required systems (except heat and A/C), as well as recharge the batteries. Alternately, the GV may travel to a parking spot with power pole or wall receptacle, to connect to electric grid power.

5.4 Software for GV Operations

Software for GV operations will be a key development hurdle as multiple systems need to be developed or revised, such as GV assignments, time-path mapping, etc. OVER’s business approach proposes that the company(s) that develop, provide and maintain the needed SW will be compensated like Contributors. Similar SW systems have been developed and are in use today, and with modification could be adapted to meet requirements. Specific SW requirements and solutions are TBD.

5.5 Structural Design

The proposed, concept GV is designed to be similar to the AVs. Most structural components would be made of strong, lightweight, honeycomb sandwich panels[3] (or similar), consisting of raw materials that are in ready supply, relatively inexpensive, and which can be mass produced. However, there is less emphasis on using lightweight materials for the GVs, especially if costly, since the weight of the GVs are not as important as in the AVs design. The exact materials/composites are TBD. The payload cabin is designed with 3-inch thick wall, ceiling and floor panels containing both insulative and sound-deadening materials, however the wall thickness could be reduced (e.g. 2 inches) if insulation and sound reduction is sufficient.

As with the AVs, each 2’W x 5’H sliding bus-type door opens upon positive iris scan recognition. When open, each door uses an internal Li-ion battery to power the “heads up” display, visible on the entry/exit side being used. When closing, a “light curtain” made of multiple photoelectric presence sensors creates multiple horizontal infrared light beams in the door opening, spaced about 2 inches apart. The beams are turned ON automatically while the doors are closing. If one or more beams are blocked/reflected, the system will stop and reverse the automatic door closing operation. As they close, the doors come together, pins into holes, and lock upon closing with automotive type door locks. When closed, spring-loaded electrical connectors mounted in the door jambs provide DC voltage to each door, to power displays and recharge batteries.

The top and nose/tail cones are attached together and to the cabin structure using the pin/slot connection method, similar to the AVs. The wheel mounting/steering components would be constructed of very strong materials to endure potholes and rough road surfaces without damage or misalignment, and will allow for about 110 degrees of turn, both left and right of center, for sideways drive. In all, the structure design provides safety, reliability, durability, longevity, and a quiet cabin, and enables rapid removal and replacement of components for service/maintenance.

[3] http://www.stressebook.com/honeycomb-sandwich-panels/

5.6 Features and Benefits of GVs

The OVER concept GVs are equipped with components similar to the AVs, including power generation system, fuel, electric motors, communications, networking, collision avoidance, computer, refueling system, etc. This section focuses on features and benefits specific to the GVs.

5.6.1 Customer-Focused Designs

The concept GVs will need to be designed and operated in a manner that meets the needs of the customer – from the very beginning. This customer-focused approach must be a key consideration throughout the design process. GV customers will need convenient loading/unloading capabilities; iris recognition for quick positive identification, auto-generated passenger/cargo manifests, level entry to accommodate rolling stock and patrons using wheelchairs and walkers, and a personalized customer profile (database) on the ATS APP to maintain personal data to include identification, payment information, and frequent destinations. Cargo operators need the ability to operate and track multiple cargo GVs at once.

5.6.2 Strong, Durable and Long-Lasting

The GV's design, from the very beginning, must provide an aerodynamic shape and be constructed to be strong enough to travel at speeds of least 160km/h (100mph), and to accommodate future motors/engines having higher power/torque capabilities which facilitate higher speeds and/or greater payloads. The design and materials must provide durable and very long-lasting GVs. The longer each GV will last, the longer the taxi-fare profits are generated, and the quicker the fare pricing for customers can be reduced. Investors, Contributors, and employees are all incentivized to proactively design, manufacture and operate strong, durable, and long-lasting GVs *from the very beginning*, because all Return on Investment (ROI) and employee bonus is generated from cargo and passenger taxi-fare revenue, generated only by GVs which are still "in-use", each day.

5.6.3 Modular Wheel Systems

The OVER concept GVs contain four independent, modular wheel systems, which will be designed to turn/rotate the wheels about 220 degrees, side-to-side, which is 110 degrees either left or right of center. (*Disregard the turn/rotate dimensions/limitations in the drawing shown here*). This type of wheel turning system will allow the GV to quickly and easily drive sideways into a parallel parking spot, either to the left or right, to allow load/unload on either side of a one-way road. This capability enables GVs to easily approach, align and dock at ramp/platform structures at ground parking spots, or to just park in a parking spot without a ramp/platform. OVER proposes that the design would be incorporated and used on all GVs, regardless of manufacturer, so all can dock at a standard ramp/platform.

A similar type of wheel system is used on the EO Smart Connecting Car 2 (EOscc2)[4] pictured here, which is a research project conducted by the German Research Center for Artificial Intelligence. Similar systems were used on NASA's Modular Robotic Vehicle prototype[5] and on a one-off Daewoo Matiz[6] developed by a team of students from Taiwan, China and New Zealand. The system structure must be very strong so it can endure rough roads, potholes, etc. at high speeds, perhaps 160km/h (100mph) or more.

5.6.4 Lithium-ion (Li-ion) Batteries

GVs will contain a sufficient number of Li-ion batteries to provide power to the computer, communication systems, LED lights, HD Cameras, and door window "heads up" displays when parked. It is anticipated that the GV utility compartment would contain a Li-ion battery sufficient to power the computer, communication systems, LED lights and HD Cameras, and that each door would contain a Li-ion battery sufficient to power its respective "heads up" window display. (*Note: The Li-ion batteries are not intended or sufficient to power the electric motor/wheel systems*). The Li-ion batteries are charged by the nanoFlowcell system during GV operation and by electric grid power when connected to a power pole or wall receptacle in a parking garage *(See Chapter 3, Section 3.16.1 for a description of the pole or wall receptacles*). The charged batteries will be sized to provide the required power (voltage/amperage) for the said systems for *at least two hours* of parking, at a location without electric grid power. When parked at such a location, the heater and A/C systems will be powered by the nanoFlowcell system running at "idle", if required, which will also charge the batteries. If a battery becomes depleted while parked at a location without electric grid power (e.g. only 10% remaining), the GV will either (1) travel to a parking spot equipped with a power receptacle to connect to electric grid power, or (2) operate the nanoFlowcell system at "idle" to recharge the batteries.

5.6.5 Power Generation

As with AVs, a nanoFlowcell power generation system, powering nanoFlowcell aluminum-mesh synchronous electric motors is proposed. NanoFlowcell's revolutionary technology, if true, could provide scalable, eco-friendly power, sufficient to provide required power, speed, and duration. Unlike the AVs, the concept GV is designed to contain only one nanoFlowcell power generation system (no redundancy). The one system would power all four wheels, as well as provide power to the control circuitry providing appropriate voltages to all other components (e.g. computer, electronics, sensors, cameras, LED lights, actuators, etc.) while in operation. When parked at a standard power pole or wall receptacle, the components are powered by rectified electric grid power, as addressed in Chapter 3, Section 3.16.1. When parked where no power pole or wall receptacle is available, components are powered by the internal Li-ion batteries.

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[4] https://robotik.dfki-bremen.de/en/research/robot-systems/eo-smart-connecting-3.html
[5] https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20150004599.pdf
[6] https://www.nydailynews.com/autos/watch-electric-car-drives-sideways-parallel-park-article-1.1421229

The nanoFlowcell system appears to meet/exceed requirements for use on GVs, namely, the ability to provide continuous high power over a long travel duration before refueling, the ability to manipulate RPM with granularity, scalability, low noise levels, and no pollution. Further, the fuel has the added benefits of being nonflammable, nonexplosive, noncorrosive, harmless to health or the environment, sustainable, and less expensive to produce than refining fossil fuels, or the manufacture and use of Li-ion batteries. In all, the low-voltage nanoFlowcell technology, coupled with their low-voltage aluminum-mesh synchronous motors, and the ability to quickly refuel (eventually autonomously), appears to be a workable power solution for all GVs, regardless of manufacturer.

Mass production of the bi-ION electrolytes will be key to facilitating the use of the technology in GVs as well as AVs. The number of bi-ION production facilities required, in a given region, will be based on delivery distance, demand, and production capabilities (TBD). It is expected that total bi-ION production will far exceed the needs of just the GVs and AVs alone, and will provide capacity to meet stationary and other mobile applications as well.

5.6.6 Motor Runaway

GVs may experience motor runaway due to a short in the electrical system or motor windings. In this situation, the speed of a GV motor may be uncontrollable, and RPMs could increase to or beyond maximum limits. To mitigate such a situation, GVs will contain speed/current limiting devices (e.g. resettable circuit breakers) for each of the four motor circuits. If either speed or current exceeds predetermined thresholds, the devices would autonomously “trip” OPEN, thereby deactivating the motor circuit. When the current/voltage is removed from the motor winding, motor runaway will cease, and the GV will make an emergency stop, as per any established GV operational protocols.

5.6.7 Fire Detection and Suppression Systems

Fire and smoke present a grave risk to passengers. The risk of fire is reduced through the use of both passive and active systems. Passive methods include the use of noncombustible materials, separation by routing, compartmentalization (use of firewalls), isolation, proper ventilation and drainage. The active method is comprised of smoke detectors mounted in the cabin ceiling and front/rear nose cones, which function as independent fire detection systems. In case of a cabin fire, a hand-held fire extinguisher is used by a passenger to extinguish the fire. Due to the low risk of occurrence, there are no fire extinguishing systems in the utility compartments.

5.6.8 Cabin Environmental Control

Similar to the AV design, GV cabin environmental control would be provided by two heat pump type units, positioned behind the seats, one in the front utility area and one in the rear. The integrated duct work would route return air from the top of the wall, behind the occupant’s head, down across a condenser. The conditioned air is then blown by quiet, internal fans down and out the wall, below the seats. Two evaporators, one for each system, would be positioned in a small air-scoop area in the lower external section of the GV, below the forward heat pump unit. Each thermostat-controlled heat pump will simultaneously and independently provide heating or cooling to the cabin space, as required. The heat pump units would be the same or similar to those used on the AVs.

5.6.9 Sensors

The GVs will have various sensors, to perform a variety of functions. Common sensor functions include iris recognition, door obstruction, collision avoidance, smoke detection, hazardous gas detection, explosives detection, radiation detection, power generation voltage and current, and electric motor temperature and RPM. The iris recognition sensor and door obstruction sensor would be the same products used on the AVs, modified as necessary. The exact make/model of each sensor is TBD.

The *collision avoidance sensors* would be part of *two* redundant collision avoidance systems (System #1 and System #2), unique to the GVs. It is expected that the final redundant collision avoidance systems (perhaps two of the same systems, or two completely different systems) as well as swarm technology SW, would maintain the GVs proper distance from animate objects (other GVs, non-networked vehicles, motorcycles, bicycles, pedestrians, etc.) as well as inanimate objects (signage, poles, barriers, curbs, buildings, structures, trees, etc.). If either system identifies an object that, based on the calculated trajectory will come within the safety sphere of the GV, the GV's Movement Control System autonomously makes appropriate adjustments to speed, steering and/or breaks to avoid collision. Each GV ensures that it does not encroach on another GVs safety sphere, and that no object encroaches on its own safety sphere. After an adjustment is made, the GV returns to its original time-path to get back on-course and on-time. The preferred embodiment would contain at least *16* collision avoidance sensors installed around the outside of the GV, *eight* for one System #1 and *eight* for System #2. Each system would have two sensors on each side, two on the front end, and two on the rear end. The location of the sensors would create two independent 360-degree monitored safety spheres, horizontally, around each GV.

In addition to the common sensors above, cargo GVs will have two redundant *Radio Frequency Identification (RFID) sensors* inside the cargo compartment, used to digitally identify all cargo and generate cargo manifests prior to departure. Passenger GVs will have two iris recognition sensors inside the passenger compartment instead of RFID, as well as a built-in microphone and speaker.

5.6.10 High-Definition (HD) Cameras and LED Lights

GVs will have various high-definition (HD) cameras and LED lights, to perform a variety of functions including docking/parking, security, and cargo/passenger cabin video. The exact make/model of HD cameras and LED lights is TBD.

- *Docking/Parking*: OVER concept GVs contain an HD camera and two LED lights on the rear end of the vehicle, about 18 inches above finished floor (AFF), to facilitate safe back-in docking to a power receptacle, whether on a power pole or mounted to a wall. The HD camera video output is fed into the GV's Movement Control System, which detects the power receptable, and guides the GV's travel to the appropriate docking position. During a back-in docking approach, the position of the GV relative to the power receptacle is used by the Movement Control System to control steering, speed, and height to safely and accurately align the GV for docking. When the GV's power plug enters the receptacle, and the GV pins enter the receptacle sockets, the GV stops travel and is "docked". GVs will most likely require air shocks, which would be adjusted autonomously to raise or lower the GV, as required to dock. (*Note: Other manufacture's GVs will have to contain the same/similar systems and components, positioned at the same height and location, to dock/park/charge at the standard receptacle locations*).

- *Security*: The concept GVs have at least four HD cameras and various LED lights positioned around the outside for security. These cameras are always ON, with video feeds going to the GV's computer. If a camera detects motion, its video feed is automatically transmitted to GM Control for evaluation. If the motion is from an intruder that appears malicious, GM Control may notify law enforcement, and/or may direct the GV to another parking location.
- *Cargo/Passenger Cabin Video*: The OVER concept GVs contain cameras positioned in the upper corners of the cargo/passenger cabin, which record video of cargo/passengers from the time of loading/entry to the time of unloading/exit. The video is saved to the GV's computer and retained on-board for 30 days. Live-feed video could be viewed by GM Control in real time, in response to a component or system failure, sensor failure, alarm, or passenger pressing the "Emergency" button. Recorded video could be viewed within the 30-day period by the customer, manufacture, or by law enforcement (with appropriate warrant) to investigate vandalism, damage, theft, harassment, etc.
- *LED Headlights, Taillights, Break lights, and Blinkers*: GVs will contain headlights, taillights, break lights and blinkers, similar to traditional vehicles, but which operate autonomously.

5.6.11 Communications

GVs will have the same/similar communication functionality as AVs, including dedicated wireless network, satellite and cellular. It is anticipated that all communication circuitry will be integrated into the motherboard in the "computer box", instead of independent stand-alone devices.

5.6.12 Plugs, Sockets and Cabling

To facilitate mass-production, and especially service and maintenance thereafter, most if not all sensors, cameras, lights, and communication antennas will be manufactured to fit within a uniquely sized and configured "*plug*" which will plug into its matching "*socket*" (and only its matching socket) permanently mounted in the GV. Each plug and socket type/size have a unique alignment keyway and notch, to prevent the wrong type of plug from being inserted into a given socket. When the correct type/size plug is inserted into its matching socket, and the plug's keyway aligns with the notch in the socket, the plug will slide all the way into the matching socket. Most if not all plugs (containing a sensor, camera, light, etc.) will be provided power via copper cable, and will communicate with the computer box via CAT-6/7 certified twisted-pair copper cable, fiber optic cable, or the preferred embodiment - wireless. The novel plug/socket design, illustrated with copper wiring in the AV Chapter 4, Section 4.7.26, is used to easily mount or remove sensors, cameras, lights, or communication antennas to the GV as well. GVs and AVs will be designed to use the same sensors, cameras, lights, and communication antennas, with the same plugs/sockets, when possible. As with the AVs, the novel plug/socket design, used to mount each sensor, camera, light, antenna, etc. meets the following key objectives:

- Ability to remove and replace each plug from its socket quickly, easily, and independently, without having to remove a GV cover
- Ability to remove and replace GV covers without having to remove any plug separately
- Common captive bolt mounting HW, all having the same size bolt head (e.g. 8mm)
- Inability to insert the wrong type/size plug into a given socket.

The proposed location of each socket/plug, type of sensor/device, and the quantity to be installed in the cargo and passenger GVs is provided in the table below.

Location	Type of Sensor/Device	Cargo	Pass
Outside, Front End	Collision Avoidance Sensors (System #1)	2	2
	Collision Avoidance Sensors (System #2)	2	2
	HD Camera for Security	1	1
	LED Headlights, White	2	2
	LED Parking/Running Lights, Amber	2	2
	LED Blinker Lights, Amber	2	2
Outside, Rear End	Collision Avoidance Sensors (System #1)	2	2
	Collision Avoidance Sensors (System #2)	2	2
	HD Camera for Back-In Docking	1	1
	LED Lights for Back-In Docking	2	2
	HD Camera for Security	1	1
	LED Break Lights, Red	2	2
	LED Parking/Running Lights, Amber	2	2
	LED Blinker Lights, Amber	2	2
Outside, Starboard (Right) Side	Collision Avoidance Sensors (System #1)	2	2
	Collision Avoidance Sensors (System #2)	2	2
	HD Camera for Sideways Docking	1	1
	LED Lights for Sideways Docking	2	2
	HD Camera for Security	1	1
	IRIS Camera	1	1
	LED Lights, Loading/Unloading, White	2	2
Outside, Port (Left) Side	Collision Avoidance Sensors (System #1)	2	2
	Collision Avoidance Sensors (System #2)	2	2
	HD Camera for Sideways Docking	1	1
	LED Lights for Sideways Docking	2	2
	HD Camera for Security	1	1
	IRIS Camera	1	1
	LED Lights, Loading/Unloading, White	2	2
Outside, Top	Wireless Network Communications Antenna	1	1
	Satellite Communications Antenna	1	1
	Cellular Communications Antenna	1	1

Location	Type of Sensor/Device	Cargo	Pass
Outside, Left Front Wheel and Motor	Motor Temp Sensor	1	1
	Motor RPM Sensor	1	1
	Tire Pressure Sensor	1	1
Outside, Right Front Wheel and Motor	Motor Temp Sensor	1	1
	Motor RPM Sensor	1	1
	Tire Pressure Sensor	1	1
Outside, Left Rear Wheel and Motor	Motor Temp Sensor	1	1
	Motor RPM Sensor	1	1
	Tire Pressure Sensor	1	1
Outside, Right Rear Wheel and Motor	Motor Temp Sensor	1	1
	Motor RPM Sensor	1	1
	Tire Pressure Sensor	1	1
Inside, Front Nose Cone	Smoke Detector	1	1
Inside, Rear Nose Cone	Smoke Detector	1	1
Inside, Ceiling, Four Upper Corners	HD Cameras	2	2
	IRIS Cameras	0	2
	RFID Sensors	2	0
Inside, Ceiling	LED Lights, Load/Unload/Reading, White	7	7
	Wi-Fi Router, for Free Internet access	0	1
	Smoke Detector	1	1
	Hazardous Gas Detector	1	1
	Explosives Detector	1	1
	Radiation Detector	1	1
	Microphone	0	1
	Speaker	0	1

5.6.13 Alarms

An expected standard is that all sensors, HD cameras, LED lights and communication functions must be fully operational before a GV can provide service to customers. GVs must be in GREEN (fully functional) operational condition for GM Control to authorize/approve a time-path. If a GV detects that a system or component is not working properly (e.g. motor temp, collision avoidance, HD camera, etc.) it automatically transmits the alarm to GM Control. Alarms are either AMBER (diminished functionality) or RED (critical/non-functional condition). Either alarm condition must be resolved before the GV can provide service to customers. If an AMBER alarm condition occurs *during* transit, the GV will finish the trip and then auto-drive to the manufacturer service location for troubleshooting and remove/replace/repair, before it can return to service. If a RED alarm condition occurs *during* transit, the GV will make an emergency stop at any clear parking area/space, and GM Control will arrange for another GV to pick up cargo/passengers and send them on their way. Examples of different types of alarms are presented in the table below.

System	Problem	Alarm
Emergency Button	Glass broken and button depressed	RED
Power Generation	Any problem	RED
Motor, Wheel or Tire	Any problem with any component	RED
Computer	Any problem	RED
Communications	Any problem with two or more functions	RED
Sensor, HD Camera, or LED Light	Any problem with two or more items	RED
Fuel (bi-ION)	Leak, clog, or inoperative pump	RED
Fuel (bi-ION) Level	Low fuel level in either tank	AMBER
Tire Pressure	Low tire pressure, any wheel	AMBER
Communication	Any problem with one function	AMBER
Sensor, HD Camera, LED Light	Any problem with one item	AMBER

When a GV senses an alarm, it will autonomously take the appropriate action; and GM Control will monitor the GV to ensure it takes the appropriate action. For example, if a passenger breaks the glass and presses the RED Emergency Button, the GV autonomously pulls over into an available parking location, or calculates, obtains approval, and travels an emergency time-path to the nearest hospital or law enforcement facility. Appropriate action depends on whether the GV contains passengers or cargo, and whether it is in-transit or parked. If a GV is routed to a Service facility, GM Control will monitor it until it is restored to a fully functional (GREEN) condition. The table below specifies appropriate actions for the various alarm conditions.

Location	Alarm	Trip Status and Appropriate Action
In Transit	AMBER	If carrying payload, the GV will proceed to the destination GPS IAW the approved time-path. If empty (no payload), the GV will autonomously calculate and file a time-path to the nearest Service facility. If it proceeds to the destination GPS to deliver the payload, it will then be classified as “Out-of-Service” and cannot carry payload again until the problem is resolved. The GV is now in a “Parked – AMBER” condition.
Parked	AMBER	The GV is “Out-of-Service” and cannot carry payload until the problem is resolved. The GV will autonomously calculate and file a time-path to the nearest Service facility to resolve the problem, normally *with no payload*. Alternately, the customer or GM Control may request mobile service or transport.
In Transit	RED	The GV *must stop/park as soon as possible*. It will autonomously calculate and file an emergency time-path to the nearest Service facility, parking spot, or other safe area, whichever is closest. Once approved, it proceeds to the location and stops. GM Control will arrange for and dispatch another GV to the area, where cargo is moved, or passengers move to the replacement GV and continue to their destination. Once stopped, the GV is “Out-of-Service” and cannot carry payload until the problem is resolved. The GV will not continue to traverse roads in RED alarm condition, and if stopped away from a Service facility, will require mobile service or transport.

Location	Alarm	Trip Status and Appropriate Action
Parked	RED	The AV is "Out-of-Service" and cannot carry payload until the problem is resolved. The GV will not traverse roads in RED condition, and will require mobile service or transport, if not already at a Service facility.

5.6.14 Refueling

Similar to the AVs, the refueling concept provides a quick and easy way to refuel OVER's concept GVs with the bi-ION® electrolyte liquids. These GVs will travel to local refueling stations autonomously, which are provided by the JVLLC and all SLLCs, as scheduled and assigned by GM Control. Each GV contains two tanks for the charged bi-ION electrolyte liquids, each having a capacity of approximately 190 liters (~50 U.S. gallons). The GVs may contain "capless" fillers located side-by-side, sized and positioned to accommodate a unique twin-fluid, twin-spout filler nozzle, or they may be located separately and require individual filler nozzles (TBD). Once inserted, the filler nozzle(s) will allow the RED and BLUE liquids to be pumped into their respective tanks. The refueling process may initially be performed manually by an employee, but it is anticipated that the process would become a fully autonomous procedure. A GV could be refueled within a few minutes, and quickly resume operations until needing to be refueled again.

5.7 Features and Benefits Specific to Cargo Ground Vehicles (GVs)

The cargo GV is designed to transport cargo – normally without human passengers. The standard cargo GV would accommodate multiple types of cargo, to include raw materials, component parts, machinery, appliances, furniture, groceries and other food products, medicines and medical items, emergency water/food, and many other items. It is anticipated that the bulk of cargo GVs will be used by businesses to speed deliveries and provide a higher/premium level of customer service. However, they can also be used by the general public for transporting (moving) personal household goods, professional goods, and other items. They will be insulated and environmentally controlled (A/C and heat), and the interior floor and walls will be made of a tough, durable material, probably having a tough, durable, scratch-resistant material. Cargo GVs will typically have no seats or windows.

OVER proposes one cargo GV model, the GC-6.7, having approximately 6.7 m^3 (~240 ft^3) of interior space and capable of carrying about 1,000kg (~2,200lbs) of payload. Having these capabilities, cargo GVs will provide a robust ground cargo transportation system from day one, that will reduce the number of small traditional vehicle/truck deliveries, and the risks, expense, congestion, delays, noise and pollution generated by this sector of the ground-based cargo delivery system. Similar to the CAVs, the following examples illustrate how cargo GVs could be used, normally for shorter distances than CAVs.

- Transporting merchandise from distribution facilities to retail stores (maximizing Just-In-Time [JIT] processes to minimize inventory and costs)
- Transporting merchandise from distribution facilities or retail stores directly to customers
- Transporting fresh foods and other perishables directly to market or restaurants
- Transporting groceries and other food products directly to customers
- Transporting cooked/catered food directly to customers
- Transporting packages, documents, medicines, etc. between entities or to customers

- Transporting cargo to/from AV structures, providing “last mile” capabilities.

5.7.1 Specialized/Future Cargo GV Models

Specialized cargo GVs may be developed in the future with special features to meet unique customer needs. Examples include:

- *Combo* models to transport both cargo and human passengers. Combo models could be used by maintenance-type personnel to transport tools, parts, materials, etc. to/from a job site. They would be configured with a seat(s) and a window(s), as required.
- *Rigging* models for unique-sized cargo (e.g. lumber, PVC pipe, tinhorn, etc.).
- *Refer* models to transport products that require refrigeration and/or freezing
- *Tanker* models to transport refrigerated milk or other non-hazardous liquids
- *Hazmat* models designed to safely transport solid and/or liquid hazardous materials. As with CAVs, after some months/years of safe and reliable cargo GV service, DOT rules may be revised to allow hazmat to be transported on GVs. Transporting hazmat in GVs will provide a *lower risk* to the public of accident, spill or otherwise, as compared to conventional ground transportation.

5.7.2 Cargo GV Loading and Unloading

When a cargo GV arrives at a pick-up location, and an authorized operator is verified via iris scan, the bus-type doors will open. The operator may load cargo using a dolly, rolling stock cages, rolling stock tubs, special pallets sized to fit, and/or by stacking items directly on the floor by hand. As cargo is placed in the GV, the RFID sensors record each item and the data is used to generate a cargo manifest. When loading is complete, the operator enters the destination into the ATS APP (mobile device or computer). The GV calculates and files its time-path and a cargo manifest, obtains authorization from GM Control, and then departs at the approved time.

5.8 Features and Benefits Specific to Passenger GV Models

Passenger GVs are designed to transport human passengers, and a limited amount of personal/professional cargo (e.g. luggage, etc.). They would be used extensively and primarily by persons commuting to/from work, home, and school, and also for general transportation for shopping, pleasure/sightseeing, tourism and many other uses. OVER proposes one passenger GV model, the *GP-7*, capable of transporting up to seven occupants (six walk-in and one wheelchair). The GP-7 is made with many of the same components as the cargo model, and has the same dimensions and interior space as the cargo GV (approximately 6.7 m^3 or ~240 ft^3) and is capable of carrying the same weight 1,000kg (~2,200lbs). The similarities simplify assembly line design and manufacturing logistics, as well as follow-on logistics and maintenance. All occupants will sit during operation, and should use the provided seat belts. The GP-7 has eight windows, four on the starboard (right) side and four on the port (left) side, and two bus-type sliding doors on both the starboard and port sides, to facilitate loading/unloading on either side of a one-way street. All passenger GVs will be insulated, constructed with sound-absorbing/blocking material, provide free Wi-Fi-based Internet connectivity, and contain environmental controls (A/C and heat). A key feature inherent with all autonomous passenger GVs is that anyone can ride in them, alone, at any time, including individuals with disabilities (wheelchairs, blind, deaf, etc.), children (with parental permission), elderly or other individuals who can’t drive, and even “inebriated” individuals who would otherwise present a danger to themselves and others if driving a car.

When considering these key features, readers should realize that passenger GVs will provide far greater and safer mobility, for more individuals, than any other form of transportation in history.

5.8.1 Passenger GV Loading and Unloading

When a passenger GV arrives at a pick-up location, and the waiting passenger is verified via iris scan, the bus-type doors open and the passenger boards. Step-in passengers may load/unload at virtually any location, but passengers using wheelchair, stroller, walker, etc., will normally load/unload at parking spots containing the ramp/platform structure. Once passengers are loaded, the GV calculates and transmits a passenger manifest and its time-path to GM Control, obtains authorization from GM Control, and then departs at the authorized time. Upon arrival, the iris detection system identifies passengers who unload, and those passengers are removed from the passenger manifest for the next trip.

5.9 Other GV Designs

The current design of the concept GV maximizes the utility/mechanical space around the cabin, within the top cover, and within the front and rear covers. This space is for the fuel tanks (bi-ION), nanoFlowcell power generation system, computer and electronics. If the fuel tanks and power generation system do not require this much space, then a smaller, sleeker design is preferred, similar to the preferred AV design illustrated in Chapter 4, Section 4.10. Such a design could provide passengers with an SPD-Smart EDW front glass windshield, rear glass windshield, and/or roof glass (similar to the windows) for greater visibility. All windows can be lightened or darkened to control the amount of light to a comfortable level. Further, this design would be more aerodynamic and lighter, hence more efficient. Additionally, one person, two person and other smaller size models may be designed and manufactured to meet customer need/demand. In any case, operational capabilities would still meet or exceed the recommended standards (e.g. three hours of drive time, sideways drive, docking, environmental control, free Wi-Fi, etc.).

