# Autonomous Transportation: Combat Power in the 21st Century

■ By Capt. Matthew P. Henry

A few years ago, the mere mention of autonomous vehicles (AVs) in U.S. society brought on feelings of grave concern. Many people wanted trained operators, rather than computers, to be the responsible entities in our transportation system. However, discussions about AVs typically focused on privately owned vehicles rather than logistics assets. Today, the Army is in the forefront of bringing AVs into the logistics profession.

The Department of Defense (DOD) has been researching the possibility of using AVs for battlefield logistics since at least 2004, when the Defense Advanced Research Projects Agency funded specific research and technology and held its first AV competition. While the most recent technical emphasis has undoubtedly been on front-line functions such as unmanned tanks or light maneuver capabilities such as bomb disarmament, those assets are not technically AVs.

AVs, as defined by the National Highway Traffic Safety Administration, are "vehicles in which operation occurs without direct driver input to control the steering, acceleration, and braking." AVs undoubtedly have great potential to bring valuable sustainment to the warfighter.

## The Technology

AV technology uses several functions to operate in an efficient and effective manner. The U.S. military, a leader in developing technologies for AVs, used the autonomous technology employed in minesweeping to enable the current AV technology used in privately owned vehicles.

According to Markus Kuckelhaus, the vice president of innovation and trend research at DHL Express, minesweeping technology grew into four primary functions that are used in AV technology today: navigation, situational analysis, motion planning, and trajectory control.

***Navigation***. Navigation is essentially route planning using GPS technology in most cases. Linux-based communication systems could possibly enable this function in the future to integrate with the Army's Force XXI Battle Command Brigade and Below system or the Blue Force Tracking network. However, AVs exchange data between wireless area networks to recognize dangerous routes at early stages.

***Situational analysis***. Situational analysis uses ultrasound, video cameras, and surround views in order to make the operator aware of surrounding threats and changes to preferred maneuvering.

***Motion planning.*** Motion planning monitors vehicle movements and identifies oncoming objects. It also forecasts what the object's likely move will be and corrects movements based on this data.

The military used these four functions when developing the Autonomous Mobility Applique System (AMAS) prototype in 2012. Most privately owned AVs have the autonomous technology built into the vehicle, but the AMAS was designed to keep the AV technology separate from the vehicle, allowing it to be used with almost any vehicle in the inventory.

A statement from Lockheed Martin following a successful test drive of the AMAS said, "The AMAS hardware and software are designed to automate the driving task on current tactical vehicles. The Unmanned Mission Module part of AMAS, which includes a high-performance lidar sensor, a second GPS receiver, and additional algorithms, is installed as a kit and can be used on virtually any military vehicle."

## Benefits of AV Technology

AV technology can benefit the Army in the areas of safety, efficiency, cost, sustainability, warfighting effectiveness, convoy security, warehousing operations, and maintenance.

***Safety.*** According to the Under Secretary of Defense for Research and Engineering, Dr. Michael D. Griffin, 52 percent of battlefield casualties occur when sustainers are delivering needed supplies to and from the battlefield. Some of these casualties are the result of enemy attacks, but vehicle collisions and human error are significant risks to those in the logistics profession. As much as 90 percent of vehicle accidents are caused by driver error.

***Efficiency, cost, and sustainability***. AVs offer the DOD possible cost savings and more efficient transportation networks. AVs could allow line hauls to take place 24 hours a day, 7 days a week, and afford Soldiers the opportunity to rest while the convoy is en route. The use of vehicle-to-vehicle communication and autonomous system algorithms could allow logistics vehicles to avoid congested or high-risk areas and to drive for optimal fuel efficiency. AVs could possibly reduce fuel costs by as much as 40 percent and help the Army comply with federal sustainability and energy reduction requirements.

***Warfighting effectiveness***. Another possible benefit of AVs could be

the direct impact they have on the sustainers' customers. Smarter, more efficient logistics could allow more frequent logistics packages in a high operating tempo environment. If warfighters are resupplied more often, more reliably, and more predictably, they would be responsible for carrying a smaller quantity supplies.

***Improved convoy security***. Convoy security is also an opportunity for AVs to provide increased functionality. In theater, a convoy is assigned a convoy escort team (CET) consisting of four convoy protection platforms (CPPs). CPPs include a driver, a vehicle commander, and a gunner. AVs could reduce the possible number of casualties if the Army could use them to decrease the required number of CETs on the road. They also open the possibility of linking unmanned CPPs to manned CPPs through a wireless area network to vastly reduce the needed manpower.

In the past two decades, an increased number of contracts have been awarded to transnational companies to augment or supplement CETs in escorting Army convoys. AVs present an opportunity to save contracting costs and may ease concerns about using contractors for traditional military functions.

***Warehousing operations***. Leading logistics companies currently use artificial intelligence in warehousing operations. However, this technology simply stops when it encounters an obstacle, so paid staff is required to remove the obstacle or switch to manual methods. AV technology that uses functions such as situational analysis would allow more complex autonomous maneuvering for stocking and shipping military supplies.

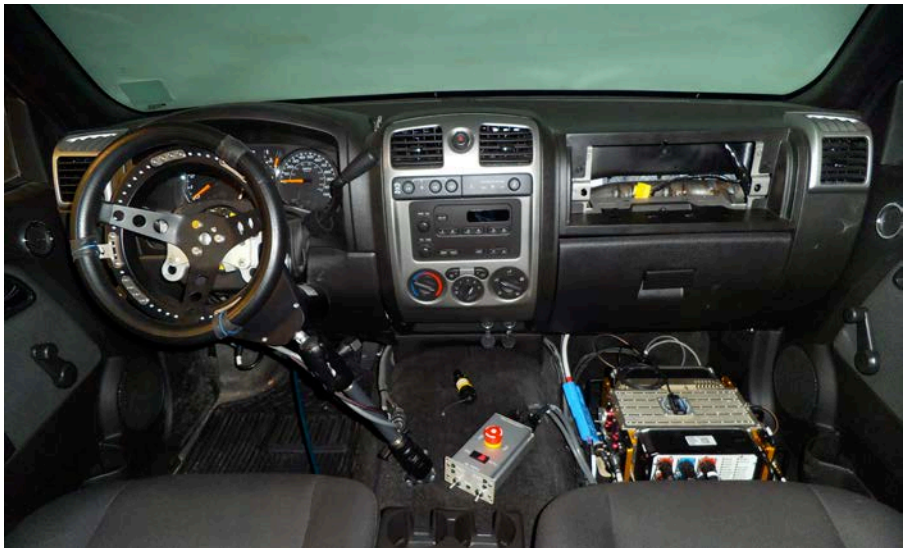
***Maintenance***. Prominent companies such as Amazon are researching the possibility of drone delivery services for small, easily transportable supplies. Repair parts could be delivered using the most efficient aerial routes and greatly reduce the time that deadlined vehicles spend awaiting parts.

## Risks to AV Technology

Several apparent risks should be considered before the Army shifts to using AVs.

***Mistakes and liability***. One thing is for certain: mistakes will occur, even if the Army is using AVs. The question then is who will be held accountable for these mistakes. Would the operator or convoy commander

*Autonomous vehicles, such as this truck with a roof-mounted Pronto4 unmanned ground vehicle kit, could possibly be used for convoy escort missions in order to reduce costs and risk of casualties. (Photo courtesy of Kairos Autonomi)*



*This Pronto4 robotic applique kit, installed on a Chevy Colorado, was successfully tested and is currently in use for target training. (Photo courtesy of Kairos Autonomi)*

share liability for an accident that occurred because of a decision made based upon data received from a sensor? Will the accountability be shifted from the operator or leader to the manufacturer of the AV?

One possible solution is to take a hybrid approach and share safety responsibility with both the manufacturer and operator by choosing a lesser level of automation so that the operator is not entirely omitted from all responsibility.

These questions still need to be addressed, but recent developments seem to suggest, at least in the civilian world, that manufacturers will share some of the liability when insurance companies deem accidents are caused by manufacturing defects or faulty instructions.

***Safety***. While AVs could make transportation safer and more efficient, there is the possibility that AVs could give Soldiers a false sense of safety and could breed complacency in staying vigilant and following safety procedures. However, as with anything else, this could be mitigated with proper training and discipline at the unit level.

***Maintenance***. With the addition of innovative technology to the Army wheeled vehicle inventory, maintenance will inevitably become a critical consideration. Highly skilled mechanics within the ordnance community will need to be trained to properly maintain this equipment. Additionally, operator-level maintenance training will have to take place Army-wide to ensure this smarter, and possibly more finicky, equipment is kept fully mission capable.

## Future and Implementation

AVs present a unique opportunity specifically for the Army National Guard. During emergencies and natural disasters, AVs could be used to improve response times, deliver necessary supplies, or provide emergency evacuation capabilities.

State and local governments have recently been discussing the need to include AV needs and capabilities in their new mobility resilience action plans and local hazard mitigation plans. As the Army is looking at moving forward with AVs in the future, the National Guard is seemingly a fitting place to begin implementation.

In the past decade, the DOD has made significant strides in developing AV technology. Several defense manufacturers have been marketing prototypes for autonomous technology. In 2013, Kairos Autonomi successfully installed its Pronto4 applique kits at several National Guard Bureau test sites to allow for optionally manned target vehicles. Most notably, in 2014 the Tank Automotive Research, Development and Engineering Center, through a partnership with Lockheed Martin, successfully tested a convoy of autonomous vehicles at Fort Hood, Texas.

The automobile industry has already released several AV prototypes, and communities throughout the country (and the world) are revising their regulatory frameworks in an attempt to get ahead of the implementation of AVs in the private sector. Large logistics companies have also recognized their potential to use AVs to gain an advantage over their competitors.

The Army logistics community, particularly within the National Guard, should further explore the potential of AVs to obtain a combat advantage for logistics superiority over our adversaries and to improve domestic response capabilities nationwide. This presents an exciting opportunity to reduce costs, energy consumption, and most importantly the risks Soldiers face when executing their sustainment missions in combat zones or here in the homeland.

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