Uncrewed land vehicles: The new proving ground for unleashing unlimited uncrewed propulsion systems

Dana Gardner: Hello, and welcome to the ePropelled Podcast. I'm Dana Gardner, your moderator for today's deep-dive examination at the global uncrewed ground vehicle (UGV) market with a veteran of electric and traditional ground vehicles, vision, design, and manufacturing.

Please join me in welcoming our guest, David Hudson, Product Manager of Ground Vehicles at ePropelled. Welcome, David.

David Hudson: Hi, Dana. Thank you for inviting me to talk to you.

Gardner: I'm delighted to have you with us. Let's start at the top and work our way through this very big subject. What's changed in the last few years that's made the UGV market opportunity both interesting and potentially explosive?

Hudson: There have been a lot of advances in robotic control of pretty much everything in the world these days, partly because he ability to put onboard computing power into vehicles has massively increased.

It's probably a bit of a trickle-down from the mainstream automotive market, but I think the idea that we can now use robotic, controlled vehicles to do things that were previously manned or crewed activities has become very strong. Hazardous situations, for example, are areas that we're trying to pull people away from. We see it on news broadcasts all the time, where you have robot vehicles going into hazardous situations like fires. They've been used in things like ordnance disposal for quite a long time.

That, and, obviously, around the world there are a few conflicts going on with the demand for military applications for uncrewed vehicles in all domains -- land, sea, and air -- growing. But civilian and humanitarian uses are growing, too.

We are now able to deploy vehicles at a lower cost, because we don't have to accommodate environmental needs of humans in these vehicles, which can make them smaller. It makes them cheaper to manufacture, and they are much more compact, increasing the amount of space available for your payloads, whatever they may be. So, I think it's a combination of these factors driving the overall growth.

But the last five years have seen an explosion of interest in robotics. It's being taught as a subject in schools. Postgraduate degree courses are coming up with robotics and connected autonomous vehicles as their themes.

Gardner: David, historically these types of vehicles were coming from very different origins, electric vehicles (EVs) and flying drones, or uncrewed aerial vehicles (UAVs), for example.

But now there seems to be more commonality across all manner of uncrewed vehicles. What's made the previously divergent technology tracks become more common, and therefore with a higher overall value?

Modular means quick time to value

Hudson: Well, we've broken down the problem in all the domains. We've broken it down into modules. We hear about software-defined everything these days. You know, you can change the character of your automobile by downloading a software module. It's like we used to have with mobile phones and ringtones where you could personalize your phone by downloading a ringtone.

Similarly, having a modular architecture for vehicles means the controller itself doesn't really care what it's controlling. If it's a vehicle, it doesn't matter if it's flying, in the water, or on the land.

We've now chopped up the problem, so we have specialists looking after the propulsion, the controls, and the communications. And then you put your interface to whatever payload you have as almost a plug-and-play module, which can just be connected to the vehicle.

And that's means that the control problem of flying an unmanned aircraft and the problem of controlling an UGV are precisely the same. You have slightly different hazards, but nonetheless the basic motion control and the physics are pretty much the same.

If the controllers are similar, and therefore the software code looks very similar, that means that we've economized by using the same tool set to fly a vehicle as we would do to propel it through water or across land.

Gardner: I think you've identified an inflection point. Not just a step-change, but a sea-change for uncrewed systems.

When you can take the intelligence, the data, the connectivity, and the ability to modularize these components and infrastructure, you gain greater diversity in the applications and uses.

But at the same time, we're seeing greater platform commonality, and therefore efficiency of scale and cost benefits on the underlying systems.

Do you agree that the next five years will deliver productivity levels for these uncrewed vehicles like we've never seen before?

Common development for uncommon speed

Hudson: Yes, I do. As well as the things you've just mentioned, one key is the time needed to develop these things. The time to develop and prove the software, for example, is not trivial. And the more lines of code you have, the more time you have to take to do it.

But if you have a control system that is already robust from a different domain and apply it to a new vehicle domain, you may be skipping 70 to 90 percent of the testing time, which means significantly reducing your time to deployment. A new system development time comes way down. And, very critically, your dependence on highly skilled and still quite scarce resources -- the software engineers – comes down, too.

You're no longer waiting in line for those people to become available from some other tasks. The act of modifying the code becomes a lower-level task, and it doesn't need the full experts to get involved every time.

So, it’s really a much more efficient way to deliver more kinds of vehicles.

Commercial to military crossover

Gardner: And just as we've seen a crossover between different types of uncrewed vehicles in different environments, we're also seeing a crossover and a blurring between what was considered commercial and what was considered military or defense oriented.

And we didn't see a lot of cross pollination between the automotive industry and making tanks 10 years ago. But nowadays there's quite a different environment.

Hudson: Yes, the military-to-commercial crossover has been a desire for a very long time. I've been involved in the automotive world for more years than I care to remember, and from time to time you come upon military procurement requests aimed at trying to get commercial-grade hardware into military applications in a safe manner.

Military procurement has finally moved away from people sitting in a dark room and coming up with a completely unique set of requirements to a group of people who are more willing to look at what's available in the commercial world, and then basically do an add-on package to it.

And a lot of military applications are particularly hard, the durability requirements are tough. But we've seen it frequently, on base logistics support, the vehicles are essentially commercial trucks. And it's only when you get to extreme battlefield tactical conditions that you need special devices.

Of course, the automotive industry, particularly in the US, has had a long history of business divisions supplying everything up to the heavy armor.

Uncrewed world gains from commercial availability

In the uncrewed world, there will be more crossover between civilian and military applications. It's a no-brainer. We've already seen it with smaller UAVs, the smaller drone sector, where the quality of commercially available, if you will, hobby drones has been sufficient.

The upper end of the hobby drone market is not that different from the short-distance battlefield surveillance drones. Sure, the heavy-duty stuff, like the Predator drones, and so on, are a special case. But for logistical support and tactical, battlefield information drones, we're seeing them as what were once carrying people's hobbies.

Photography is very similar to providing live updates on a battlefield. There's no functional difference. As an engineer, you always look at not what the solution is, but what the functional problem is that you have to solve.

The great electrification convergence

So, there's great convergence, but electrification is coming relatively late to military markets, which have been heavily dependent on internal combustion engines (ICEs) on the battlefield. It's easy to move to liquid fuels, you know. It's a little tougher to power everything by electricity, because moving electricity across a war zone is hard.

But because electrification has been lagging in military applications, they're now looking for commercial things that have been developed to satisfy commercial requirements, and saying, "Can we adapt these?"

Some of the smaller ground-based drones, for example, are already being used for things like ammunition supply and medevac kinds of applications. They're basically agricultural-type vehicles. They just need to traverse difficult terrain, but they're not particularly hardened in any way. They're not particularly armored. They just need to carry their payloads.

The only difference is in the communications protocols that you use. And obviously, when you're in a military situation, you have a different world of communications than in the commercial uses. So, you just plug a different set of radio gear onto the vehicle and you're working on secure comms rather than putting stuff up to up to cellular network.

Gardner: This cross-over trend that you've described strikes me as an inflection point, too, and that is the general design engineering principle of *fit for purpose.* And we can apply that to many systems and get great benefits, as you've discussed.

But another inflection point that results is in the economics. In the commercial space, when there's high production volume, prices come down. There's a virtuous adoption cycle of: lower price, higher adoption, yet even lower prices, etc.

Economics drives next wave of defense buying

At the same time, from the defense industry comes an increasing asymmetrical warfare incentive. There's been tremendously high funding around traditional military projects that can now be driven down by using fit-for-purpose and commercial industry economics.

So, how do you see the fit-for-purpose and asymmetric warfare principles driving more cost-efficiency and innovation across these markets?

Hudson: You're right. Defense spending globally had been a driver for innovation that supported lots of engineering and materials development. Effectively, a wealthy government paid for fundamental technology research, which later became declassified to the degree it can be used in commercial applications.

And now, those same defense procurement guys can say, "We don't need to reinvent this. We can just go and buy it." The opportunity now is to not spend massive amounts on non-recoverable expenses (NRE), but to use the money instead to buy products already on the shelf. It means you can deploy faster and in higher quantity than you would otherwise. So, I think that's definitely a factor.

We need to be careful, however, that this doesn't cause us to not be ambitious in the kinds of applications that we seek and the kinds of materials and technologies we pursue. While some of those older, notorious military activities went on for decades at exorbitant costs, they did stretch the boundaries.

We need to be cautious because in the commercial world those boundaries are typically set to what you can be done a fixed amount of time -- not what you can absolutely do given no limits. And so, we may leave some things under-discovered if we stick to purely commercial principles.

But for the fundamental stuff, such as efficient traction motors, as, of course, we at ePropelled are heavily involved in, there's no difference between the kind of traction motor you need to propel a small electric car and to equally propel a small electrified UGV on a battlefield.

You would absolutely have no need to re-engineer the motor, and you're going to buy that motor at the commercial cost, even if the military application is only for a few hundred units. In historical terms, the military cost would have been scaled to making a few hundred by crafting them by hand in a white-coat environment.

An enormous opportunity for spending disruption

So, there's an enormous market opportunity. And, if we analyze the mission closely enough so we can align the original commercial mission to the intended military mission, there's plenty of money to be saved. There is an opportunity to then reallocate defense monies to more useful kinds of deployments.

Gardner: Clearly, we're entering a very exciting time for uncrewed and unlimited. You've been on the cutting edge of mobility, as you mentioned, through your long-standing work in the automotive field. Tell us, David, about your background, and how you ended up at ePropelled.

Hudson: It's a story that, if you saw it written down on paper, it might not make a whole lot of sense, but there is a logic to it.

I began my life in in the automotive industry, initially working on noise and vibration dynamics. And that got me involved in a whole range of things on vehicle and powertrain-level stuff.

Back in those days, the late seventies through the eighties, it was all internal combustion, because the automotive industry at that time had pretty much forgotten about electrification. We know the history lesson, that there were more electric cars than ICE cars back in 1906 and 1910. But then we forgot how to do them, because the combustion engine got so much better.

I was brought up in the period where there was only one solution. And, in fact, in the luxury car sector, where I was working, that solution was only gasoline. It certainly didn't involve diesel at the time.

I got involved then with a lot of fundamental physics around the noise and vibration problem, but I also came into contact with the full range of vehicle technologies. That led me on to a group of assignments in the vehicle development field, where I got involved in vehicle engineering programs using typical automotive best practices that had been developed over many years and were common globally.

This was in Europe originally, but I later went on to do some assignments in Asia and in North America, which were more consulting-based. I was next taking the knowledge I had gained to help companies enter the next intersection, which was with EVs.

Electric vehicles re-enter the market

So, in the early 2000s, the EV was on the rise again. You know, we were starting to see hobbyists building their own EVs with some fairly scary parts at the time. But the mainstream automotive industry was just starting to become interested again in EVs. We had things like the GM EV1 program, which was definitely not a commercial, successful program, but was technologically a very big learning experience.

We had, of course, the Japanese starting to do work with the Nissan Leaf. Of course, Toyota, with their hybrid-electric vehicles, suddenly became something to be interested in. And as a curious automotive engineer, I wanted to know something about them.

Not being an electrical engineer, that was quite challenging, because all the original electric vehicles were a rather strange product of experienced automotive engineers who knew nothing about electricity and a bunch of electrical engineers who knew nothing about cars. So that resulted in some interesting war room conversations about how we did things.

But, yes, I started being responsible for building EV prototypes with a couple of companies. And that was in the last 10 years of what I'd been doing when ePropelled was founded. So back six or seven years ago, I was invited to become part of the board of advisors for ePropelled in its early days.

Then, a few years ago, I joined full time and became part of the team trying to deploy good solutions on a commercial basis for electrification. It's a slightly strange trip, but essentially started by understanding the physics of automobiles and their powertrains.

All vehicles share major design patterns

The source of the motivation is slightly different, but a car, truck, commercial vehicle, or military vehicle -- they all must do the same thing. They have to use some stored onboard energy to move in a particular way and carry a certain payload. They must maneuver over a period of time. So, the framework is the same. It's just that the tool chest we have to work with is somewhat different.

Gardner: Thanks. We've been talking somewhat generally about uncrewed and the opportunities and trends driving this very auspicious time. Let's drill down and keep our feet on the ground for the UGVs, the uncrewed ground vehicles.

We see a lot of innovation in the sky, the UAVs, the aerial vehicles. Both autonomous and remotely controlled. How is the progression of these technologies and the use cases moving in some pattern?

Is what we've seen in the sky what we're going to see on the ground? Or are there some unique opportunities on the ground? Let's speak to the opportunities for the ground vehicle market and whether that's a new innovation path.

Hudson: As we said a little earlier, the basic control blocks look very similar. So, the how we deliver it is very common. What we deliver does become slightly different, and the opportunity in ground vehicles is that you're not so constrained by the vehicle's mass and the battery size. If you're trying to fly an aircraft, the weight of everything matters down to the nearest gram.

Generally, ground vehicles have more freedom in how heavy they are and how large they are. We don't have quite the same criticality for removing absolutely every last gram of material. But, at the same time, we have an environment that can be very, very tough. You have a lot more vibration inputs, for example, on a ground vehicle.

So, you must use some of that mass to make everything more robust. But the opportunities in ground vehicles have also been driven by looking in the cupboard and saying, "What do we have available for propulsion systems? What's available for basic chassis components? How can we combine those into a ground vehicle?"

Looking at the uncrewed side of it, "What are the environmental networks available to guide that vehicle? Do we use GPS? Do we use things like Lidar and radar for sensors? And which of those are the most appropriate to control on a terrain-based vehicle?"

So, there are certainly some limitations but also a lot of opportunities for what you can realistically do in the electrically driven ground vehicles.

A diverse market demand for UGVs

If we divide up the UGV market, there are smaller UGVs up to around about one ton in vehicle mass. If we take that as a breakpoint, everything below that is pretty easy to electrify because you don't need a huge amount of power. You don't need a huge amount of battery energy.

Once you get much above four or five tons, they're almost impossible to do electrically because the vehicles are too heavy, and you'd make them even heavier with a bigger battery.

I mean, we're seeing a little bit of that in the sport utility vehicle (SUV) market now. Some of the larger SUVs and pickup trucks are becoming unreasonably heavy, and the same thing applies in a commercial or a military application.

You get to a point where it's hard to do a very heavy vehicle with an acceptable payload. But in the middle ground, between one and five tons, there's a, “It depends,” question. Maybe you can do it electrically. Maybe not.

So, yes, there are going to be UGVs that are not electrified. You'll get things up to main battle tank size, for example, that will be autonomous, but still be powered by 500- or 600-horsepower diesel engines. At the very small end, there will be dry cell battery powered. You can go and plug in some double AAs, and off you go.

There are going to be different market sectors with sweet spots. There will be things with a flowing and ready supply of available motors, transmissions, and batteries that apply to those particular vehicles. We have identified a few of those already, where some of the motors we have developed for other purely commercial electric vehicle applications work really well in solving the traction problems for any UGVs.

Gardner: One of the things that's a pass along from the electric aerial vehicles to the ground vehicles is a lack of a gearbox and managing torque manipulation more intelligently. And, of course, ePropelled has its eDTS patented technology.

Software and intelligence outperforms the gearbox

Is there a crossover here that we can look to in the ground where we have just the motor and software rather than a whole drivetrain to manage?

Hudson: The question of gearboxes and electric motors is always a compromise question. You can make an electric motor that produces huge amounts of torque at very low speeds. It just doesn't go very fast, and it may need large amounts of current.

So, typically electric motors must be designed with a balance. If you make a motor with very high torque, it’s typically a heavy motor and may have a lot of copper, iron, and magnets, all of which are expensive. It can be challenging.

So, you want to reduce the size of the motor to what is reasonable. And there comes a point where you can afford to buy a gearbox, to go on the back of it, to multiply the torque more easily than you can afford to multiply the torque without a gearbox.

So, it's like every engineering problem. There's always several ways to do it. It's not black and white. There's a continuum where you have to do that, and some in the middle is the right balance. Different teams will come up with a different compromise.

We already see it where some EVs on the road have two- and even three-speed gearboxes attached to them, as well as the electric motor.

Now, I'm not a great subscriber to that. I think if you size everything right, a single electric motor with a fixed gear ratio can usually be the right answer. I think we'll see that in the case of UGVs as well.

But you're quite correct in that. Here at ePropelled, we've developed a technology called eDTS, which stands for dynamic torque switching. And, in the old school way, a geared transmission is a torque switch. It's variable in that it gives different output torques to a given input torque, depending on which gear you choose.

We have a way of doing that on an electric motor that is seamless and dynamic, which is important. It gives you a second-to-second change in the way the motor is operating, and it allows you to get better torque and better efficiency.

Software is going to continue to help us. It's not a full replacement for all gearboxes. You still probably need a reduction gear, but with eDTS, most certainly -- and we've done the studies can substitute for two- or three-speed mechanical transmissions.

You can get the same thing effectively electronically with far fewer moving parts. And you know certainly that it's more compact, which is very important in all vehicles. You often have little space for the drivetrain.

Gardner: Sure, so less cost, less size, less weight, and fewer things to break -- so an interesting opportunity.

Hybrid propulsion improves trade-offs in UGVs

Another way to balance tradeoffs in the engineering of aerial vehicles is the use of hybrid propulsion. Again, a strong suit for ePropelled. Tell us how the hybrid opportunity is blossoming, if you will, for ground vehicles.

Hudson: Hybridization is definitely a good answer. Where you really can't do everything fully electric -- and that sort of crossover zone of the one- to five-ton vehicles, if you like -- may well be a place where we see hybridization happening quicker.

Normally, the definition of hybrid is that you have a combination of power from more than one source. And historically, that would be electricity and some sort of liquid fuel.

We're used to the idea that on hybrid passenger cars, for example, or hybrid trucks, we have a vehicle that's essentially an ICE-powered vehicle, but with a helper electric motor. And then that motor itself can also be used as a generator to harvest energy. So that's the conventional strong hybrid model as pioneered by things like the Toyota Prius.

But there are also applications where the vehicle is fundamentally an electric vehicle and has the ICE as a range extender. We've seen that with things like BMW I3, which had a range-extended version, and even the Chevy Volt was a range-extended electric vehicle, where the primary traction was provided by an electric drive system, but you topped up the range of it by running an ICE essentially as a generator.

And, in fact, Nissan has a product in the market today called the ePower, which is a similar technology. They have a small ICE and it's not directly mechanically connected to the wheels. It generates electricity, which then drives the motor. And that is very suitable for a lot of UGV applications, even in military situations. It's a little like submarines used to be where a diesel electric submarine would run in electric mode until it had no battery power, and then it would surface and run a diesel engine to charge the batteries, and then disappear again submerged as an electrically powered vehicle.

Gardner: Right. You also saw naval vessels where they had a jet engine running a generator that made the propeller spin from an electric drivetrain.

Hudson: Yes, exactly. So, hybrid electric propulsion is not an uncommon concept. It allows you to manage when you're running the ICE. Sometimes you don't want to be running an ICE when there's a risk of detection. But if have a relatively low detection risk, and you want to charge something up or you've got a location where you can, you can safely do that.

Hybrid for UAVs will be used for more UGVs

Having an onboard generator makes a lot of sense. But it should be tailored in terms of its output so to be optimized to the way the ICE operates. But the applications for these models will be out there.

As you correctly say, ePropelled has been a pioneer in the use of hybrid propulsion for UAVs, and we would imagine that all the applications that will come down to us for UGVs will be similarly benefited. And, in fact, we may even be able to take some UAV propulsion systems and use them as onboard generators for UGVs. That's something we're actively looking into.

Gardner: Another area we mentioned briefly at the beginning was the connectedness of vehicles, of being on a grid of some sort, and taking advantage of cloud or back-end intelligence in concert with processing on the vehicle. Fit for purpose when it comes to intelligence, if you will.

One of the things that's required for that, of course, is the gathering of data, and the more data from more places in the vehicle, the better. So, another ePropelled constant has been the ability to draw data from the subsystems that help identify where the strong and weak elements are, and over the course of the lifetime of the device.

Tell us how a connected infrastructure and a propulsion subsystem fit in well with a data-rich vehicle and working environment.

Hudson: The world is hungry for data these days on everything. And sometimes that's put to good use, and sometimes it's put to uses we'd rather not know about.

But the ability to sense everything about the way a vehicle is operating always gives you the option as an engineer to be able to make it work better, to find more optimal ways of operating something.

Whether you're looking at energy management in a more dynamic way, you're switching on and off things when you're able to, because you want to know where the vehicle is, and what it's doing -- all that means you need connectivity. And that can be in real time or periodic and downloaded. It just depends on what parameters you're trying to control.

But certainly, we are building in the ability to sense a lot of things about our motors and drive systems. It's very helpful for optimizing their performance. It's very helpful to doing diagnosis of anything that may be going wrong, and it's also a good thing for prognosis for looking at what the service requirements are going to be.

More data for more functions and reliability

We already see this in passenger cars, where the service interval is no longer a fixed number of driving units. It's when the vehicle decides to give you a service notification. The same thing will happen across every vehicle type in the future. And we're looking to maximize uptime. We're using this to look at having planned maintenance rather than failure.

And the ability to do that across some network protocol, and to save data off the vehicle so that you no longer have to bring it back to base to interrogate it means in real time you know where a vehicle is and what it's doing.

That's obviously a really good thing. It's a fleet manager role, if you like, and an essential part of the way the future is going. The amount of real time, off-board processing that can be done is beyond possible. We've looked at it for the early days of autonomous driving.

There were certainly a lot of ideas around having most of the processing off board the vehicle. But you then get into problems with how quickly you can exchange that data and what the latency of the connection is.

And so, we've worked harder on on-board capabilities and using the backup as a post-processing environment in which you can do deeper data mining rather than do real-time control. But certainly, real-time control is possible. Remote-piloted drones, for example, depend on a very secure and very reliable radio network to operate them over that network.

Two-way communications for added intelligence

It's running two ways. It's not just sending commands to the vehicle. It's also sending information back, including pilot video, for example, which is a data-intensive stream to manage. So, you have all the onboard radio communications that you need. It's a matter of getting the protocols on and off the vehicle to do it.

And that's where tools like our ePConnected product have driven us to look at all of the places we can use this by building it in. It goes back to a point we made a little while ago. If you build it in once, and you know what the software module and hardware look like, it's very easy to apply to a brand-new product without having to start again. You know where the hooks are, and you bring the same protocol and the same software into play.

Gardner: One of the good things about what we've been describing is a great variability and agility in how these systems and vehicles can do so many different things. The bad side of that is, it can be very complex.

So, one of the greatest solutions at our disposal now is managing that complexity through automation, through algorithms, and through machine learning technologies – on-board, in the cloud, or both.

And one of the great things about how our ePropelled systems have evolved is using dynamic torque management and automation to go to hybrid propulsion – back and forth from generator to motor, from ICE to electric motor. All of that can be managed and optimized using algorithms and automation. And then, of course, ePConnected tells us all the data that we need to bring even more intelligence and data into the equation.

So, it seems to me that yet another inflection-point that points to a great market opportunity is how that intelligence can be brought to bear across the entire mission. While you might have a human remotely managing this, they can ask the AI, "How best should I go 600 miles using multiple forms of energy? Give me the best possible outcome." And so the pilots don't have to manage the platform and propulsion complexity, they only have to manage the mission objectives, which is always the best way to go.

Hudson: Yes, I 100 percent agree there. And in a low-level way, we've had this going on for a while. If you look at the earliest days of navigation aids in our passenger cars, they were initially offline. You would have some sort of map database to figure out the best route from point A to point B, and then it would spit out a bunch of paper, which we then take into our car and drive the route.

Now we have the luxury of having that all on-board, live, and real time. We have it gathering traffic information and crowdsourcing all the data. All in the background. We don't know how they work, and we don't care how they work, but we always know when they don't work, because that's when it dumps you into a traffic jam or down that road that you really didn't want to go down. But every year brings a level of sophistication to those tools.

AI to improve potential for mission agility

And, as you say, the applications of machine learning and generative AI means that suddenly the potential only gets greater, sometimes by orders of magnitude. And in some cases, it's scaring us. And in some cases, it's thrilling us. So, I think that the skill for the engineering community in the future is going to be to harness the power of this in the most creative way.

There are a few vehicle applications that already look ahead on the map and decide when they can need battery power and when they can use ICE power. That's already happening. And you know, we're using it to manage range and energy consumption. And, of course, that's for the greater good of the environment. So yes, the tools that are now available are becoming ever more powerful.

We are getting expert groups effectively saying, “Don’t worry about what's in the box. We'll figure that out. But here's what the box does.” And that all plays back into this idea that vehicles are a collection of arranged modules. It's these building bricks you can plug together in the right way. So the main engineering task these days is system integration and making sure there's compatibility.

And that requires that you have the basic protocols well-defined. We have things like networks, which are well known. There are published standards. Most people in the world operate to those standards. There are military standards, too.

But if we know which language we're talking, and which set of protocols we're using, and we have a connector for that protocol, then making diverse systems work together is not that difficult.

Gardner: Well, we're almost out of time, David. It's been a fascinating discussion, and I think the opportunity as explosive is perhaps an underestimation of where we're going in the next five years or so.

But we've been talking in abstract terms. Are there any more concrete examples? Or at least use cases that you look to and say, “Wow, that is a harbinger of things to come?”

What are some concrete examples of how the UGV opportunity is manifesting itself today that might give us some inclination as to what's to come?

Hudson: Yes, there are many. I was recently looking at a survey of the UGV market, and there were 45 or 50 companies or organizations involved in some UGV activity. And, in fact, a similar number in the marine environment for unmanned surface vessels (USVs). And some of those are huge players. They're the multinational defense organizations.

But there are some very interesting smaller players emerging. And we've engaged with one of those, a company called Pulse EV. They've developed a small-tracked vehicle. It's being developed from a leisure activity vehicle that was manned recreational mini-tank, and they have adapted that so now it's an autonomous UGV running various agricultural missions.

A common UGV platform for many uses

It can carry, for example, a spray boom rig for moving around fields and spraying pesticides. It's a tracked vehicle. It's very maneuverable. It can turn on the spot by running the tracks in opposite directions.

It's being designed to be flat packed and assembled on site. So, it's much easier to ship. It uses a couple of small motors, so less than 10 kilowatts each, and a couple of battery packs of 10 or 15 kilowatt hours and can run all day.

This company has developed a couple of prototypes. They've sold them into an agricultural college. Interestingly, and as a result, they now have military users coming along saying, “Hey, can we take your agricultural vehicle and use it in a military environment?”

These things started as hobbies, and it takes just one spark for those things to catch on and be applied to other types of vehicles. We've now looked at that market. And there's three or four other companies already working in that same field and claiming many of the same benefits, so as a supplier into the into those new markets.

We think there's an untapped depth of the potential volumes. But in terms of the use cases, every one of these companies has started with a particular use case in mind, and whenever they look across the shoulder to the other people they see, “Oh, well, these guys are doing this as well.”

And that comes back to this idea that modularity and flexibility of the vehicle designs really works. And in fact, the guys at Pulse have now looked at putting a wheeled version of this vehicle together for places where tracked operation isn't appropriate, where perhaps you want slightly higher speeds.

They're now looking at taking the same controls core effectively and putting it onto a wheel chassis. So, yes, there are some great opportunities out there. And, of course, our job is to look at who's out there, who's interesting, and who needs motors and come up with good solutions for them.

Last question, David. For those engineers who are designing these new breeds of UGVs for myriad use cases and environments, what are some of the basic tenants that they should keep in mind when they're specifying the subsystems and solutions?

Plug-and-play modularity and standards-based come to mind. But what else should they be thinking about when they're looking for the best fit for now and for the future?

Hudson: Clearly fit-for-purpose is the motto that goes along with all of this. Durability is another important factor. UGVs by definition don't have an onboard minder. They don't have somebody sensing what's going wrong with them. So, if they're not very robust and very reliable, they could unexpectedly fail.

We've talked about having on-board diagnostics and prognostics, but there's still a need to get a feel for something, of whether it's behaving the same today as it was yesterday. We need to make sure that the level of reliability we offer is very high, and that should be high on people's shopping lists.

Energy efficiency a benefit from modular design

And energy efficiency is important. Everything we do and buy in the world these days must be driven by more efficient use of energy. We've realized that slowly this planet is reacting in a bad way to us using energy wrongly, and we've got a limited amount of time to use it better.

I think UGVs are not immune from the same trends. So, as well as all the suitability for purpose, we really have to look at that qualitative thing about how light the touch is on the planet, too.

Gardner: I'm afraid we'll have to leave it there. You've been listening to and reading a discussion on the new electric and uncrewed vehicle markets, particularly for the ground environment.

And we've been given a great deal of information, vision, and insight from David Hudson, Product Manager for Ground Vehicles at ePropelled. Thank you so much, David.

Hudson: Thanks very much, Dana. It's been good.

Gardner: I'm Dana Gardner, your moderator for the ePropelled Podcast series. Thanks for being an essential part of our audience.

Look to ePropelled for solutions

Based in Laconia, NH, USA, ePropelled, Inc. designs and builds a broad array of robust and intelligent propulsion systems for uncrewed vehicles.

The company empowers uncrewed vehicle designers to unleash their total mission creativity by solving the requirements for agile and efficient propulsion systems and solutions.

ePropelled delivers complete electric propulsion solutions, including propulsion motors, engine starters, intelligent power systems, starter generators, and intelligent air motor controllers.

From tiny to massive, from farm fields to the edge of space, ePropelled's broad range of propulsion solutions leverage patented advances in real-time software to enable hybrid and highly adaptive thrust power delivery across myriad vehicle and energy supply scenarios.

Through ePConnected™, unmanned system performance and reliability are always measured and managed, setting new and ever-improving standards in efficiency and innovation.

For more information, contact ePropelled at info@epropelled.com, call 603-236-7444, or visit https://epropelled.com.