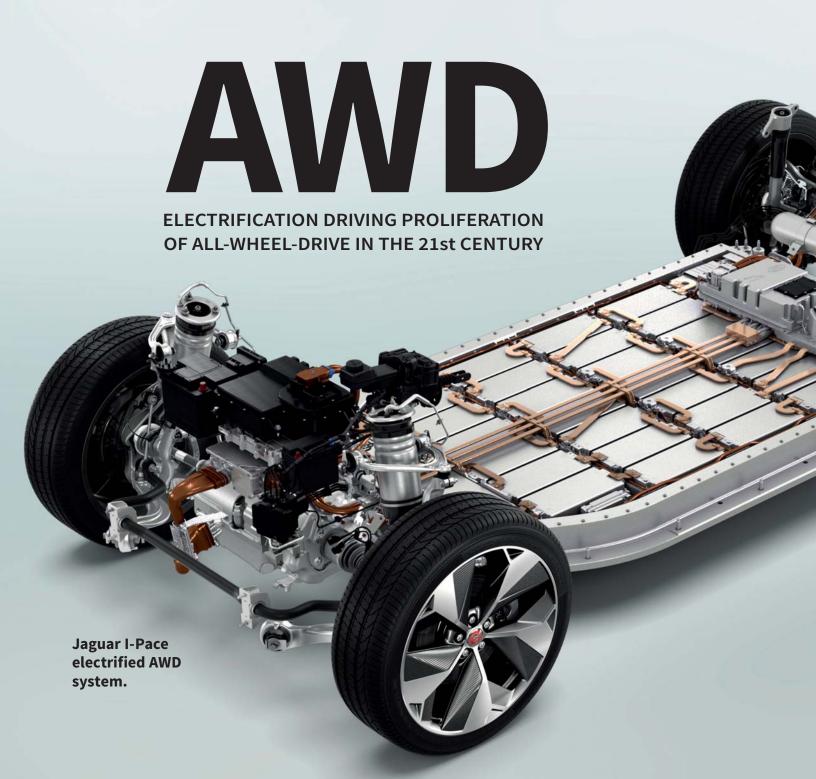


THE BIG STORY / JULY 2018





Ford F-150 Raptor.

Technology Drivers **8** 

> What's Ahead **17**

SK A HANDFUL
OF POWERTRAIN
ENGINEERS TO DEFINE
ALL-WHEEL DRIVE

and you'll likely get as many descriptions as there are AWD systems. The fact is, variants of AWD and 4WD are proliferating in the marketplace as trucks, SUVs and CUVs claim an increasingly large slice of the automotive landscape.

A Wards Intelligence report, "AWD Electrified," finds that while the shift to CUVs and away from traditionally 2-wheel-drive sedans and coupes is a primary driving force, other factors are leading automakers to offer AWD and consumers to expect and demand AWD in their vehicles: improvements in fuel efficiency, easy control of AWD systems and dynamic handling benefits. And



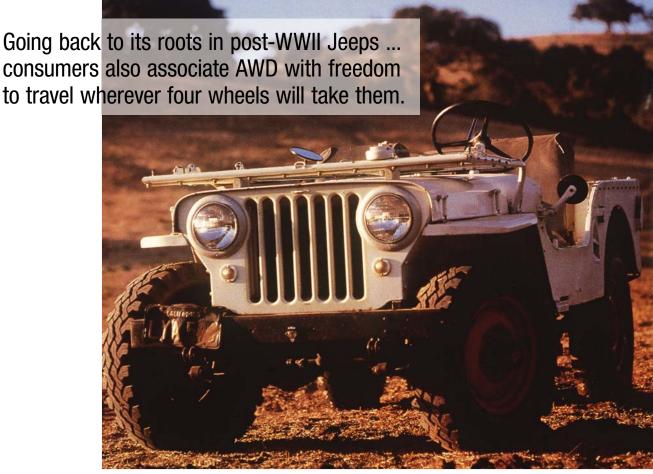


# GM Supplier of the Year 2017



Nemak is honored to announce that we have been named a winner of the GM Supplier of the Year Award in 2017. This award is a great achievement, demonstrating our ability to provide outstanding value, quality, performance and innovation. We look forward to continually exceeding expectations while providing innovative Lightweighting solutions for GM and all of our customers in the future.

Thank you to the GM & Nemak teams.

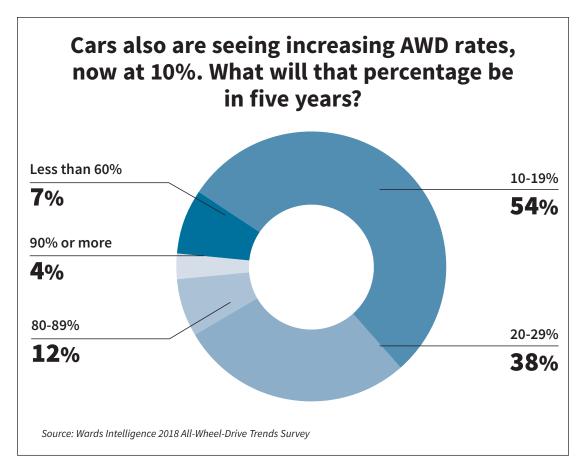


going back to its roots in post-WWII Jeeps and Land Rovers, consumers also associate AWD with freedom to travel wherever four wheels will take them.

"There's an interest in consumers for getting away from all the buzz of the city and the buzz of our cell phones and so on and...going out there and having those experiences with your friends or your family," says Seth Metzger, vice presidentlight vehicle engineering and global electrification at powertrain supplier Dana. "It's either for safety and/or mobility, or in other cases that ability to go anywhere and get out of the city, so to speak, to enjoy the outdoors."

Regardless of the reasons, AWD that once was viewed mainly as an off-road and towing enabler for the few has become a must-have feature for a broad range of



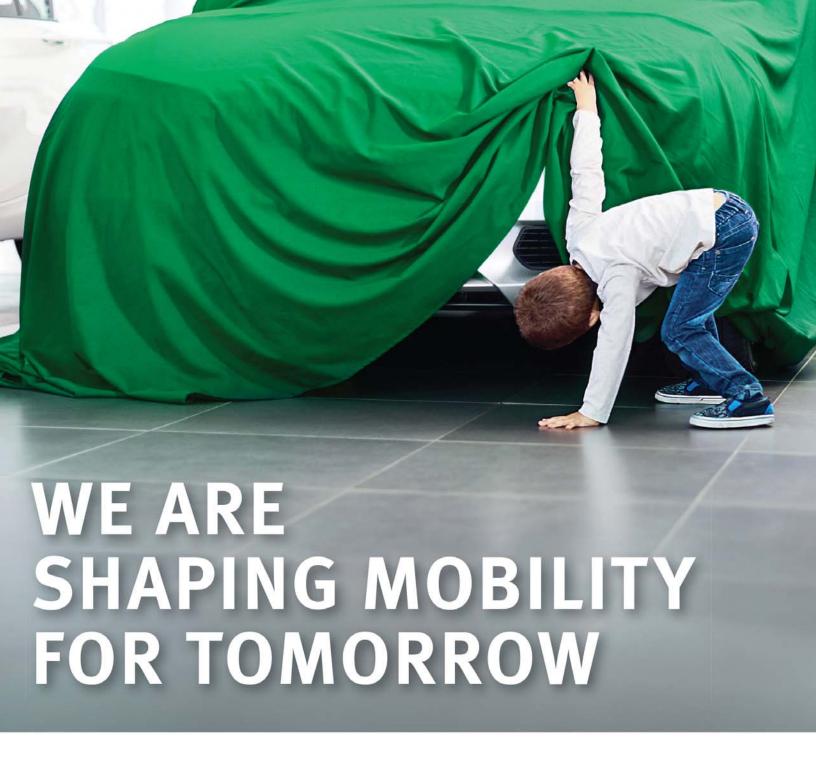


new-vehicle buyers.

As recently as 1995, AWD (including more traditional 4-wheeldrive/4x4 technology), was installed on just 15.9% of new vehicles sold in the U.S., mostly traditional bodyon-frame trucks and SUVs, according to Wards Intelligence data. However, demand has creeped up steadily from there, reaching 22.1% penetration in 2000, then jumping to 30.0% in 2005 and 36.1% in 2015.

Last year, a record 42.7% of light vehicles sold in the U.S. were equipped with AWD, as penetration on cars neared 10% and more than 61% of light trucks were delivered with the feature. That marks a sharp rise from just a year earlier, when installations accounted for 38.3% of the light-vehicle market overall.

Trends point upward globally as well, as key markets such as Western Europe and China fol-

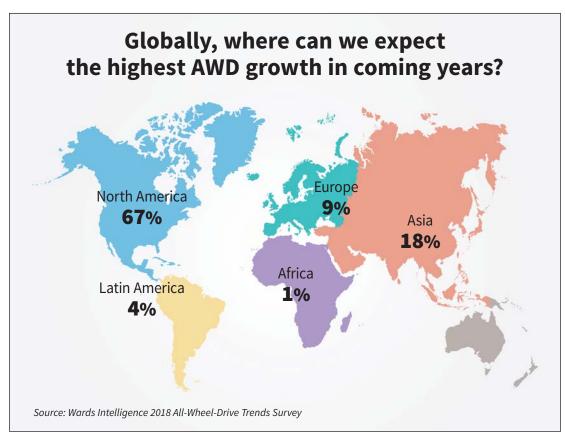


There's an inherent curiosity among Schaeffler's automotive engineers. Creating new paths to develop ideas and thinking beyond barriers is as important now as it was when the company first began in 1949.

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low the U.S. model in embracing CUVs and AWD. Wards Intelligence data shows the Asia-Pacific region leads in production of AWD vehicles, building 7.3 million in 2017, outpacing North America's 6.9 million. In Europe, 4.1 million AWD vehicles were assembled last year.

While the more mature North American and European markets have higher overall AWD installation rates, Asian AWD take rates are "exploding in growth," Metzger says.

"If you look at several years ago, all-wheel drive was a very, very low percentage (in Asia)," Metzger notes. "We're seeing a large increase in growth there."

In total, 18.8 million AWD vehicles were built in 2017, accounting for 20.0% of the new light vehicles produced globally and that figure is expected to continue rising, according to Wards Intelligence forecasts.

"The share of SUVs is growing



Ascent latest Subaru with Symmetrical AWD. around the world," notes Kaoru Sawase, chief technology engineer in Mitsubishi's EV powertrain division. "That should result in an increase in AWD sales and share."

"The trends are definitely moving towards all-wheel drive," agrees Peter Tenn, car line manager-Subaru of America. "We see it growing, even with the advent of electrification and autonomous vehicles. We think there's going to be a place for all-wheel drive and giving the customer that driving confidence no matter where the technology goes."

### Technology Drivers

Back to that initial question:
What exactly is today's definition
of AWD vs. 4WD? While marketing
plays an ever-increasing role in
creating consumer perceptions
of what makes a system AWD,
4WD or 4x4, powertrain experts
tend to agree on some general
principles: AWD typically involves
a center differential allowing fulltime operation without negatively
affecting drivability, while 4WD
(often also referred to as 4x4)
harks back to more traditional



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systems with the ability to lock both axles together via a central transfer case to provide superior off-road capability.

AWD-equipped vehicles usu-

ally are intended primarily for onroad use while 4WD vehicles tend to feature higher ground clearance, beefier underbody protection and off-road tires better suited for harsher use. Low-range gearing and locking axles and transfer cases also tend to define 4WD

But because today's AWD vehicles can be fitted with comparable

equipment to 4x4s, while 4WD vehicles can offer the on-road drivability of AWD models, the lines are getting fairly hazy. For instance, while a Jeep Cherokee 4x4 might not have the capability of a high-riding Ram Power Wagon, the road-ready Jeep CUV does offer low-ratio gearing and a rock-crawling mode that gives it serious 4x4 off-road credentials. Meanwhile, the Power Wagon is a reasonable on-road driver despite

### AWD vs. 4WD

Powertrain experts tend to agree on some general principles:

#### **ALL-WHEEL-DRIVE**

typically involves a center differential allowing full-time operation without negatively affecting on-road drivability.

#### 4WD / 4x4

has the ability to lock both axles together via a central transfer case to provide superior offroad capability.



its rugged solid axles and locking front and rear differentials capable of tackling nearly any obstacle.

"It's largely a marketing thing and the terms are blurred somewhat," observes Ashok Rodrigues, Ford's all-wheel drive technical leader. "Vehicles that we would call 'all-wheel drive' are actually highly capable off road.

We still run those through our offroad tests. But vehicles that we call '4-wheel drive' are very composed vehicles when you drive them around on dry pavement. So that line is blurred from that standpoint.

"But '4-wheel drive' is generally



Rugged 4WD enables Ram Power Wagon to traverse nearly any terrain.

used when the rest of the vehicle is more capable of off-road operation. In an F-150 you certainly expect to be able to do more than you would with the Edge. The rest of the vehicle is set up for it, it's got a higher ground clearance, it's got tires that are more suited for off road. And while you can take the Edge off road, you'd expect reasonably more with the F-150."

Maybe more important than drawing distinctions between AWD and 4WD are the userfriendly electronic controls and improvements in driveline efficiency that have fostered wider consumer acceptance of AWD.

In conjunction with the market shift to CUVs, full-time, ondemand AWD and easy-to-operate controls have made the systems far more accessible to the everyday driver. Except for some severe off-road vehicles, most systems today eschew mechanical levers, linkages and locks to manage the driveline in favor of electronically switched systems that employ electrohydraulic



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**Jaguar Land Rover Terrain** Response Control manages **AWD** modes.



or electromechanical levers to engage and disengage AWD as needed.

Some of the most sophisticated systems perform these functions automatically, using myriad vehicle sensors, and indicators such as whether headlights and windshield wipers are turned on, to determine whether to activate AWD.

Additionally, multifunction electronic controllers such as Ford's Terrain Management System, Jeep's Selec-Terrain and Land Rover's Terrain Response Control

combine a number of AWD modes in a single, easy-to-use knob. Options available via Ford's controller, for instance, are normal, mud/ruts, grass/gravel/snow and sand. Selecting a given mode affects front-rear torque bias, transmission gearing and engine throttle mapping, and stability and traction controls.

Meanwhile, driveline engineers are significantly reducing the amount of energy lost to AWD's multiple shafts, gears and clutches by managing friction, using ultralow-viscosity oils to lubricate mov-





ing parts and carefully controlling oil-flow patterns. Attention to lightweighting also improves overall vehicle efficiency.

Global drivetrain supplier Dana claims these steps cut parasitic losses 80% in its third-generation AdvanTEK AWD compared with the prior generation. Reducing or eliminating AWD's fuel-economy penalty means the systems can be deployed on a larger number and wider range of vehicles, providing more drivers with the traction and safety benefits of AWD, says Dana's Metzger.

The final step to efficiency is automatically disconnecting AWD, now in production in a range of vehicles including American Axle & Manufacturing's EcoTrac system on the Jeep Cherokee, Chevrolet Equinox and GMC Terrain CUVs, and British supplier GKN's system on several Fiat Chrysler models such as the Jeep Compass.

The systems use clutches at the rear differential and the front power takeoff unit to completely shut down all moving parts, except the rear-axle side shafts, when AWD isn't needed. GKN says



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Honda's fourth generation SH-AWD debuts on '19 Acura RDX.

its disconnect provides a 2% fuel savings compared with non-disconnecting AWD, while AAM says EcoTrac makes AWD nearly as efficient as a comparable front-wheel-drive vehicle.

Finally, the ability to improve a vehicle's dynamic performance through the application of torque-vectoring AWD adds yet another reason for automakers to install the systems on certain vehicles to improve handling.

Torque-vectoring AWD uses clutches in the axles to actively apply torque to the wheel with grip in a cornering maneuver, effectively powering the vehicle through the turn rather than applying brakes to force torque away from a wheel, losing

traction and causing a loss of momentum.

Although initially limited to high-performance applications such as the Ford Focus RS, torque-vectoring AWD is now offered on more mainstream vehicles such as the all-new Acura RDX and Jaguar E-Pace CUVs.

"The result is that the car just drives fantastically," says Aaron Alexander, senior engineer at Honda America R&D, who has worked on the last three iterations of the Japanese automaker's torque-vectoring Super Handling All-Wheel Drive. "It feels like it always has the grip that you're looking for, and the car always goes where you want it to go."





Jaguar I-Pace has electrified front and rear axles.

# What's Ahead?

Electrification is bringing considerable change to AWD as rapidly developing motor, battery and hybrid technology holds the promise of incorporating AWD in a wider range of vehicles, as well as the ability to offer AWD without a fuel-efficiency penalty.

Although the global volume of battery-electric vehicles will remain in the single digits until at least 2025, an increasing number of BEVs will incorporate AWD as an enabling technology.

Electrified axles offer the benefit

of adding AWD without the need for driveshafts and other connecting hardware, as well as the ability to easily scale AWD capability for the size and use of the vehicle.

"For 99% of what the market does, transporting kids and groceries, a low-powered e-axle – enough to get them out of slush and snow and maybe some dirt and mud – is more than sufficient," notes Jim Harkins, director-Denso electrified systems engineering.

E-AWD also permits torque vectoring by employing multiple electronically controlled motors driving each axle or individual wheels as needed.



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Volvo XC90 T8 R-Design.

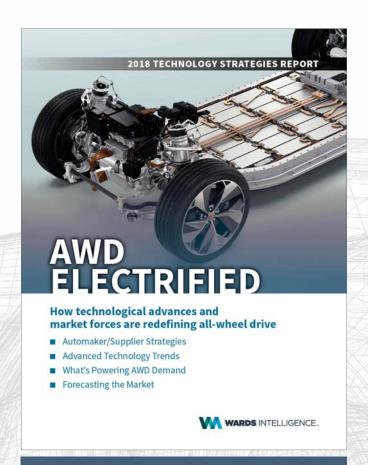


"You're...much more flexible to switch between front-wheel or left front or right front," says Hendrik Muth, head of product planning for Volkswagen of America. "You can even optimize that (torque distribution) much more without losing efficiency. I think all-wheel drive (will be) growing in this one."

AWD also is expected to be a must-have feature for autonomous vehicles that will be used in ride-hailing fleets and other commercial applications such as package delivery to ensure all-weather traction as well as assured handling. However, volumes will remain minimal near-term.

At the leading edge of e-AWD are performance applications such as those found in vehicles like the Acura NSX, BMW i8 and the Porsche 918 Spyder, but automakers already are developing mainstream performance vehicles incorporating e-axles such as the coming Ford Mustang hybrid and Volvo's Polestar-branded e-AWD models.

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Visit WardsIntelligence.com/AWD-Electrified to learn more and order now!

### WARDS INTELLIGENCE...

# HOW HAVE NEW TECHNOLOGIES REDEFINED WHAT 4x4 AND AWD MEAN IN THE 21st CENTURY?

And how do old-school solid-axles, transfer cases and crawl ratios stack up against advanced electronic clutches, electric axles and brake-force distribution systems?

This report takes a deep dive into what's next in all-wheel drive technology, including the impact of electrification on the sector, development plans and market strategies of both OEMs and suppliers and the potential for global demand and growth.

### THIS REPORT IS INTENDED FOR:



**Product Planners** 



Market Analysts



**Academics** 

Others would benefit from a detailed examination of the industry's plans for electrified all-wheel-drive technologies

For more details on this or any other Wards Intelligence product or service,

Wards Intelligence forecasts AWD vehicles will account for 22% of global production in 2025, with North America boasting the highest growth rate, followed closely by Asia-Pacific and Europe.

The forecast is in line with the outlook from respondents to a recent Wards Intelligence industry survey, in which 67% said North America would exhibit the highest AWD growth rate in coming years, followed by Asia (18%) and Europe (9%).

Among the five countries with production of more than 1 million AWD vehicles annually, the U.S. will continue to be the top-ranked producer through 2025, but China, currently No.3, is expected to surpass Japan to move into second place by 2020. Mexico is seen displacing Germany in the No.4 spot by 2025.

By 2025, there will be five automakers building more than 2 million AWD vehicles annually: FCA, Ford, Renault-Nissan-Mitsubishi, Toyota and Volkswagen. General Motors is forecast just shy of that mark.

AWD is gaining momentum in

the marketplace, with purposebuilt, electrified AWD CUVs like the Jaguar I-Pace leading the way.

"We called it the three waves of electrification," says Ray Kuczera, senior vice president-engineering, GKN Driveline. "The first wave was kind of the niche ones, the BMW i8, the Porsche 918 – technology demonstrators. Wave two was kind of converting existing platforms to having e-axles or hybridization. Wave three is cars that were designed from day one to be electrified or hybrid. And we're starting to see the wave three cars coming very soon." WA



This story
was written
by Industry
Analyst Bob
Gritzinger,
a longtime
journalist and

industry observer who covers automotive propulsion technology for Wards Intelligence.