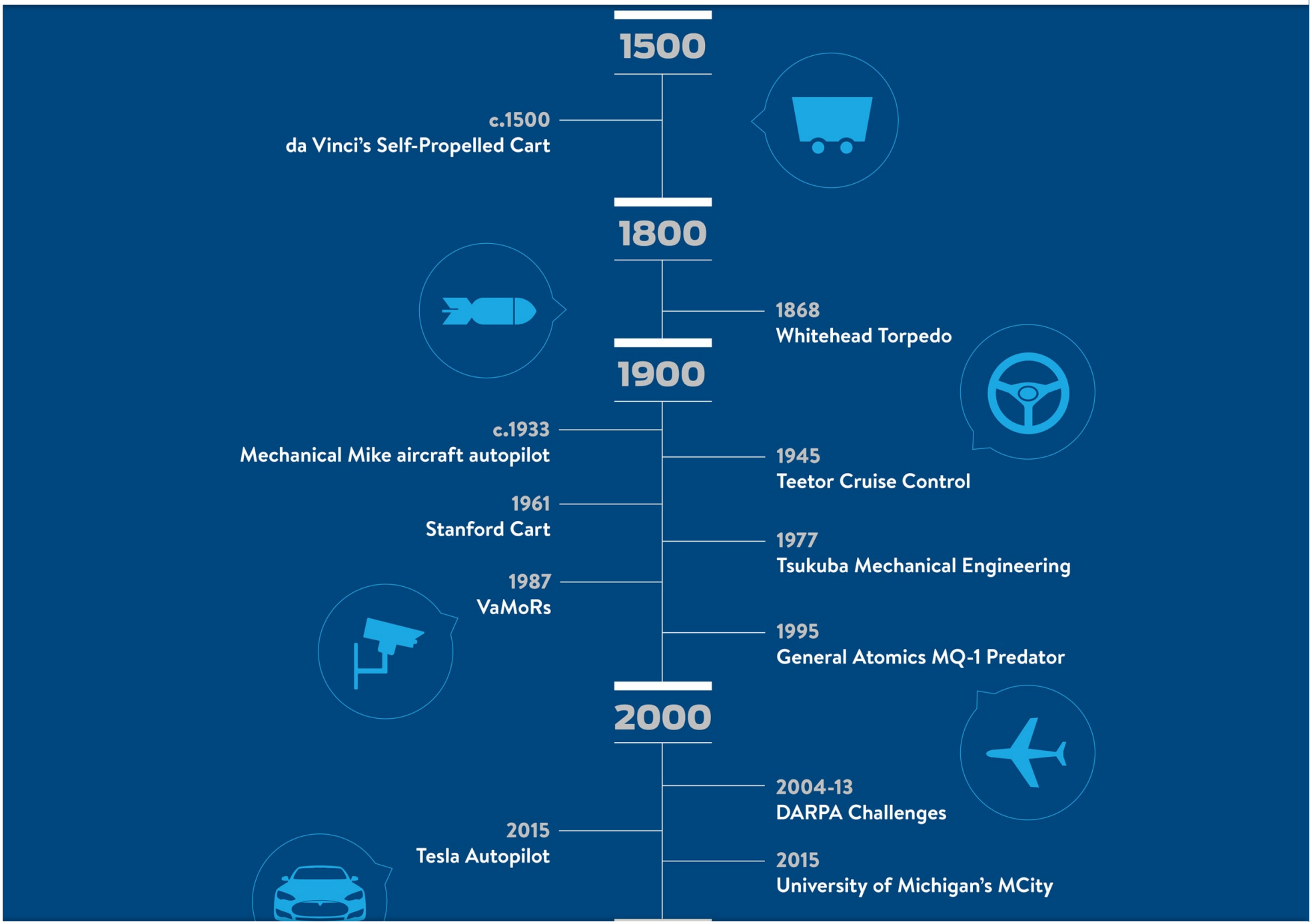

A BRIEF
HISTORY OF
AUTONOMOUS
VEHICLE
TECHNOLOGY

THE PROSPECT OF autonomous cars may still seem impossibly futuristic. Their coming debut will take our hands off the wheel and has followed an evolutionary path that stretches back to Leonardo da Vinci and beyond.

Companies such as Ford, Mercedes and Tesla are racing to build autonomous vehicles for a radically changing consumer world. Ford, for instance, recently tripled its investment in its autonomous vehicle fleet and is testing 30 autonomous Ford Fusion hybrids in California, Michigan and Arizona. And yet, the fingerprints of tech history can be seen in almost every aspect of their exciting new capabilities.

In this piece, we dug back into the history of autonomous technology and returned with an array of key breakthroughs—covering land, sea, and air—that built the foundation of the cars of tomorrow.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da Vinci's Self-Propelled Cart
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1868
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Mechanical Mike aircraft autopilot
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Teetor Cruise Control
1961
Stanford Cart
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Tsukuba Mechanical Engineering
1987
VaMoRs
1995
General Atomics MQ-1 Predator
2000
2004-13
DARPA Challenges
2015
Tesla Autopilot
2015
University of Michigan's MCity

da Vinci's Self-Propelled Cart—c. 1500 Centuries before the invention of the automobile, Leonardo da Vinci designed a cart that could move without being pushed or pulled. Springs under high tension provided the power to the cart, and steering could be set in advance so the cart could move along a predetermined path. A distant precursor to the car, the device is sometimes considered the world's first robot.

Whitehead Torpedo—1868 While these weapons of war emerged in the mid-1700s, Robert Whitehead's invention of a torpedo that could propel itself underwater proved to be a game-changer for naval fleets around the world. The Whitehead torpedo could travel several hundred yards underwater and maintain depth, thanks to a pressurization system dubbed "The Secret." Torpedo guidance would evolve dramatically thereafter and led to a wide range of weaponry, aircraft, and other autonomous devices.

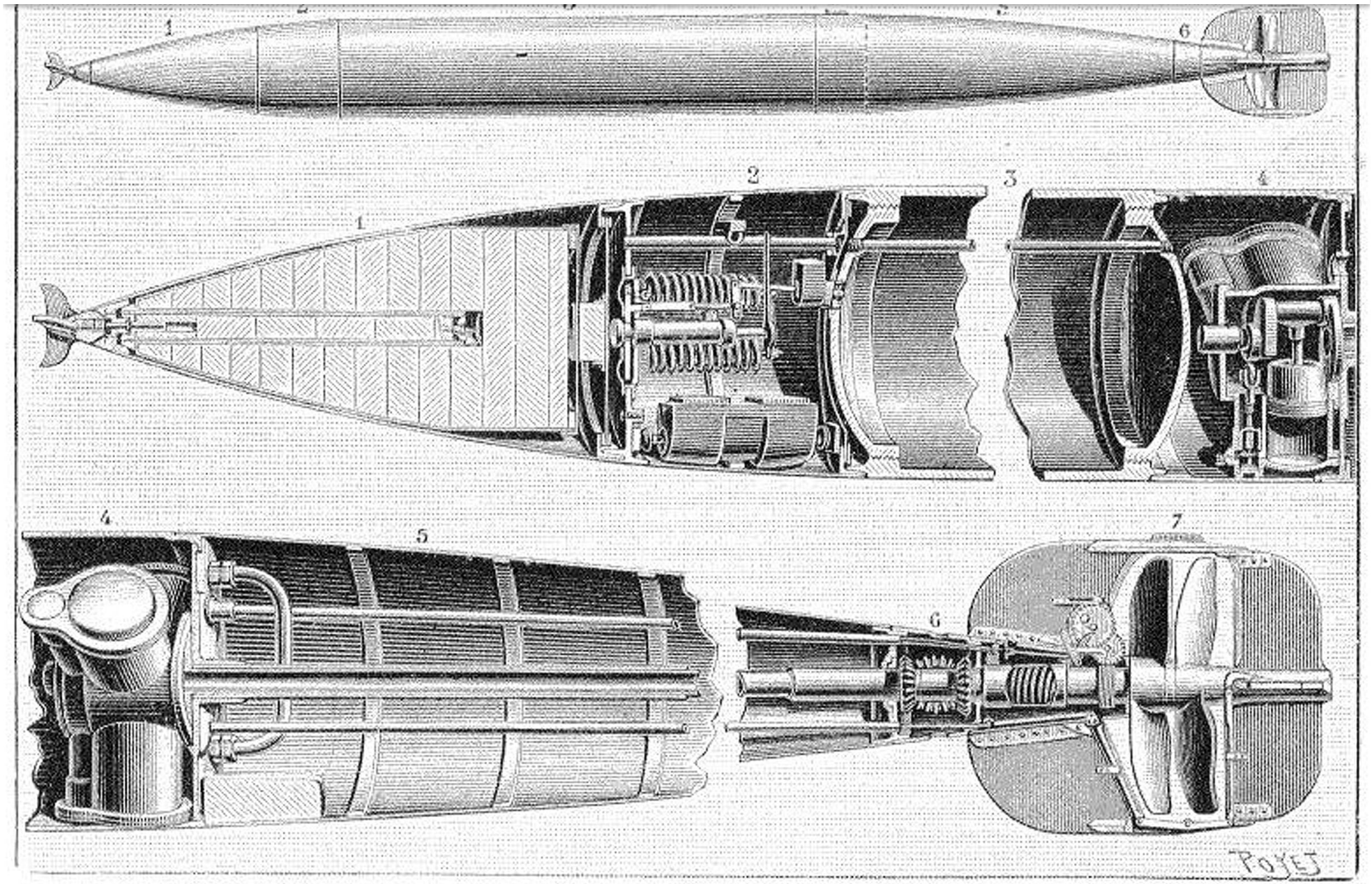


Fig. 1. — Torpille automobile Whitehead. — 1. Magasin. — 2. Chambre à secret. — 3. Réservoir d'air comprimé. — 4. Chambre des moteurs à air comprimé. — 5. Flotteur ou chambre de flottaison. — 6. Mécanisme de commande de rotation des hélices. — 7. Hélices et gouvernails.

Mechanical Mike aircraft autopilot—1933 Extended travel times forced the development of autopilot systems for long-range aircraft. Mechanical Mike was a prototype autopilot designed by Sperry Gyroscope Co., and used by Wiley Post during a 13,000-mile, around-the-world flight in 1933. Gyroscopes kept track of the plane's heading and interfaced with the controls to ensure accurate direction. Gyroscopes remain an integral part of autonomous vehicle tech today.

Teetor Cruise Control—1945 An engineer became so fed up with the rocking motion he experienced while riding in a car with his attorney behind the wheel that he developed one of the first cruise control system to smooth out the ride, using a mechanical throttle that could set the vehicle's speed. The invention was commercialized in 1958.

Stanford Cart—1961 With the space race in full swing, researchers began to ponder landing vehicles on the moon. The idea of a remote-control lunar rover was posited by James Adams, a Stanford engineering graduate student–but how would it be controlled given the 2.5-second delay between when a command was sent from earth to when it was received by a rover on the moon? The solution ultimately led to the development of the world's first truly self-driving wheeled vehicle. The Cart, as it was called, was eventually outfitted with cameras and programmed to detect and autonomously follow a solid white line on the ground. Today, successor technologies using cameras remain a vital element of autonomous vehicles.

Tsukuba Mechanical Engineering—1977 As groundbreaking as the Stanford Cart was, it was still just a four-wheeled cart that looks more at home in the kitchen than on a roadway. Japan-based Tsukuba Mechanical produced an autonomous passenger vehicle that could recognize street markings while traveling at nearly 20 miles per hour, thanks to two vehicle-mounted cameras.

VaMoRs—1987 Another important step forward in autonomous tech came from German engineer Ernst Dickmanns, who equipped a sedan with a bank of cameras and 60 micro-processing modules to detect objects on the road—in front of and behind the vehicle. Dickmann's key innovation was "dynamic vision," allowing the imaging system to filter out extraneous "noise" and focus only on relevant objects. Today, this type of imaging is crucial in helping self-driving vehicles identify potential hazards and their locations. VaMoRs proved so successful that it was able to navigate Germany's famous Autobahn at speeds of up to 60 miles per hour.

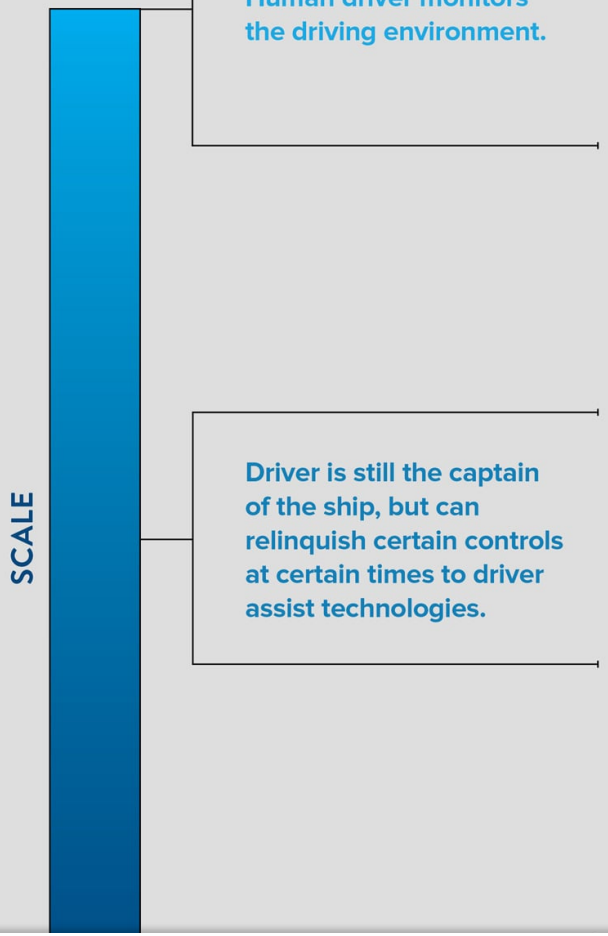
General Atomics MQ-1 Predator—1995 While we tend to think of autonomous vehicles as a means of converting humans from drivers to passengers, another class of autonomous devices are designed to travel completely alone. Nowhere is this more visible than in the world of drones, the most noteworthy of which has been General Atomics' Predator, an unmanned plane that for 20 years has been piloting over global hotspots for 14 hours at a time. Drones aren't just military vehicles, of course. The Predator is decked out with technologies being adapted for cars, including radar that can see through smoke or clouds and thermal imaging cameras that enable travel by night.

U.S. AIR FORCE PHOTO/LT COL LESLIE PRATT

technologies forward. In 2004, a competition was held to challenge vehicles to self-navigate 150 miles of desert roadway. While no car completed the route, subsequent challenges have seen dramatic leaps in capabilities. The 2007 challenge simulated a 60-mile long urban environment, with four cars completing the route in the allotted six-hour time limit.

Tesla Autopilot—2015 The most significant aspect of Tesla's semi-autonomous "Autopilot" feature, introduced in late 2015—which enabled hands-free control for highway and freeway driving— is that it was delivered in the form of a single software update to Model S owners overnight.

LEVELS OF AUTONOMY



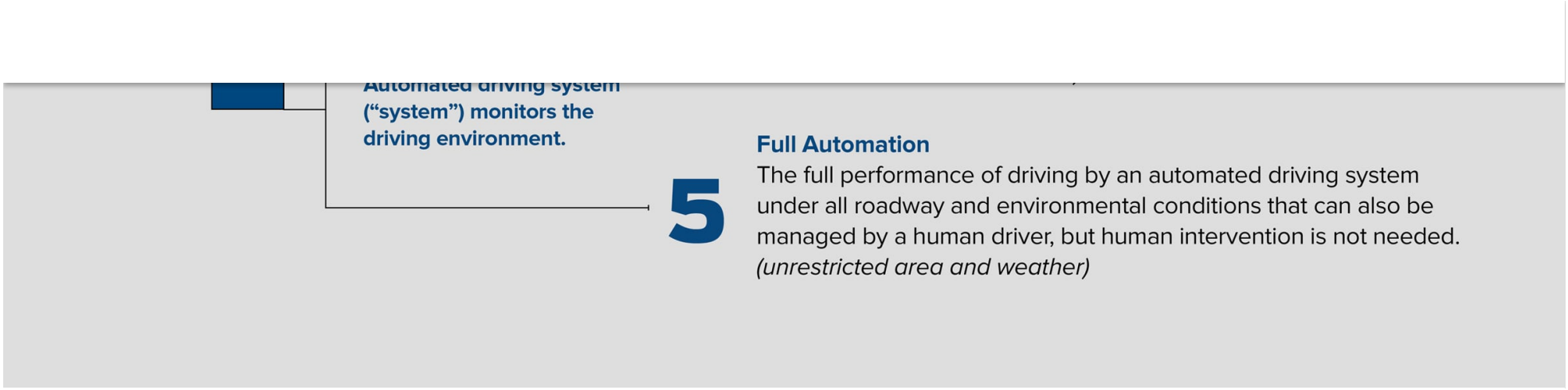
0 No Automation
The full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems *(i.e. Cars from 20 years ago)*

1 Driver Assistance
A driver assist system of *either* steering or acceleration/ deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects the driving task.

2 Partial Automation
Driver assist systems are able to control both steering and acceleration/deceleration by using information about the driving environment while the human driver performs all remaining aspects of the driving task *(I.e. The system executes the steering/accerlation and deceleration, while the human monitors and acts as the fallback "system").*

3 Conditional Automation
automated driving systems perform all aspects of the driving task, with the expectation that the human driver will respond and intervene when needed.

4 High Automation
Performance by an automated driving system of all aspects of the driving task, even if a human driver does not respond



University of Michigan's MCity—2015 The University of Michigan's 32-acre Mobility Transformation Center, called MCity, launched in 2015 as a world-class test facility for autonomous vehicle technology. Ford became the first automaker to test autonomous vehicles there, and in the harshest environmental conditions imaginable.

Perhaps the most exciting part of the dawn of the autonomous vehicle era is the collaboration between private industry, government, and academia that has already begun to fully introduce autonomous cars into our lives. As noted artificial intelligence expert Andrew Ng said recently, making autonomous vehicles a reality "cannot be done by any single organization. It will require a public-private partnership, and a community of legislators and researchers and technology companies and automobile manufacturers." At the same time, he adds, the pace is accelerating. These amazing new machines, Ng says, "will join human drivers on our roads sooner than most people think."

This story was produced by the WIRED Brand Lab for Ford Motor Company.

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