Innovation drives Michigan’s auto industry. Always will.

An explosion of technological opportunity today will make tomorrow’s cars the most powerful computers we will ever use. And if you think that the auto industry in Michigan doesn’t offer the best, creative and high-tech career options in the world, think again. The future runs on Brainpower.
There is probably no better story that represents the innovation of the auto industry in Michigan than that of two brothers who came to the state nearly 100 years ago.

Mcity—a 32-acre simulated city in Michigan—is supported by the University of Michigan, car companies and an array of technology suppliers. The goal is to develop the technologies required for both vehicles and infrastructures for automated driving capabilities.

Carmakers and suppliers are stepping up their own cyber security efforts to protect against attacks throughout the development process, production and product lifecycle.
There is probably no better story that represents the innovation of the auto industry in Michigan than that of two brothers who came to the state nearly 100 years ago.

Fred and Charles Fisher came to Michigan from Ohio, where their family had a coach-building company—as in horse-drawn coaches.

But it was the first decade of the 20th century, the decade when Henry Ford began to put the world on wheels from his plant on Piquette Avenue—where the automotive assembly line started.

The Fisher brothers, although they began with coaches, knew that the world was going to change to automobiles. In 1908, the year the Model T was introduced, they established the Fisher Body Company to serve the small-but-growing auto industry. Yes, they used the skills that they developed for carriages, but put those skills and capabilities to building car bodies for Ford and Cadillac, for Studebaker and Buick. The company was to be acquired by General Motors.

The brothers saw what was, what could be and what needed to be. And they realized it in Michigan.

It is that kind of foresight and execution that's representative of how the automotive industry—the manufacturers, the researchers, the designers, the engineers, the executives, government officials, the visionaries—in Michigan today is leading the transformation to automated and fully autonomous driving.

Michigan is the kind of place where ideas come to be realized in steel and in silicon, in composites and advanced batteries.

If the past is prologue, then know that Michigan has long been home to automotive-related developments that have had consequences the world over.

The first mile of concrete highway in the world—a section of Woodward Avenue in Detroit—was paved in 1909.

The first three-lens traffic signal was invented in Michigan in 1920, arguably the first step on the way to automated driving—there was no need for a police officer to direct traffic.

If we fast forward to the
latter half of the 20th century, Michigan-based companies have played a role not only in this world, but beyond.

General Motors, for example, developed the internal guidance and navigation systems for NASA’s Apollo program.

The first car on the moon? The Lunar Roving Vehicle that went up with Apollo 15. While it wasn’t a Chevy, it was a product of GM.

The shift that is occurring in the auto industry today is arguably seismic in scope and scale. There are huge shifts in not only technology, but infrastructure.

Only in Michigan can you find the headquarters of 61 of the top 100 automotive suppliers.

And as was the case back in the early 20th century, where people found the conditions ripe for entrepreneurialism and innovation in Michigan, it is the same today.

Michigan has—since the days when the Model T first appeared (perhaps not coincidentally, the Ford Piquette plant was just two blocks east of Woodward Avenue: even then, infrastructure was important, as it is for autonomy)—had the skills, talent and wherewithal to build cars and trucks that are renowned the world over.

The innovative spirit in automotive is as strong today in Michigan as it was at the start of the last century.

And Michigan is facilitating the development of tomorrow’s transportation—vehicles, infrastructure, technology—by attracting the world’s leading companies, OEMs and suppliers, developers of sensors and systems, scientists and technicians, researchers and makers, and by supporting their efforts through partnerships and programs.

Only in Michigan can you find a 32-acre “city” dedicated to the development of automated and autonomous driving.

Or some 375 research centers dedicated to the auto industry.

Only in Michigan can you find the headquarters operations of 61 of the top 100 automotive suppliers. Or some 90,000 engineers.

There are 15 colleges and universities in Michigan with leading engineering programs from the top of the state like Michigan Technological University in the Upper Peninsula to Hope College on the west side, Central Michigan in the middle, and a concentration of engineering academic power in the southeast (Michigan State, University of Michigan, Wayne State).

Michigan is one of a handful of states that has passed legislation permitting testing of automated and autonomous driving on public roads.

The state that helped put the entire world on wheels is working hard at helping the companies and the people who come to Michigan from around the globe to write the next chapters of the automotive journey.
General Motors is developing electric two-person “pods” that can whisk people around urban areas automatically, then park themselves.
Putting It All Together

The global auto industry is awash in high-tech possibilities that could make cars safer, more efficient and dramatically better connected with each other and the rest of the world. But how to decide which options to choose and how to implement them?

The answer lies in expertise that comes from a deep understanding of everything from software and systems integration to the realities of making high-quality products that will work as intended for well beyond a decade.

Carmakers are uniquely qualified to deliver this expertise. Not surprisingly, the world’s greatest concentration of such design, engineering and development experts is in Michigan, notes Kevin Kerrigan, who heads the automotive office for the state’s Michigan Economic Development Corp.

“When it comes to the capital, technology and talent necessary to carry the auto industry to the next level, Michigan is clearly in front,” Kerrigan declares. Data from the U.S. Census Bureau and the Center for Automotive Research in Ann Arbor, Mich., confirm that Michigan leads all others by a wide margin in automotive research facilities, technical staffing and the raw ability to not just generate new ideas but to turn them into products by the millions.

Where It All Began

The auto industry has been shepherding new technology into its cars for decades, of course. The first big wave in the U.S. began 45 years ago when the Clean Air Act ushered in emission and fuel economy standards.

Meeting these new rules has dictated huge under-the-hood advances in how we create a car’s power and deliver it to the wheels. It also demanded a shift from mechanical controls to far faster and more accurate electronics. The resulting surge in innovation has been going on ever since.

Electronics also have driven the next big revolution in cars: safety. Antilock brakes, stability control, blind-spot detection, backup cameras, automatic braking and cars that park themselves are becoming commonplace across vehicles in all segments of the market.

Today’s well-equipped cars carry about 100 computers on board. Creating the in-car networks that enable these computers to do their jobs, trading information when needed —
but otherwise not interfering with each other’s missions, has been the continuing job of the auto industry’s technical community.

Demand for software to drive all these systems has fostered a fast-growing partnership between Detroit and Silicon Valley. Virtually every major carmaker has opened offices and development centers in California to tap the code-writing expertise there.

California isn’t the only place software is being developed, of course. Ford Motor Co. has teamed up with Toronto-based software developer Pivotal to accelerate its ability to update in-car software, including apps. Ford’s latest version of SYNC Connect enables such updates to be downloaded, much as consumers do now with apps for their smartphones.

MEDC’s Kerrigan says such alliances will play a key role in enabling innovations such as connected and self-driving cars. But he says the critical step of integrating such software into the overall vehicle must happen in Michigan. The reason: The performance and reliability for the vehicle ultimately lie with the company that makes it.

The responsibility grows as cars get more complicated and last longer. According to vehicle market researchers R.L. Polk, the average age of a car on the road in the U.S. today is a record 11.5 years—three years more than the average in 1995.

The Next Big Thing
Now the automobile is entering what experts widely agree will be its biggest and most important change ever: connectivity.

Connectivity means moving beyond the notion of cars operating independently at the whim of their drivers. It means giving cars the power to signal each other automatically about their whereabouts so they can automatically avoid hitting each other. Connected cars also will communicate with traffic signals and other infrastructure.

It’s a whole new way of looking at the automobile. The largest real-world analysis of how connectivity could transform personal transportation is being launched right now across southeast Michigan by the state’s Dept. of Transportation, local and federal agencies and a host of industry partners.

By extension, cars that connect also can become vehicles with enough knowledge about their surroundings to drive themselves. The safety implications of vehicles with self-driving capability are stunning, and they have sparked an outright revolution in the auto industry.

General Motors Co. is no newcomer to the idea of self-driving vehicles. Nearly six years ago it debuted the Chevrolet EN-V, a podlike, two-seat electric vehicle for city use. The highly maneuverable concept can be driven manually or autonomously, includes wireless connectivity and is able to park itself.

Where will this revolution lead? Consider two sobering statistics. First, more than 1.2 million people die in car crashes worldwide each year, according to the World Health Organization. Second, connecting cars and equipping them...
with robotic driving capability could slash traffic accidents by 80%, says the National Highway Traffic Safety Administration.

It will take a decade or more to complete most of the transition. But the elements of the transformation are flooding into new vehicles right now.

You can experience it with blind-spot detectors that warn you about a nearby car you can’t see. Or systems that can steer your car into a tight parking space automatically. Or preemptive braking systems that warn you when you’re about to rear-end the car ahead—and hit the brakes hard to avoid or lessen the impact if you don’t respond in time.

Such systems use sensors and computers to extend our own senses. They can assess and respond to situations faster than we can. Some can learn from experience, getting even better over time. They’re always on full alert, never get tired and aren’t distracted.

Another Side to Connectivity

Connecting cars with their surroundings isn’t just about vehicle safety. It also is ushering in a whole new level of personal convenience. Cars that connect with their surroundings can find a parking spot, let your friends know when you’ll arrive and route you around traffic snags before you know there’s a problem.

At Ford, researchers have been testing biometric sensors in cars that could tell when the driver is under stress or is experiencing a medical problem.

Connectivity also will redefine how we use personal transportation. By 2050, the world population will rise by one-third to 9.3 billion, and the proportion of people living in urban areas will rise from half to two-thirds, according to a widely cited urbanization study by the United Nations.

When carmakers look at those two numbers, they see a major call to action. “If we do nothing,” cautions Ford Motor Co. Chairman Bill Ford Jr., “we face the prospect of global gridlock.” He says it’s time to begin looking at vehicles as “pieces of a much bigger, richer network” that includes other ways to get from A to B.

Ford foresees a “radically different” approach to personal mobility in which the automobile becomes part of a broad connected network that includes everything from pedestrian and bicycles to public transportation.

He’s not alone. “Some might find this massive change to be daunting,” commented General Motors CEO Mary Barra recently, “but we see the opportunity to be a disruptor.” Barra says GM’s nearly 20 years of experience with its OnStar connectivity system gives the company a big advantage over other developers in understanding how to use and expand such technology.

“Lifting Up Lightweight Materials

The Detroit-based Lightweight Innovations for Tomorrow (LIFT) consortium aims to speed the use of lightweight materials in vehicles. Lighter vehicles perform better and deliver better fuel economy. LIFT focuses on developing better ways to make, assemble, paint and process lightweight materials.

Created in early 2015, LIFT is operated by the American Lightweight Materials Manufacturing Innovation Institute.

LIFT’s founding members include the University of Michigan, Ohio State University and EWI, an independent research and development organization based in Columbus, Ohio. The initiative is supported by nearly 50 industry partners, 18 universities and research groups, and seven professional trade organizations.

MERGE:

www.michiganbusiness.org
The U.S. National Highway Traffic Safety Administration (NHTSA) has defined five levels for vehicle automation. Oddly, they start counting at zero rather than one.

LEVEL 0 is when the driver is in complete control, with no automatic systems.

LEVEL 1 is where all passenger cars in the U.S. have been since model year 2012, when NHTSA’s requirement for standard electronic stability control (ESC) went into effect for light vehicles. (Heavy trucks and buses will start having required ESC in 2017.)

LEVEL 2 involves, well, two automated technologies working in concert. Like adaptive cruise control and lane-centering assist.

LEVEL 3 is almost entirely hands-free. Under certain conditions, the vehicle takes care of the steering, throttle and brakes. But it also has the means by which it will bring the driver back into control and the mechanisms (as in steering wheel and pedals) to take control.

LEVEL 4 is the driverless vehicle.

Most vehicle manufacturers offer at least one model with Level 2 automation, but getting beyond that point is a challenge. The issue isn’t just about the hardware and software to start, stop and steer a car robotically.

The problem is that cars don’t operate in a vacuum. Traffic jams, which automated cars are engineered to ameliorate, are caused by cars,
Tomorrow’s vehicles will connect with each other and their surroundings.  
(Credit: General Motors)

trucks, ambulances, accidents, road hazards, traffic signals, and a host of other everyday elements.

So what’s this have to do with Michigan?

In addition to working on the developments related to Levels 2 through 4 on the vehicle level, there is also plenty of work going on in the vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) space.

Cars need to talk with other cars and with their surroundings.

One place where this is happening is in Mcity, an autonomous municipality that was designed and developed by the University of Michigan’s Mobility Transportation Center (MTC) in partnership with the Michigan Dept. of Transportation (MDOT).
As Mich. Governor Rick Snyder puts it, “We put the world on wheels. We transformed how the world moved. Michigan is uniquely positioned to continue to be a leader in mobility, and the University of Michigan’s new Mcity will play a critical role in that future.”

The $10-million Mcity project is located on 32 acres and has roads with intersections and traffic signals, streetlights and traffic obstacles. There are buildings like a Hollywood set. But there is nothing pretend about it. Mcity is engineered to provide a safe, controlled and realistic environment for the research and development of autonomous vehicle technology.

This isn’t just a partnership between the state government and academia. Mcity has commitments from 15 companies to invest $1-million each for three years starting in 2015. That list of companies includes global leaders in vehicles, technologies and infrastructure: Delphi Automotive, Denso, Econolite Group, Ford, General Motors, Honda, Iteris, Navistar, Nissan, Qualcomm Technologies, Robert Bosch, State Farm Mutual Automobile Insurance, Toyota, Verizon Communications, and Xerox.

Do you want to know how the automated driving world will be created? It will be by those organizations.

MTC is working with the Michigan Economic Development Corp. (MEDC) on other intelligent transportation programs, such as ramping up a
connected vehicle project that began in 2012 in the Ann Arbor area. The test has expanded from 3,000 connected cars—V2V—to more than 9,000 in cooperation with MDOT.

MDOT also is working on a 50-mile stretch of road in southeastern Michigan to create a “connected corridor.” Sensors and cameras are being deployed. Information that is collected in real-time about traffic conditions will be sent to vehicles via DSRC, or dedicated short range communications.

In partnership with GM, Ford and the University of Michigan, MDOT is creating the required infrastructure on two interstate highways, I-96 and I-696, so that smart cars can communicate with each other as well as with smart streets.

Declares Michigan Transportation Director Kirk Steudle, “At MDOT, our goal is zero deaths on the road system.”

The objective of creating a network of intelligence is to establish an environment where traffic flows in the most-effective manner possible. Potential traffic jams are anticipated and information is communicated so that clogs don’t form.

Potential collisions are detected and on-board systems are engaged to prevent them.

The road to intelligent transportation is one part actual road—instrumented road, but road nonetheless—and one part smart cars (and trucks).

That road is being paved—literally and technologically—as Michigan works with carmakers and suppliers, academicians and researchers to advance the state of smart, automated driving systems.

The first paved road in America was in Michigan. So it should be no surprise that the state is dedicated to helping make the roads of the 21st century smart.
The Next Challenge in Automotive Safety: CYBER SECURITY
Today’s cars and trucks are safer, smarter, better-performing and more efficient than ever—thanks to continuous advances in technology, engineering ingenuity and consumer demand. Next-generation models will be even more sophisticated, with myriad automated functions, including the ability to share information with each other, the roadside infrastructure, local businesses and just about everything else.

Well-equipped vehicles already contain as much as 100,000 lines of software code. By 2017 more than 60% of new vehicles are expected to be connected to the Internet.

But the new array of controllers, sensors, computer chips and connected systems also make vehicles vulnerable to a growing threat: hackers. While long a concern for businesses and consumers, hackers are relatively new to the auto industry.

**Reality Check**

There have been no known malicious attacks targeting vehicle systems. But several recent demonstrations by “white hat” experts underscore the potential for problems and the importance of developing advanced security systems to prevent them. Independent security teams have been able to remotely hack into vehicles and take control of critical operating systems, including steering and powertrain functions.

Industry-sponsored seminars have shown that virtually no car is immune from attack. In some cases, teenagers have been able to hack into vehicle systems to unlock doors and start the engine—but not without being able to gain physical access to the vehicle. As cars add more electronic features, the number of possible entry points to the onboard electronic network also increases. Computer-savvy intruders can infiltrate cars through everything from Bluetooth devices, diagnostic ports, tire pressure monitors and key fobs to navigation and infotainment systems, USB ports and smartphone apps.

Carmakers and suppliers are stepping up their own cyber security efforts to protect against attacks throughout the development process, production and product lifecycle.

In addition to commandeering individual vehicles, criminals potentially could use a hacked car to gain access to a motorist’s personal information or tap into connected infrastructure systems and businesses. Other concerns include remote surveillance, industrial espionage and even national security.

**Countermeasures**

While recent hacking demonstrations have brought public attention to automotive cyber security, the auto industry has long been aware of and is actively addressing the issue.

New vehicles already are equipped with a host of built-in security features and firewalls to protect against hackers. And carmakers and suppliers are working with cyber security experts to strengthen these efforts, identify new risks and implement countermeasures.

Experts advocate an industry-wide approach to combating hackers. To be successful, they say, there needs to be a concerted and sustained collaborative effort involving carmakers, traditional suppliers, tech companies, security experts, academia, standards organizations, legislators and government agencies.

“Cyber security and privacy must be high-priority items for the industry,” says Mark Rosekind, head of the U.S. National Highway Traffic Safety Administration. “We must reassure vehicle owners...”

---

www.michiganbusiness.org
that their data is secure, that their vehicle is secure and that we are looking out for threats from hackers, thieves and anyone else who might seek to tamper with safety critical technology.”

A variety of tasks forces, research groups and industry partnerships aimed at cyber security already exist:

- The U.S. Council for Automotive Research formed a cyber-physical systems task force in 2007 to conduct advanced research into networked electro-mechanical subsystems.
- The Defense Advanced Research Projects Agency (the Pentagon’s research arm) funds projects to test auto security in addition to sponsoring autonomous vehicle contests.
- SAE International’s Vehicle Electrical Systems Security Committee, which was formed in 2011, evaluates challenges and conducts risk analysis related to cyber security threats. The group also drafts guidelines, standards and best practices to help safeguards vehicle systems.
- In mid-2015, the Alliance of Automobile Manufacturers and Assn. of Global Automakers established an intelligence sharing and analysis center (ISAC) for cyber security. The new ISAC will serve as a hub for sharing information about cyber threats and analysis of potential vulnerabilities, as well as develop best practices.

In addition, carmakers and suppliers are stepping up their own cyber security efforts. Security considerations now are being designed into virtually every component—including software, hardware, controllers and vehicle communication networks—as well as integrated systems and the overall vehicle architecture to protect against attacks throughout the development process, production and product lifecycle.

Cyber attack points for today’s cars include a variety of electronic control units (ECUs), the advanced driver assist system (ADAS) and wireless devices that include the tire pressure monitoring system (TPMS). (Credit: Intel)
Securing Michigan’s Future

With its rich heritage of technological prowess in all things automotive, it’s not surprising that Michigan also is at the forefront of the budding automotive cyber security industry.

Several programs already exist in the state to share ideas, identify potential concerns and help train engineers. These include:

- **Michigan Cyber Range.** Launched in 2012 by Merit Network, an Ann Arbor-based nonprofit organization, the initiative includes specialized courses, certification programs and cyber security services.
- **Mobility Transformation Center and Mcity.** The University of Michigan’s MTC program focuses on developing the next-generation of automotive innovators, while the university’s new 32-acre Mcity campus serves as a proving ground for autonomous vehicle technologies (see p. 10).

Unique Solutions
The auto industry also is benchmarking and applying cyber security best practices learned from leading aerospace, defense, industrial machine, medical and rail companies.

But experts recognize that automotive systems involve unique challenges, concerns and solutions. They note that vehicles don’t behave like traditional IT networks. For one thing, they involve lots of moving parts (literally) and safety-critical systems that require industry-specific research and new tools to properly safeguard motorists.

New security measures for cars include enhanced network firewalls, software monitoring and the ability to identify and deny malicious third-party communications. To ensure a secure design, companies are using “threat modeling” to anticipate and mitigate a multitude of potential attacks. Tactics include building in layers of protection, encrypting critical and private data, and isolating software components by function.

To help defend vehicles against hackers, TowerSec, an Ann Arbor, Mich.-based automotive cyber security firm, recommends a three-pronged strategy: create “smart” firewalls to prevent attacks, adopt systems that detect security breaches, and develop secure, over-the-air update capabilities to quickly download software fixes as needed.

Developing Cyber Engineers
Designing for cyber security likely will involve a new approach to the traditional automotive
engineering process. The current practice is to design a component to perform specific tasks under various operating parameters, then subject it to stringent failure mode analysis and validation tests to verify compliance. To prevent attacks from hackers, systems not only need to be designed to perform their intended functions, they also must be prevented from doing non-approved tasks.

The industry also is working to train a new generation of engineers to be leaders in the field. This includes working with universities to develop automotive cyber engineering courses and specialized degrees. Ideally, analysts say, students will have a mix of electronics, software and automotive expertise as well as some hacking experience. And future software developers need to recognize potential coding vulnerabilities and understand how to avoid them.

POINT OF INTEREST:

Michigan’s Got Talent!

Michigan has one of the richest talent pools in the country with 650 automotive education programs offered at 91 institutions. The state’s high-tech workforce is the fourth largest in the country, boasting more than:

- 87,000 engineers
- 70,000 R&D professionals and
- 75,000 skilled tradespeople
Are you reading us?

Find out why 155,000 readers make us their second stop each business morning.

autobeatdaily.com

For a free trial subscription, please contact Robin Padgett - RPadgett@AutoBeatDaily.com

Product of Gardner Business Media, Inc.’s Automotive Group
Michigan leads in intelligent driving technologies. Distracted driving is a global problem. But solutions are being invented right here in Michigan. Sonar, radar, infrared cameras, even car-to-car wireless communications are all being developed by a diverse range of companies, entrepreneurs and engineers to bring the day of auto-piloted cars closer and closer. Drawn by a large talent pool, a dynamic automotive infrastructure and state support, companies have found that futuristic thinking is automatic in Pure Michigan.