

REINVENTING



THE WHEEL



From hybrid engines to roll-prevention systems, automobile technology is shaping up as the most advanced on the planet. And the car of tomorrow is going to blow the doors wide open.



by Lydia Lee

Alesa Flowers drives a sunset-orange Hummer H2 around the streets of Los Angeles. It's got a V8 engine, four-wheel drive — and a little box under the dashboard that keeps tabs on her engine diagnostics and other vital signs. It recently sent her an e-mail reminding her that she had driven exactly 14,592 miles and that the SUV would be due shortly for its 15,000 mile service. It also sends GPS coordinates to a website so that Flowers can log in and make sure that her nephews haven't taken the car on a joyride.

"I'm a single mom with three kids," says Flowers, who is a distributor for a line of handbags and has to travel frequently for business. "Being a lady, there's a lot of things I don't know about cars. Men know more about this stuff — when you gotta get the car in for service, that kind of thing."

The box that helps Flowers feel more confident owning her H2 is made by San Diego-based Networkcar, a company (recently bought by Reynolds and Reynolds) that has come up with one of the more ingenious applications of automotive wireless technology. Previously, you had to be a service technician, an OnStar call attendant, or a hard-core car geek with a special device to get at the diagnostics and vital stats recorded by the car. Networkcar's box, which can be retrofitted onto almost any late-model car, relays the information to the car's owner. In Networkcar's system, when the check-engine light comes on, you get an e-mail that tells you what triggered the alarm and whether it's a major or minor problem.

A car that sends you e-mail asking for a tune-up is just the beginning. In the next few years, cars will begin to rival your notebook for computing power. They'll include complex feedback systems designed to enhance performance, increase safety, and help you get over rough terrain. They'll keep you from getting lost (and away from traffic jams), make you a safer driver, and entertain you

on long road trips. You may never need to get out of the driver's seat again.

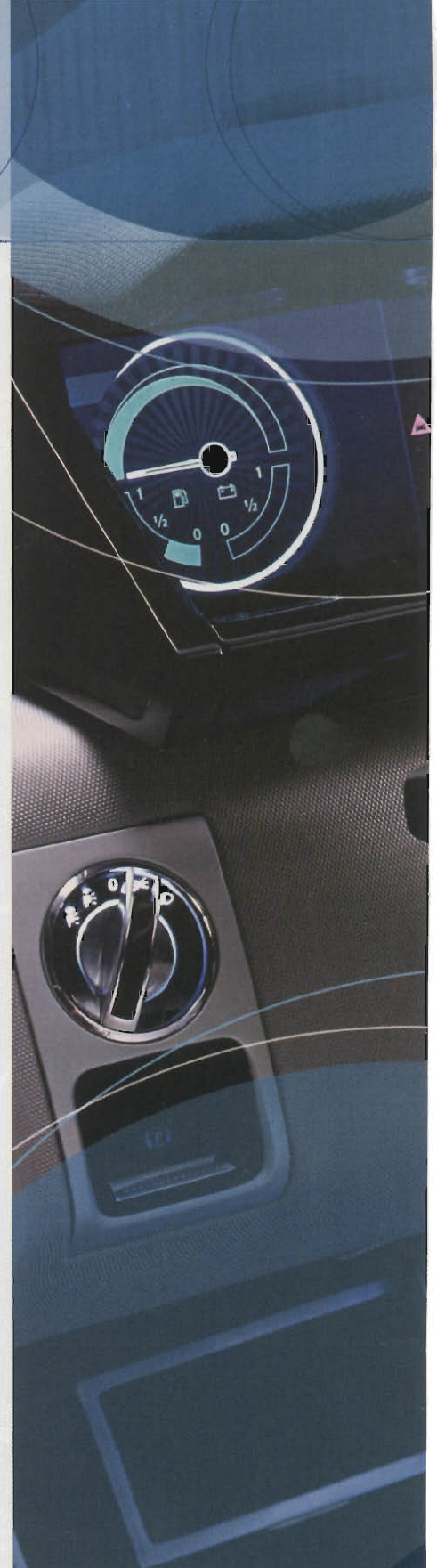
THE SOUL OF A MACHINE

For the past few decades, the car has been undergoing a Frankenstein-like transformation: It now has electronic brains to supplement its mechanical components. Many functions that used to be purely mechanical — including braking, the throttle, and even steering — are becoming electronic, or "by wire" in industry parlance. "There's so much silicon in today's cars, it's not even funny," says Frank Viquez, director of automotive research for ABI, a research company covering the wireless and semiconductor industries.

A mechanically controlled throttle, for example, has a cable attached to the accelerator. Push the gas pedal, and you open the throttle. Its electronic replacement, on the other hand, receives information about accelerator position over a wire, has a motor that opens and closes the throttle, and can be more finely controlled. "By-wire controls improve fuel efficiency and safety of cars," says Martin Thoone, global electronics product line team director for Visteon, one of the major suppliers of automotive components.

Antilock brake systems (ABS) are a good example of the benefits of by-wire controls. A car with ABS pumps the brakes far more rapidly than you could and can adjust the amount of braking on each wheel. By-wire systems can also be tied much more easily to other systems in the car. Electronic stability control, for example, coordinates the braking and throttle controls to prevent spinouts. To use a computer analogy, the modern car infrastructure is like a local area network, where many nodes run the different departments, and they collaborate over a network — typically copper wire, but in some cases fiber optics.


Putting more electronic brains into a car can also let it shift personalities. Flowers' H2, for example, has an



The Bionic Car

From electric starters to Bluetooth networks, the automobile has become steadily more tech savvy over the years

1912 After his friend dies from injuries sustained when a hand crank flies off and hits him in the jaw, Henry Leland, the head of Cadillac, commissions an automobile self-starter. Charles Kettering is credited with the invention of the electric starter as well as the electric ignition system.



electronically controlled throttle. It has two different modes: One provides a quick response to a gentle touch of the pedal for freeway driving, the other, more ponderous, kicks in for slower off-road driving. Land Rover's Range Stormer concept car, unveiled at the beginning of the year, takes advantage of the various systems you can adjust electronically with a new feature called Terrain Response.

The most high-profile arrival is true hands-free cell phone use in the car, which is now available at a user-friendly price, thanks to Bluetooth. Combining this short-range wireless technology with voice-recognition software and a few electronic components allows cell phone users to place and take calls from their cars without ever touching their phones.

The luxury market has had GM's

THERE'S SO MUCH SILICON IN TODAY'S CARS, IT'S NOT EVEN FUNNY.
—FRANK VIQUEZ, ABI

This newfangled SUV lets you select from six preset modes that optimize suspension, throttle response, traction control, and engine characteristics depending on the scenery: You can choose from snow, rocks, sand, grass, "dynamic" (for curves), and normal operation. (Land Rover's online demo of the Terrain Response system, at www.rangestormer.com, even looks like a video game.)

CAR TALK

One of the most promising new developments in car technology is wireless connectivity. When Silicon Valley was talking about "e-commerce" in the late '90s, Detroit was talking about "telematics." The term covered everything from remote diagnostics to real-time traffic reports to e-mail read by your car — and, like their Silicon Valley cousins, Detroit's digerati were lusting after the oodles of money to be made from all these new services. After the heavily touted Ford-Qualcomm venture, Wingcast, folded without launching a single service, telematics lost a lot of its buzz. But — as with e-commerce — now that the telematics hype has died down, some of the cool features it promised are actually here.

OnStar, Mercedes-Benz's TeleAid, and similar cell-phone-based services for years. These deluxe offerings provide phone service along with a gourmet menu of other features, such as live concierges to direct you to the nearest good Italian restaurant. However, they come with hefty subscription fees in addition to the overhead of a separate cell phone connection. Bluetooth, by contrast, lets you use your existing number and calling plan. When you get into the car, you activate the link to your cell phone, typically by hitting a button on your dashboard, and the car takes it from there.

The automotive industry, normally the turtle compared with the consumer-electronics hare (remember having to bring a Discman into the car in order to play CDs?), finds itself in the unusual position of driving the Bluetooth market. In the United States, cellular operators have been slow to roll out Bluetooth phones; at press time, the U.S.'s largest cellular operator, Verizon Wireless, did not offer a single Bluetooth-enabled model. "I think the [cellular] operators don't want to explain the technology to customers," says Eric Schneider, marketing manager for the Bluetooth Special

1930 Motorola [then known as Galvin Manufacturing Corporation] introduces the first commercially successful car radio.

1932 The need to power the increasing number of electric components in the car (heaters, radios, defrosters) leads automakers to switch from a 6-volt battery to a 12-volt battery. [As of 2004, the auto industry is talking about moving to 42 volts.]

1946 Bell Labs comes up with the first commercial mobile phone service. Early mobile phones were by definition car phones — they were so large that they were impossible to carry.

Interest Group. "It's such a competitive industry that no one wants to bear the burden of being the first." However, now that a number of states have restricted cell phone use while driving — or are considering legislation to that effect — Bluetooth in the car should get a boost.

Down the road, Bluetooth could supply a handy connection to cell phones and PDAs, too. Wouldn't it be nice, say, if your car could pick up contact info and addresses from your Palm so that the car could plan a route based on your appointments of the day? Or if you could surf the Web using a full-size touch

second for transferring large media files.

The company, which has prototypes of Wi-Fi-based car hardware, anticipates a time when you'll pick up the latest album on the go — literally. "In our vision of the future, we see high-value entertainment completely bypassing brick-and-mortar distribution," says Schumacher. "You'll drive into the gas station and, in the few minutes you fill up your gas tank, you'll fill up your bit tank with 99 cent music files." Or perhaps you'll buy music and movies at home and download them to your car while it's parked in the garage — as Delphi and others demonstrated

YOUR CAR MIGHT KNOW ABOUT BREAKDOWNS AHEAD AND FIND ANOTHER ROUTE BEFORE YOU NOTICE.

screen built into the car instead of a tiny mobile device?

While technically possible, the automotive industry has historically been very close-minded about opening their systems up, for strategic and safety reasons. But Bluetooth may establish a beachhead for other mobile devices. "Except for the road warrior, consumers have a limited awareness of what can be done," says Phil Magney, principal analyst with the Telematics Research Group. "Once we get a hands-free interface, people will desire access to their address books, synchronize with a PDA or phone, get traffic reports and e-mail ... those types of things."

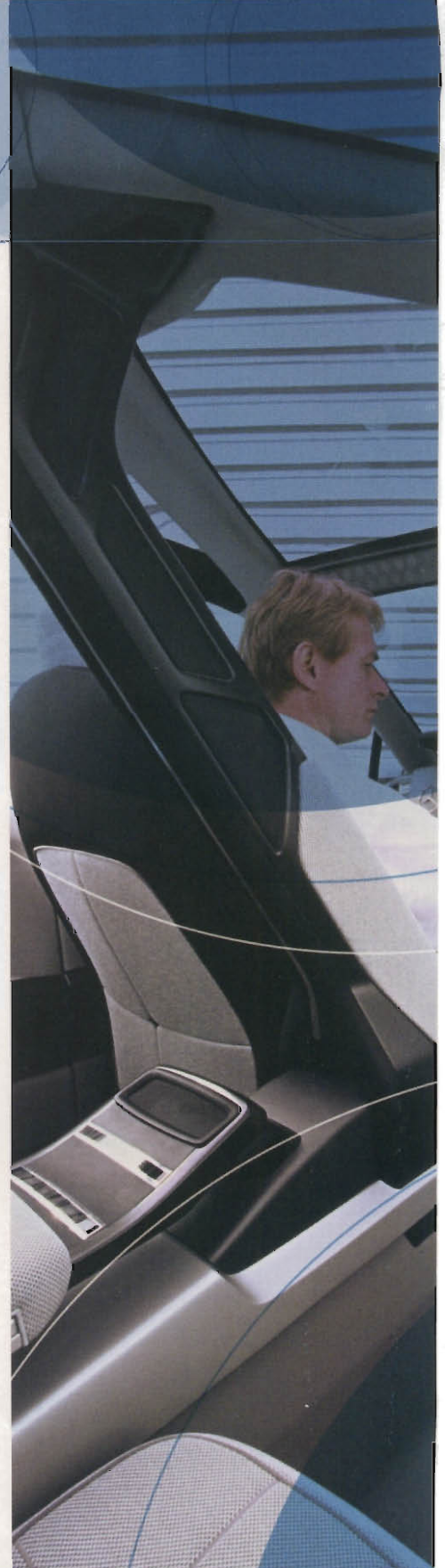
As the car travels down its evolutionary highway, wireless networking looks to be the route through which the automobile will join with other branches of the computing family. Bob Schumacher, business line executive for wireless at leading automotive supplier Delphi, describes Bluetooth and Wi-Fi as the car equivalents of USB and FireWire: The first is useful for low-bandwidth applications like hands-free calling, the

at the last Consumer Electronics Show. Throw satellite radio and (in the future) satellite TV into the mix, and you've got yourself a very happening vehicle.

THE WELL-CONNECTED CAR

While safety concerns are helping to spur Bluetooth in the car, there are compelling arguments for giving the automobile its own cellular connection as well, à la OnStar or Networkcar.

OnStar, for instance, touts its emergency services, such as live assistance in case your airbag deploys and the ability to send a command over that wireless link to open your door in case you lock yourself out. "We don't think it's a good idea to rely on the customer to bring their Bluetooth cell phone to be able to respond to an airbag deployment. Heaven forbid that your spouse should drive the car without a phone and get into an accident — that's why we believe in having an embedded connection," says Don Butler, vice president of planning and business development for OnStar. But Butler also agrees that Bluetooth makes



1958 Chrysler introduces an early electronic fuel-injection system, which delivers fuel more efficiently than a carburetor. The systems start to take off when Bosch offers them in Volkswagens in the late 1960s.

1978 Bosch develops the first antilock braking systems, which use sensors for each wheel and a centralized control unit to prevent wheels from locking and skidding.

1981 Prompted by stricter emission standards, Onboard Diagnostic (OBD) computers are first installed to monitor the engine and related systems for malfunctions.

sense for everyday phone calls, and says that OnStar is contemplating adding a Bluetooth module to its system.

Automotive manufacturers are also intrigued by the thought of having regular communiqués with their vehicles after they leave the factory, and getting real-world data about how the cars are functioning on the road. "We know we can get all this data wirelessly, and it may help our dealers service and maintain vehicles," says Jon Bucci, corporate manager for Toyota's Net Car division. A manufacturer might be able to pinpoint malfunctions more quickly and recall vehicles with defective parts, or send software updates out to cars through a wireless link. "You could download, say, the latest throttle response curve," says OnStar's Butler. "It would be similar to Windows, where the car would tell you, 'There's an update available, here are the details.'"

Back in the lab, scientists are also working on systems that will allow cars to warn each other about hazardous driving conditions and traffic jams. BMW, for example, is experimenting with ad hoc wireless networking where cars can relay a message among themselves if one car runs into, say, a patch of black ice. Individually, cars are picking up the critical data already; it's a question of passing on that knowledge. Down the road — quite a bit down the road — is a vision of an automated highway, where cars are smart enough to adapt to dynamic traffic and road conditions. In the future, your car might know another car has broken down ahead and find another route before you notice any change in traffic.

Of course, even smart cars will break down. The more technologically savvy a car is, the more complicated it is to fix. "Before, there were only three things that could go wrong: the fuel pump, the points, and the carburetor. People liked the original [VW] Beetle for its simplicity," says Harald Sinzig of Palo Alto German Car Corporation, who has been fixing new and vintage cars for the past

20 years. "Nowadays, you have several vital components that can cause the car to shut down — there's a lot of gadgets."

Modern cars may have more parts that can break, but they also have a sophisticated way of tracking problems. In the early 1980s, California started requiring cars to have an onboard diagnostic computer to detect emission failures. Today, every car made since 1996 has a standard connection called OBD II, which monitors emissions and various car functions, keeping a log to allow easier diagnosis of malfunctions. The device from Networkcar taps into this information channel. OBD III, which is currently in development, will provide a way to transmit reports of emission problems wirelessly so that you'll never have to bring your car in for a smog check unless something is actually wrong.

There are other reasons why you might want to disclose intimate details about your car to the outside world. For instance, if you were to let your insurance company track your car's actual mileage, you might get a better rate. GM's OnStar has a pilot program with GMAC insurance: Participating customers voluntarily release their information and get a discount based on their verifiable mileage. In the future, insurance companies could keep tabs on more than just mileage. "Maybe your insurance premium is based on whether you always have your seat belt on," says Mark Büniger of Forrester Research, "So there's a positive financial reinforcement and [incentive] for good drivers to become even better drivers."

The technology already helps people like Alesa Flowers act like the responsible car owners they would like to be, even if their nature is to ignore the car until it breaks down. "The technology makes me a little lazier, because I know the computer will send me e-mail [about repairs]," she says with a laugh. If you think your current car is an extension of your personality, just wait until your next set of wheels. 🚗

1987 Bosch releases specs for CANbus, an in-vehicle networking standard. The serial bus technology provides a way for diverse electronic systems like braking and acceleration to communicate over one set of wires. Currently, the industry is exploring fiber-optic networks to deal with an increasing amount of data.

1996 Ford launches the Lincoln RESCU, the first in-vehicle GPS navigation system with a hands-free cell phone and a 24-hour call center response.

1997 Toyota introduces the first mass-produced gasoline-electric hybrid vehicle, the Prius, in Japan.

Your Next Car

REINVENTING THE WHEEL

THE 10 COOLEST HIGH-TECH FEATURES YOU CAN GET IN THIS YEAR'S MODELS

Bluetooth and GPS systems are just the tip of the iceberg. The current crop of cars are loaded with high-tech options that Henry Ford never dreamed of. Here's a look at what's available.

Keep in mind: Just as a top-of-the-line Sony Vaio has more bells and whistles than a Dell workhorse, luxury car brands like BMW, Lexus, and Mercedes have more high-tech features available than midrange cars. Prices for these options can vary a lot from manufacturer to manufacturer, and even from model to model; some options come only as part of larger packages. —Lydia Lee

Active steering. A clever feature in the BMW 5- and 6-series, active steering is a combination of electrical and mechanical systems that reduces the amount of steering you have to do in proportion to your speed. So if you're trying to park and going very slow, a slight turn of the steering wheel will turn the wheels more than it would traveling at highway speeds.

Active suspension. Another feature that utilizes the possibilities of car electronics: Wheel sensors feed back information about a pothole within milliseconds after your tire hits one. That data is relayed to the adjustable shock absorbers, resulting in a smoother ride. Active suspension (aka computerized ride control) has been in luxury models for years, but recent innovations include active roll stabilization, which adjusts the car's suspension as you go around corners so that the car stays level. This feature is available in BMW and Mercedes-Benz models.

Adaptive cruise control. As with standard cruise control, you set the cruising speed. However, the car keeps track of the distance between you and the car ahead of you, using radar, and it will slow down automatically if you get too close (you also set the following distance you want). This option is offered by the likes of Audi, BMW, Infiniti, Lexus, and Mercedes-Benz; it will set you back several hundred dollars. A related feature is lane departure avoidance, which uses a camera to track lane markings and helps keep the car from drifting. Originally

developed for large commercial trucks, the feature has shown up in concept cars, and Honda has made it available in a model it sells in Japan.

Adaptive headlights. In some BMW and Lexus models, you can get headlights that keep track of your position and turn with the car, lighting up the area as you go around the curve or up a hill. "You can see so much more," says Frank Viquez, director of automotive research at ABI Research. "It's one of those things you don't realize how much it helps until you use it." It's a \$300 option in BMWs and part of a \$5,500 "performance package" in Lexuses. Lexus also offers a backup camera for a better view when you're in reverse. The tiny camera, located next to the license plate, displays video on the dashboard navigation screen.

Bluetooth. Start a conversation on your cell phone in the office and continue it in your car — while driving with two hands. To place a call, you can say the number or set up speed-dialing and simply say, "call home," for example. All you need is a Bluetooth-enabled handset and a Bluetooth-ready car, which you can get from Acura, BMW, Lexus, and Toyota. Chrysler is the first North American manufacturer to offer Bluetooth: It's a \$275 factory-installed option in its 2004 Pacifica SUV; it's also available as a dealer-installed option for \$299 (plus labor) in most of its lineup, including the PT Cruiser and the Dodge Durango. Aftermarket kits will also let you upgrade your car for a few hundred bucks.

Crash protection systems. Besides deploying air bags, a car can perform other functions to prepare itself for an imminent crash. Mercedes-Benz calls its system Pre-Safe and Lexus calls its system Pre-Collision, but they function similarly. When the car's crash alert system is triggered (when you slam on the brakes or, in the case of Lexus, when a radar beam detects a large object rapidly closing in on you) the car does what it can to protect the occupants by tightening seat belts and adjusting seats to the full upright position. It's standard on the Mercedes S-Series. On the Lexus LS 430, it's included in luxury packages (which will add \$8,185 to \$13,531 to the sticker price).

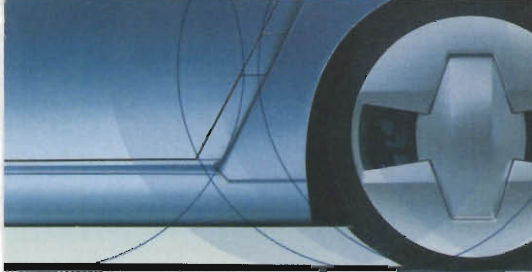
Electronic stability control. Stability control is the latest safety enhancement made possible by electronic wizardry, a next-gen version of antilock brakes and traction control. Sensors monitor your tire speed, steering wheel angle, and the car's alignment around its axis. If you have to swerve to avoid something, the electronics make braking and deceleration adjustments to keep you from spinning out of control or tipping over. A study by Toyota found it reduced vehicle crashes by 35 percent, and it may be particularly useful in preventing rollovers in SUVs. A common feature in just about all luxury vehicles, electronic stability control (ESC) is typically a pricey option for less luxe models. Volkswagen offers it for an additional \$280, but expect to pay at least twice as much for other makes. Honda and Toyota have announced that ESC will be standard in their SUVs.

Hybrid engines in SUVs. Yes, the Toyota Prius is the hip car of the moment, but take away the high-tech guts and you've got something that feels like a Corolla. But Toyota has announced two hybrid SUVs: the Highlander Hybrid (coming out in early 2005) and the Lexus

1997 Several automakers introduce electronic stability systems, which help reduce the spinouts, skids, rollovers, and crashes that can result from a sudden emergency move. Today, the feature is standard on most luxury vehicles.

2001 Mercedes debuts its precollision system, Pre-Safe, which reduces the impact of a crash in the milliseconds before it happens by tightening seat belts, moving the seat and steering wheel to the optimal position for the air bag, closing the sunroof, and extending the bumpers and door panels to take on more of the crash shock.

MAY 2004



HIGH CONCEPT

A glimpse at what the future holds, from one of the auto industry's major innovators

RX400h (late 2004). You get brains and muscle: Both of these buggies can do zero to 60 in eight seconds and get 600 miles on one tank of gas. Look for other hybrids coming down the pike, including the Chevy Silverado, the Dodge Ram, the Ford Escape, and the GMC Sierra. Hybrids tend to be more expensive than comparable conventionally powered cards — by \$6,000 in the case of the Honda Civic hybrid. Meanwhile, Chrysler has revived an old idea, cylinder deactivation, with new electronics that turn a V8 into a V4 by shutting down valves when less power is needed. The company claims the technology can provide a 20 percent improvement in fuel efficiency.

Navigation systems. Punch in an address, and the nav system will call out all the exits and turns, in prerecorded dulcet tones, as you drive. If you miss a turn or decide to take another route, the system will reroute you in real time. Built-in navigation is one of the great consumer uses of satellite technology. It's still an expensive option, but when we've collectively already spent \$14 billion funding the military's GPS program, what's \$2,000 more?

Smart keyless entry. Instead of having to click a key fob, many cars now have systems in which the door unlocks automatically when you get close to it — an especially handy feature for those who lock themselves out of the car regularly, since you never have to take your key out of your pocket. An option in the 2004 Toyota Prius, the key transmitter also lets you start the car without turning a key: You simply get in and push a power button — just like your PC. In BMWs, the key fob acts like a normal remote, but it also has a bit of memory for storing driver seat position and steering wheel tilt, and automatically adjusts the car to your settings. In addition, it records information like the last oil change for the service center to access. —



At the October 2003 Tokyo Auto Show, Mercedes-Benz showed off its vision for the high-tech car of tomorrow. All the technologies in the Mercedes F500 concept car exist today, which means they could show up in cars next year — or five years from now. The company weighs customer demand and its ability to get safety certification to figure out which features to move into production and when.

The F500, a hybrid diesel-electric car, spotlights some of the design possibilities when mechanical controls are replaced by electronics. Instead of mechanical steering, the F500's by-wire steering uses two electric motors to control the steering rack (each motor can function separately, in case one fails). Without a steering column, the steering wheel can move to one side, allowing the driver to get in and out of the car more easily. In lieu of standard brake and gas pedals, electronic touch-sensitive pads provide

finely controlled braking and acceleration, while taking up fewer inches of legroom.

For better visibility at night, the F500 has night vision, giving the driver a much larger view without actually lighting it up. Twin infrared lasers relay a grayscale video image to the car's navigation screen, showing what's out there to about 500 feet ahead. In addition, the new programmable display allows the driver to customize the dashboard — you can move instrument readouts to different areas on the dash.

The Mercedes F500 also features an ultrasound system that lets the driver listen to navigation directions, phone conversations, or audio programs in the car without disrupting any of the passengers. The audio is sent as a high-frequency signal that becomes audible only when it gets near the driver's ear, while remaining out of range for the rest of the car. —L.L.



2001 New York is the first state to ban the use of a mobile phone while driving without a hands-free device.

2002 Saab debuts the first Bluetooth-equipped car, the 9-3 sports sedan.

2007 [estimated] True voice recognition lets us speak an address to our navigation system and search our giant MP3 libraries by voice alone.

2010 [estimated] Hydrogen fuel-cell cars zip around, along with older gasoline vehicles and hybrid electric cars. Gas stations sell hydrogen as well as gasoline.