My Car, My Way

Why not? I paid for it!

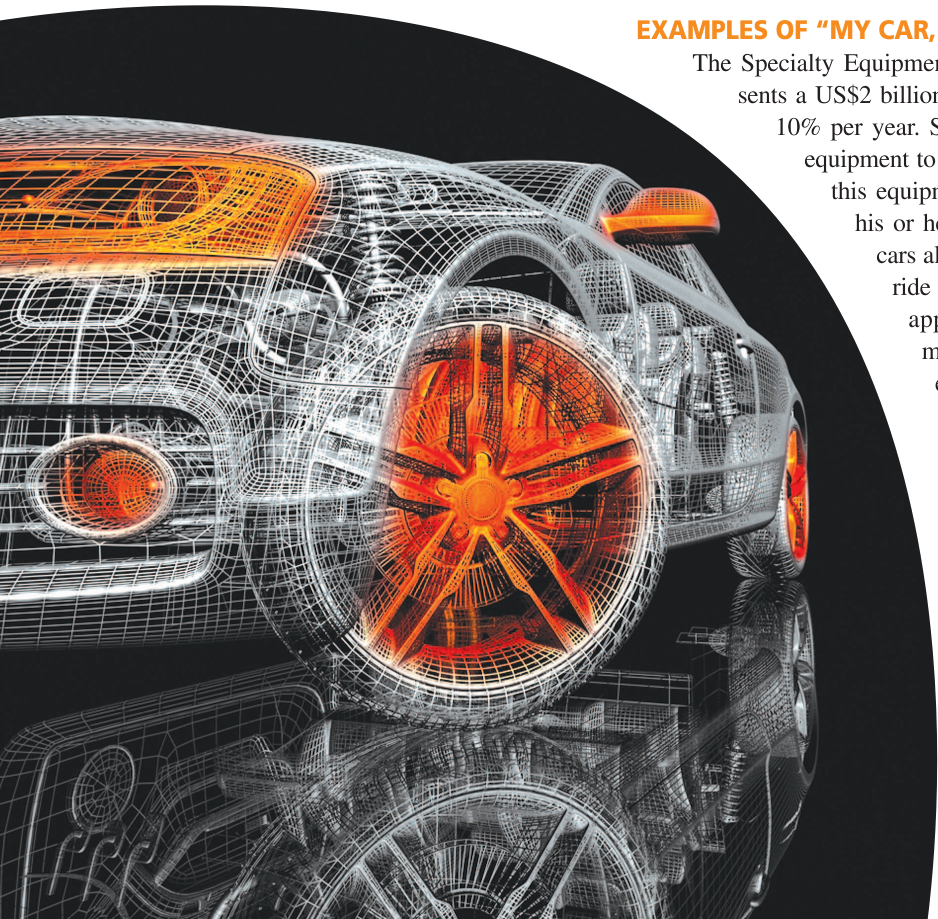
By Joe Ziomek, Len Tedesco, and Tom Coughlin

APPLE AND ANDROID PORTABLE PERSONAL COMMUNICATIONS DEVICES COME with the ability to customize their features and performance, mostly using downloadable applications. Downloading and installing applications lets users customize their device and have it their way at a very nominal or even no additional cost.

Typical automobiles cost US$15,000–50,000 and come preprogrammed from the factory based on the manufacturer's perceptions about what consumers want. The time taken to design and manufacture automobiles results in an 18–24-month delay from design to delivery, and the actual sale may take additional months.

In the mobile consumer electronics market, 18–24 months can be the useful life of the product. In that amount of time, consumers will likely upgrade to a new product, or their needs and desires may have led them to customize these devices with many downloadable applications. Cars with fixed features designed long before their delivery to consumers are an anachronism. The car of the future will be different.

Automobiles are designed around computers, storage, and software and are now as much an electronic system as a mechanical one. In a real sense, personal vehicles are also mobile consumer electronic devices. As a consequence, automobiles are becoming true applications platforms where users will download applications that can customize the features, performance, and capabilities of the vehicle to suit the needs and desires of the consumer—today's car is "my car, my way."



EXAMPLES OF "MY CAR, MY WAY"

The Specialty Equipment Manufacturers Association (SEMA) represents a US$2 billion annual business, which is growing at rate of 10% per year. SEMA members sell replacement and add-on equipment to customize automobiles. Buying and installing this equipment allows a customer to recreate the car of his or her youth or the car of the future. Customized cars allow customers to modify the performance and ride of the vehicle as well as changing the outward appearance. SEMA equipment can replace or modify the vehicle power train, interior features, entertainment system, feel (the ride), and enhance overall performance or increase efficiency. There are many automobile customers who spend considerable time and money making their car look, perform, and feel the way they want. Figure 1 shows a customized automobile.

Many industries are moving from a "you-get-what-we-make" approach to

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giving consumers much greater control and flexibility over their possessions. For instance, customer home building or buying and installing aftermarket equipment and fixtures for homes allows buyers to make a home truly theirs. This trend is likely to continue to grow, and with the rise of products such as home fabricators (three-dimensional printers), we may see even greater customization of consumer products and infrastructure.

HOW CAN IT BE ACTUALIZED?

Ray Kurzweil, in his book *The Singularity Is Near,* indicates that we are at the singularity point at which any software-driven product can deliver literally any product feature we might desire.

In modern vehicles, almost every operative feature is either controlled or enabled by electronics. The obvious vehicular features that are electronically alterable are the entertainment and information systems. However, there are other electronically influenced or controlled vehicular features that, at present, normally are not controlled by the driver, including

- steering
- suspension
- braking
- engine power
- transmission shifting
- climate control
- vehicle handling
- fuel economy
- seating and comfort
- instrument panel displays
- control locations and functions
- tire inflation
- route guidance.

Modern electronics, sensors, and software control are enabling new vehicle features that are now in development or even in the rollout stage. Some of these new capabilities and features are:

- automatic driving or autonomous vehicles (e.g., Google's autonomous automobiles)
- automatic vehicle delivery (now being considered by truck rental fleets).

VEHICLE SUBSYSTEMS THAT CAN BE ALTERED BY SOFTWARE APPLICATIONS

Let us look at particular capabilities for vehicle customization that an application-driven approach to vehicle features and capabilities makes possible.

STEERING SYSTEMS, MY WAY

Current vehicle steering systems are electronically controlled and electrically assisted. In the BMW 5 and 7 series, the driver can actively change the steering feel/ratio from relaxed to tight via an electric motor attached to the steering input. Based on the time of day, personal taste, driver energy level, and other factors, a steering application can change the steering and vehicle response from that of a Rolls Royce to that of a Ferrari. Figure 2 shows a Ferrari steering wheel.

Modern vehicles have incredible handling capability many times in excess of the individual driver's capability. Vehicles can respond to the driver's input commands (such as steering and braking) within 1–2 s, while most drivers drive with a response time in the 3–5-s range.

Steering can be what the customer wants and not what the vehicle's manufacturer determined that the customer wanted and needed years earlier. As vehicles become more responsive to individual driver needs, the vehicles' overall stability system manages the vehicles so it remains within its inherent performance capability based on vehicle dynamics and the tire friction at the tire-road interface.

MY SUSPENSION, MY WAY

Modern vehicle suspensions are controlled via electronics using shock

FIGURE 1. An example of a customized automobile. (Photo courtesy of Karl Klimek.)

absorbers that are controlled electronically using embedded firmware. This control of the suspension and shocks can soften the vehicle's ride on harsh road surfaces or stiffen the ride based on handling or other personal preferences.

BRAKING, MY WAY

Current braking systems are precalibrated for a fixed pedal feel that the manufacturer believes satisfies most users. However, young drivers, older drivers, and men and women may be satisfied with a different feel in the automobile braking system. See Figure 3 for an image of a sports car brake.

Brake pedal fall when the pedal is pushed is highly personal and could be altered with an application. This will become easier to do as automobile manufacturers move to full electric actuation at the caliper and brake disk. This electrical electronic driver/pedal/caliper control chain allows for a brake application that can tailor the feel and braking performance.

ENGINE POWER, MY WAY

Modern direct-injected, supercharged/turbocharged internal combustion engines can be electronically programmed to deliver power based on the specifics of the engine controller settings. A 2-to-1 hp variability is possible using existing engine controllers through the use of the fuel injection and engine cam control.

An engine-customization application would allow Ferrari power in the morning and econocruise on the way home. As a side benefit while in econocruise, any need for more passing power or other demands for more horsepower could be realized at the touch of the engine power application button. Any modification of conditions to extend fuel economy while driving to reach a distant fueling stop would also be possible.

TRANSMISSION SHIFT QUALITY, MY WAY

Modern vehicle transmissions employ fuzzy logic as well other modern control algorithms for the electro-hydraulic controls to provide shift quality that is smooth and seamless. Applications would provide alteration of the shift quality from seamless to neck jerking based on the driver's preference. The addition of electric–gasoline hybridization can provide additional control strategies for the transmission functionality.

VEHICLE HANDLING, MY WAY

Sharpening vehicle response through faster steering inputs, faster throttle response, faster transmission downshifts, and more sensitive braking causes the overall vehicular response to move from normal to about 75% of that observed in a Ferrari. The overall vehicle stability would be managed by

FIGURE 2. Ferrari steering wheel—control within your reach. (Photo courtesy of Karl Klimek.)

FIGURE 3. A sports car brake. (Photo courtesy of Karl Klimek.)

Customized cars allow customers to modify the performance and ride of the vehicle as well as changing the outward appearance.

the stability-control electronics, which will soon be standard on all new production vehicles.

TIRE INFLATION, MY WAY

Tire inflation, one of the most important requirements of a vehicle, remains a neglected part of vehicle operation for many drivers. While federal laws in the United States mandate tire pressure monitoring, use of this monitoring by consumers is infrequent. New tire pressure monitoring technology, which self-inflates the tires (although not at the rate of fill the driver can accomplish at a service station), allows the vehicle to be soft riding but gives a stiffer ride on bad roads. Tire inflation can be programmed within the limits of the self-inflatable tire's capability, allowing a personally tailored ride and handling, depending on the journey and road environment.

FUEL ECONOMY, MY WAY

All drivers want to extend their driving range to accommodate an extended driving period both to reach their destinations without a fuel stop and to reach more economically priced fueling stations. Current hybrid owners are in fact hypermiling their vehicles to see who can extract the most from the vehicle's fuel. A car customization application would allow, at the touch of a button, a high-mileage fuel strategy in the automobile, causing a new estimate of driving range and, if coordinated with modern telematics, predicting the location of the next gas station and its brand, location, and price. Customization applications could prevent gas stations from over charging.

CLIMATE CONTROL, MY WAY

Differences between passengers result in some passengers feeling too hot and some too cold at the same temperature. Other complaints include "my feet are hot," "move the air away from my face as my contacts are drying out," and so forth. Factory programming of the climate control system averages out the driver, front-seat passenger, and rear-seat passenger's comfort needs, and thus nobody is really happy. The "my car" application would allow individual passenger control of the climate control system, eliminating complaints about the climate during a drive and resulting in a more pleasant journey for all.

SEAT COMFORT, MY WAY

Good seating requires a tradeoff of several factors. Soft, plushy seats may be needed to get the customer in the automobile showroom to feel that this is the car for him/her. However, soft seating, after a period of time, is the antithesis of driving comfort. In general, long-term seating comfort is the antithesis of short-term comfort. "My car, my way" would allow personal customization of seating attributes. Seats could be soft initially (when the driver first starts driving) and firmer, perhaps even massaging the lower torso, as the driver continues driving.

Seating comfort is highly personal due to the variability of the human body as well as age, gender, and physical size (lean versus full). In a home, seating can range from a bean bag chair to an Aeron mesh-based chair to a Barcalounger. Our adaptive restraint seating, seat belts, and air bags should also conform as required to the psychological, physiological, and personal needs of the driver/passenger.

DISPLAYS, CONTROL LOCATION, AND FUNCTION, MY WAY

The new Fisker and Tesla electric vehicles feature large flat-panel displays both on the centerline of the vehicle as well as in front of the driver. Consumers have grown accustomed to touch screens from their mobile devices, and they will expect this capability in modern cars. The manufacturer currently preordains the placement, design, location, and viewing angle of displays. Certain critical vehicle information such as speed and fuel level should always be located in the primary viewing area. However, other information can be located wherever the driver wishes them to be. A new generation of touch-screen displays in automobiles should allow for the customization of the displays as well as touch-based control of the displays.

ROUTE GUIDANCE, MY WAY

Maps or GPS-driven devices can be emotionally straining if the routing suggested is less than optimal. Figure 4 shows the large system information and navigation display in the Tesla Roadster.

A "my route" application should allow the driver to choose scenic, expressway, turnpike, and side-road routing. Route guidance should be provided clearly, concisely, and hopefully in a soothing voice (or any voice the driver chooses) or by using windshield-projected directions with velocity and points of interest.

At the driver's command, vehicles with voice control and voice input from the driver to the guidance system could even go beyond simple guidance to include the history of the area and the people who live there and other informative and useful information. This could be a plus for the driver, as the routing directions would be supportive as well as informative. These features should result in many more happy drivers and passengers.

MY TRUCK, MY WAY

Generally, new electronic technology is implemented in passenger cars and light trucks before commercial vehicles (i.e., heavy-duty trucks and buses and industrial/agricultural and off-road vehicles).

The advent of driverless cars such as the Google car shown in Figure 5 can certainly cross over to commercial

FIGURE 4. A Tesla Roadster display. (Photo courtesy of Karl Klimek.)

vehicles. Commercial truck drivers can spend 48–60 h straight driving a load from one location to another. What better application of driverless cars than driverless trucks, or at least the electronic guidance that can provide a cross-country driver some rest when he/she needs it. So with commercial vehicles our mantra might be: "My truck, my way! Driverless? Why not? I paid for it!"

Today's long-distance truckers work 10–11-h days. With many of these truckers driving privately owned tractors, they have an economic incentive to drive 24 h/d with two drivers (sometimes husband and wife) per tractor. These private operations do very-long-distance drives at a fixed pay per mile. As a consequence for the owner operator, driver fatigue and drowsiness is an important issue.

There are many driverless or driver-assistance protoypes. In addition to the Google autonomous vehicle technology and the U.S. Defense Advanced Research Projects Agency autonomous vehicle challenges, Nissan has just announced a driverless project at its new research laboratories in Santa Clara, California. It is clear that driverless or driver-assistance technology is coming to a vehicle near you.

A tireless electronic driver or driver assistant could make the life of long-distance truckers much safer and more comfortable. With fatal traffic accidents costing in excess of US$1 million per fatality, this driverless and driver-enhancement technology will also save a lot of money for insurance companies.

FIGURE 5. Google's autonomous automobile. (Image courtesy of Google.)

Insurance companies should become major supporters of a demonstrated and safe autonomous vehicle or driver-assistance vehicle program.

SUMMARY AND CONCLUSION

Google has over 150 engineers devoted to developing driverless vehicles. Many new 2014 vehicles are capable of lane following, active speed control, collision warning, automatic braking, and drowsiness detection. The fundamental building blocks of technology are in place for driverless and electronically assisted vehicle operation.

Each year, there are over 35,000 automobile fatalities and 1.5 million serious vehicle accidents. In the United States, 150 million drivers pay approximately US$1,000 each year for automobile insurance.

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Customized vehicles will not only provide a more interesting drive but also a safer one, and they will save time and money for the world's drivers. The tools are in place, demonstrations have been made—it is time to take this concept out for a spin.

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