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## FEATURE ARTICLE

### GOING GREEN: The Challenges & The Solutions

“The conservation of natural resources is the fundamental problem. Unless we solve that problem it will avail us little to solve all others.”—Theodore Roosevelt

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By [Kevin Kelly](#), Sr. Editor



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Even Ferrari is thinking green. Its Mille Chili concept uses advanced aerodynamics, hybrid powertrain and lightweight materials to boost fuel efficiency.

Roosevelt’s words are a perfect summary of the problems facing automakers in relation to balancing the survival of their business and protecting the global environment. Lawmakers, scientists and activists around the globe are

demanding automakers become more environmentally-conscious. Rising global temperatures, skyrocketing fuel costs and changing weather patterns are all held up as the payback for years of neglecting the environment and of the production and use of inefficient vehicles that are designed to stoke egos more than the ecosystem. While the auto industry itself is not solely to blame for the world’s changing environment—livestock emit more dangerous greenhouse gas emissions than all of the vehicles on the planet and commercial buildings and homes are notorious energy wasters—the massive visibility of the automobile and ever-clogging roadways make it an easy target.

#### Driving Forces

Automakers are not known for their responsiveness when it comes to meeting the demands of environmentalists. This resistance has resulted in lawmakers and regulators forcing the hand of the industry to become more conscious of the impacts the automobile poses on the environment.

In the U.S., pressure has been placed on the industry by both state and federal governments. California is leading the way on when it comes to state action. The California Air Resources Board (CARB), established in 1967, has taken up the mantle by passing regulations to reduce automobile carbon dioxide (CO2) emission levels by 22% from the 2002 fleet average by the ‘09 model year—equal to 323 g/mi. The regulation further requires vehicles to achieve a more stringent 205 g/mi average by 2016—a 30% reduction from the ‘09 levels. Taking a page from California’s rule book, New York, Rhode Island, Massachusetts, Connecticut, New Jersey, and Maine have all decided to adopt similar requirements. On the national level, Congress has finalized plans to increase the Corporate Average

#### A CLOSER LOOK



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**For more information on the California Air Resources Board visit:**  
» <http://www.arb.ca.gov/homepage.htm>

**To read the McKinsey study Reducing Greenhouse Gas Emissions: How Much at What Cost? Go to:**  
» <http://www.mckinsey.com/client-service/ccsi/greenhousegas.asp>

**For more on car sharing, visit:**  
» <http://www.carsharing.net/>

**For more information on Fiat’s EcoDrive system visit:**  
» <http://www.fiat.com/ecodrive>



GM’s solar array plan in California required no capital outlay from the automaker, even though it saved on energy costs. Its partner in the program actually sells power back to the grid.

Fuel Economy (CAFE) standard to 35 mpg by 2020, from the current 27.5 mpg average for passenger cars and 20.7 mpg for light-trucks.

Similarly, European regulators are addressing vehicle emissions with Euro 5 standards, which go into effect in 2009 for vehicles on sale in the '11 model year. The regulation calls for diesel vehicles—which account for more than 50% of the European light-duty vehicle market—to achieve carbon monoxide (CO) output levels of 500 mg/km, along with NOx emission levels of 60 mg/km—a 24% reduction from current Euro 4 standards—with particulate matter output (diesels produce soot and aerosols including ash and metallic abrasion particulates, as well as sulfates and silicates) limited to 5 mg/km—an 80% reduction from Euro 4 standards. Gasoline-powered vehicles must achieve CO targets of 1,000 mg/km, with total hydrocarbon outputs set at 100 mg/km and NOx output capped at 60 mg/km—a 25% reduction from Euro 4. The European Commission is currently drafting rules for Euro 6, slated to take effect in the '15 model year, which is likely to include a 50% reduction in passenger vehicle emissions from Euro 5, along with diesel NOx and hydrocarbon emissions capped at 170 mg/km. Beyond just looking at tailpipe emission, European regulators will require automakers to design their vehicles to support a target of 95% recyclability by weight by 2015.

### Social Pressures Build

The auto industry is feeling pressure from consumers to develop higher-mileage vehicles, particularly in light of rising gas prices. According to the Bureau of Labor Statistics, the average U.S. consumer is expected to shell out an additional 12% for gasoline in 2007, while average hourly earnings are increasing at a rate of only 3.5%, meaning consumers are finding a bigger portion of their budget going out the tailpipe. The situation does not bode well for automakers, especially those relying on big trucks and SUVs to support their bottom lines. It's not only pocket book pressures influencing consumers. From news reports about seemingly aberrant weather patterns to films like *An Inconvenient Truth* and *Happy Feet*, people are learning more about the environment than ever before. Scientists are also taking their message directly to the public as the latest report from the United Nations Intergovernmental Panel on Climate Change—declaring the temperature of the Earth has increased by 0.74°C from 1906 to 2005, along with a 1.8 mm/yr. rise in sea levels from 1961 to present—has been debated in print, on television and radio.

### Green Beyond Automotive

The lengthy product development timeframes automakers face tends to put them behind other industries when it comes to designing products that take advantage of consumer eco-friendliness concerns. Here's what some other companies are doing:



Steelcase's Think chair can be disassembled in less than 5 minutes and is 95% recyclable.

- IBM ([www.ibm.com](http://www.ibm.com)) changed the way it applies acoustic foam to its computer panels by discontinuing the use of chemical-based adhesives and replacing them with dart-shaped connectors that hold the foam in place. This change not only helped IBM reduce the amount of greenhouse gas emissions in the production process through the elimination of the adhesive, it also provided for ease in recycling when the product reached the end of its lifecycle.
- Steelcase's ([www.steelcase.com](http://www.steelcase.com)) Think office chair was designed with a focus on recycling. It can be disassembled with the use of a few hand tools in 5 minutes with 99% of its overall content able to head to the recycling heap.
- Intel's ([www.intel.com](http://www.intel.com)) Haifa, Israel, server facility uses water to chill the room to keep the computer systems running at peak performance. Traditional practice would route the heated water at the end of the process to cooling towers to evaporate, but Intel uses the hot water to heat the adjacent buildings in the winter and provide hot water to the showers in the facility's gym.
- Sun Microsystems ([www.sun.com](http://www.sun.com)) decided to take the LEED building concept one step further by eliminating office space altogether. As part of its Open Work program, employees can work from home if they choose. The program cut Sun's real estate costs by \$67.8 million and prevented nearly 29,000 tons of CO<sub>2</sub> in 2006, alone.
- Otis Elevator's ([www.otis.com](http://www.otis.com)) Gen2 lift replaces the outmoded steel cables used to lift the passenger cars with

Former U.S. Vice President Al Gore has become household celebrity through his relentless raising of concern over global warming. "There's a growing awareness of climate change and the rapid availability of information is driving this change in mindset," says Jacquelyn Ottman, who has been advising the U.S. Government and Fortune 500 companies on responding to the environmental movement for more than 20 years as the president of J. Ottman Consulting ([www.greenmarketing.com](http://www.greenmarketing.com)).

### Environment = Massive Commitment<sup>2</sup>

Although the U.S. auto industry—which has lost more than \$20 billion since 2005—is developing alternative-fuel vehicles and improving the efficiency of plants and building operations, there is a general failure in developing a holistic commitment to sustainability throughout entire organizations, from the most senior executives down to the plant floor. The necessity to improve the image and performance of the auto industry in the area of sustainability cannot be accomplished in the short term, nor can it be the responsibility of engineering, manufacturing or design alone. It's time to embrace sustainable innovation as a core competency, aimed at changing the mindset toward improving the environmental impact of the entire industry. Suppliers also must become responsive to the needs of OEMs when it comes to sustainability, making sure their own operations are energy and resource efficient. If the industry fails to meet the challenge, the pressures will only get more pronounced. A recent study from McKinsey & Co. ([www.mckinsey.com](http://www.mckinsey.com)) projects annual greenhouse gas emissions in the U.S. will rise 35% by 2030 to 9.7 gigatons. Of that, the transportation sector, which contributes 2.1 gigatons each year, is expected to grow by 1.3% to 2.8 gigatons.

When thinking along the lines of sustainable innovation, automakers must change the way they balance "green" with the bottom line. The auto industry seems to lack the financial foresight to take advantage of long-term savings and goodwill that comes with being green. "We need to have a one-year payback," Tom Neelands, director of GM's Worldwide Facilities Group, Energy and Utility Services, responds when asked how GM weighs investment decisions in green technology at the plant and facility level. That short-term outlook, unfortunately, is not uncommon in the industry, and it is something that needs to be addressed. Andrew Hobbs, director of the Environmental Quality office at Ford, says his company is trying to change the way financing of green technologies are handled: "One of the things we're trying to convince the financial community to do is look at the long-term liability. We find we can make a great business case for some technologies when we think about the potential liability of not having them five, ten, or fifteen years from now."

### Little Things Mean a Lot

The answers to solving the complexities of sustainability will not be solved by a silver

used to fit the passenger cars with polyurethane-coated steel belts, resulting in a lubrication-free system that does not require an expensive machine room to operate. The technology also provides for regenerative drive, which returns electricity to the building when the elevator travels downward, resulting in an elevator that is 75% more efficient than traditional systems.

- Key Tech's ([www.locknpop.com](http://www.locknpop.com)) Lock n' Pop water-based adhesive can be sprayed onto the bottom and top of boxes to secure them in place on top of pallets during shipping. Once they arrive at their destination, the boxes can be removed from the stacks without any damage. Lock n' Pop reduces harmful gas emissions emitted when producing or using traditional adhesives.

### Ford's Environmental Focus

Ford is taking a step-by-step approach to meeting the green challenge.

And unlike other automakers that are taking a "moon shot" approach to

trying to create environmental technologies, Ford is working toward making the millions of cars and trucks it builds more fuel efficient through cost-effective, common sense approaches. "We're on this path for a long time and it's a long-term commitment and it is a commitment that is best served not by technologies that you can provide in the tens or twenties or even thousands; we need plans that work on millions of vehicles and that means these plans need to be affordable and the infrastructure needs to be in place to support them," says Derrick Kuzak



Lincoln's MKS, which goes on sale late in 2008, will be the first to feature Ford's direct-injection turbocharging technology, which is said to improve both fuel efficiency and vehicle performance.

bullet. Most progress will be made in incremental steps across all facets of each organization. Simple things, like switching to the use of compact fluorescent or LED lighting systems in office buildings, or turning off all computers and electronic equipment at the end of the workday, can make notable differences when they are added up. On the engineering side, close scrutiny of vehicle and component weight, powertrain and transmission optimization along with development of hydrogen and electric drive systems, all play critical roles in helping the auto industry gain regulatory compliance and share of consumer mind when it comes to sustainability.



Ford's soy foam seating material can be hardened and used as structural support and sound deadening. Soy oil is used as a replacement for conventional petroleum-based foams.

Vehicle design is playing an increasingly vital role in the development of green vehicles. Designers must not only develop exteriors that look jaw-dropping, but they must also pay attention to the aerodynamic performance of their designs, particularly as the industry tries to squeeze every minute mile per gallon gain out of each vehicle. Designers will also have to utilize new materials in an effort to reduce the overall weight of the vehicle, again a key demand when it comes to improving overall efficiency. One of the materials that will find more application is aluminum, due to its inherent strength and reduced weight compared to traditional steel. Aluminum's formability is another benefit. In order to fully optimize the benefits of aluminum, however, designers and engineers will have to look beyond the skin of the vehicle for maximum optimization. According to a study by the Massachusetts Institute of Technology, the body-in-white accounts for 27% of the total weight of the vehicle, providing enormous potential when it comes to improved weight efficiency. Moving from a traditional unibody to a space frame design could help optimize weight reduction and vehicle rigidity. Space frame designs have been used in low volume, niche applications for several years—Audi is the most notable proponent of the technology. Making complex rails that maximize the benefits of improved aerodynamics can be better

support them," says Dennis Kuzak, Ford's group vice president of global product development.

In the near-term—from 2008 through 2012—Ford intends to improve the efficiency of its internal combustion engines through the addition of direct-injection and turbocharging technologies, resulting in a 10% to 20% improvement in fuel economy and better performance. "Fuel economy is at the top of the list for our consumers in terms of purchase considerations, and we have to respond to that quickly," Kuzak says, adding Ford also plans to launch a family of dual-clutch transmissions to support its new engine strategy and install electric power steering systems in nearly 90% of all vehicles. Once that's complete, Ford will concentrate on reducing the average weight of its vehicles anywhere from 250 to 750 lb. by doing thing like using more lightweight materials, including high-strength steels, aluminum and composites. Kuzak predicts if Ford reaches its weight savings goals and can install smaller displacement engines in its vehicles with turbo technology, fuel economy can be improved as much as 50%. Beyond weight savings, Ford will improve battery and vehicle electrical systems management, along with improving vehicle aerodynamic performance. "At the same time we will continue to progress on hybrids. We have already committed to a plug-in hybrid," Kuzak says. Further down the road—beyond 2020—Ford plans to increase electric drive systems in its vehicle. Kuzak suggests that by then, the nature of powertrains will be different: "Now the high volume becomes plug-in hybrids, or fuel cells or hydrogen-powered internal-combustion engines. We don't know which of them will win, but they will all play a role." And at that point in time, Ford will make its high-volume moves.

All of these technologies will help boost Ford's green status, but it still remains critical the company develop products that customers demand. "If our products are not relevant, we are not supporting sustainability from an economic standpoint. The most important part of sustainability is having relevant products going forward and as customers needs change we realize we need to change," says Nancy Gioia, director of Ford's sustainable mobility technology and hybrid vehicle programs group. Building green products that customers aren't interested in is possibly less environmental than not having them at

accomplished through space frame construction. Aluminum has failed to gain mass acceptance because of its higher raw material cost compared to traditional steel, but looking at material selection through the approach of sustainable innovation and a holistic systems approach could change the perception of its total cost in the near future. However, steel producers have developed a range of strong, lightweight materials, so the hurdles for aluminum will continue to be set high.

The use of natural materials is likely to expand in design studios as vehicle recyclability pressures build. Ford currently uses soy-based foam in the seats of its Mustang and plans to expand use of the material into other areas of its vehicle, including structural applications in A-pillars. Likewise, the company is studying ways to use natural fiber materials, such as coconut fiber, for bumper supports and interior trim pieces. These materials are easier to recycle and take less energy to produce than petroleum-based plastics. Besides recyclability benefits, using green materials as visual cues on vehicle interior and exterior applications can help boost the “environmental” image of a particular model. Chrysler, for example, is studying using bamboo and cork materials in future interiors. “If the appearance is a positive and the cost is a positive, there is no reason we shouldn’t use those materials,” says Brandon Faurote, head of Chrysler’s advance exterior and interior design group.

### Being Green Italian Style

Improved fuel efficiency is hardly something you’d expect to see on the radar at one of the most famous high-performance car brands, but Ferrari isn’t taking a backseat to the high-volume producers. The company plans to improve the efficiency of its future cars with a target of reducing fuel consumption by 40% by 2012 and reducing vehicle CO2 emissions from 400g/km to 280-300 g/km. The Mille Chili (Italian for 1,000 kg—the target weight of the vehicle) concept provides a glimpse into plans for making its cars more efficient, complete with active aerodynamics via openings in the underbody that change size and shape, depending on vehicle speed. The chassis and bodywork are constructed from carbon fiber and composite materials; low rolling resistance tires provide added efficiency.

Beyond just looking at the vehicle, there are other approaches. Ferrari’s owner, Fiat, has tasked its engineers with changing the way consumers interpret how their driving impacts the environment. The automaker has developed EcoDrive, a computer software program developed by Microsoft that records vehicle CO2 emissions output and fuel economy on a USB key. The key can be plugged into a PC where the software will analyze the performance of the driver and provide useful tips on how to improve fuel economy and lower harmful emissions by minor changes to driving behavior.

### Green Factories

Manufacturing’s role is probably most crucial in helping to improve the environmental performance of the industry. The hundreds of millions of dollars spent retrofitting and upgrading assembly, stamping and powertrain facilities provide more than ample opportunity for the industry to achieve significant financial gains when it comes to being green. Clay Nesler, vice president of Global Energy and Sustainability at Johnson Controls Building Efficiency division ([www.jci.com](http://www.jci.com)), says it’s critical for the auto industry to include sustainability as part of plant upgrade expenditures. But even on-going operations can provide advantages: “We find that the highest return on investment when it comes to building efficiencies is looking at maintenance of equipment and this requires little capital outlay, but provides marked savings,” he says, noting lighting is one area that provides quick returns with little outlay. According to the McKinsey study, lighting accounts for more than 19% of greenhouse gas emissions associated with buildings and retrofitting incandescent lighting systems with compact fluorescent or LED lighting systems can cut power consumption by as

environmental than not having them at all.



Zipcar’s vehicle sharing business model allows its members to use vehicles by the hour or day. Members have “zipcards” that allow them access into the vehicles, which include more than 25 makes and models, from the Prius to the BMW 325i to pickups and SUVs, and are located around cities including Boston, Chicago, Ann Arbor, and Los Angeles. One benefit of the model, according to the company, is that it eliminates the need for some people to have a second car. This could have some ramifications on OEMs should the car sharing become more prevalent..

much as 12%.

The biggest area of potential benefit from a cost savings and emissions reduction perspective are paint shops, which represent 60 to 75% of total assembly facility operating costs, according to Gordon Harbison, Services and Solutions manager at Dürr Systems (<http://www.durr.com/en/>). Since paint shops use massive amounts of air to keep spray booths clean and compliant with tight climate control requirements, it's vital to find ways to reduce the amount of natural gas used to heat the air entering the booths. Dürr developed a system it installed at a few GM facilities using a process called "building-2-booth" where general shop ventilation, which is already climate controlled, is routed to the spray booth using the building itself as the duct work. The program is expected to result in saving an average of \$4 per vehicle over traditional spray booth control processes with a reduction in harmful greenhouse gas emissions. Dürr is also working to promote the use of energy-curable coatings, which use ultraviolet light or electron beams to cure vehicle paint on bodies. Several pilots are being tested for use on spot repairs at the end of the assembly line and the results are promising, with less paint being discarded due to the fact that the paint does not begin to dry until it is hit with the light or beams. Using the process on full vehicle bodies has proven challenging because complex surfaces found on many vehicles cause light bending problems and uneven cures.

Providing power to the plant itself holds ample promise for reducing cost and improving efficiency. Johnson Controls' Nesler says automakers should look at using cogeneration for plant operations. Currently, most power plants vent the heat produced during electricity production through cooling towers directly into the atmosphere. Through cogeneration, the heat generated is used for climate control of the facility being powered, thus reducing the need for separate heating equipment that uses natural gas or other resources. Cogeneration plants can use multiple feedstocks to provide heat and electricity, including waste woodchips, straw or various biomass materials. "This becomes a very attractive option when you look at the rising costs of natural gas and other resources," Nesler says. Beyond cogeneration, automakers can also turn to the sun to power their facilities. While solar panels have been available for decades, the technology used to produce them is becoming more cost-effective. The cost of photovoltaic technology is expected to drop from \$300 to \$350 per megawatt-hour in 2005 to \$90 per megawatt-hour in 2030, moving solar power penetration from a 0.5-gigawatt capacity in 2005 to 148 gigawatts in 2030, according to the McKinsey study. GM has installed photovoltaic panels on two of its parts warehouses in California under a unique business partnership with Constellation Energy ([www.constellation.com](http://www.constellation.com)), which designed, built and owns the arrays. GM agreed to a long-term contract to buy electricity generated from the solar systems, while any excess power is sent directly to the general power grid, where Constellation earns money from the state utility.

A holistic approach to green building has been developed by the U.S. Green Building Council ([www.usgbc.org](http://www.usgbc.org)). Its Leadership in Energy and Environmental Design (LEED) building certification program awards points for satisfying specific building criteria in several categories: sustainable sites, water efficiency, energy & atmosphere, materials & resources, indoor environmental quality and innovation in design. Buildings are awarded either a certified, silver, gold or platinum certification level, depending on the points earned. LEED certification can be granted for existing facilities, with a focus on improved maintenance and upgrading of equipment over a set timeline. LEED has become vogue of late, with Toyota, GM, Honda and Ford being some of the biggest proponents of the program. Honda already certified two of its U.S. facilities—the Honda R&D central plant facility in Raymond, OH, and its Northwest Regional Center in Gresham, OR, at the Gold LEED level—and has plans to expand to two more facilities in 2008.

### Unfamiliar Territory

Being green isn't rocket science, but it does require a significant change in thinking. Automakers should look beyond the dealer lots to see how they can truly reshape the image of the industry going forward because the pressures from environmental groups and regulators will not abate. "In the early 1990s we went through a period of 'green washing' where if you came



out with one product you were green. Now, consumers know better,” says green marketing expert Ottman. She suggests that auto execs may have to think as former IBM CEO Lou Gerstner did, when he changed the model from computer-maker to technology solution-provider. As urban centers get more densely populated, it may be time for the auto industry to look at itself as transportation solution providers. With more than 645 cities around the globe offering car sharing services to their residents, it may be beneficial for automakers to look at partnering with the companies that provide the shared vehicle services.

What about the dealers and market share? No doubt they will shrink, but if one automaker takes the lead, there will likely be fast followers. Speaking of the automakers, Ottman says, “They have to be looking at these things in order to stay in the game long term—if they see the writing on the wall.” The writing can no longer be ignored by those companies that want to survive.

Fiat’s EcoDrive, developed in conjunction with Microsoft, provides real-world data on how driving behavior impacts fuel efficiency. The objective is to improve the way people drive. Vehicle manufacturers have to look beyond the walls of their factories and the parking lots of the dealerships in their efforts to provide more-sustainable transportation.

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