

GREEN WAYS

Working toward an advanced automotive society

DENSO



River Cleanup

Doug Patton, senior vice president of Engineering at DENSO's North American Headquarters, hauls logs away from Michigan's Rouge River during the annual Rouge Rescue volunteer event.

Photo: Phillip T. Dattilo

GREEN WAYS in North America

DENSO's green ways permeate every facet of our global business- from management, initial R&D, product development, manufacturing, distribution and disposal, to our employees and even the communities in which we operate.

Our green ways are not new. As a young automotive components supplier struggling to get on its feet, DENSO produced an electric car in 1950 – 40 years before the first mass-produced electric vehicles hit the roadways in the early 1990s – to demonstrate our technology capabilities.

Today, DENSO supplies advanced automotive technology, systems and components to all the world's major carmakers, employing approximately 126,000 employees in 35 countries.

Automobiles continue to be an essential part of people's daily lives: More than one billion are in operation worldwide. But, automobiles do have some negative impact on the environment. DENSO believes helping reduce that impact is one of its most important responsibilities. To do so, DENSO has dedicated its worldwide resources to help create what we call an "advanced automotive society" – a society in which automobiles co-exist in harmony with the environment.

In North America, we're putting into action our second environmental plan, based on DENSO's global EcoVision 2015, our most recent 10-year strategy for DENSO environmental activities throughout the world.

North American goals for the next five years include:

Eco Products

- Deliver products that are lightweight, energy saving and help improve the environment.
- For all our products, reduce our use of resources, control and reduce environmentally hazardous substances, and integrate environmental planning in the product design stage.

Eco Factory

- Reduce the environmental impact of our North American manufacturing facilities (including manufacturing and distribution) through reduced water use, CO₂ emissions, landfill waste and hazardous substance emissions.

Eco Management

- Develop environmental action plans at each North American facility and reinforce environmental partnerships with suppliers through activities such as developing green procurement guidelines and promoting the purchase of environmentally friendly products.

Eco Friendly

- Contribute to a better society by encouraging and supporting employee environmental activities, proactive information disclosure and communication with stakeholders, environmental education, and environmental and social contributions.

Ultimately, we hope to help prevent global warming, recycle resources and further reduce environmentally hazardous substances in North America.

During our previous five-year North American environmental action plan, all our facilities achieved ISO 14001-certification, a globally recognized and totally voluntary standard of excellence for environmental management.

To truly understand our commitment, please read the following pages.



Eco-Education

At EcoPark during Waterfest in May 2012, Great Smoky Mountains National Park Ranger Mike Braun engaged youth with tips on protecting land and wildlife.

Photo: Maryville Daily Times

*“This land is your land,
this land is my land...”*

– Folksinger Woody Guthrie



EcoPark

It all began with two organizations, a vision and a need.

At DENSO Manufacturing Tennessee (DMTN), President Van Saka wanted to demonstrate the company's commitment to the environment, and he had a vision to create a wetland learning environment on the company's campus.

Meanwhile, Keep Blount Beautiful (KBB), a local non-profit organization whose mission is to improve their community by encouraging litter prevention, waste reduction, and beautification, was facing a dilemma. Their outdoor classroom pavilion at a local landfill had to be removed for a new cell to hold landfill waste.

So, in the fall of 2010, DMTN and KBB joined ecological forces to develop a new EcoPark to serve the community both as a wetland learning environment and also as a refuge where native plants, grasses, trees, small wildlife and a variety of birds and insects can flourish.

Plans to build EcoPark near DMTN's Body Electronics Plant 203 were quickly put into motion. KBB raised the funds for construction of a pavilion that would be used as an outdoor classroom, and DMTN provided the land, trails, trees and other resources to create the park.

Just over a year later, on May 10, 2012, EcoPark officially opened. To celebrate, DMTN and KBB welcomed more than 300 Blount County elementary school students to the park for a special event, dubbed

Waterfest. The event featured learning stations about wetland wildlife and ways to protect the environment.

Since the park opened, KBB uses the wetland learning environment as part of an environmental education field trip program that includes a two-hour tour of the Alcoa/Maryville/Blount County Landfill, followed by a waste-free lunch and a visit to EcoPark. The goal: to educate every local child by the sixth grade through participation in the program.

By the end of its first year, EcoPark hosted more than 800 elementary school students.

During their visit to EcoPark, students learn about composting, litter prevention, recycling and pollution prevention. There is a special emphasis on storm water pollution prevention, which was a primary focus for DMTN when developing the park.

KBB also uses the site to host adult learning sessions with groups such as its own board of directors and the community's Leadership Blount.

The park includes three wetland areas, including a retention pond and energy dissipaters for water flow. These help manage storm water collection and filtration from nearby rooftops, parking lots and roads to ensure the water is clean before it enters neighboring Culton Creek. A side benefit is help in the prevention of soil erosion while maintaining an overall healthy habitat at EcoPark.



Water Watchers

In the Southern California desert, water cannot be taken for granted. At DENSO Products and Services' (DPAM) facility in Murrieta, Calif., no one does. Especially not Recycling Specialist Eldon Shernaman who keeps an eye on the company's daily water use.

Shernaman makes certain that he and his 115 co-workers watch every single drop. Literally.

Since 1997, the facility has been recycling 100 percent of its manufacturing process water, cleaning water and even air conditioning condensate – or 200 gallons of water daily – with zero discharge to the city's sewer system. All this is on top of the facility's primary function of remanufacturing automotive starter motors and alternators.

Remanufacturing itself is an advanced form of recycling that involves the disassembly of products into their component parts. Components are then remanufactured, assembled and tested, emerging as close-to-new products. Most of the materials, energy, labor and capital equipment contributions used to produce the near-new products are retained for reuse.

That includes the water – all the water.

Here is how the water recycling works: During the process of disassembling, cleaning and reassembling used starter motors and alternators, Shernaman washes the starter and alternator units in hot water and aqueous cleaners. The discharged water then filters through the facility's own recycling system, which removes all grease and chemicals. After this cycle, the now-clean water is routed back into the system's main storage tank for reuse.

Shernaman's co-workers mop the plant floors with the recycled water. After the floors are clean, Shernaman filters the leftover mop water back through the system, cleaning it again. The recycled water is also used to rinse all soiled work gloves, rags and mop heads before laundering. Soap, grease and dirt from the laundry rinse and wash cycles are filtered out through the recycling system and again routed back as clean water into the system's holding tank.

For this ingenious system of water conservation, the California Water Environment Association awarded the facility with its Southern California Plant of the Year back in 1997.

Now, the facility uses a weather-monitoring satellite to control the sprinkling system, telling it when the landscape needs watering and when the watering needs to stop, all depending on current Murrieta conditions.

What next?

DPAM is currently considering several future projects, like converting to a water conservation landscape to save 1,500 gallons of water each month. They're also looking at converting more of the landscape from spray irrigation to a drip irrigation system, and using a boiler to heat process water for cleaning and evaporation.

Why? Because every drop counts.

Wash, Rinse, Recycle

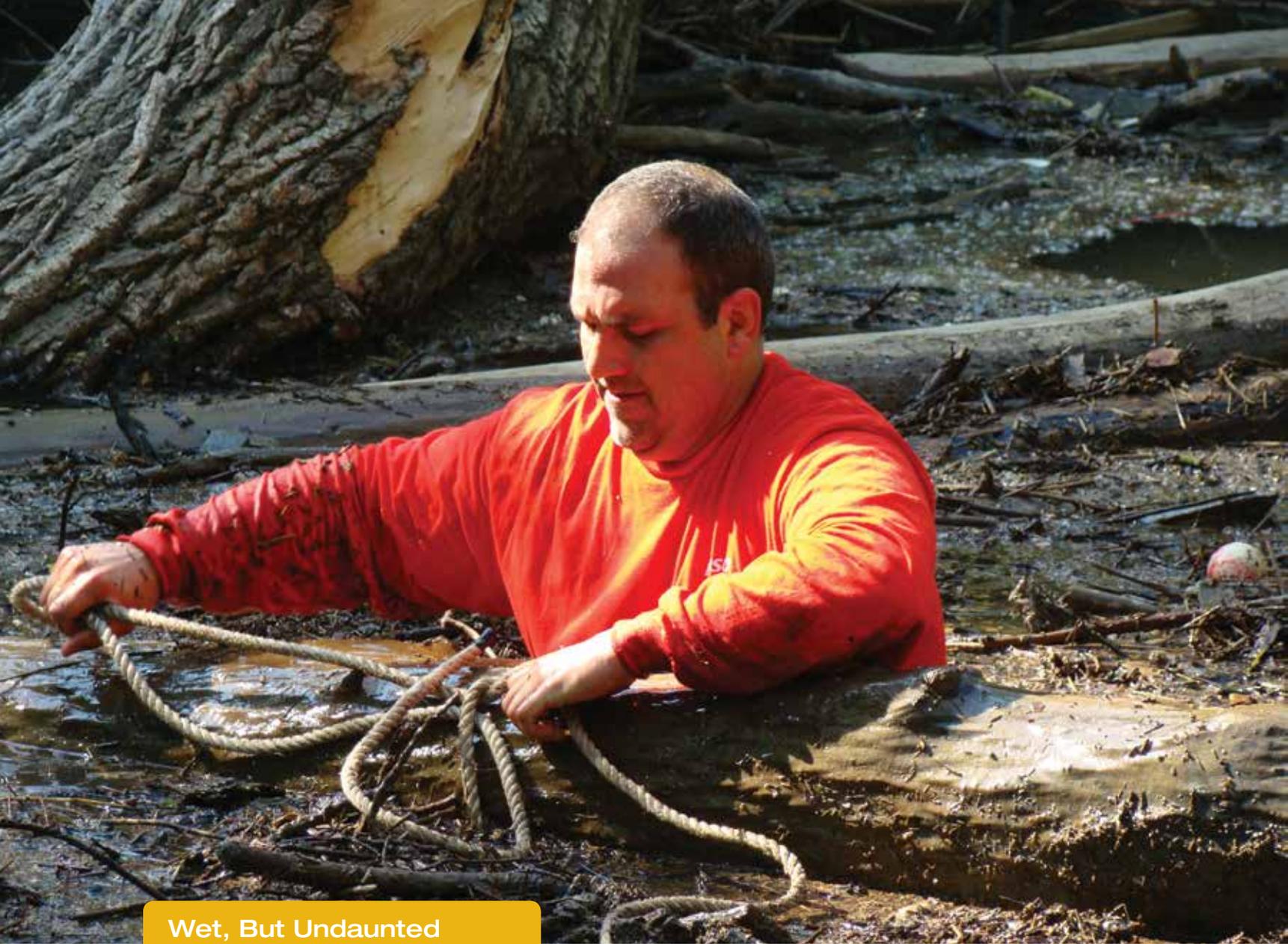
DENSO Product and Services' facility in Murrieta, Calif., recycles 100 percent of its manufacturing process water every day through the company's recycling system (above). After filtering out grease and chemicals, the now-clean water goes back into the main storage tank for reuse.

Photos: Cristina Salvador

“Nobody can be in good health, if he does not have all the time, fresh air, sunshine and good water.”

– Oglala Sioux Indian Chief Flying Hawk

Restoration



Wet, But Undaunted

Bob Townsend ties up a heavy, water-soaked log so a crew of more than 50 fellow DENSO volunteers can pull it up out of the Rouge River, near DENSO International America in Southfield, Mich.

Photos: Phillip T. Dattilo

“Conservation is a state of harmony between men and land.”

– American ecologist Aldo Leopold



Take Me to the River

Chest-deep in the waters of the Rouge River, Bob Townsend maneuvered an enormous log toward the river's right bank. A thick rope, tied around the log, snaked up the eight-foot-high bank and stretched 75 feet into the deep woods, gripped all the way by volunteers from DENSO International America.

“One, two, three – pull,” shouted the team leader as the group pulled hard on the rope. Townsend, a director at DENSO, and several volunteers carefully guided the waterlogged tree trunk slowly up the riverbank. In other areas along the river, groups of DENSO volunteers cleared other logjams and pulled invasive plant species that take over native plants.

All were participating in the Rouge Rescue, a multi-community cleanup designed to help keep the river healthy, reduce erosion and provide habitat for fish and wildlife. The annual event, sponsored by the Friends of the Rouge, depends on the sweat equity of local volunteers like Townsend to break up logjams and clear trash.

For DENSO, maintaining a healthy Rouge River is personal.

The company's North American headquarters, DENSO International America, sits near the Rouge River floodplain in Southfield, Mich. That's one reason DENSO has been involved in its restoration since 1997.

More than just a local river, the Rouge centers an entire ecosystem right in the middle of Michigan's most densely populated, urbanized land area. Running 126 miles through southeastern Michigan before emptying into the Detroit River, the Rouge connects to Lake St. Clair, which then connects to Lake Erie, one of the five Great Lakes.

Since first participating in Rouge Rescue, as many as 150 DENSO volunteers from 14 local communities turn out to help – the largest corporate volunteer group in the event's history. DENSO also aids the Rouge ecosystem in other ways. The company has contributed more than \$140,000 in money and in-kind gifts to the Friends of the Rouge since 1997.

In addition to the Rouge Rescue volunteer event, DENSO has also supported the Rouge Education Project, a nationally recognized water quality monitoring and watershed education project for local area students.

Through the project's hands-on, real-world science activities, such as monitoring the river's water quality, students increase their awareness of the Rouge River watershed, how they impact it and how it impacts them. In turn, they can apply the knowledge they gain to address environmental issues throughout their lives.

For future generations – that's why Townsend and DENSO employees, family and friends took to the river in the first place.



Reclamation Fever

Out on DENSO Manufacturing Michigan's plant floor in Battle Creek, large furnaces tower among the assembly lines. These furnaces hum along nearly 24 hours a day, working their magic on partially assembled products, joining metals with their 1,000-plus-degree temperatures.

Step close to one of these furnaces and through the crisscrossing bars of the grate, and you can see the assembly line passing through the system and feel the heat that radiates within the belly of the furnace.

These furnaces generate a lot of wasted heat, and that is where the heat reclamation project comes in.

Above the furnaces, huge silver and beige ducts travel along the ceiling. Their presence is unremarkable to the average eye, blending with ceiling supports and myriad fixtures high above the plant floor.

However, these ducts perform a significant function: They take wasted heat from the furnaces, carry it upwards, circulate it with fresh air from the outside and transport it to cooler areas of the plant. This process is called heat reclamation, and it is used to keep the plant warm during the frigid Michigan winters.

In the first year after DENSO Manufacturing Michigan's heat reclamation project began, employees monitored the plant conditions daily. As part of the company's original heating system, 37 burners throughout the facility were on standby, ready to fire up and heat the building as conditions demanded.

Yet according to Pat Carpenter, facilities engineer, after the heat reclamation equipment was installed and operational, on average only two or three burners were ever in use on chilly days, and only 17 percent of their capacity was needed.

"Even on zero degree days, only five or so burners fired up and only at 5 to 10 percent capacity," he says.

The reclaimed heat was doing the job of heating the facility nearly on its own.

When the project began, the goal of the Facilities department was to reduce utility costs. But as the team evaluated the impact it would have, they realized it would have a big effect on CO₂ emissions as well.

The end result? The Battle Creek facility reduced its consumption of natural gas by more than 33 million cubic feet and its CO₂ emissions by 3.9 million pounds—exceeding even DENSO's ambitious goals for CO₂ reduction.

The wheels of progress have long turned with power generated from fossil fuels. But as supplies decline and concern about greenhouse gases increases, industry will define progress not just by the products DENSO produces, but by the by-products it doesn't produce and the resources it conserves and protects.

DENSO takes that challenge seriously.

The heat is on...and DENSO Manufacturing Michigan stands ready to reclaim it.

The Heat is On

Ceiling ducts draw wasted heat emitted from the furnaces at DENSO Manufacturing Michigan in Battle Creek, transporting it to cooler areas of the plant. This heat reclamation system reduced natural gas consumption by more than 33 million cubic feet, and CO₂ emissions by 3.9 million pounds.

Photos: Phillip T. Dattilo

“Society cannot continue to live on oil and gas. Those fossil fuels represent nature’s savings accounts which took billions of years to form.”

– Futurist R. Buckminster Fuller



As the Worm Turns

Sitting alone under the Mexican sun having lunch, the temperate air soothing his thoughts, Jorge Haros came upon an idea almost the same way the Cerro de la Silla mountains come into view along the eastern foothills of the Sierra Madres— as an inspiration.

A pioneering use for the heaps of food scraps tossed out daily from the cafeteria at DENSO Mexico's Apodaca plant, thought the manager of Safety, Health and Environment, would lessen the burden on the growing number of landfills in the Monterrey region – Mexico's second most important industrial area.

While researching solutions, Haros came across a fellow DENSO employee in India, S. M. Aggarwal, who was experimenting with an organic recycling method known as vermicomposting. Haros went to DENSO India to study with him.

What he brought back to Apodaca is a can of worms.

This is a can like no other – a farm, in fact, crawling with some 150,000 California Redworms, which daily consume their own weight in garbage, the organic variety, of course.

Besides the cafeteria's hundreds of discarded chicken bones and other food refuse, DENSO Mexico's sewage sludge, garden waste and sanitary paper – all previously designated for a landfill – are converted into a highly rich fertilizer as a result of the worms' work, or vermicomposting.

The worms, scientifically referred to as *Eisenia foetida*, collectively polish off about 3 ½ tons of junk food a week, saving DENSO Mexico more than \$33,000 in annual disposal costs.

While the global target for DENSO companies is to reduce landfill waste from manufacturing operations by 75 percent, DENSO Mexico's target is zero emissions.

“Our goal is to waste nothing,” says Haros. His thinking: “We'll have to get to zero eventually, so why not start now?”

At one time such an ambitious goal might have been called a whole lot of trash talk, since a company would have to find a reuse for just about everything, including organic refuse.

For years, communities have been able to recycle such items as plastics, metals, paper and batteries, while even printing inks, chemicals and oils can be processed into supplementary fuels.

But organic waste has always been sort of a recycling quagmire for environmentalists because there are few items that organic materials can be converted into that offer any real value.

Now, the worm farm changes matters, says Haros. Besides producing a useful fertilizer, vermicomposting gives Apodaca plenty of wiggle room to meet its stringent zero-emissions standards.

Apodaca's organic waste recycling yields about 18 tons of fertilizer a year. Some goes to DENSO employees for home garden use and the remainder is distributed to local municipalities for tree planting.

Cristabel Meza, who oversees vermicomposting at Apodaca and holds on-site workshops for employees, students and environmental groups, says, “We want to turn others into pioneers, building their own worm farms at home, at school and places of business.”

Crawl Space

Nearly 150,000 California Redworms convert cafeteria waste into highly rich fertilizer for the surrounding area at DENSO Mexico's worm farm in Apodaca, N.L. Tended by Advanced Team Leader Cristabel Meza (left) and Manager Jorge Haros, the worms can eat their own weight in organic garbage daily.

Photos: Fausto Tovar

*“Waste not, want not
is a law of nature.”*

– British engineer John Platt

Preserving Clean Air (Fuel Efficiency/Reducing Emissions)

Monolithic Carrier

The monolithic carrier acts to reduce or oxidize harmful emissions such as hydrocarbons, carbon monoxide and nitrogen oxides.



Air Flow Meter

This air flow meter measures the flow rate of air into the intake manifold, resulting in the correct air-fuel ratio for efficient combustion.



Stop/Start Starter

Stop/start systems cut the engine when the vehicle is at a stop or in other idle traffic situations, helping to improve fuel efficiency by approximately three to five percent and to reduce CO₂ emissions.



High Pressure Fuel Injector

The high-pressure fuel injector, developed for gasoline direct-injected engines, allows for more precise controlling of combustion and emissions, which translates to improved fuel economy.



Fuel Injector

This fuel injector's atomizing capability dispenses fuel in precise quantities and allows for better mixing with air, increasing fuel efficiency.



Spark Plug

Tough metal alloys applied to the tip of the plug assure proper ignition even during idling, with less fuel consumption and less noise.



Oil Control Valve

The oil control valve controls the direction of oil flow and activates the variable camshaft timing valve, providing more fuel savings and power.



Variable Displacement Compressor

The variable displacement compressor can alter refrigerant displacement to control air conditioner cooling capability, making it highly fuel-efficient.



Promoting Recycling (smaller, lighter, recycled material)



HVAC Unit

The plastic case on this HVAC (heating, ventilation and air conditioning) unit is molded with 20 percent in-house recycled material. A titanium-based process provides corrosion resistance for the evaporator rather than hexavalent chromium, an environmentally hazardous substance. Lead solder was eliminated from processing operations by a raw material switch from copper to aluminum.



Starter

The die cast process reuses 90 percent of internal scrap aluminum.



Power Window Motor

The power window motor is engineered to be the most compact, and is available in multiple output torque levels and three versions of control: standard, sensor and smart.



Alternator

A redesigned segment conductor produces a smaller, lighter alternator with higher efficiency and lower noise.

Reducing Hazardous Substances

Instrument Cluster



The instrument cluster and air conditioning panel are manufactured without the anti-corrosive hexavalent chromium, an environmentally hazardous substance that can leak into the underground water table if a product containing the metal is not disposed properly.

Air Conditioning Panel



Cooling Fan Motors

The fan motor is manufactured with lead-free electrical brushes.



Windshield Wiper System

The wiper motor is manufactured with lead-free electrical brushes.



Power Seat Motor

The power seat motor is engineered to optimize material usage while maintaining performance and size advantages for today's innovative, lightweight seat system.

Radiator Tank (plant-derived resin)

The plant-derived resin radiator tank, which is made from castor oil, is green all the way around. Compared to conventional products, it releases less CO₂ emissions into the environment during its life cycle because it is partially made from material extracted from plants, which absorb CO₂ through the photosynthesis process. It also helps conserve oil, a fossil fuel which is being depleted.





Green Thinking

With water pressure providing energy, Samantha, the Garden Robot Worm simultaneously aerates and irrigates soil as she moves. Brothers Mike Ely (left) and Eric Ely, of DENSO Manufacturing Michigan in Battle Creek, won third place in DENSO's global idea contest for this creative concept robot. The global contest promotes innovative thinking among employees.

Photo: Phillip T. Dattilo

North American DENSO Environmental Policy

It is the policy of DENSO in North America to conduct its business in a manner that is consistent with environmental preservation and harmony with society.

To implement this policy, DENSO commits to the following principles:

- DENSO will operate as an environmentally responsible corporate citizen;
- DENSO will seek to prevent pollution and to ensure that its operations comply with relevant environmental laws and regulations and other related environmental obligations;
- DENSO will implement an environmental management system which includes objectives and targets, periodic review and a commitment to continuous improvement; and
- DENSO will communicate this policy to all DENSO in North America associates and make it available to others upon request.

For more information please visit:

www.densocorp-na.com

www.globaldenso.com

Email: corp_communications@denso-diam.com

Printed with soy inks (derived from vegetable matter and manufactured without petroleum products or volatile compounds) on 100% post-consumer recycled and elementally chlorine-free paper, using advanced printing technology that eliminates the need for wetting with isopropyl alcohol or other hazardous substances. Mastering was handled through a computer-to-plate system that eliminates use of both polyester acetate film and alkali developing fluid, and reduces resource and energy consumption.

