Steel wheels in style

The "mag" wheels on the retro-styled Mustang are not magnesium, or even aluminum, but rather are Hayes Lemmerz spoked steel wheels clad in chromed plastic to create the appearance of vintage mags at an affordable price.

Conventional wisdom on steel wheels is that consumers prefer the appearance of aluminum alloy wheels and expect to see them on premium vehicles. Steel wheels are those ugly black ones hidden by hub caps, and even the hub caps have gone from stylish chromed steel to cheap-looking plastic, right?

Not anymore. Steel wheel makers are looking to reclaim some market share lost to aluminum, and they are not just making a case for the economics of steel. Improved materials and stamping techniques make possible steel wheels that weigh the same or less than comparable aluminum wheels, while featuring the kind of open-spoke styling that is popular with consumers. Witness the high-end chrome wheels on the Mustang GT.

Consumer surveys showed that buyers do not care from what material their cars' wheels are made, only that they have the open-spoke styling that is so popular, said Jim Cran, Project Manager for **American Iron and Steel Institute**'s wheels task force, which commissioned the poll. Steel-wheel market share dipped to about 42% by 2000, but has since rebounded to about 47%, according to the institute.

Car makers have adopted aluminum wheels in the belief that they are what consumers want, when in fact those customers only want the appearance that was until recently only possible with aluminum wheels, he asserted.

"[OEMs] thought the consumer preferred aluminum and would pay extra for that wheel," said Cran. "Actually, the consumer does not know what material the wheel is made of, and they don't care. They showed no preference between steel and aluminum."

This news was met skeptically, according to Cran. "At first, they [OEMs] were incredulous. But the cost savings were so great and with this information, we finally started making some inroads."

Cost seems to be the most important criteria in today's fiercely competitive market, and the potential savings from replacing an aluminum wheel with a steel one of the same size and similar appearance is about $120 to $160 for a set of four car wheels, said Cran, and the **Ford** F-150's chrome-clad steel wheels save $200 compared to aluminum wheels.

Because steel wheels are stamped from thin sheets of steel, they lack the three-dimensional appearance of aluminum wheels, so suppliers dress them up with plastic cladding that simulates the appearance of popular alloy wheels. Of course, steel wheels have long been dressed up with hub caps, but most consumers do not like their appearance or their susceptibility to falling off. Today's cladding is either bolted or glued on, so falling off or theft is no longer a concern.

"If you dress up a wheel, it doesn't really matter what is behind it," observed Scott Murray, Director of Clad Development for **McKechnie Vehicle Components**, a supplier of plastic cladding. "It levels the playing field from the aesthetic side."

It is still easier to create large wheel openings with aluminum than with steel because of the added depth of the aluminum material, but high-strength steel and new stamping techniques are permitting ever larger openings on steel wheels, Murray said.

"In the last five years, the steel wheel started to catch up because of the high-strength steels that were available and also because of new improved simulation techniques for wheels with larger, more open windows," said Eduardo Mikami, Product Engineer for the Wheels Division of **ArvinMeritor**. So advances in steel wheels are also attributable to improved design and simulation software that lets engineers maintain necessary strength while trimming away material, he said.

This chrome-clad steel wheel for the Ford F-250 saves $50 per wheel in cost compared to the aluminum alternative.

Even painted steel wheels need not be the plain black discs usually seen beneath hubcaps, as this ArvinMeritor wheel illustrates.

Though conventional wisdom says that optional aluminum wheels reduce weight, these Hayes Lemmerz 16-in steel wheels (shown on the Chevrolet Malibu), at 17.7 lb (8 kg), are more than 1 lb (0.45 kg) lighter than the available 17-in aluminum wheels, which have a mass of 18.9 lb (8.6 kg) each.

"Before, we had to make the tools, then test them, and then go back to the drawing board if there was a problem. Now, it is much easier because we can predict the process flow. When we go to the shop and build the tools, we already know how it will go, so it saves time and money," said Mikami.

That is not to minimize the importance of new types of steel. "The [traditional] steels wouldn't support the deep draws that are in the stamping process," he said. "With improvements in the manufacturing process, they came up with the high-strength low-alloy (HSLA) and dual-phase steel that allowed us to expand into deep draws."

Those materials also let the wheels feature thinner spokes without using a thick gauge of steel that would make the wheels very heavy. As a result, the steel wheels sold on the **Chrysler** PT Cruiser are only 0.1 lb (0.05 kg) heavier than the alloy wheels, and those on the **Chevrolet** Cobalt are only 0.2 lb (0.09 kg) heavier, according to Cran. "We don't say steel is lighter or heavier, because it is style-dependent," he said.

So weight has been pretty well eliminated as an issue, but one of the concerns held by OEMs has been the durability of the cladding. With real-world experience growing by the day, car makers are gaining confidence in the technology. "[OEMs] say, 'We have to make sure this is not going to fall apart,'" Mikami said.

Another concern has been fear of being seen as misrepresenting the product to customers, because the chrome-clad steel wheels are commonly assumed to be alloy wheels. "Sometimes the dealer doesn't even know what wheels are on the car," said Cran, so OEMs are trying to educate sales staffs and consumers on the issue.

The result is increasing interest from the domestic manufacturers, with transplant manufacturers still taking a wait-and-see approach, said Tom Heck, Director of Engineering for North American Wheels at **Hayes Lemmerz International**. "I expect there to be renewed interest from the Asian transplants, probably next year," he said.

One advantage of steel wheels is higher durability and tolerance for scraping curbs. The steel wheel itself is less prone to damage, and the clad surface can simply be replaced if it is damaged. "If [drivers] do curb the wheel, rather than having to replace the whole wheel, you replace the trim," said Heck. "The cladding bolts on, so it is very secure, but if you do need to remove it for repair, you can do that."

Dan Carney

Researchers aim to improve recycling

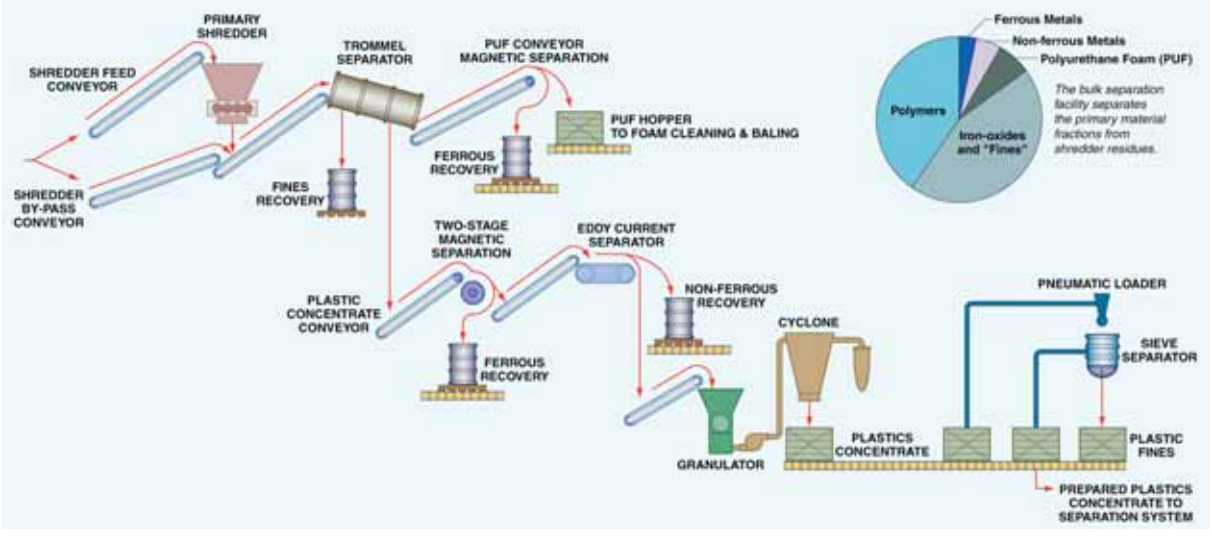
A joint research project between the U.S. **Department of Energy** (DOE) and the **Vehicle Recycling Partnership** (VRP) is making solid progress to increase the percentage of recycling when vehicles are discarded. A pilot line is capable of processing 1 ton (0.9 t) of material an hour, removing materials that currently end up in landfills.

The DOE is currently in the second of a three-year Cooperative Research and Development Agreement with the VRP, which consists of the **American Plastics Council**, the U.S. Council for Automotive Research (**USCAR**), and **Argonne National Laboratory**, a DOE national research lab that is the center of the project.

Researchers aim to reduce waste from the 15 million cars and trucks in the U.S. that reach end of life each year. Currently, 95% of those vehicles are recycled, but only iron and steel are typically removed for reuse.

Much of the development work will focus on improving efficiency at the 200 or so shredders in the U.S., where large machines turn vehicles into fist-sized lumps of co-mingled materials. Once steel and other magnetic materials are removed for recycling, the remainder typically goes into landfills.

"After recycling, there's around 20-



Removing small "fines" from shredded vehicles is a key focus in Argonne's recycling project.

25% of the material left. We want to reduce that," said S. William Gouse, Executive Director of USCAR, a consortium consisting of **General Motors**, **Ford**, and **DaimlerChrysler**. That percentage totals between 3 and 4.5 million ton (2.7 and 4 million t), he added.

A pilot line running at Argonne can separate 95% of plastics, far more than other researchers can, said Edward Daniels, Argonne's Energy Systems Division Director. A key focus is to remove "fines," the small materials that are harder to separate than larger shredder residue. While magnets can easily pull out large metallic shredder residue, the fines are often mixed with metals, plastics, and foams, so they are difficult to process.

While efforts focus on techniques for removing materials, the consortium also hopes to make sure there are economic incentives for recyclers to adopt these techniques. "We want to develop the technology that ensures that materials can be recovered, and to ensure that there will be a market for those materials," Daniels said.

This broad view extends beyond recycling, going back to vehicle design. "We're taking a life-cycle approach, from making the vehicle, the energy it consumes when it's being driven, and recovering the materials to make sure it's not impacting the environment in a negative way," said Claudia Duranceau, Ford's VRP Representative.

The DOE's interest extends to energy conservation. "One way to improve the efficiency of the vehicle is to lighten it. One option is polymeric fiber-reinforced composites, which can save 50-60% of a vehicle's weight," said Joe Carpenter, a Department of Energy spokesman.

Currently, the inability to recycle nonmetallic materials is one of the checkpoints slowing the adoption of lighter materials. The global aspect of the research is attempting to help remove these negative marks.

"We want to make sure that materials are not de-selected because they aren't easily recyclable," said Dave Mattis, GM's Representative to the VRP.

Terry Costlow

Polypropylene moves to a position of strength

A two-year research program into creating automotive materials able to meet European recycling legislation requirements has resulted in a successful new process for producing self-reinforced polypropylene (SrPP). The work was carried out by a consortium of engineers and scientists working on RECYCLE, a UK research program under the **SMMT** (Society of Motor Manufacturers and Traders) Foresight Vehicle Initiative. Companies involved are **Lotus Engineering**, **NetComposites**, **Propex Fabrics**, **BI Composites**, **Warwick University**, **Trauma-Lite**, and **London Taxis International**.

The SMMT has announced that the consortium has solved the problem of how to mold, join, and finish SrPP, which is up to six times stronger than PP; previously working with SrPP on an industrial scale had proven difficult. Indications are that the team's success signals the material's use on lightweight automotive parts that can not only be recycled effectively to conform with the European Union's End of Vehicle Life directive, but would also be easier to manufacture at lower cost and have added strength.

PP has many advantages as an industrial material but is not regarded as sufficiently strong for many potential automotive applications. To overcome this, it has to be reinforced to achieve required strength and stiffness, using glass fiber, natural materials including hemp, flax, and sisal, or, for more exotic purposes, carbon fiber. As well as adding cost and complexity to the manufacturing process, this mix of materials can make recycling a complex, time-consuming, and consequently expensive operation, offsetting some of PP's advantages.

SrPP involves regular PP undergoing heat and weaving treatments to stretch and align molecules to achieve added strength without any weight gain. A problem that had to be overcome by the RECYCLE team was that reheating SrPP during the production process could negate the material's special properties. Solving this was a major part of the Foresight consortium's agenda. They worked to carefully apply heat to enable the SrPP sheets to be molded, pressed, joined, and finished without losing either their stiffness or strength.

The RECYCLE production techniques have also demonstrated other pluses. Cutting and stamping tools benefit from the omission of glass fiber because of the absence of abrasive materials, and SrPP can be molded at relatively low temperatures with A1 surface quality and other cosmetic qualities achieved when necessary. SrPP products have high impact strength, an important aspect of pedestrian and passenger safety design. Because it is wholly PP, it is nontoxic, very resistant to corrosion, and meets standard automotive manufacturing test requirements for hydraulic fluids and fuels. The research program has also determined methods of bonding and joining SrPP to other materials and to other SrPP parts.

"Using this new material has a host of advantages," said the Project Manager for RECYCLE, Brendon Weager of NetComposites. "It will be easier and less expensive to mass-produce than other materials because the tooling does not have to cope with high pressures or abrasive materials. The finish is much smoother than glass fiber reinforced plastics (GFRP) and safer to handle by operators."

Weager says that with the major technical hurdles successfully overcome, the RECYCLE team is working towards full production. Interestingly, the research work has resulted in potential spin-offs for uses outside the auto industry, including body armor, safety helmets, and suitcases.

Stuart Birch