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Michelin's Tweel automotive application on an Audi A4



The non-pneumatic Tweel unit replaces the traditional tire/wheel/valve/pressure monitoring assembly

Passion for an airless future

A friend once told me, "Show me your checkbook and your calendar and I'll tell you what you're passionate about." It's true. Passion requires commitment of both time and resource.

Michelin is passionate about technology and innovation, which have been bred into the company's culture since its founding more than 100 years ago. Michelin sustains its dedication to technology and innovation with R&D spending that is second to none in the industry, both in total dollars and as a percentage of gross sales.

Nearly 60 years ago, Michelin invented the radial tire, which is now the recognized standard for most tire segments. Some companies might have been tempted to hold that ground, focusing simply on manufacturing and distributing that one range of technology. But Michelin continues working to improve the performance of the radial because there is still more ground to be gained in fuel economy, rolling resistance, traction, wear life, and other properties. That drive comes from a passion for continuous improvement.

Over the last several years, Michelin's commitment to innovation has centered on continued-mobility options, where Michelin Zero Pressure tires and the Michelin PAX System continue to gain acceptance in Europe and North America. Last year, the **Honda Odyssey Touring Edition** became the first mainstream vehicle in North America to use the PAX System.

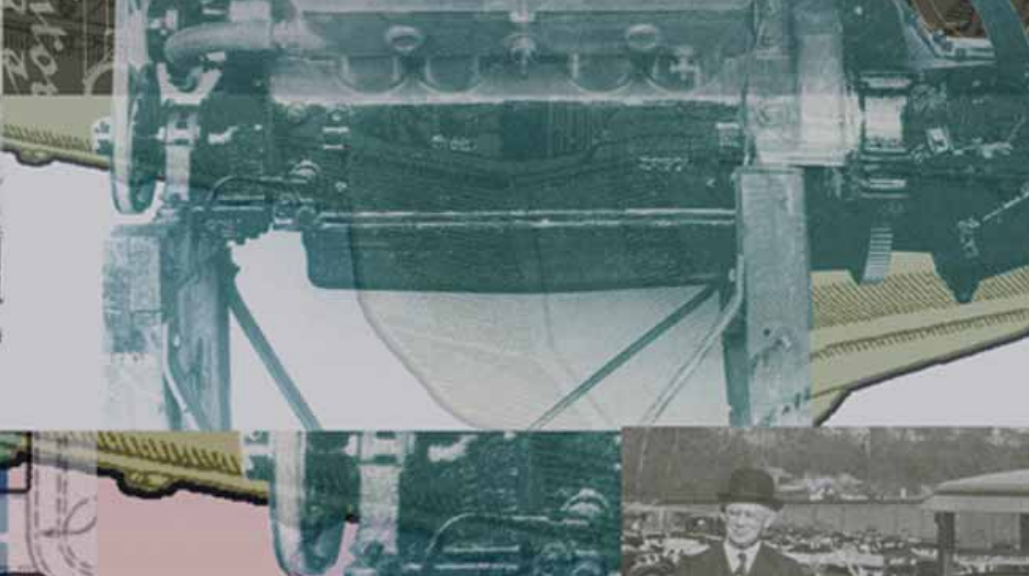
Still, Michelin continues to look towards the future to seek better mobility. Last fall at the Paris Auto Show, Michelin introduced two examples of new technologies that are non-pneumatic—tires without air—the Michelin Airless and Michelin Tweel. The fusion of tire and wheel into a single component, Michelin Tweel technology was developed in North America at the company's technology center in Greenville, SC.

Tweel is one of the most exciting advances in tire technology in my lifetime: tires operating without air—on purpose. Without the need to retain air, there is no longer a need for a rigid wheel. A flexible wheel using new polyurethane and glass-reinforced plastics can start to provide suspension-like functions to the new Tweel design.

And by fusing the tire and wheel together, some complex systems can be eliminated. The traditional tire, wheel, valve, and tire pressure-monitoring system is replaced with a single Tweel assembly. This innovation eliminates the need for mounting and dismounting and simplifies the logistics. A flexible wheel also eliminates the possibility of pinch shock, sidewall damage, and wheel strike-through, all hazards of conventional tire-wheel assembly.

One of the most amazing aspects of the Tweel unit is that it performs like a pneumatic tire. Tweel architecture supports the load mechanically, yet it deforms to absorb bumps and road hazards for ride comfort, and generates a contact





patch. In fact, the contact patch on the prototype passenger-car application is almost twice as large as the contact patch of the original OE fitment.

As the Tweel unit began to take shape, fitment opportunities quickly became apparent. Michelin has a long history of collaboration with **Segway**, which led to the first real-world fitments for the new Segway Concept Centaur and iBOT wheelchair from **Independence Technology**.

The Tweel non-pneumatic solution for the iBOT wheelchair provides consistent performance and maintenance-free operation. Additionally, the use of small Tweel assemblies on the front casters allowed designers to eliminate the need for a complicated suspension device. The adaptation of non-pneumatic Tweel units complements the Centaur's off-highway capability.

Both iBOT and Centaur are on the lower end of the vehicle maturity curve in terms of speed and weight. The next steps up the vehicle curve are low-speed applications on much heavier industrial and military vehicles.

The Tweel assembly has completed a second round of field testing on skid steer machines at working locations in the U.S., Italy, France, and the Netherlands. The elimination of air pressure has drastically reduced downtime—a critical issue for the construction industry. The Tweel fitment is more stable than traditional skid steer tire solutions, and enables the equipment to work faster with more comfort for the operator,

which reduces driver fatigue.

The U.S. military's interest in Tweel technology centers on its unique continued mobility, even after multiple hits from land mines and incoming artillery. The Tweel assembly does not have a single point of failure. It also has high blast resistance, directing the explosive energy of land mines and other direct hits outward, rather than up through traditional tires and into the vehicle itself.

First applications for Tweel—iBOT, Centaur, skid steer, and multiple military uses—are reality for this new airless technology. In the realm of long-term future applications, Michelin is experimenting with Tweel fitments on passenger cars. Engineers have found that some properties can be tuned independently of each other, which is a significant change from conventional tires. Vertical stiffness—which primarily affects ride comfort—and lateral stiffness—which affects handling and cornering—can be optimized independently.

The Tweel prototype offers responsive handling while staying within 5% of the rolling resistance and mass levels of today's tires. That translates to being within 1% of the fuel economy of a comparable OE fitment of the test application. Additionally, lateral stiffness is increased by a factor of five in this application.

The radial tire will continue to be the undisputed standard for some time to come. Tweel is a stretch application for the future. **aei**



Michelin's approach to the market



Non-pneumatic Tweel assemblies complement Segway Centaur's off-highway capability