With a Motorized Hub, the Wheel on the Bus Goes 'Round

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Most electric vehicles work by connecting the wheels to a motor. But tomorrow a Dutch company plans to unveil a bus in which motor and wheel are one, a refinement that promises more miles per charge and a vehicle that is safer and easier to maintain.

The company, e-Traction, has modified a city bus as a diesel-electric hybrid. It has a small combustion engine that charges the batteries, but propulsion comes from two electric motors with tires attached that serve as the rear wheels. E-Traction, based in Apeldoorn, the Netherlands, where the bus will operate as part of the local transit service, predicts that the system will more than pay for itself because diesel fuel consumption will be reduced by 70 percent.

The idea of such a wheel-motor was first advanced by the automotive pioneer Ferdinand Porsche more than a century ago. Many companies have since tried to popularize such a motor, and a few are currently producing them - including WaveCrest Laboratories, a Virginia company that is using a similar motor to power a bicycle.

But plenty of technological and economic hurdles must be overcome before such motors gain widespread use in transportation. "It is the future," said James Worden, founder and chief executive of Solectria, a company in Woburn, Mass., that has produced drivetrains for more than 100 hybrid electric buses. "Whether it is 10 years out, 20 years out or 30 years out."

Mr. Worden said he had so far not embraced wheel-motors like E-Traction's because he felt that the underlying technology was not quite ready. But he said he would stop far short of saying it would never work, for fear that in 20 years, his comment would sound like a buggy manufacturer's prediction circa 1900 that cars were just a fad and would never replace horses.

E-Traction, which has already built a wheel-motor for a forklift truck, claims that the time is now. For one thing, it argues that in mass production, two wheel motors would cost no more than the large engine and other parts that the motors would replace on a regular diesel-powered bus. The prototype bus nonetheless cost $500,000, about two and a half times the cost of an ordinary bus, said Peter le Comte, a spokesman for the company.

The circular shape of e-Traction's motor is not unusual, but the basic parts are reversed. Usually an electric motor consists of a ring-shaped part that does not move, called a stator, through which a current runs, developing magnetic forces that turn the shaft that runs inside it, the rotor. For years, engineers have talked about building a motor in which the shaft is fixed and the ring turns. If the shaft were to serve as an axle, and the ring were to have a tire attached, the result would be a motor that serves as a wheel.

Such an arrangement would have only one moving part, and would eliminate the parts of the drivetrain, which transfers power from the engine to the wheels. For example, it would eliminate the differential, gears that allow a vehicle's wheels to turn at slightly different speeds when cornering. With a direct-drive motor on each wheel, speeds could be independently controlled.

Electric wheels would also be a simple way of making a vehicle four-wheel drive. And if one wheel started to slip in acceleration or braking, a central computer could determine that far faster than existing traction control or anti-lock braking systems, advocates say, and make adjustments.

Those benefits could be approximated by any vehicle that used one motor for each wheel. But the E-Traction wheel goes two steps further.

First, it squeezes into the wheel an electronic part called the inverter, which changes the direct current from the battery into alternating current for the motor. Converting the current elsewhere in the bus would require running long AC cables to the motor, and such cables lose energy, said Arjan Heinen, the inventor of the motor. Running DC cables from the battery to the wheel and converting the power there to AC increases efficiency, he said.

In addition, some electronic tricks can make the motor turn at speeds fast enough to run the bus without gears, he said. The result is to drop the gearbox, a source of weight and friction. Unlike vehicles with internal combustion engines, most electric vehicles do not need variable transmissions, but they do need a gearbox of some kind.

If something went wrong with the motor, with the inverter or with the chips that control the motor, a mechanic could replace them all in about 25 minutes by

swapping out the wheel, Mr. Heinen said. That requires unscrewing 12 to 20 bolts, depending on the wheel, and disconnecting a handful of cables, he said.

Yet Mr. Worden of Solectria said that one drawback in the bus design was that the electronics in the motor were in direct contact with the road, not protected like the rest of the bus is by shock absorbers. If the tire hits a bump, he said, "it beats the living daylights out of any motor or electronics."

He said the loss of the gearbox was a major benefit, if it could be made to work, but questioned whether having the current inverter in the motor was much of an advantage. Electric buses with inverters nearer the batteries do not lose appreciable amounts of current through the AC cables, he said.

Mr. le Comte said the real proof of the design's viability would be the operation of the bus in Apeldoorn. Meanwhile e-Traction is also working on a Mercedes Jeep borrowed from the Royal Netherlands Army and a Range Rover. Both will have four motors, one on each wheel.