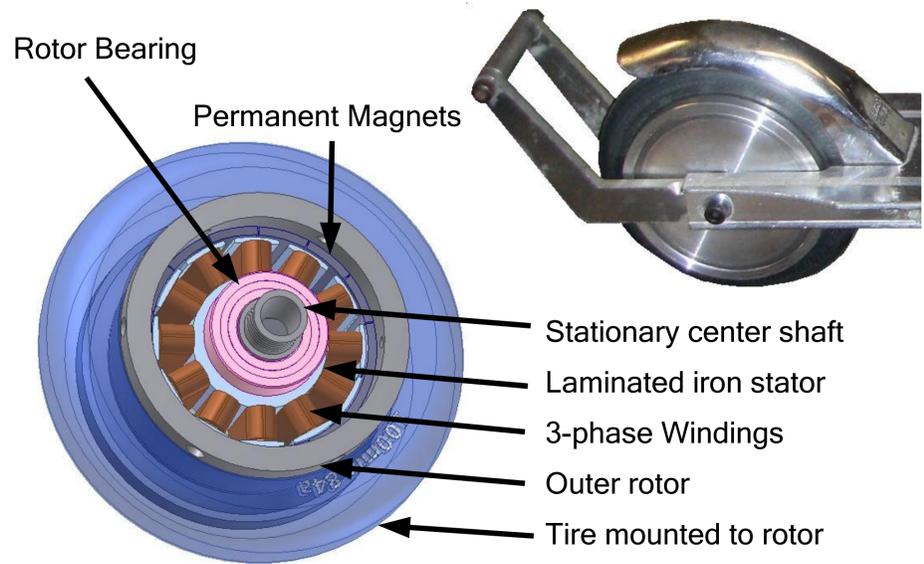
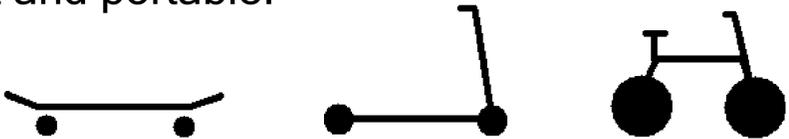


MINIATURE ELECTRIC HUB MOTORS

A *hub motor* is a form of vehicle propulsion where the motive torque is produced entirely within a wheel. Vehicles with *hub motors* have no central propulsion source such as an engine. Electric hub motors have already been produced for automobiles and industrial vehicles, but one innovative use for them is in personal electric vehicles (PEVs), such as electric scooters, which carry one passenger and need to be light and portable.



Student-led work at the Massachusetts Institute of Technology has produced *miniature* hub motors for use on ultra-compact personal electric vehicles (PEVs). These motors, constructed inside wheels that are 90 - 150mm diameter, have been used successfully on several student-built PEVs including three electric scooters, an electric longboard, and even electric inline skates.



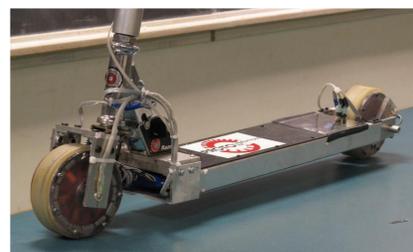
These motors are all of the *permanent magnet synchronous* topology, commonly called “Brushless DC” motors. These motors do not have the complex carbon brush mechanics found in a DC motor. Consequently, they must be controlled with an electronic *inverter*. Despite this requirement, they are capable of higher efficiency and power than a DC motor. They can therefore produce useful torque at small scales.



The first hub motor scooter, “RazEr”, weighs only 6 kg and can travel at 20 kph



The Electric Longboard has four 500 watt brushless hub motors



The “BWD” scooter is an all-wheel drive scooter



“Pneu Scooter” is an experiment in using pneumatic tires with hub motors.

Demonstration Vehicles



RazEr rEVolution

Top Speed (kph)	30
Weight (kg)	9
Battery Voltage (V)	42
Battery Capacity (Ah)	4.6
Efficiency (Wh / km)	18
Motor Power (W)	1400
Wheel Size (mm)	125

RazErBlades

Top Speed (kph)	15
Weight (kg)	6
Battery Voltage (V)	22.2
Battery Capacity (Ah)	2.6
Efficiency (Wh / km)	17.5
Motor Power (W)	95
Wheel Size (mm)	90



These vehicles were designed and built by students in campus facilities available at MIT, including machine shops and electronics laboratories. Open access to equipment and tools enabled individual creative design exercises such as these to be completed.