MIT EVT

Electric Vehicle Team

electric vehicle team '09

Introduction to the EVT

The MIT Electric Vehicle Team (EVT) is a student-run organization dedicated to the research, design, construction, and testing of electric vehicles. Founded in late 2006, the team has fostered an environment where students can gain insight and hands-on experience with real challenges in the development of EVs. Support from MIT faculty and industry sponsors have allowed us to begin work on the elEVen project, the conversion of a mainstream sedan into an electric vehicle that can be charged in under 11 minutes, in June of 2009. The EVT believes that manufacturers and consumers will soon favor all-electric drivetrains as an alternative to gasoline engines, and intends to expedite this process by developing technology that will utilize the latest advancements in batteries.

What We Do

> Research, develop and test electric vehicles, with a focus on new battery and charging technologies.

> Provide MIT students with real-world educational opportunities and project experience in the areas of electrical and mechanical design, system and component modeling, testing, data analysis, fabrication, marketing, and management.

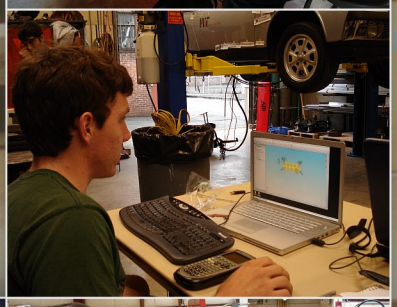
> Promote public awareness and understanding of electric vehicle technologies and the need for cleaner transportation by showcasing our vehicles and being present at energy-related community events.

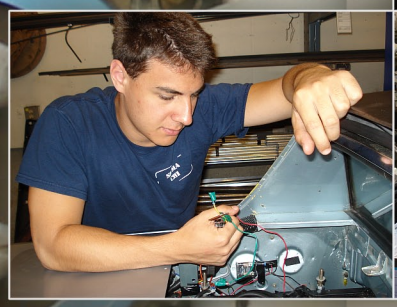
> Publicize our sponsors through positive exposure and press coverage.

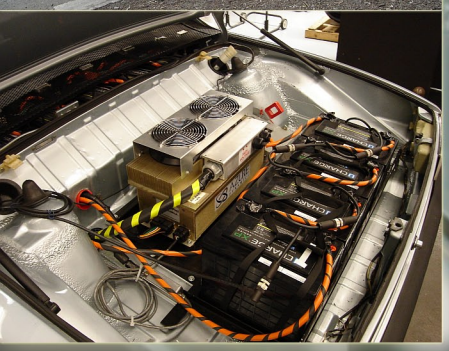
Opportunity

Electric vehicle prototypes are rousing attention in the automotive community, but time and development are needed before these vehicles will be ready to compete opposite gasoline-powered cars in the mass market. The MIT Electric Vehicle Team can contribute a unique combination of ability and resources to this endeavor; building on the success of a converted lithium-ion Porsche 914 EV, the team now intends to take the next step forward by building an EV with similar specifications to a gasoline-powered vehicle. To this end, the elEVen project sets out to achieve performance and range capabilities that compete with those of conventional cars, with a recharge comparable to the time it takes to refill at a gas station.

An 11-minute charge is possible with today's battery technology; however, advanced engineering is required. Achieving such a swift charge time in the elEVen will require power on the order of 350 kilowatts. The feasibility of this project opens many questions for the future of electric vehicles and the charging stations they will need. Where, and how, will electric vehicles be rapidly recharged? How will this affect the power grid? With the elEVen project, we attempt to find the answers to these questions, and develop the enabling technology. Moreover, we publicize all of our research to provide an open source for electric vehicle development.







The team's first project began in late 2006, when MIT professor Yang Shao-Horn and Dr. Quinn Horn of Exponent donated a 1976 Porsche 914, motor, charger, and controller. A handful of motivated students converted the car to electric power, removing the engine and its related parts and installing a 3-phase AC induction motor and 18 U-Charge® XP Lithium Phosphate batteries donated by Valence Technology.

Demonstrated Success: Porsche 914 EV

From the beginning, EVT students designed this lithium-ion conversion to achieve two underlying objectives: establishing the vehicle's usefulness for research, and maximizing the electric system's safety. More recently, members of the team installed a real-time computer and touch panel (donated by National Instruments) to allow logging and analysis of all vehicle system parameters.

The Porsche 914 EV has similar driving performance to the original vehicle, with the added advantage of regenerative braking, which recaptures energy as the car slows down. The car provides students with a platform for hands-on design experience and reliable automotive research. The Porsche 914 EV is street legal, so students on the EVT can often be seen driving around the Boston area on test drives, or on the way to local events to educate the public about EV technology.

The Next Step:
Rapid Recharge

The only fully-electric, commercially available vehicle today that is nearly comparable to a gasoline vehicle is the Tesla Roadster. This vehicle costs just over $100,000 USD, has a range of 244 miles, and requires a minimum of 3.5 hours to charge, using a special high-power connector. For a consumer, waiting so long to get back on the road is inconvenient, and the associated possibility of being stranded while recharging during a trip could be reason enough to altogether forgo buying an electric vehicle. To compete favorably in a market dominated by gasoline vehicles, an EV must have an equivalent – or better – life-cycle cost, range, and refilling (recharging) time.

Some companies have proposed a large-scale "battery swapping" program, where the consumer pays on a per-distance-traveled basis, rather than for the upfront capital cost of the battery. With this system, a depleted battery would be exchanged for a fully charged battery at any participating service station. Given that battery swapping will require a heavier infrastructural investment and, potentially, battery pack standardization between automakers, rapid recharge might be a preferable method to repower EVs.

Rapid recharge of lithium-ion cells has become practical due to advancing battery technology. This advantage to rapid recharge is especially notable considering the projection that the power density (ability to charge and discharge quickly) of lithium-ion batteries will greatly improve with continuing electrochemical research, while energy density (amount of energy stored per unit volume) will remain essentially the same. There are obstacles to rapid recharge: power availability, charger design, cell chemistry, and battery pack design. The requisite cell chemistry is readily available, and thus the EVT focuses on exploring the following technologies that will enable rapid recharging:

> Hardware development and real-world testing on actual electric vehicles.
> Battery pack charger design.
> Thermal, electrical, and mechanical properties of battery array.

elEVen

Our second vehicle conversion -- the elEVen project – aims to travel **200 miles on an 11-minute charge**. The elEVen is a battery-electric conversion of the Ford CD3 platform, used in the Ford Fusion, Mercury Milan, and Lincoln MKZ. The team began work on the vehicle in July 2009, removing the factory powertrain to make room for an electric motor and controller, a chain drive, and a lithium-ion battery pack. The battery pack is the heart of the elEVen, consisting of 8,000 lithium iron phosphate cells from A123Systems. These batteries have an extremely low internal resistance – ideal for rapid recharge. Moreover, they are chemically stable, making them safe for automotive applications.

A **250-horsepower**, 3-phase AC induction motor, donated by SatCon and designed for use in a 16.5-ton electric transit bus, will propel our electric sedan. This motor can accelerate the elEVen from 0 to 60 miles per hour in under 9 seconds – with a top speed of 100 miles per hour. In addition, the team will modify the tires, suspension, motor control logic, and aerodynamics to achieve the efficiency needed for a 200-mile range.

The elEVen sedan will be charged in under 11 minutes using a custom-developed 350-kilowatt charging unit, which will draw electricity from either an industrial-grade AC power source or an external bank of lead-acid batteries.

Outreach

Lack of widespread awareness and understanding about alternative vehicle technologies is a challenge facing the move away from internal combustion engines. EVT invests energy in demonstrating its developments to the green community and the general public as a whole, and takes advantage of its presence at the Institute by participating in energy and transportation conferences, as well as other technical poster sessions. So far in 2009, we have taken part in a multitude of outreach events, including the MIT Energy Showcase, EcoExpo, the Cambridge Science Festival, and the MIT Earth Day Festival. Also, we chronicle our projects with regular blog updates, accessible from the team website: http://web.mit.edu/evt.

EVT encourages members of the community and students alike to explore and understand vehicle efficiency, battery technologies, design and fabrication, and electrical control systems. In turn, members have also taught classes on electric vehicles for secondary school students and the MIT community through programs like Spark!, which is hosted by the MIT Educational Studies Program, as well as MIT's Independent Activities Period. We collaborate with the Mechanical Engineering department's 2.007: Design and Manufacturing class to provide students with class-credit design opportunities, and with the Undergraduate Research Opportunities Program to allow students to research, design, and build electric vehicles over the summer.

Sponsorship

Our commitment to a cleaner future for transportation is made possible by the support of like-minded individuals and organizations. In return, we provide our sponsors with exposure through vehicle demonstrations and press coverage.

Platinum — $40,000

> Large logo prominent on vehicle
> Publicity during media interviews
> Exposure during public appearances
> EVT representation at company events
> Promotion on team website and displays
> Access to team resume book

Gold — $20,000

> Logo prominent on vehicle
> Exposure during public appearances
> EVT representation at company events
> Promotion on team website and displays
> Access to team resume book

Silver — $10,000

> Logo on vehicle
> Promotion on team website and displays
> Access to team resume book

Bronze — $1,000

> Promotion on team website and displays
> Access to team resume book

Donor — up to $1,000

> Promotion on website
> Access to team resume book
> Tax recognition

For more information:
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