Restoring a Classic Electric Car

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ONE hundred years ago, automobiles were powered by steam, electricity, or internal combustion. Female drivers favored electric cars because, unlike early internal-combustion vehicles, they did not require a crank for starting. In fact, Clara Ford, wife of automotive magnate Henry Ford, was the owner of a Detroit Electric automobile.

The "JET" on the rear of the car represents JET Industries

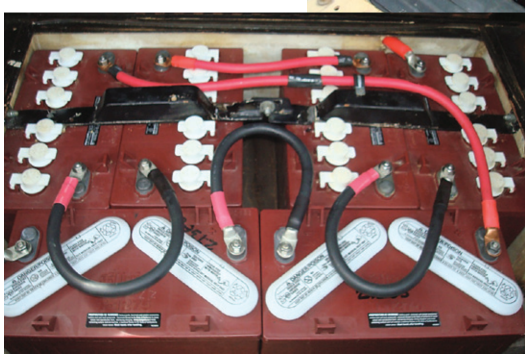
Nonetheless, internal-combustion vehicles came to dominate the industry and it's only in recent years that the electrics have gotten more attention. As an industrial technology teacher, I developed an interest in electric vehicles (EV) through my students' involvement in Electrathon America competitions in Hawaii and Nebraska. Eventually, I ended up restoring and driving an electric car and thought other technology educators would find the process interesting.

Acquiring a Car

A couple of years ago, in a high school auto shop, I ran across a 1981 Mercury Lynx that was a Jet Industries conversion. After initial manufacturing of the body, chassis, and drive train in Detroit, a few thousand Ford, Mercury, and Chrysler vehicles (primarily compacts) were converted by Jet Industries to plug-in electrics. A local electric company had donated this particular vehicle to the school several years earlier. Apparently, it had not been driven for many years. Its batteries needed replacement—a costly prospect—so I suggested making a donation to the school and taking the vehicle off their hands. EVs have a reputation for reliability and endurance if treated properly and I wanted to test this theory by refurbishing this vehicle and putting it back on the road.

A year or so later, the transfer took place and the Lynx was towed to my garage for initial inspection and repair. These EVs operate at 96 V, normally using 16 6 V flooded lead acid batteries. Another 12 V battery provides power to the lights and accessories. An onboard charger mounted in front of the brake master cylinder is used to recharge both the 96 V and 12 V systems. The car

Above, front battery compartment and battery charger



At left, rear battery compartment

Before retiring, Thomas E. Kraft was associate professor of industrial technology education, University of Nebraska.

consists of three battery compartments, two under the hood and one in the rear beneath the hatchback. The electric motor is attached to the front wheel drive transfer case and nestles underneath one of the front battery compartments.

Battery Capacity vs. Weight

After recycling 17 lead acid batteries, I decided to replace the 6 V with 12 V. This would require half as many batteries (8) to make the 96 V total I needed to power the dc electric motor. Less is more right? Well not always—in this case I was making a financial savings with fewer batteries and reducing vehicle weight by nearly 400 pounds.

However, the capacity (measured in minutes) for the 12 V batteries is about half the 6 V when operating at 75 amps. In short, I would be trading performance for range. The vehicle would accelerate better because of

The small gauges at the top center indicate voltage and amperage.

the lighter weight, but it would have a reduced range—a critical factor for electric vehicles.

So I purchased eight new lead acid batteries, repaired the brakes, and replaced several battery cables along with the struts that hold the hatchback open. In addition, I spent hours cleaning corrosion from the battery cases that had developed over the years of non-use.

Most important, I repaired the emergency brake. The vehicle is equipped with a four-speed manual transmission. Since an electric motor doesn't have compression like an internal combustion engine, the parking brake is an essential piece of equipment to keep the vehicle from rolling when parked.

Driving, Shifting, and Coasting

Electric motors like the one in this car should never be operated unless they are under a load. In other words, you don't rev it up and dump the clutch. That would be the end of your electric motor. On the other hand, the Lynx is rather simple to drive. You just put it in gear, energize the circuit (ignition switch), press the accelerator, and away you go. The clutch is needed to shift from one gear to another, but it is not required to start the vehicle rolling because the motor will smoothly propel you forward from 0 revolutions per minute.

Initially, I put the transmission in second gear and drove the vehicle around town like an automatic transmission. Instantaneous torque made this possible. However, I later found owner's manual information that indicated this uses more amperage. The text recommended that up to 20 mph use first gear, up to 35 mph use second, and above 35 use third. Around town I rarely drive above 45 mph and I really don't care what the top speed is—my electric Lynx is not that type of vehicle.

Aside from the shift points, operating this vehicle is really a matter of judiciously applying power to bring the car up to speed and then adding more power (amps) as necessary to maintain speed. Anytime I am on a downhill slope the vehicle coasts at 0 amps. I coast whenever possible, which is the secret to increasing the range. Owning this EV is like having a car with a one-gallon gas tank and a filling station in my own garage. However, since battery capacity

The 220 V electrical outlet. It can be plugged into a wall outlet or portable generator.

varies with temperature, my gas tank expands in the summer and contracts in the winter. By design, the car forces me to drive conscientiously and conservatively in regards to energy use.

Charging

Following any trip, I recharge the batteries to bring them back to 100% capacity. Since the 12 V batteries have a smaller capacity than the 6 V, charging time is less. The on-board charger uses a 220 V outlet and charging time depends on how far I have driven. Normally, recharging takes two to three hours.

Recharging is simply a matter of plugging in my electric cable and removing the battery covers. Removing the covers assures me that gasses (oxygen and hydrogen) vent properly during the charging process. These gasses are not detectable, but I am always cautious not to create an ignition source near the batteries during charging.

An ammeter on the charger indicates the number of amps the battery pack is accepting. As the voltage increases in the batteries, the charger amperage slowly decreases. The amperage stops decreasing when the batteries are fully charged.

I didn't know what to expect as far as an electric bill after the first month of use. I had not crunched the numbers to determine how many kilowatt-hours were used during the charging process. Fortunately, my local electric rates are reasonable and

I found the first month of charging to be hardly detectable—possibly a $5 to $10 increase in usage compared with the same month the year before. In any event, it was considerably less than fueling my pickup truck.

Details on Costs

The new Nissan LEAF (which stands for Leading Environmentally friendly Affordable Family) car lists at about $32,000. Available tax credits can reduce that amount. The plug-in LEAF has a range of 100 miles and uses lithium-ion batteries. A depleted battery requires 8 hours of charging at 220 V and 40 amps. The vehicle is manufactured in Nashville, TN.

By comparison, my Lynx has cost approximately $5,500. (This breaks down as $3,000 for the donation to the school, $1,300 for batteries, $700 for parts, and $488 for installation of a 220 V outlet in my garage.)

A recent trip illustrates more specifically what it costs to operate the vehicle. A visit to my parent's house amounted to 9.3 miles total. It required an hour and a half to recharge the batteries. For the first hour, the current required to charge the batteries was an average 20 A at 220 V, which equals 4,400 W. Power (measured in watts) equals voltage times amperage. The last half hour required an average of 12 A at 220 V, which equals 2,640 W, or a total of 6,040 W for recharging. The current rate for electricity is 9.5¢ per kWh. I used 6.04 kW at 9.5¢ for a total of 57¢. At $2.50 per gallon of gas, this is equivalent to 40.7 miles per gallon for an internal combustion vehicle.

To date, my best performance in terms of range is about 30 miles. This does not sound very far, but for purposes of driving around town it is more than adequate. Yes, there have been a time or two when I overestimated battery capacity and crawled home for the last several blocks.

I expect better performance in the summer as the batteries warm up. Lead acid batteries peak at 100° F. In any case, as a second vehicle this EV works well. I use the Lynx for around-town hauls and my pickup (internal combustion) for heavy lifting and out-of-town trips.

Appropriate Technology

In the early 20th century, the electric car was phased out because it could not compete with internal combustion vehicles primarily due to the low cost of gas. Unlike 100 years ago, the electric car is now poised to play a more prominent role as a transportation technology. When we consider the world of technology that surrounds us, I like to emphasize technology that is appropriate. In other words, technology that is simple, low in cost, self-reliant, and reduces environmental impact.

While not as technologically advanced as the Nissan LEAF, my simpler Lynx—which is very similar to an Electrathon vehicle—gets me around town and produces zero emissions in the process. And with this car, you will never see black or blue smoke leaking from the back end nor will you be rattled from your silence by noisy pipes!