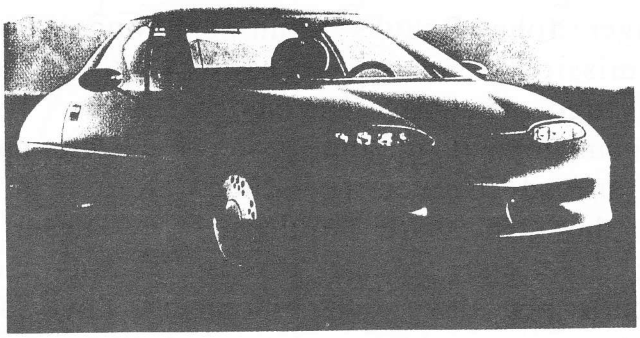
ELECTRIC AUTO ASSOCIATION NEWS

July 1990

Vol. XXII No. 7

Centenary of the Motor CAR ---- Watch the Discovery Channel See Below

BY JOHN SISSON



GM's electric Impact. Next year's models may sport navigation systems, video maps, and anti-collision radar.

One day, cars may be on display in museums next to Conestoga wagons, while people outside walk or bike, or ride buses, trains and contraptions not yet invented.

That future is undoubtedly a long way off. Indeed, for anyone who commutes in rush-hour traffic, a carless society may be hard to imagine. We take the automobile for granted, as we do its spin-offs: shopping malls and suburbs, motels and drive-ins, not to mention back-seat necking.

In 1986, the U.S. had one-third of the world's 386 million cars, according to the Motor Vehicle Manufacturer's Association. That's one car for every 1.8 people, including those not even old enough to drive.

Yet for all the automobile has freed the individual, it has also burdened society. As Worldwatch Institute notes, automobiles exacerbate pollution, acid rain and global warming. (They also keep us dependent on foreign countries for energy.)

Unless cars become cleaner and cheaper to use, drivers will doubtless use them less. But how will cars change? What materials will be used to build them? What fuel will be used to propel them?

"In many respects, they aren't going to be much different from the ones we have today," says Don Postma, a spokesman for General Motors. "They'll probably have four wheels, the same seating, and as much trunk space as we can fit."

Many drivers, however, may be filling up their tanks with alternative fuels to reduce air pollution and curb reliance on foreign oil. Just in the last 20 years, car makers virtually doubled fuel efficiency. Today they're developing cleaner, alcohol-based fuels made from corn, sugar cane and beets. Cars also are being run on natural gas, although the world's reserves are limited.

Gasoline or gasohol, the fuel must still be burned, producing carbon dioxide and contributing to the greenhouse effect. The most promising fuel for the car of the future may be electricity—so long as it isn't produced in coal-burning power plants.

Electric engines are quieter, cleaner, and more efficient than internal-combustion engines. To date, no portable power system can drive an electric car the distance and speed a gas-powered car can go, but battery power is being improved.

General Motors announced in time for Earth Day that it will soon begin producing electric cars. Although the auto industry greeted that announcement with doubt, GM claims the electric vehicle will make a good second car for running errands.

"I know our critics have been skeptical about it," said Postma. "We aren't going to tell people when and where production will begin, but it may be a lot sooner than people think."

Until an electric car is developed, automobiles will run mostly on gasoline because it's available and cheap. Meanwhile, auto makers may begin marketing cars that can also run on ethanol.

The car of the future may also run cleaner not because of what it burns but because of what it's made of: plastic. Plastic reduces both weight and drag, and thus requires less energy.

At present, steel is cheaper than plastic for mass production, yet plastic has replaced steel on body panels, dashboards, bumpers, even engine components.

Not only does plastic weigh less, it doesn't rust. It can even be made to resist dents. And manufacturers are designing plastic parts that may be easily removed from junked automobiles for recycling. Frank Beafore of Dow Chemical's automotive plastics group speculates that paint jobs may become a thing of the past when motorists can drive into a dealership and have their plastic panels replaced.

Then again, Beafore says, it's hard to predict automotive evolution. "If you look up dashboard in an old dictionary, you'll see a listing that says 'see splashboard.' That was the board between the driver and the horse. All we've done is punch a few holes in it and hang some instruments."

Still, if the air becomes fouler and gas becomes dearer, reliance on automobiles may decline as motorists move from the driver's seat to seats on trains, buses and bicycles—or vehicles yet unknown. Fewer than a hundred years ago, when horse-drawn wagons were as common a sight on American streets as the horseless carriage is today, the cutting edge of transportation was covered by a monthly journal called *The Horseless Age*. Who can say when *Carless Age* magazine might be published? ❑

John Sisson is a free-lance writer in Arlington, Virginia.

CENTENARY OF THE MOTOR CAR
Wednesdays at 10:30 p.m. ET
Sundays at 5:30 p.m. ET
Through September.

Centenary of the Motor Car returns to The Discovery Channel to celebrate the past, present and future of the automobile.

Great things are happening with EAA's Hybrid Vehicle Project in Palo Alto, California!

The HEVP (Hybrid Electric Vehicle Project) team first assembled in January 1989 to design, build and test an experimental test-bed hybrid electric vehicle.

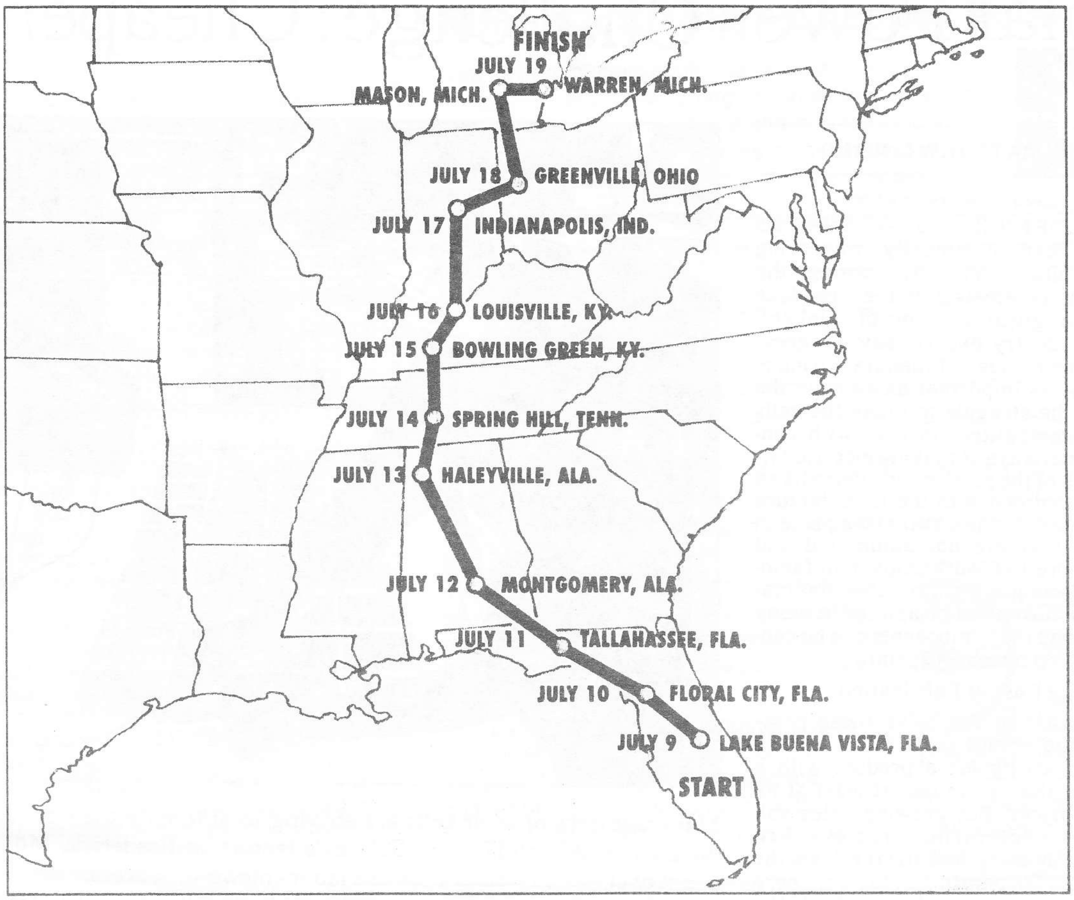
Project Manager John Reuyl's winning proposal with the California Energy Commission's Energy Technologies Advancement Program (ETAP) provided the project with funds for hardware and professional management of the project. EAA members and others (including Stanford University students) are providing volunteer time to meet the cost share requirement. From the early monthly brainstorming meetings to the recent frantic pace of 7-days per week, 20 hours per day, EAA members have so far volunteered thousands of hours towards completion of the project.

Team members began with a stock Chevrolet Corsica. The engine was removed and replaced with a GE 'Bradley' electric motor. The small light-weight 120 volt battery bank consists of 10 Delco Remy batteries (they are testing both 12 volt Freedom and 12 volt Voyager deep cycle batteries) for short range trips. Unlimited range comes from a small liquid-fuel Wankel rotary engine and Unique Mobility generator.

Testing begins on July 9th in Orlando, Florida at the GM pavilion at Epcot Center when the Corsica will accompany the Stanford University Solar Race Car in GM's Sunrayce USA. The 10 day, 1500 mile race has 32 student teams vying for 3 places in the 1990 World Solar Challenge in Australia. The Sunrayce route ends in Warren, Michigan on July 19th at the GM Technical Center.

After the Sunrayce, plans include a display in Washington, D.C. at the Department of Energy on July 23rd and participation in the Light Wheels Rally from Washington, D.C. to New York City between July 24-28th. After the team returns with the car to California, they will accompany the car to Willits, California, for the Solar Car Race in August.

THE RULES, THE ROUTE



All entries in the 1,625-mile Sunrayce USA are subject to a technical and safety inspection before qualifying for a starting position.

•All entries must fit into a box 19.7 feet long, 6.6 feet wide, and 5.2 feet tall.

•The solar array must not exceed 13.1 feet of that length for a single-seat entry; the array for a two-seat car can cover the entire body.

•For two hours at the end of each day and two hours before the teams hit the road the next morning, the teams can charge their car batteries in the sun. No overnight maintenance of any kind is permitted.

•Racing will occur from 9 a.m. to 6:30 p.m., with a mandatory pit stop at 11 a.m. Cars that do not complete the day's route must be transported to the overnight impound area and will be assessed a time penalty.

•The cockpit must be fully enclosed on the bottom, seats must have five-point safety harnesses, and in an emergency an occupant must be able to escape in 15 seconds.

Other than that, it's a race to see which car can travel the 1,625 miles from Florida to Michigan in the shortest time, fueled exclusively by the sun. The car with the lowest actual elapsed time on the course wins.—*B. N.*

THE COLLEGE TEAMS: As of press time, there were 32 student teams entered in the race: **Sun Devil Cruiser** Arizona State Univ. (Tempe); **Sol of Auburn** Auburn Univ. (Auburn, Ala.); **Solar Flair** Calif. State Polytechnic Univ. (Pomona); **Sun Luis** Calif. Polytechnic State Univ. (San Luis Obispo); **Solar Eagle** Calif. State Univ. (Los Angeles); **Csun Blazer** Calif. State Univ. (Northridge); **Kalahkwaneha** Clarkson Univ. (Potsdam, N.Y.); **Stelar V** Colorado State Univ. (Fort Collins); **Star II** Crowder College (Neosho, Mo.); **Sunvox III** Dartmouth College (Hanover, N.H.); **SunDragon** Drexel Univ. (Philadelphia); **Florida Sunshine Special** Florida Institute of Technology (Melbourne); **Prisum** Iowa State Univ. (Ames); **Northern Light** Mankato State Univ. (Mankato, Minn.); **Pride of Maryland** Univ. of Maryland (College Park); **Solectria VII** MIT (Cambridge, Mass.); **Sunrunner** Univ. of Michigan (Ann Arbor); **Centennial** Univ. of North Texas (Denton); **Team Ralos** Univ. of Ottawa (Ontario); **Solsation** Univ. of Pennsylvania (Philadelphia); **The Shining Star** Univ. of Puerto Rico (Mayaguez); **Spirit** Rochester Institute of Technology (Rochester, N.Y); **Solar Phantom** Rose-Hulman Institute of Technology (Terre Haute, Ind.); **SunSurfer** Stanford Univ. (Stanford, Calif.); **Solis Tyrannus Cognoscis** Stark Technical College (Canton, Ohio); **Texas Native Sun** Univ. of Texas (Austin); **Wild Solarcat** Villanova Univ. (Villanova, Pa.); **Solaray** Virginia Polytechnic Institute and State Univ. (Blacksburg); **Midnight Sun** Univ. of Waterloo (Ontario); **Sunseeker** Western Michigan Univ./Jordan College (Kalamazoo/Grand Rapids, Mich); **Viking XX** Western Washington Univ. (Bellingham); **Starduster** Worcester Polytechnic Institute (Worcester, Mass.)

THE NEW YORK TIMES, WEDNESDAY, JUNE 13, 1990

Solar Power Challenge: Cheaper Cells

By MATTHEW L. WALD

Special to The New York Times

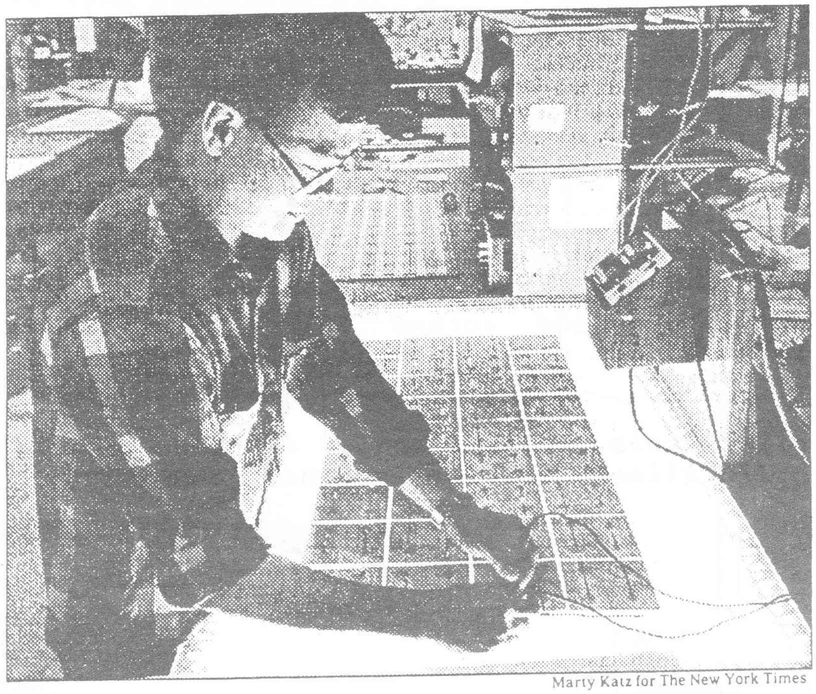
FREDERICK, Md. — Scientists have been continually improving photovoltaic cells by raising the amount of electricity they produce from a given amount of sunlight. Now, industry experts say, progress in the technology of manufacturing is at least as important as gains in the lab in the struggle to make the cells more competitive in cost with conventional ways of making electricity.

Much of the production, which has a lot in common with the manufacture of computer chips, still takes place in rooms that are not automated and look more like workshops than factories. Costs are high, because the materials must often be applied in many steps, and the components can be contaminated by a fingerprint.

Studying Ease of Fabrication

Automation can solve these problems and reduce costs, but it is difficult to justify for a product with a market that is limited, at least at today's prices. But growing sales volume is encouraging progress. Primarily by using industrial robots, the Solarex Corporation's factory here turns out cells with one-third the manpower of three years ago. Another Solarex plant is automating the complicated task of producing "thin film" cells that use less costly materials in small amounts.

Other manufacturers are considering the ease of manufacturing when developing designs for cells. Some are expanding production, and in the process are discovering efficiencies that cut the cost per unit.



Marty Katz for The New York Times

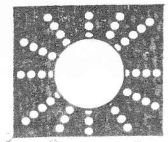
Manufacturers of solar cells are striving to automate their plants to reduce costs. A technician at Solarex's factory in Frederick, Md., tests a panel of crystalline solar cells in a labor-intensive process.

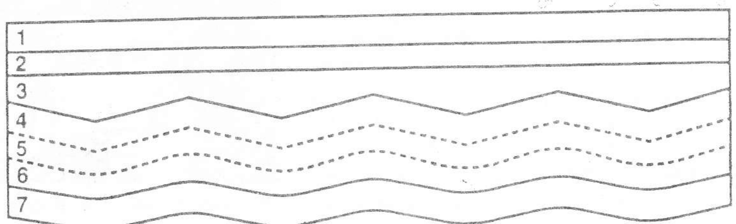
Photovoltaic cells use the energy in sunlight to shake loose electrons from atoms of silicon or other materials. The electron, with a negative charge, and the atom that gave it up, with a positive charge, migrate to separate terminals, creating an electric current. The technology, which was born in 1954 and got its first big boost from the space program, has found growing applications in everything from wristwatches and hand-held calculators to remote microwave communications relays and navigation buoys.

But photovoltaic power is still far too expensive to compete with coal or even oil for making electric power in the amounts useful to utilities. Electricity from solar power still costs more than 25 cents a kilowatt-hour; residential customers in the United States pay an average of about 10 cents.

Manufacturing a Cheaper Solar Cell

New "thin film" cells could make solar power more competitive with other energy sources because they use less expensive materials and in small amounts. But manufacturing still requires many processes, which Solarex has automated on a small scale.



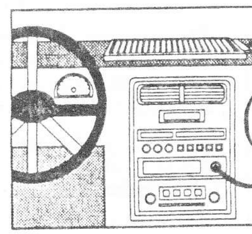


Drawing not to scale

Work begins with ordinary window glass **(1)**, to which microscopic layers must be added one by one. On the glass is a layer of silicon dioxide **(2)** to prevent charged particles from drifting into the working part of the cell.

Then tin oxide **(3)** is applied in a layer that allows light into the electricity-generating region and keeps it there. The light's energy is captured when it dislodges electrons in a layer of silicon **(5)**.

The electrons migrate to another silicon layer with traces of phosphorous **(6)**; the positively charged holes migrate to a layer of a silicon carbon alloy with traces of boron **(4)**. Both of these layers are wired to draw off electric current. Light passing through all these layers is reflected back by a layer of aluminum **(7)**.



One use for a thin film cell: Keeping a car battery charged by using a unit that plugs into the cigarette lighter.

Source: Solarex Corp.

The New York Times

Costs have fallen, however, because the efficiency of the cells — the ratio of the energy deposited as sunlight to the electricity produced — has risen to 28 percent from 6 percent for the first silicon crystal cells. Thin-film cells, a more recent development made by applying to glass small amounts of materials that convert light to electricity, have achieved efficiencies of 15.6 percent in the lab and are competing successfully with crystalline cells because they are cheaper to produce.

In fact, it is production cost, rather than wattage per square foot, that is developing as the key variable, industry officials say.

"You're seeing the focus going from the lab, on being science-driven, to being one where, if we're going to succeed, we're going to be good at manufacturing," said John Corsi, the president of Solarex, a subsidiary of the Amoco Corporation of Chicago and the largest American-owned photovoltaic producer.

Indeed, the Bush Administration has proposed a $43 million budget for solar research next year, up from $35.5 million this year and the first increase in eight years. Nearly all of the increase would go into studying the technical roadblocks to multiplying the scale of production, said Scott Sklar, executive director of the Solar Energy Industries Association, in Washington.

"You could probably lower the cost of photovoltaic modules a lot more easily in dealing with the manufacturing approach than in worrying about the efficiencies of the modules," Mr. Sklar said.

But Kenneth B. Zweibel, the manager of polycrystalline thin film research at the Solar Energy Research Institute, a Government-supported laboratory near Denver, pointed out that makers do not even agree on the ingredients for the product whose fabrication they are trying to improve. In addition to silicon, in crystals or in an amorphous, non-crystalline state, companies are aggressively researching materials including copper indium diselenide, gallium arsenide and cadmium telluride. All function by having light energy shake loose electrons, but they differ in efficiency and longevity.

The choice of materials can be influenced by problems in manufacturing, said Scott P. Albright, vice president of Photon Energy Inc., a young company in El Paso. Photon is working to bring to market its first cell, made of cadmium telluride. Nearly all of the steps involved are performed at atmospheric pressure, so capital costs are only one-tenth those of amorphous silicon, the dominant thin-film cell, which requires that some steps be conducted in a vacuum, Mr. Albright said.

The cost of fabrication is also the key factor at the Solarex factory here, according to officials. Much work has been done, and continues, on the recipe for making silicon blocks from which the polycrystalline cells are made. But another problem is turning the blocks into wafers.

Large Amount of Waste

The old method is to use a saw to slice wafers, one by one, that are 12 mils, or 12-thousandths of an inch, thick. Thinner wafers would work as well, but the saw cannot cut them. Worse, using a saw turns half of the block into a sawdust-like waste.

The company has recently begun to use as a saw a thin steel wire wrapped scores of times around a block, to slice the whole brick simultaneously. It makes wafers that are only 7 to 8 mils thick, with 20 to 25 percent less waste.

The silicon accounts for only 8.5 percent of the cost of the finished cell, but making the technology competitive with oil will mean increasing the efficiency of every step, company officials say.

At another plant, in Newtown, Pa., the company is pursuing another strategy: thin-film cells. Here, materials cost is not really an issue; half the cost is in the ordinary window glass on which the cell is built. But engineers are putting finishing touches on an automated production line that would turn out cells with a capacity of one megawatt a year, with four workers a shift, and have begun assembling parts for a line that would turn out 10 megawatts a year with the same number of workers.

The next step, said Dr. David E. Carlson, a thin-film pioneer who is in charge of the project, is a 100-megawatt line, which would cost only triple the model one-tenth as large. That development might require putting the plant adjacent to a glass factory, to achieve economies of scale.

Even the large plant would be of modest size by the standards of the utility industry; a single large coal plant produces 600 megawatts, and a nuclear reactor may produce 1,100. But the scale is huge by the standards of the photovoltaic industry, for which total worldwide production last year was only about 40 megawatts.

Insights

Commentary by Peter Huber

WHO WILL BUY THE ELECTRIC CAR?

At the beginning of January, with some modest fanfare, General Motors rolled out a prototype, two-seater electric car. It's called the Impact, as in "environmental." The car comes with good acceleration, pretty good range (120 miles between recharges) and the electric car's classic weakness—a battery pack that costs too much and dies too young. Sooner or later, however, better batteries will be developed.

And then what? Then the fate of electric cars will be up to government types and environmentalists. Judging from their early reaction to the Impact, the bureaucrats and self-appointed protectors of the earth will mostly vote the wrong way. And that will be bad news for both the environment and our national economy.

For now, the gasoline engine enjoys a huge advantage over any potential competition: an established network of fuel and service stations. To crack that advantage, the first-generation electric cars will have to shine in some other way that counts. Barring miraculous advances in battery technology, the edge won't be either the price of the electric car or the cost of running it.

The first potential advantage is national interest. The gyrating price of oil was behind President Carter's economic problems in the 1970s, just as it has been behind Comrade Gorbachev's in the 1980s. Oil imports account for half of our trade deficit and 60% of the Soviets' hard-currency exports. The point is, oil remains the most politically potent commodity on the planet, at both ends of the pipeline. Today, we import two out of every five barrels that we burn—which is to say, we import only a bit more than it takes to run our cars. Get the oil out of the car and we win a huge new measure of national independence.

Then there's the environmental side of things. Contrary to intuition, it's better to burn fuel in the external combustion engine of an

electric power plant than in the internal combustion engine of your average car—even if the fuel is oil, which it rarely is in a power plant.

Technology Management Services of Washington, D.C. has worked the numbers. A good electric power plant converts about 35% of its thermal energy into electricity. The best car engine can convert barely 20% of its heat to mechanical energy at the wheel. Transmitting electricity, charging a battery and running an electric motor entail some energy loss, but refining oil for cars entails even more.

Add it all up and it becomes a good bit more efficient to burn oil and distribute electricity than to refine oil and distribute gasoline. That means that right off the bat generating electricity for transportation causes less pollution than refining and burning gasoline.

Besides, even if it has a smokestack, an electric power plant can be sited miles from urban areas, operated with high-temperature, well-maintained combustors and sanitized with scrubbers and such. Internal combustion engines, by contrast, stick close to people, and exhaust is dirty even when run through the best catalytic converter on the market. And when it's up to millions of individuals to tune the engine and maintain the pollution controls, millions won't. As recent research has confirmed once again, auto exhaust is far harder on the environment than anything coming out of power plant smokestacks.

If the electric car is still a distant prospect, the electric train isn't. Most U.S. locomotives rely on internal combustion diesel engines, hardly more efficient than car engines. Europe and Japan (by contrast) are rushing to embrace all-electric locomotives. Batteries aren't needed here, and the electric engines are well developed. U.S. companies in fact did much of the developing in the early part of this century. Once again, burning the fuel at a power plant and delivering electricity to the train is considerably more efficient than burning fuel in the train.

You'd think with cleaner air, domestic jobs and a better balance of trade at stake, electric power would win hands down. You would also expect that the liberals and their friends in the environmental movement would be clamoring for electric transportation of any kind. No way. Why will they stand in the way of getting the gasoline out of transportation? It's a sad story.

Too many of the greens launched their careers fighting central power stations, and they shun technology that would require more. The Natural Resources Defense Council dismissed General Motors' Impact project with a sour remark: "We have to generate the electricity somewhere, and that would create a great deal more pollution."

It would create a great deal less. Electric transportation wouldn't even require much in the way of new power plants. Running every car in the country on electricity would consume about 25% of the power existing plants can generate. Battery recharging would occur largely at night, however, in off-peak hours when there is already abundant capacity to spare. As a side benefit, the price of electricity would fall as we squeezed major new revenues out of a sunken, often idle, capital investment.

So who will buy the electric car? No one, until we collectively put a new premium on energy independence, the balance-of-trade relief that goes with it, and the considerable environmental benefits of going electric. Those aren't priorities that any individual is going to set alone. But sooner or later the government may. If not the government in Los Angeles or Washington, D.C. then perhaps the government in Azerbaijan, Tehran or Tripoli. ■

Peter Huber, a senior fellow of the Manhattan Institute, is the author of Liability: The Legal Revolution and Its Consequences.

Vehicle Safety & Security Report

January 1990

Prepared By Lee S. Cole & Associates, Incorporated

New Fuels - Part IV

The automobile powered by electricity has been the subject of speculative search since the beginnings of its existence. As early as 1899, Hautier was building a car powered by electricity produced by a series of storage batteries. The problem then, and for many years thereafter was limited range, low speed and the bulk of the batteries. Experiments continued from time to time throughout the 20's, 30's and 40's. Some success was reported in reducing battery weight and size, but range remained short and batteries required frequent overnight charging. With the exception of a few short haul delivery services the electric powered automobile remained a rarity.

With the growing concern over environmental pollution generated by motor vehicles interest in the electric powered car has been rejuvenated.

According to a *Popular Mechanics* article in the November 1989 issue, the U.S. Congress appropriated $14.1 million for research and development of an electric car. European Community Transport Commissioner Karel Van Miert told a seminar of electric transport experts in Belgium "We aim to introduce several million electric driven cars by the end of this century". Peugeot S.A. of France has developed the model 205 and expects to sell 10,000 of them by 1992. In an article appearing in the October 16, 1989 issue of *Automotive News* Peugeot 205's performance was listed as 62 MPH top speed, range of 62 miles, acceleration to 31 MPH is 11.6 seconds. The vehicles use 12 six volt batteries mounted under the hood. The battery powered 205 weighs 660 pounds more than the standard gasoline fueled 205.

BMW has developed a front wheel drive electric powered version of the "3" series. The vehicle has a 584 pound liquid sodium battery mounted in the rear. Power from this battery drives a front mounted Asea Brown Boveri direct current motor developing 145 volts at 2,400 RPMs. It has a 2 speed automatic transmission. First gear is used only on steep grades. Acceleration is 0-1 MPH is 9 seconds, top speed of 62 MPH and a cruising range of 93 miles.

While I was preparing this article for Vehicle Safety & Security Report a representative of General Motors announced on Radio Station KCBS, San Francisco on January 3, 1990 that his company has built a prototype electric car called the "Impact". The vehicle is a two seater, described as a "concept car" and capable of doing 0-60 MPH in 8 seconds according to the GM representative. The Impact takes advantage of lighter weight construction and improved battery technology. The range was announced as 120 miles. No expected date of production was announced. Obviously this vehicle is in early stages of development, but the announced results are impressive. Electric cars may answer part of our future transportation needs in a pollution reduced world.

Mercedes Benz and BMW are also experimenting with hydrogen powered vehicles. Mercedes Benz has a hydrogen powered research vehicle using a 2.3 liter four cylinder engine putting out 105 HP. The engine has a hydrogen distributor instead of a carburetor and an intake manifold, water injector. BMW has produced a 735 iL with a 3.5 liter engine that operates on hydrogen. The May 22, 1989 issue of *Autoweek* reported that the vehicle's fuel tank is insulated with 70 layers of aluminum foil and fiberglass matting to keep the liquid hydrogen at minus 487°F. Chilled hydrogen is injected directly into the combustion chambers. The vehicle has a 186 mile cruising range. Liquid hydrogen has an energy density of 34,000 BTU's per gallon. Gasoline has a density of 110-126,000 BTU's for the same quantity.

Liquid Hydrogen has a wide flammability range, 4.1 - 74.8% according to *Hazardous Materials* by Isman and Carlson, 1980, Glencoe Publishing Company. The authors state "To give you an idea of what can happen in a release, hydrogen gas when mixed with sufficient air to yield 4% of the lower flammable limit, forms a combustible hydrogen-air mixture with a volume 21,000 times that of the original liquid. When hydrogen was released to the atmosphere, ignition occurred 6.2% of the time; in release to enclosures, ignition occurred every time (100%)." Until dangers in the use are overcome its use as a future fuel for motor vehicles is doubtful.

Quality Control

Amdahl's CEO proves the magic can work in the USA as well as Japan

Widely shared by Americans, among them many top business executives, is the belief that the Japanese possess some magic formula that assures a level of manufacturing quality control (QC) no one else can equal.

To which John C. (Jack) Lewis, president and chief executive officer of Amdahl Corp., has a one-word reaction: "malarkey."

Charles Barry

Lewis: The solution "is so simple it's scary."

Lewis, a recent guest speaker in the Leavey School of Business and Administration Lecture Series, puts no stock in the belief that U.S. private industry cannot meet or even exceed the quality standards for which the Japanese have become famous.

"One of the most overrated things in the [business] world is the Japanese manufacturing process," he asserted. There is irony in this pronouncement, for Amdahl is 45-percent owned by Fujitsu Ltd., which is as Japanese as sushi. A major reason U.S. businesses are playing quality catch-up, he said, is because "we have institutionalized the error process."

U.S. businesses typically practice "upward delegation of problems," Lewis said. Workers at all levels have the attitude "if, if, if only *some*one would do something to fix this problem." The workers tend to look up the power pyramid for solutions to problems they may well be causing themselves, or at least contributing to, said Lewis, who joined Amdahl as president in 1977 after stints at IBM and Xerox.

Amdahl, based in Sunnyvale, is a leading manufacturer of large-scale, high-performance computer and communications systems and disk-storage products. Sales in 1989 exceeded $2 billion.

Concerned about QC at his own company, Lewis initiated a sweeping, top-to-bottom program targeted not at problem-fixing but at problem prevention. His inspiration, he said, came from a book entitled *Quality Is Free* by Phil Crosby, a well-known QC guru who runs a QC training college in Florida.

After attending the three-day course himself, Lewis said he "got enthused" about adopting the management precepts at Amdahl. He better understood, he said, that "you have to build quality in. It's a management problem, a [company] culture problem, not a people problem." The solution "is so simple, it's scary," he said.

At the behest of Lewis, now a QC evangelist, Amdahl's 8,000 workers officially began the quest for QC "enlightenment" in 1983. Five years later, the process was "technically complete," but, he noted, "it's never really complete, it's ongoing, never-ending." (The Japanese word for continual improvement is *kaizen*. Its practice, long embraced by the Japanese work force as a given, is widely credited as the underlying and driving force behind Japan's near-obsessive intolerance of product defects.)

After forming a QC task force, Lewis said the first formal step was to find answers to "What are Amdahl's values, goals, purposes?" This led to publication of a document called "Quality Values." Every employee receives a copy.

The key to reaching the desired end was "attitudinal," not managerial, Lewis said. The organizational hierarchy was left virtually untouched. Not so, however, were how the employees viewed themselves, their associates above and below, and—most importantly—the customer.

One of the most significant things learned from the corporate soul-searching operation, he said, was "the need for every employee to view every other employee as a customer." Doing so eliminates much of the blame transference—the it's-not-my-job attitude—that bedevils many businesses.

According to Lewis, companies also must

- Involve all employees.
- Develop a common language within the company that everyone speaks and understands.
- Strive for zero defects.
- Recognize that the idea of zero defects is threatening to many, so ingrained is the (erroneous) belief that a certain number of mistakes are unavoidable.
- Provide constant training.
- Provide positive reinforcement—being generous with "attaboys."
- Change communications conduits from vertical to horizontal.

It was one-and-one-half years before any significant results were visible, Lewis said. But the results were worth waiting for. For example, before Operation QC, Amdahl had been spendng $60,000 a year correcting mistakes in employee time cards; after Operation QC, $450 a year. And after just six months, accuracy of warehouse inventorying improved by 97 percent, and inventory turnovers, with the same number of employees, increased by 40 percent.

Most telling—and most important—was that the customer rejection rate on parts fell from 32 to 3 percent, he said. "Our product was determined [by our customers] to be five times more reliable than before."

Amdahl's metamorphosis hasn't escaped the attention of others. The 1989 Datapro Survey of Mainframe Computer Users showed that Amdahl again swept the field of contestants, earning highest ratings in 19 of 25 performance categories. Amdahl ranked first in mainframe reliability, maintenance, and service and technical support. And it also was the only company surveyed to score a perfect 100 percent when users were asked if their system met all expectations and if they would recommend the system to a fellow user.

"The biggest problem with American industry," said Lewis, "is its unwillingness to admit there *is* a [quality] problem."

How big is the problem?

"Twenty-five to 40 percent of all money the typical U.S. company spends is on fixing errors," Lewis said.

—Thomas F. Black

NEW FROM JAPAN

Products & ideas from the world's most exciting business scene

Plug It In

● It won't take you far and it won't get you there fast, but the SCV-O solar car from Kyocera has one noteworthy feature: It doesn't rely exclusively on the sun for power. Solar tiles in the hood and roof convert sunlight into energy for the car's battery. But if the weather isn't cooperating, have no fear: The car can be charged by plugging it into a wall socket. The SCV-O seats two and reaches a top speed of 37 m.p.h. Price not set.

101ST CONGRESS
2D SESSION

H. R. 3852

To require the Secretary of Energy to carry out a program for purposes of accelerating the development and demonstration of electric vehicle technology.

IN THE HOUSE OF REPRESENTATIVES

JANUARY 23, 1990

Mr. BROWN of California (for himself, Mr. FAZIO, Mr. LEWIS of California, Mr. MOORHEAD, Mr. CAMPBELL of California, Mr. PACKARD, Mr. BATES, and Mr. WAXMAN) introduced the following bill; which was referred jointly to the Committees on Energy and Commerce and Science, Space, and Technology

A BILL

A REPLY TO PETER HUBER'S QUESTION

Those who have designed, built and operated an electric car have found that even a car with 25 mile range can be useful for much urban transportation. A good analogy for electric car use is the variety of tools in a toolbox. In it are found pliers, screwdrivers, wrenches, and other tools. A wrench is used for bolts, screwdrivers for screws, hammers when impact is required. Each tool is used for its appropriate task. Limited-range electric cars similarly can be used where they are adequate for the trip.

An electric car can be a life-extender for a conventional car. A present-value analysis shows the electric car has an economic advantage over a 15 year period when its operating, maintenance and 3-year battery amortization costs are compared to the similar costs for a a conventional car on a 5-year replacement cycle.

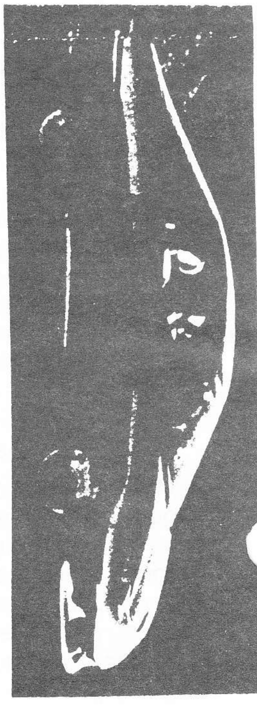
The conventional car as it ages does not perform well for short-range errands. An acquaintance who uses a car in this manner recently found out it can be expensive. The engine began behaving erratically at 40,000 miles. After a $500 investigation by the car dealer the problem was corrected.

I believe this advantage needs to be considered, along with the energy independence and environmental factors that are usually cited for electric cars.

William H Shafer

Specifications

Dimensions	
Wheelbase	95.0 in.
Length	163.0 in.
Width	68.2 in.
Height	47.5 in.
Ground Clearance	6.0 in.
Track, f/r	57.9/48.4 in.
Curb weight	2200 lbs.
Gross weight	2550 lbs.
Weight distribution (with driver, % f/r)	53/47
Aerodynamic drag coefficient	0.19
Motors	
Type	AC induction
Horsepower	57 bhp @ 6600 rpm (per motor) 114 total horsepower
Torque	47 lb-ft @ 0 to 6000 rpm (per motor) 94 total lb-ft
Typical efficiency	90-95%
Electronics	
Type	dual MOSFET inverters
Maximum current	159 Amps rms to each motor
Maximum system voltage	400 volts
Frequency range	0-500hz
Battery charger	computer-controlled, integral with dual inverter package
Maximum charge rate	50 amps, 400 volts
Batteries	
Type Configuration	Delco Remy recombinant lead acid 32, 10-volt batteries wired in series, packaged within center tunnel
Batteries	
Capacity	42.5 Amp-hour, 13.6 kWh
Battery pack weight	870 lbs.
Drivetrain	
Type	front-wheel-drive, one motor per wheel
Transmission	single-ratio planetary
Final-drive ratio	10.5:1
Lubrication	turbine oil, pressurized oil spray jets
Typical efficiency	94-98%
Body/chassis	
Type	fiberglass-reinforced plastic monocoque simulating the strength and weight of an aluminum structure
Tires	low rolling resistance Goodyear radials inflated to 65 psi
Tire size	P165/65R-14
Wheels	14x4-in. forged aluminum
Steering	rack-and-pinion
Suspension	two control arms per wheel, coil springs, gas-pressure shock absorbers
Glazing	PPG "Sungate"
Performance	
Pounds per horsepower	22 (at gross weight)
Motor speed at 60 mph	9500 rpm
0-60 mph	8.0 sec.
55 mph cruising range	120 miles
Top speed	110 mph (rev. limiter at 75 mph)



Around the World EV News

AUSTRALIA. A PERTH-based firm, SHERWOOD OVERSEAS P/L is involved with EXXON and JOHNSON CONTROLS (USA), TOYOTA (Japan) and SEA (Austria) in developing zinc/bromine (Zn/Br_2) flow battery technology for EVS. A 45kwh/220v unit installed in a one tonne VW Bus EV has been successfully tested in the Alps by SEA of Murssuschlag, Austria. SEA is now producing 5kwh/48v and 22.5kwh/216v modules.

AEVA, Nov. '89 and EVP, 15 Dec. '89

NOTE: A Zn/BR_2 battery has just been purchased from JOHNSON CONTROLS to use in the University of Ottawa solar-powered EV "RALOS". This Zn/Br_2 battery is the first of its type to be operated in Canada and is being studied at the Electrological Science and Technology Centre at University of Ottawa.

There are now 35 entries received for the WORLD SOLAR CHALLENGE, which starts 11 November. For the first time there are entrants from Canada, England and New Zealand.

AEVA Jan. '90

ITALY ROME, MILAN and other Italian cities have now banned (private?) passenger vehicles in their city cores during peak traffic periods. This is a serious move to reduce automobile exhaust emissions which destroy a healthy environment.

EVP, 1 Nov. '89

BELGIUM. 15 EVs ran a fixed route through Bruges during the "Twelve Electric Hours of Bruges", Sept. 8, 9 '89. The winner, a RENAULT MASTER EV using Ni/Cd batteries ran 10½ hrs. with only one pause for opportunity charging and covered over 100 miles. During the associated seminar, the 140 delegates agreed to form an EV Association of European Cities. They also passed a resolution to commence an EC program "Advanced electric drive systems for buses, vans and passenger cars to reduce pollution". AVERE was authorized by the Commission of the European Communities to arrange for the studies and will coordinate them.

EVP, 1 Jan. '90 & AEVA, Jan. '90

CANADA Some Federal MP's rode and drove in a Na/S powered WV JETTA shown in OTTAWA 21 December by ABBA and POWERPLEX TECHNOLOGIES INC. of Toronto. This passanger EV has a 120 km range at 90 km/h and accelerates to 50 km/h in 9 seconds. It was also demonstrated in LOS ANGELES.

The City of TORONTO has issued an RFP for 1 to 10 electric vans. Specifications can be met by the GM G-Vans being assembled by VEHMA, a subsidiary of MAGNA INTERNATIONAL, Markham, Ont.

BATTERY TECHNOLOGIES INC. of Mississauga, Ont. has received a $199,000 contract from the Ontario Enersearch Program to assist in development of a rechargeable Alkaline Manganese Zinc battery.

Electrical Business, Jan. '90

ELECTROFUEL MANUFACTURING CO. Toronto, has received a $499,963 contract to carry out Phase III of a LiAl/FeS prototype.

R&D Bulletin, DSS Can. Dec. '89

UNIV. OF OTTAWA Dept. of Mechanical Engineering will get a grant of $201,715 for a project with ALCAN and UNIQUE MOBILITY INC. to develop an energy-management system designed to lower the cost and imprve the driveability of EVs. This funding is from the Ontario Government matching the Industrial Research funding.

Ottawa Citizen, 10 Feb. '90

French-designed Electric Garbage Trucks ELECTROBENNE ST 1836 may be built in Canada under licence to SITA, a specialty vehicle group in France.

EVP., 15 Nov. '89

FRANCE Last October PEUGEOT announced that an Electric PEUGEOT 205 would go into production in 1990. It will use SAFT's new Ni/Cd batteries which are now in commercial production. The car will have a range of aboutt 100 kms per charge. All the drive system and batteries are contained under the front hood so the vehicle has the same space and appearance as its ICE counterpart. PEUGEOT is the first major auto maker to start building passenger EVs.

About 200 of the newly designed VOLTA microvans are expected to be produced this year by SEER in LaRochelle, France.

EVP., 1 Jan. '90

SWITZERLAND The Swiss are willing to sacrifice auto range and speed in order to reduce pollution and reduce energy needs. They are importing vehicles from Italy, France and Denmark (the Mini-EL) and converting as necessary to electric drive.

DEVC, Dec. '89

UNITED KINGDOM The ELECTRIC VEHICLE ASSOCIATION (EVA) has changed its address to 8 Leicester Street, London WC2H 7BN, and the new Director is Derek Lawrence. Electric Truck and Vehicle World, the EVA quarterly will now be incorporated in BATTERIES INTERNATIONAL, a new quarterly publication specially for Battery makers and users in the European area. Don Gribbie is the Editor and the address is: Aberdeen House, Headley Road, Grayshott, Hindhead, Surrey GU26 6LA, UK.

An excellent 150 page EVA MANUAL of Good Practice for fleet users and first-time buyers is now available from EVA. Editor Don Gribble and contributing authors have produced a "MUST" Book for every fleet user's EV library. 40 pds. Sterling.

U.S.A. EVs selected for the LOS ANGELES INITIATIVE are reported to be: **GM G-VAN** to be supplied by VEHMA INTERNATIONAL with input from GM for the Van "gliders", Chloride EVS for the drive system and Pb/acid batteries. Cargo capacity is 1000 lbs. Range about 100 km/charge, 300+ charges, top speed over 90 kph.

UNIQ M-90 MINI-VAN to be supplied by UNIQUE MOBILITY, Englewood, CO. with Chrysler T115 "gliders", gelled Pb/acid batteries from Johnson Controls, GE motor drive systems and a Range Extender to be used when required. The extender will be a Honda 12hp propane or CNG-fueled ICE driving a Uniq alternator to take the extra load of air conditioning, etc. Cargo capacity is 500 lbs. Range over 160 km. top speed aver. 120 kph.

CAT LA 301 4-seat Commuter EV from C.A.T. HOLDINGS LTD. of Sweden and UK. LA 301 is a sleek "ground-up" EV complete with range extender ICE and air conditioning as standard equipment. Based on Denmark's WHISPER design concepts, it has a fiberglass body on galvanized steel frame, uses Chloride Pb/acid batteries, 12-34 kw dc shunt motor. Range extender ICE burns propane or reformulated gasoline. Range is over 100 km on batteries or 240 with APU. Top speed 100 kph.

EVP, 15 Jan. '90

CALENDAR

JULY 8-19,1990 GM SUNRACE USA, Orlando,FL to Detroit, MI

WORLD SOLAR CHALLENGE-Due to start in Darwin, Austrila on Sunday November 11 1990. ENERGY PROMOTIONS P.O. BOX 290, Bribie Island Qld. 4507, Australia

Willits Ca. EV Rally Aug. 11 & 12, 1990

Dec. 3-5, 1990 EVS - 10, Hong Kong

Bradley GTElectric: Great Show car (EXPO 86) or use for dailey Commute. Strong accleration in 96V or good economy in 48V operation. GE Controller and motor. Lester automatic charger. White with Red interior. $7,800 (408) 225-5446

MSASERATI Bora Replica, GE Series motor, transistor PWM, Digital meters. Priced to sell $6,900 (415) 388-0838

DINO FERRARI Fiberglass Replica on VW Chassis. 72Volt system with Whiley"8" controller. Baldor Motor. Used very little, like new, very good looking. On board Charger. Will consider delivery. Make offer. (206) 623-8662 ask for LU.

WANTED: China Motor, PMC controller and charger for 96V system. Interested in any EV's for sale in Pacific Northwest, running or not. George McCrae (604) 987-7792. 1322 Hope Road, North Vancouver, BC Canada

Want more news monthly about electric vehicle and related developements (in addition to the good EAA news)? For subscription info, write to: Electric Vehicle News, Arlington, Va. 22209

Advertisement Rates: 5 Lines for $5.00 - 1/4 page for $15.00
Full Page for $50.00 Submissions to be "CAMER READY"

EAA Chapters

ARI ZONA: Phoenix
Lee Clouse 602 943 7950
P.O. Box 11371
Phoenix, AZ. 85061

CALIFORNIA

East Bay
Charles Smith 415 525 4434
61 San Mateo Rd.
Berkely, Ca. 94707

North Bay
G. Schaeffer 415 456 9653
211 Ballan Blvd.
San Rafael, Ca. 94901

Peninsula
Jean Bardon 415 355 3060
540 Moana Way
Pacifica, Ca. 94044

Santa Clara
Lee Hemstreet
787 Florales Dr.
Palo Alto, Ca. 94306
415 493 5892

San Jose
Don Gillis
5820 Hermes St.
San Jose, Ca 95123
(408)255-5446

Los Angeles Metets 1st Sat.
I.L.Weiss (818)841-5994
2034 N. Brighton "C"
Burbak 91504

Southern Cal-EVA of SC
Ken Koch 714 639 9799
12531 Breezy Wy.
Orange, CA. 92669

TEXAS: Houston
Ken Brancroft 713 729 8668
4301 Kingfisher
Houston, TX. 77035

WASHINGTON: Seattle
Ray Nadreau 206 542-5612
19547 23rd N.W.
Seattle, WA. 98177

WISCONSIN: Milwaukee
Dave Pares 414 481 9655
3251 S. Illinois
Milwaukee, WI. 53207

NEW JERSEY: Hackensack
Kasimir Wysocki 201 342 3684
293 Hudson St.
Hackensack, NJ. 07601

NEW ENGLAND
Bob Batson 508 897 8288
1 Fletcher St.
Maynard, Ma. 01754

VANCOUVER, BC:
VEVA 604 987 6188
543 Poweii St.
Vancouver, BC. V6A 1G8

American Solar Car Assn.
Robert Cotter
PO Box 158
Waldoboro, Me. 04572

NON-AFFILIATED GROUPS

CANADA: Ottawa, Ontairo
EVCO
Box 4044 Sta. "E"K1S 5B1
Ottawa, Ontario, Canada

Denver, CO. DEVC
George Gless 303 442 6566

Fox Valley, IL. 312 879 0207
John Stockberger
2S 643 Nelson Lake Rd.
Batavia, IL. 60510

Eastern-EEVC 215 696 5615
P.O. Box 717
Valley Forge, PA. 19482

For information on forming a chapter in your area write to the address below or phone between 10AM-5PM Pacific Time 415 591 6698

EDITORS: JOHN NEWELL-BILL PALMER-PAUL BRASCH-E.W. AMES
Send your chapter news, coming events, articles to the address below

ELECTRIC AUTO ASSOCIATION NEWS
1249 Lane Street
Belmont, Ca. 94002
July1990

NON-PROFIT ORGANIZATION
U.S. POSTAGE
PAID
SUNNYVALE. CA.
PERMIT NO. 420

Forwarding and Return Postage Guaranteed, Address Corection Requested

TIME DATED MATERIAL-PLEASE DO NOT HOLD