Electric Auto Association NEWS

March 1989

Vol. XXI No. 3

WELCOME TO THE ETAP HYBRID ELECTRIC VEHICLE PROJECT!

Want to help design and build an experimental vehicle that can operate on electric power yet go long distances on liquid fuel? Want to work together with EAA members, Stanford students and faculty as team members? This is your chance! On the ground floor of this exciting project! Two organizational meetings have been held and so far 28 EAA members have signed on. Now for the details.

The winning proposal was prepared by EAA member (and Stanford University Visiting Scholar) Dr. John Reuyl in response to a Request for Proposals from the Energy Technologies Advancement Program (ETAP) of the California Energy Commission (CEC)). The CEC will provide $180,000 in funds for hardware and professional management of the project. The project will provide a matching equal amount in time volunteered by EAA and Stanford team members, project advisors, and time and donations from corporate sponsors

Thus, the project will have resources (and complexity) equivalent to at least $360,000. In terms of complexity the project is even larger, since the team is comprised not of a few fulltime researchers in an existing research laboratory but rather of many part-time volunteer members scattered in different locations and lacking any shared research tradition and discipline.

However, although the project may be complex, the number and diversity of its team members is also its strength. The project builds upon our predecessor Stanford Solar Car Project, and it is the first time the EAA has been able to undertake such an ambitious joint project.

The 27-month project is divided into three phases: Project Definition - 6 months; Design and Fabrication - 9 months; Assembly and Testing - 12 months.

The purpose of this research contract is to advance technology toward practical, energy-efficient, environmentally benign vehicles.

The goals of this research contract are to:

1. design and build an experimental test-bed hybrid electric vehicle[s] that can operate on both electric power and liquid fuels,

2. test the vehicle under various operating conditions, and

3. from the preceding, establish technical and economic criteria for prototype hybrid electric vehicles that could lead to commercially successful vehicles with lower emissions, lower noise levels, lower dependence upon imported fuels, and greater reliance upon energy sources indigenous to California.

After completion of the contract, the EAA plans to continue tests and demonstrations of the vehicle to:

1. gather on-the-road operating experience with the vehicle,

2. establish test cycles using electricity from the electric power utility and from the 3.5 kW PV [photovoltaic] array of the Stanford Solar Car Project,

3. disseminate results of the research,

4. seek funding for continued development of follow-on vehicles, and

5. encourage early mass-production of cost-effective, energy-efficient, environmentally-benign transportation vehicles.

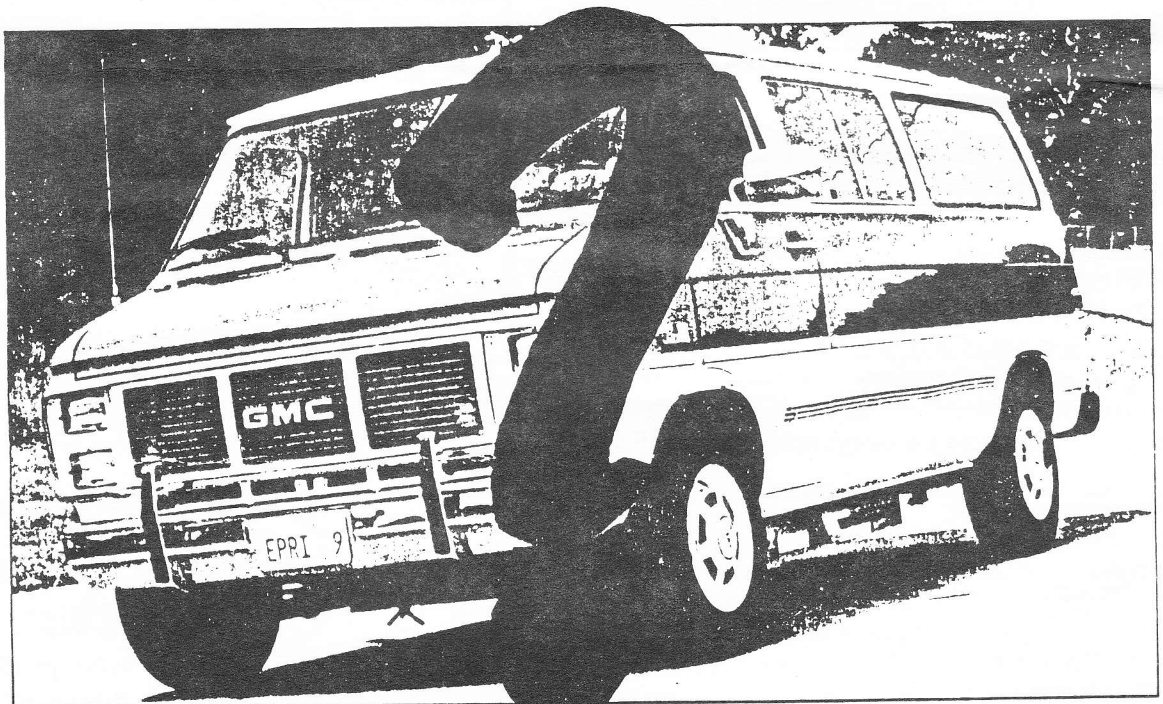
Once-a-month planning meetings will be held on the 4th Saturday of each month. Call John Reuyl (415) 857-9340 for time and place. Please write if you'd like to get involved, have questions, suggestions, or just want to get on the mailing list. Address correspondance to: Dr. John Reuyl , Director, ETAP Project, P.O. Box 8683, Stanford, CA 94309.

Special Edition: TODAY'S EV

EV STATUS REPORT

Vol. V No. 3 September—December 1988

What's so new about the new electric vehicle?



In 1973, the United States hoped EVs would help solve the gas crisis. Today, we hope they'll alleviate problems with air pollution, energy security, and the trade deficit.

EVs weren't ready for production 15 years ago. Are they ready now?

con't pg. 5

Memo to: All EAA members March 5, 1989
From: Bill Palmer
Subject: EAA Sponsorship of Electric Car Development Projects

In the 22 years that I've been a member of the EAA nothing has given me more hope and optimism for our achieving real progress in EV technology than the ETAP Project. Here is an opportunity for EAA members to accomplish so much more as a team than we have been able to individually on our limited budgets. With money for hardware we have the life blood that inspires us to work together to put on the road the ideas we have been developing for years.

We have this opportunity mainly because member John Reuyl spent thousands of hours laying the groundwork, preparing proposals and negotiating with the California energy Commission (CEC)in Sacramento with a little help from other EAA members. We have this opportunity also because the CEC recognizes the EAA as an organization of competent electric vehicle designers. EAA sponsorship was an important factor in the CEC's decision to fund John Reuyl's project.

If sponsorship by the EAA will help get contracts, I think the EAA should sponsor any projects that are in line with the objectives and purposes of the EAA. The EAA By-Laws say that one of the objectives and purposes of the Electric Auto Association is "To encourage experimentation in building of electric autos." To implement this By-Law provision the EAA should sponsor experimental projects. Unfortunately, the EAA cannot fund projects because our only source of funds is membership dues. But any well prepared project, like ETAP, will attract member participation. And that can make the difference to a potential source of funds between a struggling individual and an organization of experienced EV designers. The EAA should recognize that the award of any development contract will be based mainly on the quality of the initiator's proposal and his ability to sell it to a source of funds.

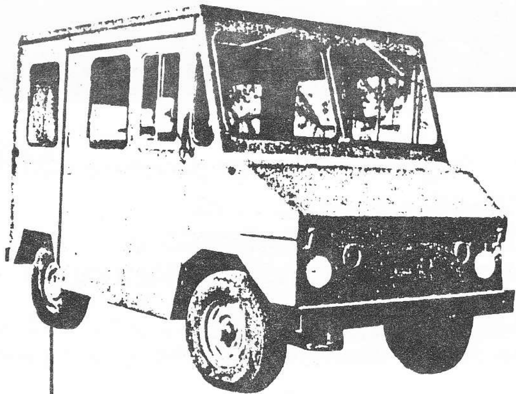
The ETAP Project is a new and additional activity of the EAA and members are free to work on it or not, as they wish. Those EAA members who would like to do so (28 so far) are welcome and are urged to do so. For those who do not or cannot, the EAA will continue with all of its other activities. But I hope more members will be inspired to develop their ideas, prepare proposals and negotiate development contracts with sources of funds.

To avoid the differences of opinion we have encountered on the ETAP Project, I am suggesting that the EAA adopt a policy for project sponsorship which states clearly what the EAA will and will not do and what the responsibilities of the project initiator are. I will appreciate your suggestions for improvement of the proposed policy which is printed on the other side of this sheet. Please send them to me at 44 Dior Terrace, Los Altos, CA 94022. I will present it to the EAA Board of Directors after incorporating whatever good ideas you suggest.

PROPOSED EAA POLICY ON SPONSORING PROJECTS

EAA members are encouraged to develop project plans, make proposals to potential sources of funding and negotiate contracts for performing experimentation in exchange for funding. For projects which are in line with EAA objectives and purposes, the EAA will sponsor the project even to the extent of being the nominal contractor if that becomes necessary to get the funding. Projects are encouraged to, but not required to, invite EAA members and others to work on the project, as volunteers or for pay, as a means of furthering the educational and promotional purposes of EAA.

If the EAA is the nominal contractor its oversight of project performance will be limited to that necessary to insure compliance with the contract. The initiator of the project is responsible for managing the project and the funds in compliance with the contract. The distribution and utilization of funds is a matter of agreement between the initiator and the funder. EAA will not try to manage the project nor dictate what the project does except to insure contract compliance. Of course, all legal matters will be negotiated to the mutual satisfaction of the EAA Board of Directors, the initiator and the funder.



"In the late '70s and early '80s, EVs captured the country's imagination. The oil crisis was still in people's minds, and gas prices were still volatile. Reality set in when gas prices leveled out: 'Who's going to fix my EV if it breaks? Where do I get parts?'"

— Michael Lechner, former product development engineer in charge of EV demonstration, Public Service Company of New Mexico

Few products have suffered such rampant credibility problems as the modern electric vehicle. The trouble began 15 years ago, when political events led to a rush to get EVs on the road.

In 1973, an Arab oil embargo severely restricted U.S. petroleum supplies. In response, Congress passed Public Law 94-413, the Electric and Hybrid Vehicle Research, Development and Demonstration Act of 1976, with the intent of stimulating rapid development of EV technology.

Those involved in the EV movement at that time remember what Paul Brown, director of DOE's Electric and Hybrid Propulsion Division, calls the "heroic job" done by the small companies that tried to answer the cry for EVs. However, P.L. 94-413 (later amended by P.L. 95-238) was a reaction to a crisis. The emphasis was on near-term demonstration.

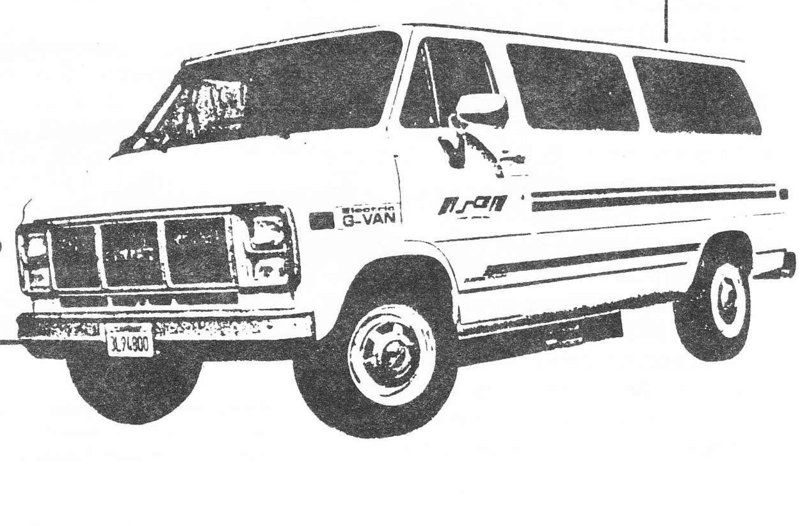
"The country was naive — both the manufacturers of the vehicles and the people who bought them," says a participant in DOE's EV demonstration program of that time. "They thought, 'It's an electric vehicle, how much could there be to it?' But they found out there was a lot more than anticipated."

Then an additional problem developed: The embargo ended and, as oil prices fell, federal subsidies for vehicle demonstration ended as well. Most EV companies were forced to fold, and EV users were left alone to battle problems with performance, reliability, safety, and servicing. Many people began to question whether the EV would ever be able to compete as a road vehicle.

But, despite their problems, these earlier EVs left an important legacy. First, they proved that the basic technology worked. Second, they showed that EVs "needed to follow the sequential steps required in the evolution of any new product: feasibility, design, field testing, and *then* commercialization," says Jerry Mader, president of the Electric Vehicle Development Corporation. In the mid-1980s, while researchers continued to refine the technology and field-test new vehicles, EV developers began to focus on a new area: positioning the technology toward the most promising introductory markets. And they started tailoring vehicles to meet the needs of those markets.

Now, this market-oriented approach is paying off. The Electric G-Van, a full-sized vehicle designed for service fleets, is scheduled for testing at selected utilities in the United States. Unlike the EVs of the '70s and early '80s, the G-Van is made and supported by major automobile and component manufacturers. It is engineered as an EV, not as a conventional-vehicle retrofit. And its powertrain has undergone extensive testing: In essence, the G-Van is the "new model" of the GM Griffon electric van, which has logged over six million service miles in North America and Great Britain.

But negative impressions are hard to overcome. Some who remember the problems of earlier EVs continue to doubt the commercial potential of EVs like the G-Van. To help readers understand how the EV commercialization movement has evolved in the past decade and a half, this special edition of the EV Status Report is devoted to outlining the differences between "then" and "now."



Performance

Then: "Two-thirds of the operators said they were achieving a range significantly less than initially expected (10-25 miles versus 25-45 miles). Limited range forced some operators to eliminate some initially planned applications . . . . Applications were also eliminated because of inconsistent range performance."

— "Electric Vehicles: Market Assessment and Demonstration Planning for Commercial Applications," University of Michigan Institute for Social Research, April 1983 (a review of U.S. electric vehicle research and demonstration up to 1982)

Put simply, EV performance revolves around *range*. The range of earlier EVs was so short and inconsistent that the vehicles were impractical for almost every use.

Now: Today's EVs deliver a dependable range of 60 miles per charge — two to three times the range of earlier EVs. This improvement has been well documented in a three-year field test of the GM Griffon electric van.

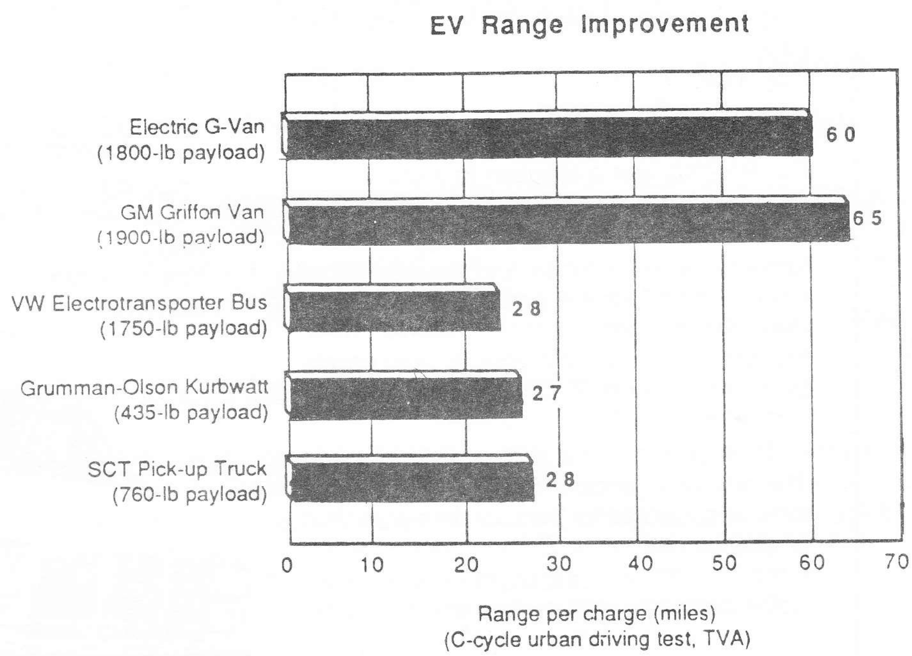
The test began in 1985, when EVDC introduced the Griffon into 11 North American utility fleets to help determine the van's commercial potential here. (In England, as the "Bedford CF2," the van had already logged millions of miles of dependable fleet service.)

The Griffon's 60-mile range rating is actually conservative. At Detroit Edison (DECO), senior engineer Bill Tripp regularly achieves ranges of over 60 miles in the Griffon he uses as a commute vehicle. His years of data on DECO's seven Griffons also prove that the van's Chloride lead-acid battery is clearly superior to earlier batteries:

- **It lasts five times longer.** In a four-year test of 26 electric VW Rabbits built around 1980 by South Coast Technology, DECO recorded an average battery life of approximately 6000 miles. In contrast, DECO's tests on the Griffon are showing full battery performance at 30,000 miles. This confirms TVA test results in which a Griffon used for commuting logged over 39,000 miles.
- **Its gives years of dependable performance.** In DECO's 26 Rabbits, dependable range plummeted as testing continued, and the vehicles were eventually only trusted on missions averaging about 10 miles. In contrast, DECO has seen no deterioration in Griffon range after three years, and the vans are still used on the same missions assigned when new.

Now, EPRI and EVDC have joined with Chloride EV Systems (manufacturer of the Griffon battery), Magna International (a leading automotive-component manufacturer), and General Motors to produce the "new model" Griffon — the Electric G-Van. Even with 48 extra cubic feet of cargo space, the G-Van still delivers a 60-mile range, due to battery improvements and an upgraded motor and controller. The van is being targeted for use in large service fleets, where sales could reach 25,000 units a year, according to a 1987 EVDC survey. Efforts such as those of Southern California Edison are essential to realizing this potential: SCE is already using the G-Van itself and is actively promoting the vehicle's use in other commercial fleets.

Work is also continuing on batteries that could extend current range and make EVs competitive in passenger-fleet and personal-vehicle markets. An Eagle-Picher nickel-iron battery being developed with support from EPRI and DOE could provide a 120-mile range in the Chrysler TEVan, scheduled for production in 1991. Other high-performance systems being developed by EPRI and DOE include the lithium metal-sulfide and sodium-sulfur batteries, which could boost range to 150-200 miles by the year 2000. ■



Refinements in propulsion batteries give today's electric vans, the Electric G-Van and the GM Griffon, twice the range of earlier light-duty vehicles such as the VW Electrotransporter Bus, the Grumman-Olson Kurbwatt, and the South Coast Technology Pick-up.

Reliability

Then: "We ran the (electric) Pacers and Fairmonts for three years, but half of that time they were out for repairs or maintenance. They had as much down time as on-the-road time."

— EV evaluator at a Northeastern utility

In the late '70s and early '80s, there was no objective way to test and trouble-shoot EVs before they were sold. As a result, the vehicles often broke down soon after entering service.

Now: Of all recent EV improvements, "the quantum jump is in reliability," says Paul Brown, DOE's Electric and Hybrid Propulsion Division director:

Problems associated with poor design, such as faulty brakes and loose suspension, have been virtually eliminated in the past ten years. Today's improved vehicle design stems from two sources: (1) thorough testing before the sale; and (2) a decade of comprehensive, high-quality battery and component R&D.

Testing the Technology

Today, no production EV sponsored by EPRI and EVDC is marketed without first undergoing months of laboratory and field evaluations at the Electric Vehicle Test Facility in Chattanooga, Tennessee. EPRI and TVA set up this facility in 1981 to objectively quantify the performance of foreign and domestic EVs and EV parts. By the end of 1987, 57 vehicles, 14 battery systems, and five battery chargers had been evaluated.

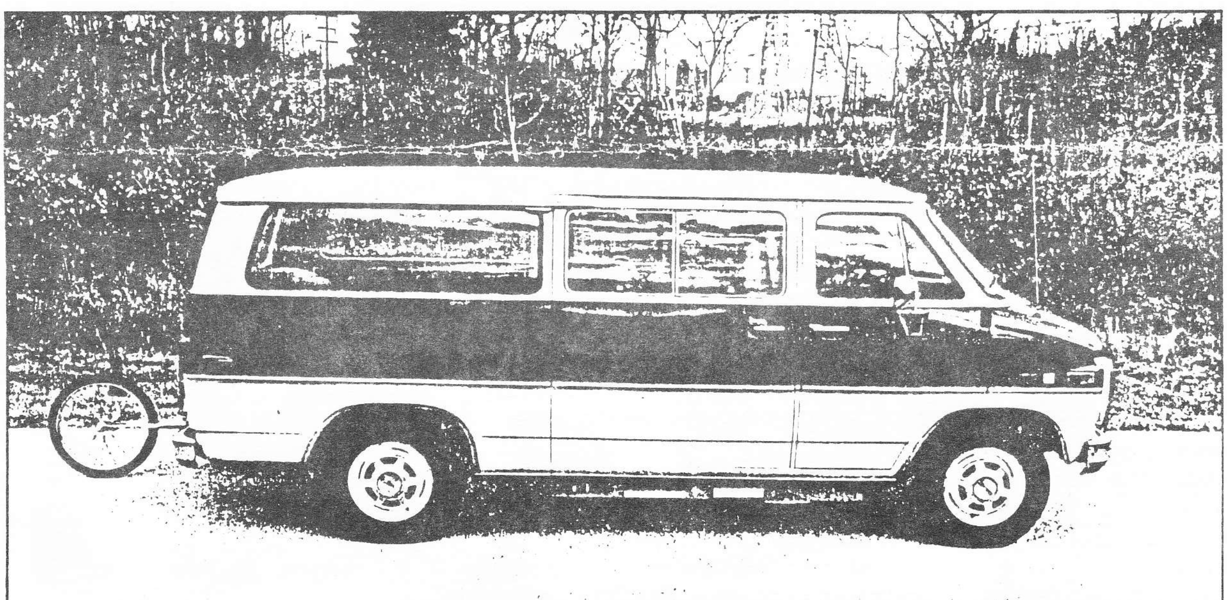
It was through the Test Facility that EPRI and EVDC identified the GM Griffon electric van as the most promising EV for near-term commercialization. EVDC's subsequent GM Van Demonstration Program — which placed the Griffon in fleet use at 11 electric utilities in the United States and Canada — confirmed the van's basic technological soundness. After initial in-house evaluations, Detroit Edison, one Demonstration Program participant, "felt comfortable enough with the Griffon's reliability that we put the vans in the hands of 'real customers,' " says Gerry Nicholas, Detroit Edison's marketing director. In a special marketing project, the utility loaned Griffons to 11 commercial customers for four- to six-week periods. The vans performed so well that several customers expressed interest in buying Griffons if they could be made cost-competitive with conventional vehicles (see "Marketability" section).

Refining the Technology

Today, production EVs are engineered as EVs, not as retrofits of conventional vehicles. Consequently, incompatibility problems have been reduced — components in the EV powertrain are designed and built specifically for that powertrain.

Current EVs are also more reliable because the technology has matured through several years of road use. In essence, the "new" Electric G-Van is far from new; its basic propulsion system has logged over six million miles in the GM Griffon. With slight refinements to the battery, an improved controller and motor, more standard features, and a thoroughly tested, domestically built chassis, the Electric G-Van promises to be even more reliable than the Griffon.

Additional incremental improvements in reliability will follow as research continues on EV controllers, dc/dc converters, and auxiliary battery systems. ■



G-Van evaluation at the Electric Vehicle Test Facility

Driver Acceptance

Then: "Our drivers wouldn't use our (electric) VW Rabbits when it rained — if they drove through a puddle, water splashed into the wiring and the car would conk out. And in cold weather, the controllers would seize and the guys could get stranded."

— Bill Tripp, senior research engineer, The Detroit Edison Company

Drivers easily tired of the discomforts and frustrations inherent in operating early modern EVs.

Now: EV backers are competing for drivers used to vehicle comfort and convenience. They're listening closely to what these drivers have to say about today's EVs.

One valuable source of feedback is the GM Van Demonstration Program, which began in 1985. As part of the Program, 11 electric utilities in the U.S. and Canada have been operating GM Griffon electric vans as service vehicles for three years. By gathering monthly comments from Program drivers, EVDC has identified ways to make the Griffon's successor, the Electric G-Van, more acceptable to the fleet market. Of particular value have been comments about:

Handling. Griffon users agree that the van gets the job done, but its ride isn't as smooth as a conventional van's. They also mention a certain 'tinniness' in the frame: Parts of the body, such as the steering wheel and door handles, seem poorly made or insecurely fastened. Comments like these underscore the importance of using a standard, domestically produced chassis in the new Electric G-Van. (The Griffon was an import from England.) As a result, the G-Van will feature the well-accepted, thoroughly tested frame used in the GMC Vandura and Rally. It will not only have all standard features found in conventional GM vans, but will also come equipped with electrically driven power brakes and power steering, improved suspension, and an antilock braking system.

Comfort. Griffon users in southern climates feel that air conditioning is essential for widespread acceptance of an electric fleet van. Therefore, EPRI is supporting the development of an electrically driven air conditioning unit for EVs. This unit, which is more energy efficient than regular air conditioners due to its larger condenser and use of recirculated air, will be evaluated in G-Vans at the Electric Vehicle Test Facility and Southern California Edison in 1989. To meet comfort needs in winter weather, the G-Van will also have, as standard equipment, a diesel-fired water heater for space conditioning. And, because of its single-speed transmission, the vehicle will not require shifting.

In addition to Griffon-drivers' suggestions, other EV-users' suggestions are being incorporated into the G-Van design:

Maintenance. Drivers of many earlier EVs found maintenance requirements to be extensive and cumbersome. One fleet user retired his electrically powered pick-up trucks, built circa 1980, because of time-consuming battery watering requirements: Every 11 days, the trucks had to be raised on a lift, the battery pack lowered, and each module watered manually in a process that took over two hours. In contrast, today's electric vans feature an easily removable battery pack (which does not have to be removed for watering) and a single-point, automatic watering system that reduces filling time to 15 minutes every three weeks.

Safety. In many earlier EVs, the propulsion battery rested directly behind the driver, monopolizing the back seat or cargo area and raising questions about safety in a collision. Poor ventilation of the battery system caused additional safety concerns: One utility found that the brake linings in its early EVs corroded due to ventilation problems. In today's electric vans, the battery does not intrude into passenger or cargo space. It rests securely under the floor, in a tray built to ensure proper ventilation.

The issue of safety is taken very seriously by today's EV developers. Current commercial-track EVs undergo the full course of standard, preproduction auto-industry evaluations. For instance, Magna International, manufacturer of the new Electric G-Van, is not only designing the van to meet Federal Motor Vehicle Safety Standards but also to optimize driver safety in the event of a collision. ■

Commercial Backing

Then: "Ever since Jet Industries went bankrupt, we keep our Jet vehicles operating by 'faking it' — when a part wears out, we get a replacement off a salvage vehicle or go back to the company who made the part. I do this not because I want to but because I have to. Of course I'd prefer manufacturer backing."

— Harold Bell, research engineer, Arizona Public Service Company

Most EV companies of the early '70s and '80s offered little service support after the sale. Many of these companies eventually dissolved, leaving EV owners on their own to find parts and service.

Now: Potential EV users have learned to ask not only 'What can the vehicle do?' but 'Who's backing it up?' Current EV developers know that, to be marketable, today's EVs must be built by well-established manufacturers offering solid warranties and ready access to parts and service.

As a result, EVs have evolved out of the days when, as one early-EV evaluator puts it, "you were dealing with a product that came out of somebody's barn." Today's EVs are built and backed by some of the biggest names in the automobile industry, and their design and engineering are coordinated by the leading EV development agencies of the electric utility industry and the federal government.

The new Electric G-Van is an excellent example of the thorough engineering characterizing current EVs. The G-Van's body is far from experimental — it is identical to the one used in the GMC Vandura and Rally. The van's Chloride lead-acid battery is an improved version of the dependable GM Griffon battery. And the van's powertrain is being engineered and installed by Magna International, one of the largest builders of automotive components in the world.

The G-Van will feature a coordinated manufacturers' limited warranty covering standard vehicle parts, special mechanical components, the battery pack, and the drive system. Selected GMC Truck dealerships and other authorized franchises will service both mechanical and electrical components. Service contracts will be available, and the G-Van manufacturers will also offer a comprehensive training program to owners who want to handle their own inspections, diagnostics, repairs, and routine maintenance. For assistance in trouble-shooting or correcting unusual problems, the service staff will also operate an "EV Hotline." Similar assistance will be available for near-term EVs such as the Chrysler TEVan. The TEVan, a minivan scheduled to be introduced in 1991, will feature a high-performance nickel-iron battery made and backed by Eagle-Picher Laboratories.

In short, EV users can now count on some of the world's largest automobile and component manufacturers for parts and service support.

EV developers are also nailing down the fine points on distribution and sales. EPRI, EVDC, and selected utilities are establishing a joint venture to manage large-scale EV distribution. This system will be up and running in time for G-Van market introduction in mid-1989. ■

Quality inspection of the Electric G-Van body at General Motors of Canada

Marketability

Then: "The Battronic trucks weren't being commercially produced, so utilities couldn't start a marketing program to sell them. But they shouldn't have been sold commercially anyway because they had so many problems."

— Carey Rowan, research engineer, Philadelphia Electric Company

EVs of the late '70s and early '80s were built and sold in a hurry, as a response to the oil crisis. No truly commercial vehicle evolved during that period.

Now: Today's EVs are dependable, long-lived, and backed by a solid parts and service network. But they still won't sell commercially if the price is too high.

To make EVs cost-competitive with conventional vehicles, EV developers are not only streamlining production costs, they are also following a well-defined marketing strategy: *Build a first-market of customers who value the lower life-cycle costs and the societal benefits of EVs.*

Fleets. In 1987, two EVDC studies revealed important facts about the cost-competitiveness of electric vans. The first, using the Griffon as a comparison model, showed that the life-cycle cost of today's electric vans won't fall to that of conventional vans until yearly production of the electrics reaches 5000-10,000 units. The second study showed that the best place to try to sell that many electric vans is in large service fleets.

Responding to these findings, EVDC is targeting service fleets consisting of 11 or more vans. EVDC research shows that fleet managers compare life-cycle costs, not just sticker prices, when buying vehicles. These managers are attracted to the EVs' inherent economies stemming partly from their longer life. For instance, an EV like the Griffon, which substitutes a proven electric drivetrain for an internal combustion engine and transmission system, will last as a low-maintenance fleet vehicle considerably longer than a conventional van. Fleet managers are also attracted to the EV's lower maintenance needs. EVs like the G-Van can cost 50% less to maintain than conventional vans, because their propulsion systems have fewer mechanical parts to adjust and replace, and improvements such as the "Autofil" automatic battery watering system are steadily decreasing routine-servicing time.

An EVDC survey showed that the Electric G-Van could replace as many as 161,000 service vans in the country's 30 largest metropolitan areas. On this basis, EVDC and EPRI are working with Chloride EV Systems (manufacturers of the G-Van propulsion system) and Magna International (builders of the G-Van) to tailor the van for a wide variety of fleet needs. The van will be available as both a cargo van and an eight-passenger wagon.

EVDC research also showed that the size of the potential electric-van market increases as range-per-charge increases. For example, an electric van with a 90-mile range (50% more than today's G-Van) will raise market potential to 283,000 vans, or nearly 80% of the large-fleet van market. Market potential could also rise dramatically when the longer-range Chrysler TEVan is introduced in the early 1990s. This minivan, with the popular Plymouth Voyager/Dodge Caravan body and a nickel-iron battery delivering a projected 120-mile range, will help EVs move into the passenger-fleet vehicle market.

Government. Besides fleet managers, legislators and regulators are also being approached to help establish a core EV market. Government is renewing its interest in EVs because of the vehicles' potential to help solve air-quality and fuel-diversity problems. Government can help the EV industry in two ways: (1) by purchasing EVs for internal fleet use, and (2) by passing laws and regulations supporting EVs (such as air-quality credits and vehicle tax and registration waivers for EV users), which would give industry-fleet managers an additional reason to buy EVs.

Some local agencies are already nurturing the EV industry. The City of Los Angeles is promoting the idea of having 10,000 EVs operating locally in three years. Also in Southern California, the South Coast Air Quality Management District board has proposed that, beginning in 1993, all fleet owners be required to buy only vehicles powered by clean fuel, such as electricity. By the year 2010, this market could comprise four to five million vehicles.

Government support could be what one EV researcher calls the "edge" that moves EVs back into the spotlight. But the vehicles themselves will get the industry off the ground. EV developers now have a vehicle with breakthrough performance targeted toward a carefully defined group of first-customers. As EVDC president Jerry Mader summarizes the progress of the last 15 years: "The evolution is over. The technology is here. It's time to test the market." ■

EVs Then and Now

	EVs of the '70s and Early '80s	EVs of Today
Performance	Range per charge: 10-30 miles	Range per charge: 60+ miles
Reliability	No objective testing; down-time often 50% or more	Thorough lab and road evaluation by EPRI and DOE; down-time negligible
Driver Acceptance	Extremely low	Greatly improved through use of standard U.S. auto bodies and addition of standard U.S. features such as power steering, power brakes, and air conditioning
Commercial Backing	None or negligible	Complete warranties and service support from the world's largest automobile and component manufacturers
Marketability	None	Strong in large service fleets

The EV Status Report is published by the Electric Vehicle Development Corporation with partial funding by the Electric Power Research Institute. For more information, write or call the Electric Vehicle Development Corporation, 20823 Stevens Creek Boulevard, Suite 440, Cupertino, California, 95014, (408) 253-5262.

CALENDAR

Mar. 28-30: Georgia World Congress Center, Atlanta, GA.
(800) 421-6816 (213) 772-2965

April 2-6: International Solar Energy Conference, Holiday Inn, San Diego, CA

April 11-13: IEEE Electro 89, Jacob Javits Con. Center, NY City

April 25-26, El-Tech '89 - Technical Symposium & Exhibits, Raleigh Civic Ctr., Raleigh, NC (803) 686-3737

April 30: MAC'S PACK RUN for YOU
Open Run - Show & Shine, Richard Moya Park
Bring your car for Run and Show.
Contact: C. A. McMillin,
5802 Hammermill Run, Austin, TX 78744
(512) 462-3577

May 1-3: 1989 Vehicular Technology Conference, Sir Francis Drake Hotel, San Francisco, Wrex Beaman, (415) 328-3825

EV Marketplace

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