Tech Brief

New Jersey Fuel Cell Hybrid Electric Vehicle (New Jersey Genesis)

FHWA-NJ-2001-001-TB June 2001

BACKGROUND

The intent of this project was to retrofit a donated aluminum Ford Mercury Sable with an electric drive train, fuel cell power system, advanced battery pack, and a hydrogen generator to conduct a preliminary demonstration of the technology.

HERE'S THE PROBLEM…

Currently, there are several high profile electric vehicles and hybrids commercially available through various automotive manufacturers. Many of these manufacturers are now evaluating hydrogen as a potential fuel source to power these vehicles. However, overall there still exists a lack of information regarding hydrogen fuel power.

AND, HERE'S THE SOLUTION…

To develop a prototype vehicle incorporating an advanced fuel cell and using a novel method of hydrogen storage. Hydrogen will be generated, stored, and transported in the form of a 20 percent solution of sodium borohydride in water. In the vehicle, the sodium borohydride solution will be passed over a catalyst to generate gaseous hydrogen. Thus, successfully using hydrogen as a fuel source for vehicles and mobile applications in the form of a fuel cell.

BUT HOW CAN IT BE DONE?

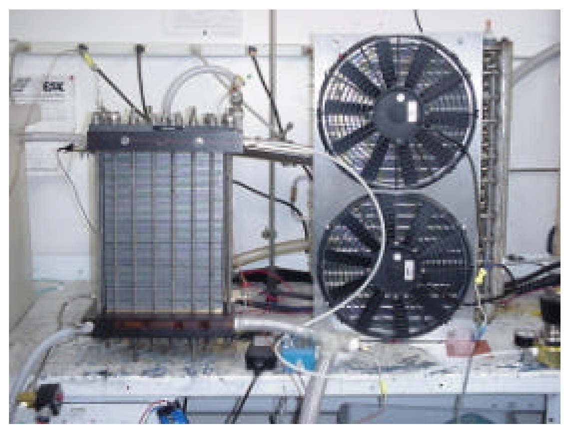
By developing a prototype vehicle incorporating an advanced fuel cell, using a novel method of hydrogen storage.

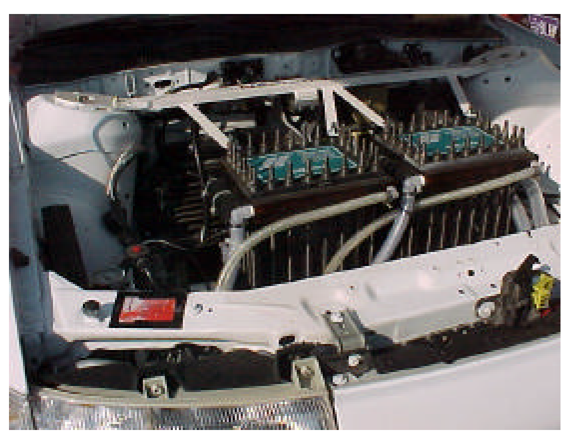
THESE ARE OBJECTIVES:

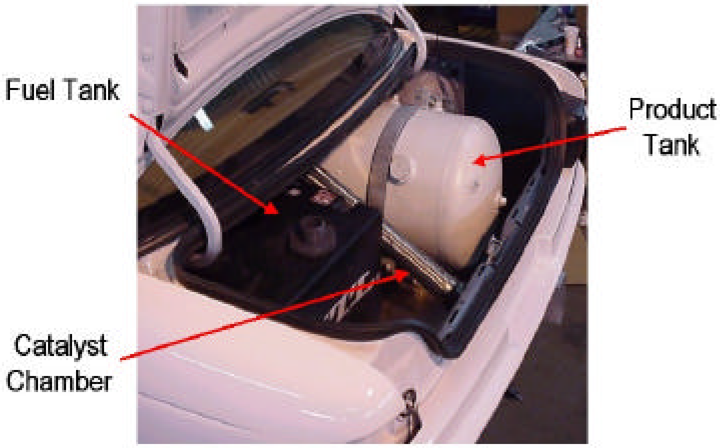
- To design and develop an advanced fuel cell/electric hybrid vehicle using hydrogen as a fuel, and utilizing sodium borohydride as a storage medium for hydrogen.
- To produce an operational prototype vehicle- the New Jersey Genesis- and ready it for driving on public roads.
- To make minor improvements to the 1999 New Jersey Venturer fuel cell/electric hybrid vehicle and prepare it for the 2000 Tour de Sol competition.
- To educate the public regarding the benefits of the new, clean vehicle technologies represented by the Genesis and Venturer, and provide opportunities for students to learn and gain hands-on experience in an advanced technology development environment.

HERE IS WHAT WE DID…

The first step was the design and development of an advanced fuel cell/electric hybrid vehicle using hydrogen as a fuel, and utilizing sodium borohydride as a storage medium for the hydrogen. Ford Motor Company donated an aluminum Mercury Sable as the platform for the prototype development. The advanced fuel cell and hydrogen generator were developed as a path to clean transportation technology. After modifying the proprietary catalyst systems, which included both chemical substrate and manufacturing methods, a Hydrogen-On-Demand™ System was created by Millennium Cell, Inc.







The Hydrogen-On-Demand™ system was designed using stainless steel and plastics, which are resistant to the alkalinity of the fuel. In this system, a solution of sodium borohydride solution from the fuel tank to the reaction chamber. As the solution flows over the catalyst, hydrolysis occurs and hydrogen gas is released; the byproducts of this reaction are water, heat, sodium borate, sodium hydroxide, and hydrogen.

A Fuel Cell Power Control System was designed and manufactured by Recon Industrial Controls Corporation. This system consisted of a Recon single stack controller and a Recon Data Acquisition Module. The controller was connected to a PC through a serial port to a monitor fuel cell operating parameters, and to adjust those parameters. The Data Acquisition Module was connected to the serial connection and allowed for continuous data storage.

The second task accomplished was the production of an operational prototype vehicle, designated the *New Jersey Genesis*. The Ford Motor Corporation donated the aluminum body and frame Mercury S, one of twenty aluminum intensive prototype vehicles constructed by Ford. This created the base for a large, lightweight, and attractive vehicle that would become known as the *New Jersey Genesis.*

The efficiency and weight advantages of the vehicle were enhanced by Team New Jersey, so that the *Genesis* would have optimal weight and was finally retrofitted to a 3,100-pound weight. The resulting customized sub frame ended up weighting 50% less than the original, as cast iron and steel parts were replaced with aluminum parts.

Range calculations and fuel consumption rates were established at approximately 450 miles on a single refuel. A Global Positioning System (GPS) was installed for both consumer endorsement and to enable Team New Jersey to better follow the Tour de Sol rally route. Side view mirrors and their housings were replaced with state-of-the-art cameras that display images on an in-dash video screen. Replacement of standard incandescent turn signals with LED lights occurred to improve electrical efficiency and reduce spark potential. The location of key vehicle components was modified to reflect the Hydrogen-On-Demand™ System; climate control features were removed; and the original drive train was replaced with a custom 105 horsepower, 78-kilowatt Solectria motor.

	Previous Generation used in the NJ Venturer Vehicle	Next Generation used in the NJ Genesis Vehicle
Purge Valves	1	4
End Caps	Stainless Steel	Plastic
Rods Holding Stacks Together	Stainless Steel	Titanium
Flow Channels	4	16
How Many Fuel Cells	1	2, in series
Total Kilowatts	4.2 kW	11.7 kW
How Many Cells	64	100 per stack
Stack Controllers	1	1, running both stacks
Blowers	1	1 for both stacks
Hydrogen Source/Generation	Tank Storage	Sodium borohydride
Hydrogen Storage	12 tanks in backseat	1 tank in trunk

A third step involved making minor improvements to the *New Jersey Venturer*, the Team New Jersey's 1999 entry in the Tour de Sol competition. These alterations were made in anticipation of entering the *Venturer* in the 2000 program. The hydrogen containment system was improved, the battery pack was rehabilitated, and the controls were repaired or replaced as necessary.

Finally, technology transfer activities occurred as a means of educating the public about the benefits of new clean vehicle technologies represented by the *Venturer* and *Genesis*. The *Venturer* was entered in the 2000 Tour de Sol and completed it successfully. Throughout the entire competition, the only source of power used to fuel the *Venturer* was power from the solar photovoltaic power from Team New Jersey's unique fuel cell hybrid power station; no utility power or any other source was used to complete the 360-mile trek. During the Tour de Sol, the *New Jersey Venturer* placed first in overall scoring among all entrants in the 2000 competition and won First Place in the Renewably Fueled Vehicle category. Throughout the design and development process, students were included in planning activities. Overall, approximately 60 students and faculty were involved in the design and production phases. Students were taught, and participated in, many aspects of the vehicle's retrofit. Students were also involved in modeling the *Genesis* and simulating crash test to evaluate the car's safety. Other technology transfer components included interviews, poster boards, and printed material distribution. The project brochure was distributed at press conferences and public events.

CONCLUSIONS

The New Jersey team, headed by the New Jersey Department of Transportation, was engaged in incorporating this new technology into an optimized hybrid fuel cell/battery electric drive train in an advanced car. The vehicle platform is a prototype all-aluminum Mercury Sable contributed by Ford Motor Company.

The project received much recognition; the project team was accepted as a Whitehouse Millennium Council Partner. The project fulfilled a concise objective in providing students an opportunity to learn and gain hands-on experience in an advanced technology development environment.

It is anticipated that the vehicle will be completed using a more developed configuration and, made operational, to participate in a future America Tour de Sol competition.

WHAT IS THE NEXT STEP?

Although the objectives of this project were met, this project has initiated broader interest as to the uses of this technology. Numerous projects could stem from this project. Potential refinements and future work for the project include a technology comparison with other types of hydrogen generation and to perform a really good dynamic simulation model to assess stability and control performance issues. Future research may yield an inexpensive process to regenerate sodium borohydride from sodium borate, which would be a significant step in demonstrating this fuel as a renewable resource.

FOR MORE INFORMATION CONTACT:	
NJDOT PROJECT MANAGER:	Michael Strizki, November 16, 1999 – June 16, 2000 Donald Borowski, June 17, 2000 – June 31, 2000 Henry Schweber, July 1, 2000 – June 12, 2001
PHONE NO.	
e-mail	
UNIVERSITY PRINCIPAL INVESTIGATORS	**Mr. Patrick Szary**
UNIVERSITY:	**Rutgers University -CAIT**
PHONE NO.	**(732) 445-0579**
e-mail	**szary@rci.rutgers.edu**

A final report is available online at http://www.state.nj.us/transportation/research/research.html

If you would like a copy of the full report, please FAX the NJDOT, Bureau of Research, Technology Transfer Group at (609) 530-3722 or send an e-mail to Research.Bureau@dot.state.nj.us and ask for:

Report Title: New Jersey Fuel Cell Hybrid Electric Vehicle (New Jersey Genesis)

NJDOT Research Report No: FHWA-NJ-2001-001