Honda’s Hybrid Engine versus Toyota Hybrid Engine

Abstract

While Toyota was the first to market hybrid cars (Prius debuted in Japan in 1997), Honda was the first to market hybrids in the U.S. The Insight was released in 1999 and quickly won accolades.3Though both vehicles use a combination of electricity and gasoline for power, they do not use identical hybrid designs. Honda’s hybrid models are designed for fuel-efficiency, in contrast to Toyota’s hybrid vehicles, which are designed for reduced emissions. These differences in design goals translate into very different hybrid engine architectures. The Honda Insight was designed as a “parallel” hybrid system, where the electrical power system and the gasoline power system run in parallel to simultaneously turn the transmission, and the transmission then turns the wheels.4 The electric motor in the Insight aids the gas engine by providing extra power while accelerating or climbing, and supplements braking power. The electric motor can also start the engine, obviating the need for a traditional starter component. The Insight’s electric engine is not powerful enough alone to propel the car; therefore, the gas engine must be running simultaneously. The Insight mileage ratings were 61 mpg in cities and 70 mpg on highways, with 0–60 miles per hour acceleration in approximately 11 seconds. At lower speeds the electrical components provide the extra horsepower to propel the car, reducing the gas engine’s effort and thus saving fuel. The batteries are regenerated by capturing energy during braking or slowing and through standard electricity-generation provided by the traditional generator component in a standard car engine. Therefore, one does not have to plug in the Insight, or any of Honda’s hybrids, to recharge the batteries. In contrast to the parallel system configuration, a “series” hybrid system is designed to have a gas-powered engine turn a generator, which in turn powers an electric motor that rotates the transmission or recharges the batteries. The gas-powered engine does

not directly power the vehicle.5 The Toyota Prius was designed to reduce emissions during urban driving, and its design incorporates both parallel and series system elements. To reduce emissions, the Prius utilizes a power-train design in which the car runs at its most efficient speed by virtue of a "power split device" that links the gas engine and electric motor through the generator with a parallel system design, but allows the car to run exclusively on electrical power at lower speeds, like to a "pure" series system design. Consequently no gas is burned and emissions are negligible under these conditions.6 Thus, for low-speed urban traffic, the Prius meets its engine design goal of reduced emissions, with better mileage ratings than the heavier Honda Insight. In addition, unlike the Insight, the Prius is a four-door midsize sedan with back seats for extra passengers, something that the original two-door Honda Insight lacked, but was later offered on hybrid Civic and Accord models.

Honda Corporate Website, August, 2003

Honda's strategy had consistently emphasized innovation, independence, and environmental friendliness. In 1972, Honda introduced the Civic, which became an immediate success, ranking first in U.S. fuel-economy tests for four consecutive years starting in 1974. Through the 1980s and 1990s, Honda made a number of advances in environmentally friendly transportation. In 1986, it developed the first mass-produced four-cylinder car that could break the 50 miles per gallon barrier, the Civic CRX-HF. In 1989, it became the first auto manufacturer in the U.S. to use solvent-free paint in its mass production facilities. In 1996, Honda introduced a record-breaking solar-powered car (a prototype not designed for commercial production), and in 1998 it introduced a completely electric vehicle. Though the electric car was not a commercial success, developing the electric vehicle built a foundation of expertise that Honda would later employ in its development of fuel cell technology. Fuel cells were considered to offer great potential for the eventual replacement of combustion engines (DOE, January 2002).In Honda's research and development of its hybrid engine system, management decided to keep collaboration to a

minimum, essentially "going solo" with a risky—but potentially profitable—strategy to change basic automotive power design for the first time in a century. Honda's decision to not collaborate stood in stark contrast to the licensing and joint venture strategies pursued by Toyota.Toyota had aggressively pursued collaboration agreements for its hybrid technology and had accrued over 1000 patents on hybrid-related technology as of 2006. Toyota also promoted its hybrid technology design by licensing the technology to Ford and Nissan.11 While some industry observers were perplexed by Honda's decision to avoid collaboration, others pointed out that Honda's independence both gave it more control over its technological direction and ensured that the accumulated learning remained in-house. Consistent with this, Honda's management insisted that keeping development exclusively in-house compelled Honda to understand all aspects of a technology, from its strengths to its weaknesses. This in-house know-how could lead to sources of competitive advantage that were difficult for competitors to imitate.

By the end of 2005, Toyota's hybrids were outselling Honda's hybrids by about three-to-one, causing many analysts to question Honda's staunch position on pursuing a different hybrid technology from Toyota and to not collaborate or license with other auto producers.

Hydrogen Fuel Cells and Hydrogen Combustion

Hydrogen is the most abundant resource on earth and its combustion produces only water vapor as an emission. Many environmentalists and industry participants thus believed that the auto industry should focus its investment on technologies that utilized hydrogen as the fuel source. The two primary technologies under consideration were fuel cells and hydrogen combustion. Fuel cells convert fuel to electricity that is stored in a large battery. By converting chemical energy directly into electrical energy, fuel cells had been known to achieve a conversion efficiency of better than 50 percent—twice the efficiency of internal combustion engines. Hydrogen combustion works much like

traditional engines except that hydrogen is used instead of gasoline in an internal combustion engine. Either method results in only water vapor being produced as an emission. However, the development and commercialization of fuel-cell powered vehicles has been significantly hindered by the state of battery technology.13 Furthermore, widespread adoption of either alternative would first require building an almost entirely new fuel infrastructure. There was also speculation that fuel cell or hydrogen combustion vehicles would be dangerous since the hydrogen fuel (a highly combustible substance) would have to be stored under great pressure.

Honda had developed fuel cell vehicles in parallel with its hybrid development. In July 2002, Honda succeeded in manufacturing the first fuel cell vehicle to receive certification by the U.S. Environmental Protection Agency (EPA) and the California Air Resources Board (CARB) by meeting all applicable standards. This new fuel cell vehicle, called the FCX, was certified as a Zero Emission Vehicle and by the EPA as a Tier-2 Bin 1 National Low Emission Vehicle (NLEV), the lowest national emission rating. In 2005, Honda's FCX became the very first fuel cell vehicle in the world to be sold to an individual consumer (a family in southern California).

While Honda claimed that its work in hybrids helped it create internal knowledge of component design and manufacture that improved its options with respect to fuel cell technologies, some questioned whether it made sense to invest simultaneously in both technologies. Did it make sense for Honda to abandon fuel cell development in favor of spending more on promoting hybrids? Alternatively, should Honda abandon its hybrids to focus solely on fuel cells? Or is it important for Honda to pursue synergies (and preserve its options) by developing and promoting both?