The INNOVATION Issue

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The Old Man and the Sky

In 1946, Soichiro Honda began building two-stroke engines for bicycles. Now, Honda Motor Co. produces the Acura luxury car line, a $100,000 sports car, and a $3 million race bike. In 2010, it will deliver a $3.7 million jet.

But for Honda, the sky may not be the limit.

By Michael Schulze

Five years ago, Honda Motor Co. engineer Michimasa Fujino wrote a technical paper in which he described a small jet with a bizarre design. At the time, engineers agreed that a jet’s engines could be mounted on its tail or beneath its wings, but you could not put them atop the wings, because they would generate too much drag. However, Fujino proposed to do this. He claimed that, using software of his own devising, he had tested a variety of positions for jet engines and had found a “sweet spot” where air flow became optimal. He said that tests in Boeing and NASA wind tunnels supported his theory, and he noted that his engine configuration could provide a good deal of extra room for the cabin. Some of Fujino’s colleagues advised him not to publish his article: “It will just embarrass you,” one said.

Fujino is now president and CEO of Honda Aircraft Co. in Greensboro, N.C., and his HondaJet is one of the more exciting members of the growing lineup of very light jets (VLJs) that will arrive over the next couple of years. Honda is offering the jet for about $3.7 million and will begin delivering it in 2010. The jet will reach customers later than some other VLJs—including Eclipse Aviation’s Eclipse 500, Adam Aircraft’s A700, and the Cessna Citation Mustang—but that does not seem to be affecting sales: Honda began taking orders for the aircraft in October at the National Business Aviation Association convention in Orlando, Fla., and by the end of the week the company had received more than 100 deposits.

In a quiet room at the NBAA conference, Fujino traces the steps leading to the HondaJet’s production. A soft-spoken, charming man, he nevertheless conveys irritation at times. He acknowledges that his years of development work were not always pleasant. “In any business, you often receive very little support until you’ve already succeeded,” he says, “but now, even the

Beginning with an engine shop in Hamamatsu, Japan, Soichiro Honda (above, second from left) built an empire that now has produced the HondaJet (opposite), a very light jet with a unique design.
skeptics agree we’ve made something beautiful.” He leans forward, ticking off the jet’s selling points. “It will have about 30 percent more interior space than its closest competitors. It will be 30 to 35 percent more fuel-efficient. It will be faster and have more range.” (The jet will achieve a maximum speed of about 485 mph at 30,000 feet and have a range of about 1,610 miles.) “And also,” he says, smiling, “unlike most VLJs, it will have a separate lavatory. The wives like that.”

Honda’s approach to creating the jet was as idiosyncratic as Fujino’s design. The company began exploring aviation in the 1980s, but it did not hire experts from aircraft companies. Instead, it selected Fujino and a handful of other engineers from its car and motorcycle divisions to study aerodynamics in the United States, in the hope that, if they learned the subject from scratch, they would be more likely to deliver an innovative design. This did not happen at first. The team constructed an experimental light jet called the MH02, but it contained no startling advances, and Honda scrapped the program in 1995. The group returned to Honda’s research and development center in Tochigi, Japan, where, without a clear agenda or support, it seemed headed for oblivion.

But Fujino continued to puzzle over the design until, one day in 1997, he sketched out his engine concept. Honda’s then-CEO, Nobuhiko Kawamoto, invited him to present his idea to the company’s board, which, despite objections from some members, endorsed his plan. The company submitted a patent application for the engine configuration two years later. In 2003, new CEO Takeo Fukui announced that he wanted to see the plane in the air by December 17 of that year, the 100th anniversary of the Wright brothers’ first flight at Kitty Hawk.

Fujino settles back, grinning. “We made the deadline,” he says, “with two weeks to spare.”

HONDA IS NOT KNOWN for making multimillion-dollar products such as the HondaJet. Rather, it is widely perceived as a manufacturer for the masses. Soichiro Honda founded the company in 1946 after he discovered a market for bicycles outfitted with simple, two-stroke engines. The company’s first prototype automobile, introduced in 1959, was an inexpensive four-seater referred to as the People’s Car. Since then, Honda has produced a broad range of mass-market machines, including lawn mowers, watercraft, and weed cutters.

But Soichiro Honda also insisted on originality, and he was prepared to suffer setbacks in its pursuit. The Old Man, as he was called throughout the company, made his employees suffer as well: In the tradition of Japanese masters of apprentices, he frequently screamed at them and sometimes hit them. But he was remarkably tolerant of engineering problems, viewing them as a requirement for innovation. “Success is 99 percent failure,” he once
said. His people generally recognized that his “thunderbolts”—their term for his physical and verbal assaults—were meant to be educational, and they worked feverishly for him.

An avid racer of motorbikes and cars, Honda encouraged his engineers to view racing vehicles as “mobile laboratories” for technologies that ultimately would make their way into production machines. Those technologies have trickled down into mass-market products as well as elite, high-performance vehicles such as the $100,000 NSX sports car, the Acura line of luxury cars, and the RC211V race bike, which has a starting price of $3 million. Meanwhile, the company has explored entirely new lines of technical development for its HondaJet and its ASIMO robot (see “Honda’s Humanoid Hero,”).

Every Honda CEO has emerged from the company’s engineering ranks, and each one has been involved with racing. Indeed, all of Honda’s engineers are required to rotate through the racing units, which prepare vehicles for Formula One, CART, Motocross, and other challenges. Takeo Fukui, the current CEO, once managed the design of Honda Grand Prix motorcycles, and he still drives Motocross bikes and Formula One cars.

At the NBAA conference, Fukui, now in his 60s, looks back on his racing days. “In the 1970s, we came up with the idea of an oval motorcycle piston, which no one had ever considered,” he says. “It allowed us to shorten the bore stroke and push rotations per minute to 20,000, a big achievement in two-stroke engines at the time. Ultimately, the design didn’t work out. But that didn’t really matter. Whether our engineers succeed or fail, we want them to work on racing vehicles because they often have only a week to solve a problem before the next race. That experience toughens them up and teaches them to be practical and work fast. Then, when they’re assigned to a production vehicle, they bring the same approach to it. Most of our biggest innovations have come from our work on racing.”

One might add that some big failures have come from racing as well. During Soichiro Honda’s day, his engineers despaired when the Old Man attended one of their races, for they knew they would not win. In the 1990s, one of them, Kimio Shimura, explained why: “The reason is that just before the start of the race, he would fiddle with your machine. It’ll probably be good to do this, you think, but then he doesn’t stop. He just can’t quit.” Honda’s endless tinkering sometimes caused products to fail because they contained too many new ideas. This occurred early in the company’s history, with its two-stroke chimney engine (so named for the long projection on the end of its piston).

The Old Man’s inability to leave well enough alone is deeply ingrained in the company’s culture, and as a result, vehicle development can be a slow, tedious process. The design of the low-emission CVCC Civic in the 1970s, for example, required more than 10 years of trial and error. Like the HondaJet engineers who had no prior aeronautics experience, the Civic engineers had to learn lean-combustion technology from the bottom up.

Nevertheless, the racing division continues to produce innovations that
eventually improve the production vehicles. In Honda cars, these technologies include computerized engine control, V-6 turbocharging, and a double-wishbone suspension design that improves wheel control. Honda’s motorcycle racing engineers are responsible for the production bikes’ four-stroke engines, magnesium wheels, and weight-reducing aluminum shrimp-shell frames. In the 1980s, Honda’s F/1 engineers invented telemetry gear to monitor a racecar’s performance from a distance—technology that ultimately found its way into modern in-car functionsensing systems. And in building both cars and bikes, Honda employs computerized analysis tools originally created for racing vehicles.

This technology migration should be apparent in the second-generation version of the Honda NSX, which is due in 2009. NSX stands for New Sportscar eXperimental; Honda says that during the car’s design phase, the X also served as algebraic shorthand for unknown. The first version, an aluminum vehicle with a V-6 engine that debuted in 1990, marked the first time a Japanese company had made a car that could compete with European exotic automobiles and the Chevrolet Corvette. In the Super GT circuit, the NSX consistently is among the top three cars in the series, along with the Toyota Supra and the Nissan Skyline GT-R. Honda remains tight-lipped about the new NSX but has revealed that, instead of a V-6 engine, it will have a V-10 similar to the one that powers Honda’s F/1 cars. The chassis will derive from the racecars as well. Racing also influenced the design of Honda’s second-generation Acura MDX, an SUV that debuted in October. According to engineer Frank Paluch, who led the MDX design effort, his team included several racing engineers, whose efforts are evident in the vehicle’s engine and suspension system.

As the engineers rotate through the company’s racing and production units, Honda technologies tend to cross-pollinate each other, so that innovations devised for one vehicle make their way to another. “When we worked on the HondaJet’s interior, we consulted our Acura people,” says CEO Fukui. “Conversely, our experience with HondaJet is teaching our Acura team something about aerodynamics. And our work on traction for F/1 cars has helped us invent control systems for ASIMO.”

HONDA NOW IS FOCUSING intensely on green technologies. In a recent speech, Fukui noted that Honda pioneered gas/electric hybrid systems (with its Insight car, in 1999) and has created a clean diesel engine that performs as well as a gasoline-driven one. The company is making engines that run on bioethanol (fuel made from

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Soichiro Honda (top, at right) as an apprentice engineer in the 1920s. An all-new Acura NSX sports car (the 2005 model is pictured above) is forthcoming from Honda in 2009.
organic matter), and in 2005 the American Council for an Energy-Efficient Economy named Honda’s Civic GX, which runs on natural gas, the greenest vehicle of the year. The company also has introduced a hydrogen-powered fuel-cell concept car called the FCX. And in perhaps its most extraordinary initiative, it is testing a refueling station in which solar energy is applied to water to create hydrogen for fuel cells. If this technology takes hold, a network of hydrogen filling stations (widely seen as a costly but needed addition to the landscape before zero-emission, hydrogen—cell autos can become a reality) could be unnecessary. Instead, each hydrogen car owner could have an energy dock at his or her home. (This invention has roots in racing as well. In 1993 and 1996, vehicles powered by Honda solar cells took first place in Australia’s World Solar Challenge.)

Meanwhile, Honda is preparing for the HondaJet’s certification with the Federal Aviation Authority. The aircraft, made of lightweight composites originally used in racecars, can reach an altitude of 43,000 feet. It will be offered with seating for seven (five passengers plus two crew) and also in an air-taxi layout that will seat two pilots and six passengers in forward-facing seats. The cabin will have just less than 5 feet of standing room.

As for the engine placement, Michimasa Fujino still expresses wonder at his discovery. “Move the engines 4 inches in either direction on the wing,” he says, “and the jet would not fly.” His article proposing the engine configuration—which ultimately was published in the November 2003 issue of the American Institute of Aeronautics and Astronautics’ Journal of Aircraft, a month before the HondaJet’s first flight—is now widely perceived as marking a breakthrough in aeronautics. When asked about the colleagues who doubted his work, Fujino betray a small smile and says, “I never heard from them.”

———Gregory Anderson

**THE GOLD STANDARD**

Big Ben Roethlisberger no doubt wishes he had been wearing a helmet when his Suzuki Hayabusa sport bike famously met the business end of a Chrysler New Yorker last summer. But had the Pittsburgh Steelers quarterback been cruising helmetless on a Honda Gold Wing—the first motorcycle equipped with an air bag—his face might not have met the car’s windshield quite so suddenly.

Honda’s flagship touring bike does not render the helmet redundant, and it cannot compete with sport bikes capable of exceeding 190 mph. However, it is the latest in a series of technological tours de force that span more than 50 years. Whether it is a 50 cc moped, an all-terrain vehicle (Honda created the category in 1970 with its three-wheeled ATC90), or a $3 million MotoGP race bike, a Honda motorcycle has employed breakthrough technology.

The Gold Wing features such novelties as a liquid-cooled, horizontally opposed 6-cylinder engine, as well as optional GPS navigation, antilock brakes, and a six-speaker sound system. The addition of an air bag makes the Gold Wing the gold standard for motorcycle safety.

Honda also has been focused on speed. In fact, if it were not for Honda innovations, extreme street-legal motorcycles such as the Hayabusa would not exist. In the late 1980s and early '90s, the Honda NR750 sported a V-4 engine with twin connecting rods and twin spark plugs, which essentially created the performance of a V-8 engine through the use of four oblong-shaped pistons. Since its introduction in 2002, the lightweight RC211V has dominated MotoGP with a V-5 engine that achieves more than 14,000 rpm and 200 mph. Seeking to make its race bikes as light as possible, Honda became the first manufacturer to use carbon-fiber wheels in the early '80s. However, the company learned to its chagrin that when carbon fiber breaks—as the rear wheel did under rider Freddie Spencer in 1984 as he was trying to qualify for a race—it shatters. Still, as anyone who is spared more serious injury by the Gold Wing’s air bags will attest, Honda’s feats far outweigh its flubs.

———Gregory Anderson

Honda Motor Co., www.honda.com
As the lights dim at Disneyland’s Honda ASIMO Theater in Anaheim, Calif., a blue curtain rises to reveal what appears to be the set of a sitcom. A living room connects to a home office, stairs lead to a second-story hallway, and a doorway opens to an imaginary world outside, from where ASIMO, the show’s futuristic protagonist, makes its entrance.

Four feet tall and sporting a gray backpack on its white plastic body, ASIMO evokes a second-grader in a Star Wars costume—except that the robot seems eager to do as it is told. With fists clenched, slender legs cocked slightly as if ready to pounce, and a faint smile carved below two large, round eyes on its black plastic face, Honda’s humanoid stands ready to receive and follow orders.

ASIMO, or Advanced Step in Innovative Mobility, is the product of a research program Honda launched in 1986. The company says the program’s goal is to build robots that one day will provide “vicarious mobility” for elderly and disabled people who cannot perform basic tasks themselves.

The project’s early experimental models, which consisted of simulated hips, legs, and feet, required nearly five seconds to take a single step forward, but Honda eventually refined bipedal motion and other anthropic movements. In 1993, the company added a head, torso, and upper limbs to create the P1, a 6-foot-2-inch, 386-pound behemoth that could grab a doorknob and turn an electrical switch off and on. The P3, which debuted in 1997, was smaller and capable of ascending and descending stairs, but Honda’s major breakthrough came in 2000 with the introduction of ASIMO.

ASIMO’s diminutive size places its head near the eye level of people who are confined to a bed or wheelchair, while still enabling the humanoid to perform such tasks as turning off a light or clearing a kitchen counter. The robot’s dimensions, as well as the smile on its face, also contribute to a benign appearance that Honda believes will be agreeable to consumers, who may be unsettled by the thought of a 386-pound piece of machinery lumbering through their homes.

Other advances in ASIMO include its ease of use (it is controlled with a portable computer) and freedom of motion. During the 15-minute demonstration at Disneyland, ASIMO rotates and bends its arms from the shoulder, elbow, and wrist; walks forward, backward, and to the side; struts up and down stairs; dances the hula; and even kicks a soccer ball into a makeshift goal. On command, the humanoid accesses a weather report online and verbalizes the forecast.

ASIMO’s backpack contains a computer that allows this functionality, and its eyes are cameras that enable the robot to view its surroundings. ASIMO remains incapable of tasks that will be necessary before it is ready for home use, but Honda already has built a more advanced model that can run faster (3.7 mph compared to 2 mph), operate longer on a battery charge (one hour versus a half hour), and even walk over to a wall, plug in, and charge itself when it is about to lose power.

Honda will not reveal when it plans to market humanoid robots, but the company’s most challenging task—equipping ASIMO with bipedal motion—is behind it. Honda engineers now are focused on improving the robot’s ability to think on a conditional basis and react to its environment. Such a humanoid eventually could perform tasks with complete autonomy and, in addition to helping the needy, serve as an assistant in homes and offices. According to Honda, it is a future that is closer than most people might think. —Bruce Wallin

Honda hopes that ASIMO one day will help elderly and disabled people with household chores.