The bicycle which David Gordon Wilson rides to work each day looks something like a cross between a lawn chair (minus the lawn) and a conventional bicycle (minus the usual brake levers and handlebars). The rider's arms are at his sides, and his legs stick out far beyond the sixteen-inch front wheel. The machine is the constant object of gapes, gawks, and cheers by astonished onlookers. Of the 95 million bicycles in the country, it is one of a handful of so-called "recumbent" bicycles.

Fortunately, Wilson, the chief designer and leading advocate of the recumbent, is well-equipped to handle the attention. Muscular and trim, he has an easy smile, a twinkle in his eye, and a ready, dry British sense of humor. To a group of city kids who gathered to gaze in disbelief at his machine he quipped, "Do you think it will sell?" On a recent trip to New Hampshire he mounted a sign on the back

RONALD KOTZSCH, an avid bicyclist and runner, is on the last leg of his doctoral degree at Harvard University.

PHOTO BY CHUCK HOLT

DAVID GORDON WILSON'S RECUMBENT BIKE

BY RONALD KOTZSCH

REPLACING THE AUTO

of the bike in order to discourage inquiries. It read: "Anti-perspirant Test." Commenting on the relative safety of the recumbent he remarks, "On my conventional bikes people used to give me all kinds of trouble. Now everyone is very sweet. They think I'm some kind of an invalid!" Yet, all kidding aside, Wilson's contribution to bicycle designing may prove to be as important in transportation history as the Wright brothers' plane or Henry Ford's Model T. Environmentalists, city planners, and other social observers are hailing human-powered vehicles such as the recumbent bike as the successors to the family automobile and the answer to the energy crisis and the nation's transportation needs.

David Gordon Wilson apparently is one of those people genetically wedded to the bicycle. He recalls that at age seven he was very upset that his parents decided to wait two years to let him have a bike. Growing up in England Wilson became used to the bicycle as a mode of daily transportation. He rode five miles to school and came home for lunch each day besides. He has used bicycles as a primary mode of transportation throughout his life, including during a two-year stay in Nigeria. He estimates that altogether he has ridden a third of a million miles. He owns a car but uses it mainly to go wind-surfing (a high-energy sport, he observes). He rides his eleven-year-old around on a two-person tandem, referring to it as a DDV, "daughter delivery vehicle."

Wilson first came to this country in 1955 after finishing his doctorate in mechanical engineering at the University of Nottingham. He returned in 1966 to take up his present post at the Massachusetts Institute of Technology, where he teaches in the Department of Mechanical Engineering and specializes in gas-turbine and other high-technology propulsion systems. His departure from Britain, Wilson chuckles, "was a severe blow to the British economy. The pound went into a tailspin, and the Bank of England announced that people like myself couldn't take their money with them." Wilson used his savings to establish a prize for developments in Human-Powered Land Transportation. The competition attracted international attention, and there were seventy-three entrants before the final judging in 1969. Among these were some designs for recumbent bicycles.

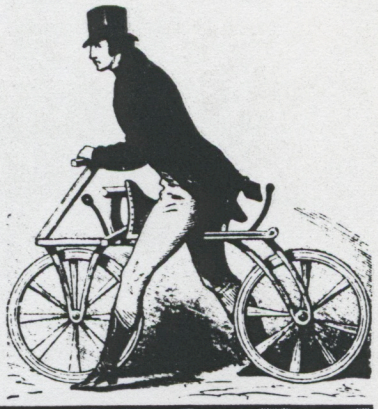
Through the competition Wilson became seriously interested in pioneer bicycle technology. He co-authored a book called *Bicycling Science* (M.I.T., 1976) and came to be known as an authority in the field. Early in the 1970s he received a letter from a student and bicycle mechanic in California named Fred Willkie. Willkie was interested in building a recumbent, and Wilson sent him some preliminary sketches. The first model turned out to be uncomfortable and difficult to ride. Wilson suggested some improvements which Willkie incorporated. Wilson bought this second prototype and it sat in his basement until he took it to school one day to show a class. On his way home down busy Massachusetts Avenue Wilson found himself cheered by strangers and admits to having been hooked at once on the recumbent.

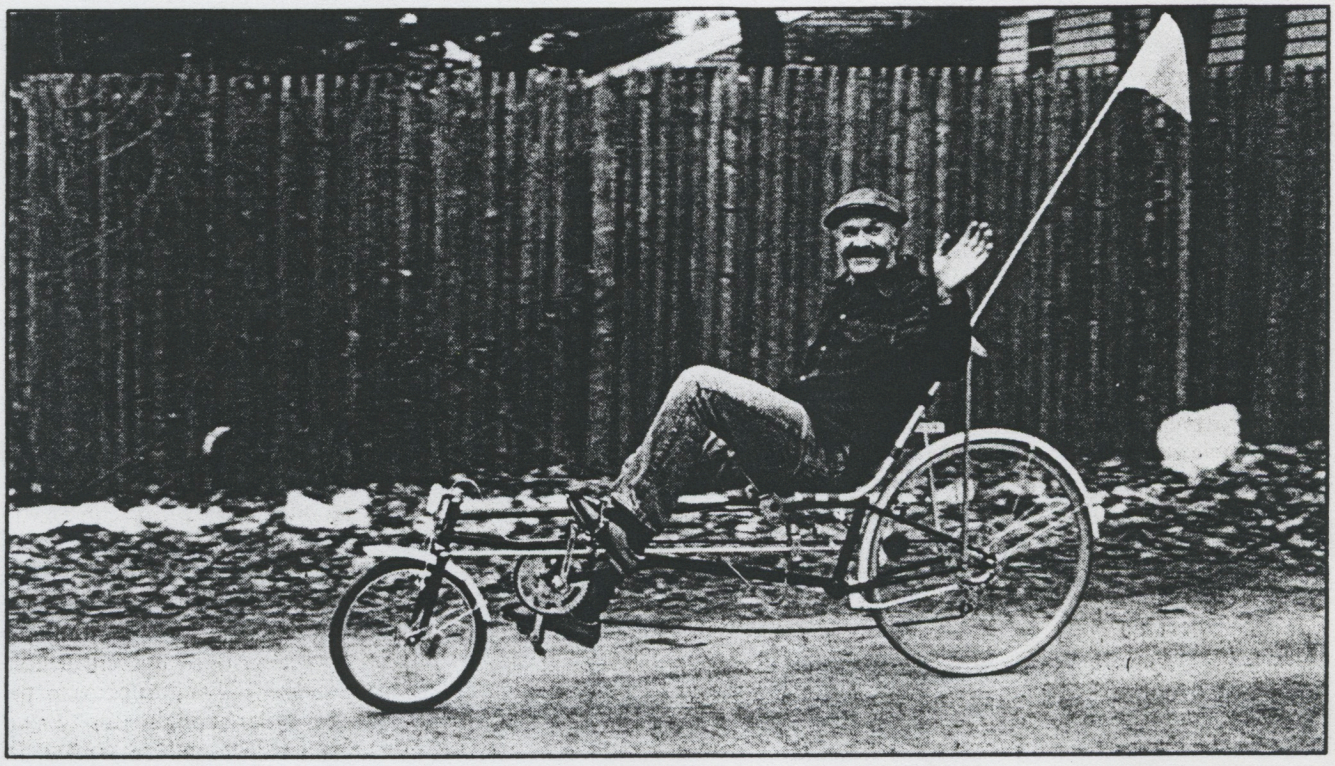
Wilson then connected with two local bicycle builders, Richard Forrestal and Harald Maciejewski. They collaborated on producing improved versions of the recumbent. Prototype number four, the Avatar 1000, is what Wilson rides around Boston. Prototype five is the bike which Forrestal and Maciejewski, incorporated as Fomac Inc., are producing and marketing as the Avatar 2000. Another company on the West Coast, apparently borrowing an earlier Wilson design, is selling a recumbent as the Hyper-Cycle.

According to Wilson, the recumbent bicycle has numerous advantages over the conventional "safety bike" which we all recognize as "the bicycle." It is more efficient, more comfortable, and safer. The recumbent position, with the back against a support, allows the pedaler to generate up to twice his or her body weight in pedal force. In the usual upright position the rider can achieve more than his or her own body weight only by pulling hard on the handlebars.

One of the main obstacles to easy cycling is air drag. At typical cruising speed about a third of the effort is used to overcome air friction. The percentage increases with

The conventional bicycle is built for discomfort. The standard bicycle seat, harmless as it looks, can become an instrument of torture.





speed so that at racing speeds, over 80 percent of the cyclist's energy is expended in moving through the air. The semi-reclined position lets the air flow around the body much more easily. No air pocket is created beneath the rider's hunched shoulders and chest. Also, the cyclist's breathing is much freer. In the standard crouched racing position, pressure on the stomach and diaphragm prevent this.

As Maciejewski says, the conventional bicycle is built for *dis*comfort. This is an experience which any serious cyclist confronts early in life. The torso weight is supported by hands, arms, and shoulders, and on long rides these become sore and even numb. The standard bicycle seat, harmless as it looks, can become an instrument of torture which renders the crotch area numb. After such an assault on his paternal and social aspirations, even the most ardent male cyclist will question his dedication to the sport. With the recumbent, the comfortable seat and the lack of any weight on the arms obviate these problems.

Wilson is a veteran of twenty years of cycling in the traffic purgatory known as metropolitan Boston. He was once lassoed by a rider in a passing convertible. He has been hit by cars at least three times, being "left for dead, squirming in the road." But not when he was riding a recumbent. The recumbent's safety features alone, he maintains, make it a superior machine. There is almost no possibility of an over-the-front "swan-dive" type of accident or an impalement on the handlebars or shift levers. In any mishap the feet are usually the first part of the body to hit the ground. Once Wilson was going at close to thirty miles per hour when an object jammed the front wheel. He thought that the wheel had exploded or gone into a manhole. On an ordinary bike this might have been a fatal accident, but Wilson escaped with a few bruises.

There are several disadvantages. One is that the recumbent bike, being low, is less visible to motorists. The use of a high safety flag is necessary to alert drivers to the cyclist's presence. It also affords less overview of developing traffic situations. Wilson says that the eye-level contact with motorists is actually a plus, since it encourages a friendly response to bike and rider. Looking to the rear before turning is somewhat more difficult but after some experience on the bike is not a major problem. The machine and the riding position take several weeks to get used to, but new riders have found that they soon come to prefer it to conventional bikes.

The successful developing and marketing of the recumbent design marks a milestone in the history of bicycling. The first "bicycle" was the wooden "hobby-horse" developed by the Baron von Drais in Germany in 1816. It

PHOTO BY PEGGY MCMAHON

Left: *Richard Forrestal, a Boston bicycle builder, collaborated with Wilson (right) and Harald Maciejewski (not pictured) to produce improved versions of the recumbent.*

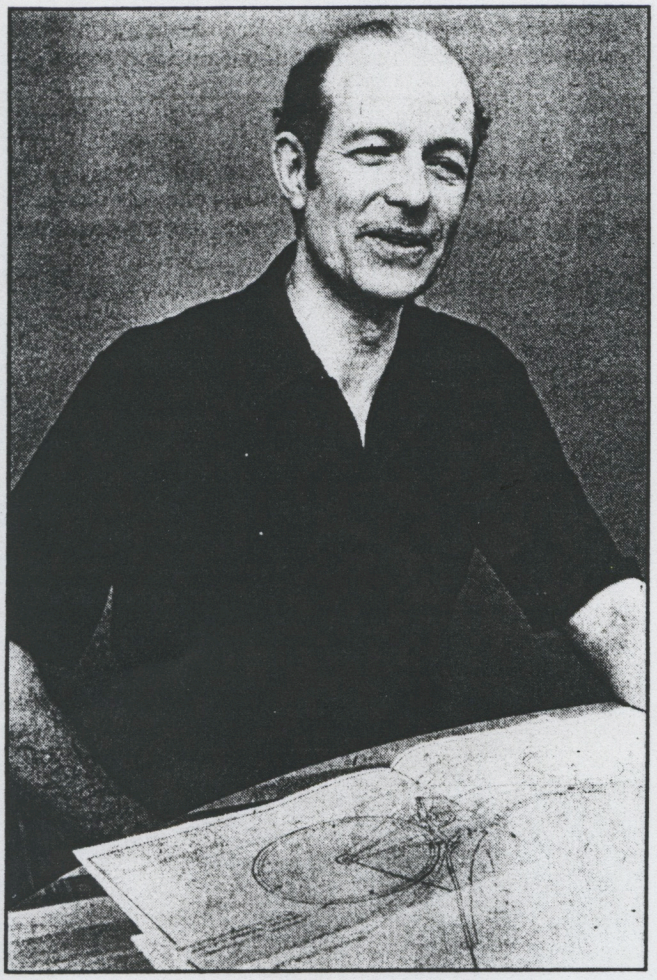


PHOTO BY CHUCK HOLT

was propelled by the rider pushing off the ground with his or her feet. In 1835 a Scot applied pedal drive to the rear wheel of a bicycle, and in about 1860 a Frenchman installed pedals and cranks on the front wheels of a hobby-horse. After 1872 this developed into the "penny-farthing" bicycle with the huge front and tiny rear wheel. The "safety bicycle" was developed by the Briton J.K. Starley in 1885 and featured two thirty-inch wheels, a chain-driven rear wheel, and hard rubber tires. After Dunlop developed the pneumatic tire three years later, there has been no major change in the configuration and mechanics of the bicycle. Recumbent designs appeared briefly around 1895, 1901, and 1913. In the 1930s a French version called the Velocar was built. A little-known rider used it to challenge and defeat the world champion cyclist. The furor in the cycling world ended when the authorities declared the Velocar "not a bicycle" and banned it from competition. So for the past century manufacturers have been happily and profitably turning out millions of diamond-framed bikes. There has been little need or demand for anything else.

However, the recumbent's day may be approaching. Pollution and energy crises are making alternatives to automotive transportation attractive and necessary. Wilson points out that half of all urban trips are of three miles or less, and 95 percent of the people who make them are able to ride a bicycle. The recumbent's superior efficiency, comfort, and safety make the bicycle a viable transportation alternative. Fitted with a "fairing" or windbreak, the Avatar 2000 would allow even relatively nonphysical types to attain speeds of twenty mile an hour with relative ease. Wilson feels the 20 mph figure is a crucial one since that is about the average speed of an automobile in the city. Thus trips of ten miles or less would be within the reach of most people. And a physically-fit individual could easily travel thirty to thirty-five miles.

Wilson's optimism, however, is tempered by caution. He is well aware of the image of the bicycle as a toy, and adult riders are generally considered a social aberration. These stereotypes are changing slowly. "When I first came to America, I was the only adult cyclist in the cities where I lived. People treated me as if I were a freak. Now it is much better. The bicycle is even coming to be regarded as an accoutrement of the leisure or youthful class." But still Wilson asks, "How is it that it is acceptable for people to wait ten to forty minutes at a bus stop in a wind chill factor of 60 below zero, when it is not acceptable to ride a bicycle? . . . My motor starts every morning without any digging with the key and so does my heater. In a minute I'm generating a kilowatt of energy."

Wilson is also acquainted with the inertia of corporations making large profits with existing products. Several years ago a student and he developed a new, more effective bicycle brake. The usual brake is adequate in dry weather but in the wet loses 95 percent of its efficacy. His own tests and those of manufacturers proved the superiority of the new brake. However, no government regulation requires a wet-weather standard, and the existing dry-weather standard relieves the companies of any responsibility in case of accident. Although the cost of the new brake would be negligible and it could easily save lives, no one is reportedly interested.

The opinion currently popular among bicycle developers is that the vehicle of the future is not a bicycle at all but a three- or four-wheeled vehicle. In California last summer at the Human-Powered Speed Championships, a low-slung, recumbent, fully-enclosed vehicle called the Vector broke the one-person world record with over 55 miles per hour. A two-person version clocked in at almost 63 mph and later covered forty-two miles on an interstate highway at an average speed of over 50 mph. Some social planners envision lines of such vehicles rather than automobiles wending their way in from the suburbs each morning. Because of their greater efficiency, multi-wheeled recumbent vehicles could carry several passengers as well as freight or cargo.

This vision may become a possibility in the future when there are special highways for bicycles, wide pathways completely protected from automobiles. For the moment, though, Wilson feels that these vehicles are not practical. For one thing they are too low. "They would just disappear under somebody's taillight." A safe commuting machine would have to be high. Also, a tricycle with big wheels, in order to have any maneuverability, would have to have the paired wheels far apart. "You'd take up a whole lane," Wilson observes, "and not be very popular. . . . Besides, tricycles are damnably unstable things. My first car was one and it would turn over at any opportunity!"

Wilson's inventiveness extends to other areas. With a student he designed a pedal-powered lawn mower. With

his fifteen-year-old son he uses a human-powered snowplow to clear the driveway of their Cambridge home. Having lost five bicycles to thieves, he is understandably concerned about security. An early attempt involved a system which, when the bicycle moved, activated a blank bullet cartridge. The detonation inflated a balloon which then discharged into a police whistle. Unfortunately the first experiment resulted in the blank almost hitting him in the eye. Now he looks to developments in microelectronics to produce a practical alarm system. His own version has saved his bicycle once already.

And if David Gordon Wilson's ideas catch on, they may save this country precious lives and energy that have been lost in the era of the conventional auto and bike. □

The Bike That Sells Itself

Richard Forrestal (left) and Harald Maciejewski (above) at work.

At FOMAC Inc. in Wilmington, Massachusetts, about twenty miles north of Boston, Harald Maciejewski and Richard Forrestal are producing and marketing the only recumbent bicycles with the optimal design of David Wilson's Prototype Five. About five years ago each man had his own bicycle shop in the Boston area and was well-known and respected in bicycling circles. They became interested in the recumbent concept and started working with Wilson to produce a version which would be commercially viable. Two years ago each sold his shop and began preparation for full-scale activity.

In early March of this year the first run of fifty Avatar 2000s came off the production line. The new owners had been waiting for up to a year for their vehicles: Four orders came from foreign countries. The rest were scattered over the fifty states. FOMAC intends to produce about 750 bicycles during 1981.

Both Forrestal and Maciejewski have reputations as master craftsmen and perfectionists. The bikes they are building are directed to a specific segment of the market, the bicycling connoisseur, particularly those interested in long-distance touring and commuting. The frames are made of Reynolds 531 butted tubes and the other elements are of similarly high quality. The cost is $1,792, which is not high these days for a hand-crafted bicycle. Aluminum-frame models of conventional machines begin at around $3,000 and go up to $6,000. As with calculators and other new products, the price is expected to fall as production techniques are improved and demand increases.

Already FOMAC has commitments on another 150 bikes. The company has done almost no advertising to date. Maciejewski, who handles the business side of the operation, feels that the bicycle "will sell itself." Next month a bicycle racer named Len Vreeland of Allentown, Pennsylvania, plans to ride an Avatar 2000 across the country. If his attempt to break the existing bike record (eleven days, ten hours) succeeds, the recumbent should attract much positive attention.

In the future FOMAC hopes to market a version of the Avatar that has outrigger wheels in the back. This feature would allow its use by older people. They are also committed to developing applications of the recumbent design for other purposes. In the conceptual stage are plans for a pedal-powered lawn mower and a pedal-powered boat. FOMAC is looking for larger manufacturers who would be licensees to produce less expensive versions of the Avatar.

More information on the Avatar 2000 can be obtained through FOMAC Inc., 40 Oakdale Road, Wilmington, Mass. 01887.

—*R.K.*

PHOTOS BY PEGGY MCMAHON