gested HPV bodies that are flared outward at the skirt, to isolate underbody pressure. To solve the ground-effect problem for two-wheel vehicles, Glen suggested tall vehicles with low-cross-section wheel fairings. This technique allows a good aerodynamic shape, minimal area near the ground to cause ground interference, yet would maintain a small overall vehicle cross-section area. This would also keep the mass of the vehicle high off the ground, which is important for two-wheel- vehicle stability.

Aerodynamics promoter extraordinaire Doug Malewicki woke up the audience with a dynamic presentation on jet motorcycles, John Howard's paced bicycle-speed-record attempt, nuclear-war games, and...human-powered vehicles. He presented a paper written with Chet Kyle and Al Gross for the December 1983 issue of Scientific American. Doug presented some astute observations on the human-power-output curve, and expanded on the Kyle table of drag on various bicycle configurations. His table includes the drag of "perfect" bicycles and "perfect" fairings, and combinations useful for judging the potential benefits of various technological improvements in human power.

Chet Kyle himself presented more data on his efforts to produce winning Olympic bicycles. Extensive wind-tunnel tests were conducted with the support of Alex Moulton of Britain. The tests showed drag decreases with slight yaw angles for faired bikes and streamlined-tube frames. due to the "sailing" effect. Small front wheels (24 inch) aid in allowing bicycles to draft closer together. Data on wheels show only slight reduction in drag with oval-rim wheels, but large reductions with covered wheels. The drag of human hair was found to be significant. A sleek new helmet was developed which produces very low drag. Magnanimously (or quixotically), the helmet was given to the Russian team, who used it to set a new world record.

Joe Mastropaolo, professor at Cal State Long Beach, and known for his training of Bryan Allen for the Gossamer human-powered-aircraft flights, presented the results of his scientific training techniques on cyclists, kayakers, and swimmers. Training consists of measured efforts on ergometers, in restrained boats, or using other power-absorbing devices. For short, intense events, Joe Mastropaolo has achieved performance increases of 1-4% per week over months of training.

Extensive studies on the biomechanics of pedalling were presented by Maury Hull of the University of California at Davis. Using a mathematical model of leg motion, he discovered strong sensitivity of hip moment to pedalling rate. Knee motion, however, was less sensitive to rpm. Since hip moments relate directly to muscle use, his data help explain how spinning improves power output, and indicate how pedal motion might be redesigned for better human efficiency.

The Shimano Biopace and other non-circular chainwheels were described by Fred Delong, author of "DELONG'S GUIDE" and contributing editor of BIKE-TECH. He related the results of experiments with various elliptical chain-ring gears at various phase angles. He found less knee strain on hills to be especially significant with non-circular chainwheels. Larry Brown gave details of the Bio-Cam and the newer Power-Cam. These devices reduce energy wasted in crank tension by reducing force variations during the pedalling stroke. Performance improvements are most dramatic with maximum output efforts. Larry also described the use of instrumentation mounted on pedals. He felt that this type of instrumentation, coupled with the use of flywheels, was far superior in measuring human output to standard ergometer testing.

INNOVATIVE BICYCLES

After completing an exhaustive study of the last 100 years of development in folding bicycles, David Hon described and demonstrated his recently developed model. He noted that fore-and-aft rigidity is more important than lateral rigidity in a folding bicycle. His folding bike can be carried or pushed on a caster wheel. The design also incorporates an ingenious folding crank arm.

A short history of recumbent-bicycle designs and the evolution of the Avatar 2000 were presented by Dave Wilson of MIT. He discovered that recumbents with high front-wheel loading were difficult to handle in snow and soft ground. Designs with up to 70 percent of the static weight on the front wheel have been built. They may have 100 percent of the weight on the front wheel during braking. The Avatar 2000 has only 31 percent on the front, versus 40 percent for a normal ten-speed, which greatly enhances safety. Dave noted among the several claimed advantages of recumbents the ability to pedal through a turn, to stop in traffic with both feet on the ground, and improved neck, back and eye comfort due to body position.

Tim Brummer, co-designer of the record-setting White Lightning, described the design and construction of the Lightning X2, his faired recumbent bicycle that won the speed trials for bicycles this year. A full Kevlar fairing was made using a plaster male and fiberglass female mold. The 17-kg (38-lbm) vehicle has a clever trap door for foot launches and an easy-opening shell. Tim recommends a 1115-mm (44-inch) wheelbase for recumbent bicycles.