Bicycles

Impending energy shortages require alternative transportation modes; the bicycle is ideally equipped to fill some of the gap. Healthy, convenient and relatively fast, urban bicycle use can be significantly enhanced with inexpensive infrastructure improvements such as bicycle lanes isolated from motor traffic, separate bicycle signals, and covered and lighted bikeways. Attitudes must also change to make cycling a widely accepted, green alternative.

The world faces an energy crisis of unprecedented proportions, as the fossil fuels that have sustained the industrial way of life for two centuries begin to decline. Oil and gas production will begin their decline within the next few years. Coal will follow a few decades later, and in any case it cannot substitute for the transportation fuels that power the modern economy. In the future, then, alternatives to fossil fuels must be found to power transportation.

One component of the future transportation mix that will probably grow in importance is the humble bicycle, human-powered but amazingly efficient. Two-legged locomotion places humans among the least efficient animals, but humans on bicycles go further per calorie of energy than any other animals except soaring birds (essentially solar-powered flight). On level ground a cyclist can move about three times as fast as a pedestrian with the same effort. This is the promise of cycling as transportation, but it comes with some reservations.

History

The bicycle is a surprisingly recent invention. After numerous experiments in the 18th and 19th centuries, bicycles similar to modern models appeared in the 1880s. Practical bicycles depended on two inventions of the modern industrial era, the ball bearing and the pneumatic tire. Together with steel fabrication methods, these inventions made bicycles light, comfortable and affordable by almost everyone. But they were also key steps to the automobile, invented only a few years later.

The 1890s were the golden era of cycling, between the invention of the modern bicycle and the introduction of affordable automobiles, when the bicycle dominated the popular imagination. Bicycles enabled workers to live further from places of employment, resulting in the development of near-in suburbs around many cities. They made possible weekend jaunts into the countryside for urban dwellers, while creating demand for paved roads. Together with the new urban and interurban electric trolleys (trams), an efficient, pollution-free transportation system took form.

With the rise of the automobile and later the superhighway, bicycles gradually slipped into subsidiary roles as sports equipment and children's toys, not taken seriously for transportation in the U. S., though in parts of Europe they remained an important transportation option.

Function

The bicycle is an intimate interaction of machinery with human physiology. Muscles are strongest near the middle of their length range; on a properly adjusted bicycle, the

knee and ankle are not quite fully extended at the bottom of a pedal stroke, and the knees not too bent at the top of the stroke, so that the leg muscles, the largest and most powerful in the body, are at their strongest. Pedaling with the toe allows the muscles surrounding the ankle to participate in propulsion. Bicycle shoes that clip onto the pedals allow the rider to perform a power stroke on both the up and the down phases of pedal motion; for commuters who prefer ordinary shoes, toe clips (small cages for the toe of the shoe) perform that function. This innovation helps make cycling more efficient than walking, where the lifting phase of the stride performs no motive work. Coasting requires no work at all, unlike walking where even downhill segments require effort. A century of refinement has made the modern bicycle light, flexible and easy to ride at any speed, with gearing schemes to keep the muscles working at the same speed and torque (twisting power) on all but the steepest hills, while allowing higher speeds on level or down-sloping terrain.

Bicycles as Transportation

To affect society's energy mix, bicycles must be used widely for transportation, not only for recreation. They are ideal for short-distance commuting and running errands; 22% of commutes in the U. S. and 35% in Canada are less than 5 km, well within comfortable bicycle range. At a reasonable 20 km/hour (12 miles/hour) this means about a 15-minute ride. Bicycles offer transportation on demand; no walking to and waiting for a bus or tram. They go where the commuter wants to go, not where an established route directs. The consistent, mild exercise is better for health than powered transport. The bicycle is inexpensive, about 2% of the cost of an automobile. Maintenance is similarly inexpensive, though bicycle parts are by nature fragile because they must be light. Parking is usually right outside the door of the destination, making cycling faster than driving for many urban applications.

Despite these advantages, bicycles do not dominate urban transport. Here the limitations of bicycle travel become clear. First, cycling is not for everyone. The handicapped, aged, or others who cannot physically handle the demands of the bicycle need alternate modes of transportation, and once those alternatives are in place, others will be tempted to use them. Riding is unpleasant and often dangerous in cold weather, in rain, and at night – the bicycle is a fair-weather friend. In cities such as San Francisco or Pittsburgh, hills are a significant barrier. And the speed of bicycles limits them to short-distance trips, a barrier in sprawling American cities such as Los Angeles or Dallas. A rider produces about one-tenth of one horsepower, one-eighth in short bursts, inadequate to move loads much heavier than a briefcase.

If bicycles are to become significant contributors to a green energy mix, green public policy should minimize the bicycle's inherent limitations. Some limitations are easily overcome; others require more investment or a longer time frame. Perhaps most important is better rights of way. Most city planning considers bicycles more an annoyance than a transit alternative. Bike lanes, where they exist, are usually stripes painted on the sides of traffic lanes, between moving and parked vehicles, offering no protection from either. The few dedicated bicycle rights-of-way are usually designed for recreation (often in parks) rather than transportation.

For guidance on better alternatives, planners can look to Europe. A main artery in Munich has two-way bicycle lanes on each side, above the curbs and separated from sidewalks. Cyclists are protected from moving vehicles by the lines of parked cars. Separate traffic signals regulate bicycles, and parking racks surround subway entrances. Because the system is heavily used, drivers are aware of the stream of cyclists at intersections. Along Munich's river, bikeways detour under bridges to eliminate most intersections, a bicycle autobahn. Such facilities lead to extensive bicycle use even in large cities. The Netherlands, famous for its bicycle density, has not only urban bicycle lanes but inter-city paths exclusively for bicycles. Such facilities are inexpensive compared to motor vehicle highways; the lanes are narrower, and are built to carry 200 pounds of vehicle and rider rather than 3000 pounds or more of automobile and driver.

In addition to well-designed bike paths that separate bicycles from moving motor vehicles, facilities such as secure parking and showers encourage riding. Some employers, including many universities, already offer such facilities. Bicycle racks in front of buses, and spaces in urban rail transit cars, help to eliminate the distance restrictions of bicycle commuting while maintaining door-to-door convenience.

Beyond current infrastructure, new facilities can compensate other disadvantages of cycling with existing technology. To counter dark and rain, lighted and covered bikeways can make cycling pleasant at all times and in all weather except extreme cold, at very low cost compared to new highways. Eventually, urban areas must be reconfigured to be more compact.

Some of the factors limiting bicycle use are psychological rather than physical. Cycling must become an accepted transit alternative, not seen as mere sport or exercise, or as something only for children too young to drive. Convenient, safe rights-of-way are only part of this transformation. Enforcement of traffic rules regarding cyclists might seem unfriendly to cyclists, but in the long run it contributes to cycling being taken seriously, and improves safety. Cyclists are often seen without helmets, riding on the wrong side of the street, riding at night without lights, weaving through traffic, or drifting through stop signs. The latter problem, caused partly by irresponsibility and partly by reluctance of riders to give up their hard-won momentum for regulations designed for motor vehicles, can be ameliorated by substituting yield signs for stop signs in many locations. For the rest, education and experience are the only alternatives.

With enlightened but inexpensive public policy, the bicycle can be made into a sustainable, green transit mode for a substantial fraction of transit needs. Bicycles are not completely free of fossil fuel requirements – their manufacture requires fossil fuels, and paving rights of way also requires fuels. But those needs are minimal compared to those of automobiles.

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