Aerial Technology

Power from Wind. A History of Windmill Technology. RICHARD L. HILLS. Cambridge University Press, New York, 1994. x, 324 pp., illus. $59.95 or £45.

To many, the windmill evokes the image of a quiet Dutch country scene where blades turn slowly against a background of tulips and canals. Windmills were, indeed, heavily used by the Dutch to pump water for land reclamation. By 1850 there were around 9000 operating in the Netherlands. As late as 1896, long after the introduction of steam power, 41% of the drained surface in the Netherlands was still being kept dry with windmills.

But, as Hills's book makes clear, there was much more to the windmill than this. Britain and France may have had as many windmills as the Netherlands, and Germany and Finland had twice as many. Moreover, Dutch and British millwrights adapted windmills to a host of other processes besides raising water, including milling flour, sawing wood, grinding cement, and producing oils, dyes, snuff, paints, paper, and textiles. Americans in the late 19th century adapted the windmill to their own purposes, developing a simple and cheap device to pump water in the arid West. The leading American windmill company, Aeromotor, claimed to have placed over 800,000 in service by 1950.

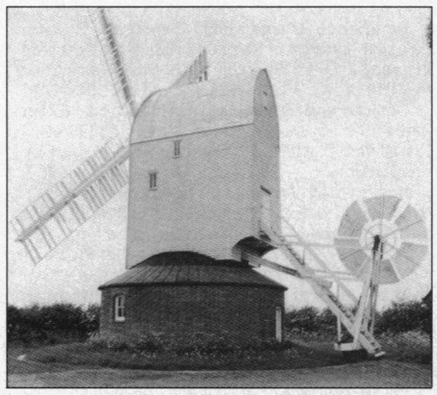
As Hills notes, the windmill has ancient origins. He accepts the authenticity of a description, attributed to Hero of Alexander around A.D. 60, of a model organ powered by a toy windmill but notes that full-scale use of wind power emerged only in the Seistan region of Persia in the 7th century. The Persian windmills, however, were horizontal windmills, that is, their axis was vertical but their blades rotated in the horizontal plane. Hills regards the Western windmill, with its horizontal axis and blades rotating in the vertical plane, as an independent invention of the 12th century, possibly of English origin but rapidly spreading and taking hold all over Europe in regions where water power was lacking and where steady winds were available.

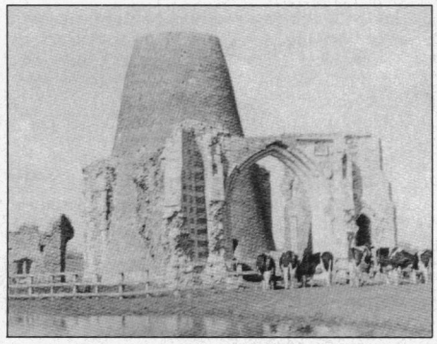
Hills makes it very clear that by the end of the medieval period windmill technology was already elaborate. He describes in some detail the various types of mills and the complexities and evolution of gearing, breaking, speed control, direction control, and sail design.

He focuses particularly on sails. These were, in many ways, the most important and vulnerable elements of a windmill. The traditional windmill required almost a small gale (7 to 8 meters per second, 15 to 18 miles per hour) for the blades to move steadily and well. Very high winds could destroy the mill if the blades could not be slowed down, leading to extensive attempts to develop self-regulating sails. Relying at first on past experience and trial and error and later on scientific calculation, mill designers also experimented with blade size, number, and configuration, seeking the optimum compromise between two mutually exclusive design criteria: good starting torque and efficient high-speed operation.

The emergence of steam power in the 18th and 19th centuries ended the windmill's importance as a source of mechanical power. Hills describes the steam engine's displacement of the windmill in use after use, pointing out how the need for a reliable, steady power or power in very large units—which the steam engine was able to supply and the windmill was not—led to the latter's displacement.

But the windmill did not completely disappear. Constructed with new materials and equipped with computer speed regulators and scientifically designed blades, windmills contribute modest amounts of power to today's electrical grids. Hill's final chapter reviews the emergence of the windmill as a generator of electricity.





Clockwise from upper left: "The post mill at Aythorp Roding, Essex, fitted with a fantail on framing over the ladder with the tail pole shortened." "North Leverton subscription mill is still operating with a full set of patent sails, fantail and ogee cap. The whips or stocks are bolted onto an iron cross on the end of the windshaft. The chain and weight for controlling the patent sails hang down to the left of the mill." "A case of 'adaptive reuse' for the tower mill at St. Bebet's Abbey was built around one of the arches in the gatehouse. It was used first as an oil and then a drainage mill." [From *Power from Wind*]

Power from Wind is not really a complete history of wind power, for it focuses very heavily on Britain and the Netherlands, with occasional infusions from the United States. Other areas are treated peripherally, if at all. Finally, though the book contains over a hundred illustrations, many the author's photos of extant windmills, readers not already familiar with windmill technology would have profited from a few more line drawings, some labeled with the technical terms used in the text. Moreover, I was disappointed that Hills did not make much use of the superb drawings of windmills published in the 17th- and 18th-century Dutch mill books and other contemporary technical literature.

Despite these reservations, *Power from Wind* is an important contribution to the history of technology, for it is the first solid, scholarly monograph devoted to the history of the windmill. It synthesizes material from "buff" and tourist literature, from industrial archeology, from early technical and scientific literature, and from scholarly work in the history of technology. It will be, until a more com-

prehensive work is written, the place from which all subsequent studies of the windmill's history begin.

Terry S. Reynolds
Department of Social Sciences, Michigan Technological University, Houghton, MI 49931, USA

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