Veblen, Oswald | Encyclopedia.com

Complete Dictionary of Scientific Biography COPYRIGHT 2008 Charles Scribner's Sons
6-8 minutes

(*b*. Decorah, Iowa, 24 June 1880; *d*. Brooklin, Maine, 10 August 1960)

mathematics.

Veblen's parents were both children of immigrants from Norway. His mother (1851–1908) was born Kirsti Hougen; his father, Andrew Anderson Veblen (1848–1932), was professor of physics at the University of Iowa; and his uncle, Thorstein Veblen (1857–1929), was famous for his book *The Theory of the Leisure Class*. Veblen himself had two B. A. degrees (Iowa, 1898; Harvard, 1900) but was most influenced by his graduate study (Ph.D., 1903) at the University of Chicago under E. H. Moore. He had a happy marriage (1908) to Elizabeth Mary Dixon Richardson. His influentioa teaching career was at Priceton, both at the University (1905–1932) and at the Institute for Advanced Study (1932–1950).

The axiomatic method, so characteristic of twentieth-century mathematics, had a brilliant start in Hilbert's *Grundlagen der Geometrie* (1899). In this book, precise and subtle analysis corrected the logical inadequacies in Euclid's *Elements*. Veblen's work, starting at this point, was devoted to precise analysis of this and many other branches of geometry, notably topology and differential geometry; his ideas have been extensively developed by many younger American geometers.

The initial step was Veblen's thesis (1903, published 1904), which gave a careful axiomatization for Euclidean geometry, different from that of Hilbert because based on just two primitive notions, "point" and "order" (of points on a line), as initially suggested by Pasch and Peano. With this systematic start on the axiomatic method, Veblen's interests expanded to include the foundations of analysis (where he emphasized the role of the Heine-Borel theorem, that is, of compactness) and finite projective geometries. His work in projective geometry culminated in a magnificent two-volume work, *Projective Geometry* (vol. I, 1910; vol. II, 1918), in collaboration with J. W. Young. This book gives a lucid and leisurely presentation of the whole sweep of these geometries over arbitrary fields and over the real number field, with the properties of conics and projectivities and with the classification of geometries by the Klein-Erlanger program. It includes a masterful exposition of the axiomatic method (independence and categoricity of axioms), which had extensive influence on other workers in algebra and geometry.

Veblen's greatest contribution probably lies in his development of analysis situs. This branch of geometry deals with numerical and algebraic measures of the "connectivity" of geometric figures. It was initiated by Poincaré in a famous but difficult series of memoirs (1895–1904). It came naturally to Veblen's attention through his earlier work on the Jordan curve theorem (that is, how a closed curve separates the plane) and on order and orientation to Euclidean and projective geometry. Veblen's 1916 Colloquium Lectures to the American Mathematical Society led to his 1922 *Analysis Situs,* which for nearly a decade was the only systematic treatment in book form of the pioneering ideas of Poincaré. This book was carefully studied by several generations of mathematicians, who went on to transform and rename the subject (first "combinatorial topologu," then "algebraic topology," then "homological algebra") and to found a large American school of topology with wide international influence.

Veblen also did extensive work on differential geometry, especially on the geometry of paths (today treated by affine connections)and on projective relativity (four–component spinors). His more important work in this field would seem to be his part in the transition from purely local differential geometry to global considerations. His expository monograph (1927) on the invariants of quadratic differential forms gave a clear statement of the usual formal local theory; and it led naturally to his later monograph with J. H. C. Whitehead, *The Foundations of Differential Geometry* (1932). This monograph contained the first adequate definition of a global differentiable manifold. Their definition was complicated; for example, they did not assume that the underlying topological space is Hausdorff. Soon afterward H. Whitney, starting from this Veblen-Whitehead defintion, developed the simpler defintion of a differentiable manifold, which ahssnow become standard (and extended to other cases such as complex analytic manifolds). In this case the Verblen-Whitehead book had influence not through many readers, but essentially through one reformulation, that of Whitney.

Veblen had an extensive mathematical effect upon others; in earlier years through many notable co-workers and students (R. L. Moore, J. W. Alexander, J. H. M. Wedderburn, T. Y. Thomas, Alonzo Church, J. H. C. Whitehead, and many others) and in later years by his activities as a mathematical statesman and as a leader in the development of the School of Mathematics at the Institute for Advanced Study.

BIBLIOGRAPHY

I. Original Works. Veblen's thesis was published as "A System of Axioms for Geometry," in *Transactions of the American Mathematical Society*, **5** (1904), 343–384. His other works include *Projective Geometry*, I (New York, 1910) written with J. W. Young; II (Boston, 1918); *Analysis Situs, in Colloquium Publications*. *American Mathematical Society*, **5** pt. 2 (1922); 2nd ed. (1931); "Invariants of Quadratic Differential Forms," in *Cambridge Tracts in Mathematics and Mathematical Physics*, **24** (1927); "The Foundations of Differential Geometry," *ibid.*,**29** (1932), written with J. H. C. Whitehead; and "Projective Relativitätstheorie," in *Ergenbnisse der Mathematik und ihrer Grenzgebiete*, **2** , no. 1 (1933).

II. Secondary Literature. On Veblen and his work, see *American Mathematical Society Semicentennial Publications*, **1** (1938), 206–211, with complete list of Veblen's doctoral students; Saunders MacLane, in *Biographical Memoirs*. *National Academy of Sciences*, **37** (1964), 325–341, with bibliography; Deae Mongtomery, in *Bulletin of the American Society*, **69** (1963), 26–36; and *Yearbook*. *American Philosophical Society* (1962), 187–193.

Saunders Mac Lane