MR1667209 (2000a:01012) 01A45

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Introducing movement into geometry: Roberval's influence on Leibniz's analysis situs.

Historia Sci. (2) **8** (1998), *no.* 1, 53–69.

In the 1670s Leibniz became interested in using symbolic methods to analyze the concepts and propositions of elementary Euclidean geometry. His efforts, which resulted in several essays first published in the middle of the nineteenth century, go under the name "analysis situs" and are sometimes regarded as an early forerunner of modern topology. Recent interest in this subject was stimulated by the publication in 1995 of a French translation of and commentary on Leibniz's writings under the editorship of Javier Echeverría.

The article under review (written in uncorrected English) is a serious study of the character and origins of Leibniz's analysis situs. The first part provides an account of the essay "Characteristica geometrica" (1679); the second tries to show the influence on Leibniz of Gilles Personne de Roberval's *Éléments de géométrie* (1675). Leibniz's idea was to make congruency the basic notion of plane and solid geometry. Two plane figures ABC and $A'B'C'$ are congruent if ABC can be moved about in the plane so that it coincides with $A'B'C'$. The use of congruency and motion of figures enabled Leibniz to develop a formal theory different from Euler's ruler-and-compass approach to geometry. Among other things, existential considerations receive much more attention in Leibniz's theory than they did in Euclid's.

Hayashi identifies Roberval's *Géométrie* as the key influence on Leibniz, more particularly the fundamental role of displacement of rigid figures and solids in the *Géométrie*. This work is now available in a scholarly edition published in 1996 and edited by Vincent Jullien [G. P. de Roberval, *Éléments de géométrie de G. P. de Roberval*, Vrin, Paris, 1996; MR1650319]. Although Roberval is usually regarded as the founder of kinematic geometry, Hayashi agrees with Jullien that Roberval understood motion in terms of a more general notion of displacement, abstracted from the concept of velocity as such.

Leibniz's analysis situs was not so much a progenitor of topology as it was a deductive revision of the first book of the *Elements* using a formal notion of congruency defined in terms of the motion of figures. What is now needed is a critical estimation of what Leibniz achieved—was his alternative to Euclid a success, and does his analysis situs hold up under close examination? *Craig G. Fraser*