Jack Warga (1922–2011)

Boris Mordukhovich and Qiji Zhu

Jack Warga, a pioneer in optimal control theory and nonsmooth analysis, passed away unexpectedly on June 26, 2011, in Boynton Beach, Florida. Despite his almost eighty-nine years of age, Jack was in remarkable physical and mental condition and was actively engaged in mathematical research until he had a fall in his garage a few days prior to his death. He was preceded in death by Faye, his wife of more than sixty years, and is survived by his son Arthur, daughter Charna, and their families.

Jack was born to a Jewish family in Warsaw, Poland, on September 20, 1922. In 1938 he was sent by his father to Belgium for his education. During World War II he became separated from his family, narrowly escaped the Holocaust, arrived in the United States in 1943, and participated in the war as an officer in the U.S. Army. In the meantime, most of his immediate family perished in Nazi concentration camps.

After receiving his Ph.D. degree in mathematics from New York University in 1950, Jack worked in industry for sixteen years. His deep involvement in problems related to the control of satellites led to his interest in optimal control theory. Jack joined Northeastern University in 1966 as a professor of mathematics and remained there until his retirement in July 1993. He was an invited speaker at numerous meetings in the United States, Canada, Europe, and Israel.

It is hard to overstate Jack's seminal contributions to optimization, control theory, and nonsmooth analysis. He introduced the concept of a relaxed control and used the method of relaxation systematically in analyzing optimal control problems in a two-part paper in 1962. Since then the scheme of relaxation has been applied by many researchers to various control systems governed by ordinary, functional, and partial differential equations. Jack himself further developed this method in his 1972 classical monograph *Optimal Control of Differential and Functional Equations*. Jack's study of nonsmooth control systems led him to the discovery in 1975 of a generalized derivative now known as the Warga derivate containers. This concept and its extensions have played a crucial role in nonsmooth and variational analysis as one of the most delicate and effective tools.

Jack Warga

Jack also actively served the applied mathematics community at large. In particular, from 1964 to 1989 he served on the editorial board of *SIAM Journal on Control and Optimization* and he was the co-managing and managing editor of the journal from 1967 through 1978. He was a force in establishing the journal's international reputation and high standard of scholarship.
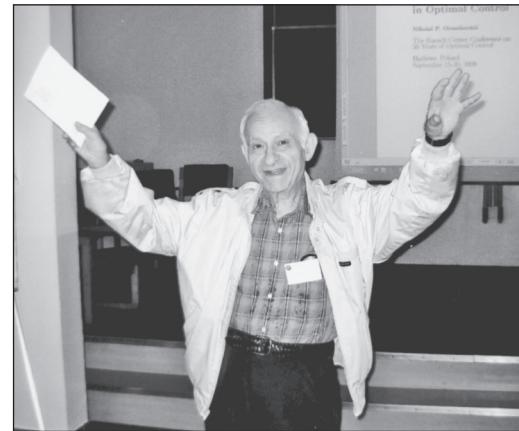
Besides being an outstanding mathematician and extremely deep researcher, Jack also had a wide range of interests in the intellectual pursuit of history, philosophy, poetry, music, and languages. Jack was exceptionally kind and generous, especially towards young mathematicians. Anonymously, Jack also worked extensively for human rights for scientists throughout the world. He will be sorely missed by his students, colleagues, and the mathematical community at large.

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