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## Research paper

## Professor Bernard (“Bernie”) Roth: A short biography

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## ABSTRACT

This brief biography is intended to highlight the historical prominence of Professor Bernard Roth, whose scientific and academic life and contributions are more than well known among the mechanism and machine science community all around the world. Bernie is celebrating his 85th birthday in the spring of 2018. His long and profitable career has been renowned, not only by his large number of achievements and contributions, but also by his sincere dedication to the highest standards of human integrity. Several different aspects of his life are considered in this work, namely, his education and scientific and academic career, the awards and honors bestowed upon him, and his cooperation with, and his leadership within, the international community.

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## 1. Education

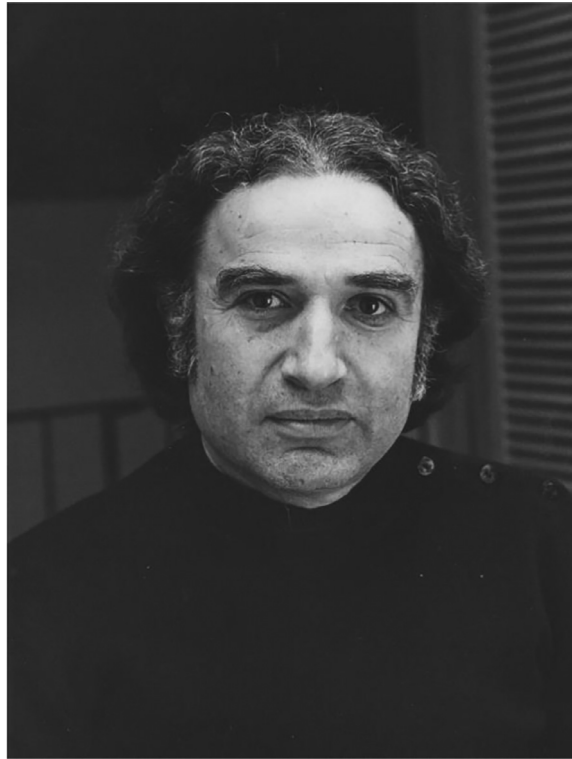
Professor Bernard (“Bernie”) Roth was born in New York City on May 28th, 1933. He attended Public School 96 in the Bronx, New York, and junior high at Public School 89. He moved on to Stuyvesant High School in New York City and then transferred to his local high school, Christopher Columbus, midway through his junior year. After graduating from high school, Bernie enrolled at the City College of New York and at the end of his junior year, in 1954, Bernie married Ruth Ochs. In 1956, Bernie graduated from the City College with a Bachelor of Mechanical Engineering degree and commenced his graduate studies at Columbia University. Bernie obtained a Master of Science degree in 1958 and a Ph.D. degree in mechanical engineering in 1962, studying under the mentorship of Professor Ferdinand Freudenstein [1,2].

## 2. Career

In the fall of 1962, Bernie and his family left New York for California to commence his academic career in the Design Division of the Mechanical Engineering Department at Stanford University. Fig. 1 is a photograph of Bernie in the 1960s a few years after his arrival at Stanford. He was promoted from the rank of Assistant Professor to Associate Professor in 1967 and then to Professor in 1972. Some of the courses that Bernie has taught at Stanford over the years include: kinematics of mechanisms; kinematic synthesis of mechanisms; advanced kinematics; mechanics of robots; mechanical engineering design; analytical methods in design; computer-aided design; applied mathematics; technology and society; the role of the designer in society; transformative design; educating young STEM thinkers; and design and creative problem solving. The Stanford Artificial Intelligence Laboratory (SAIL) was founded the same year that Bernie arrived on the Stanford campus. This

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**Figure 1.** Professor Roth (circa 1968).

was a center of excellence for artificial intelligence research, teaching, theory, and practice. Bernie became heavily involved with the research activities conducted at SAIL and ensured that everyone there was interested in robotics. Although his primary interest was kinematics, he had a strong background in computer science and programming. He was the faculty member in the Mechanical Engineering Department who had the most in-depth involvement with robotics. Bernie was known as the professor who would go out of his way to advise and assist the research students working in the laboratory.

During his early research years, Bernie developed an efficient numerical method for solving systems of nonlinear polynomial equations, which he called the bootstrap method that presaged what are now known as the continuation or homotopy methods. He also focused his research activities on an investigation of the mathematical theory of rigid body motions and the application of these motions to the kinematic synthesis of mechanisms. He placed a special emphasis on geometric kinematics over the more traditional time-based formulations, which allowed him to make important contributions to Burmester theory, curvature theory, and screw theory. Bernie deserves much of the credit for the modern development of Burmester theory, which began with his doctoral thesis that focused on a generalization of the classical theory. In 1967, Bernie developed the spatial analogue of planar Burmester theory and for this original contribution to the science of kinematics he received the ASME Melville Medal, which is the highest ASME honor for the best original paper published in the ASME transactions during the two calendar years immediately preceding the year of the award.

In 1968, Bernie spent his first sabbatical working with Professor Oene Bottema at the Technological University of Delft, The Netherlands. Their collaboration led to several technical papers and the book *Theoretical Kinematics*, which was published by the North-Holland Publishing Company in 1979 [3]. The global family of kinematicians regard this publication as one of the most elegant and rigorous treatments of the science of kinematics. Bernie has made significant and pioneering accomplishments in teaching, research, and consulting on various aspects of mechanical engineering, with a special focus on mechanism design and the mechanics of robotic manipulators. He has established a worldwide reputation as a researcher in the kinematics and design of mechanisms and computer controlled mechanical devices. He was a pioneer in the field of robotics with a special focus on the kinematics, mechanics, and control of robot manipulators.

### 3. Major awards

Bernie received the American Society of Mechanical Engineers (ASME) Machine Design Award in 1984. The award recognizes eminent achievement or distinguished service in the field of machine design, which is considered to include application, research, development, or teaching of machine design. Two years later, Bernie received the Robotic Industries Association Joseph F. Engelberger Robotics Award (the most prestigious international robotics honor), which is presented

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