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Professor Bernard ("Bernie") Roth – His journey from kinematics to design thinking

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ABSTRACT

Dr. Bernard Roth (see Fig. 1) is the Rodney H. Adams Professor of Engineering at Stanford University and the co-founder and current Academic Director of the Hasso Plattner Institute of Design (also known as the d.school). His long and distinguished academic career at Stanford consists of significant and pioneering accomplishments in teaching, research, and consulting on various aspects of mechanical engineering, with a special emphasis on mechanism design. Bernie has established a worldwide reputation in the kinematic synthesis and analysis of mechanisms and is a pioneer in the field of computer controlled robot manipulators. Bernie has investigated the mathematical theory of rigid body motions and the application of these motions to the kinematic synthesis of mechanisms. He has placed a special emphasis on geometric kinematics over the more traditional time-based formulations which have allowed him to make important contributions to Burmester theory, curvature theory, and screw theory. His text book, *Theoretical Kinematics*, co-authored with Oene Bottema, is regarded by many kinematicians as the most elegant and rigorous treatment of this applied science. Also, his popular book *The Achievement Habit: Stop Wishing, Start Doing, and Take Command of Your Life* describes some of the innovative techniques that he employs in the classes, workshops, and short courses that he has offered on creativity and design thinking.

1. Introductory comments

It is a great pleasure for me to contribute to this special issue of Mechanism and Machine Theory to help celebrate Bernie's 85th birthday. I first met Bernie some 40 years ago in December 1977. I had traveled from Sydney, Australia, to the Stanford campus in Palo Alto, California, to talk with Bernie and try to enlist as one of his doctoral students. As I stood outside his office door, waiting for a response to my knocking, I noticed a gentleman walking down the corridor toward me. I asked him if he knew Professor Roth and he said he did. In fact, he was Professor Roth! He invited me into his office and we had a conversation regarding graduate school during which time he informed me that he was not in a position to offer me any financial assistance for the 1978–1979 academic year. However, he suggested that I meet with Professor Charles W. Radcliffe (regarded as the father of prosthetic biomechanics) at the University of California, Berkeley, and discuss my plans with him. The next day I visited Professor Radcliffe in his office and found him busily working on the proof pages for his soon to be published text book, *Kinematics and Mechanisms Design*, co-authored by Professor Chung Ha Suh. Radcliffe was a very pleasant gentleman but he too was unable to offer me financial assistance for my graduate studies. However, he arranged for me to meet with Professor An Tzu ("Andy") Yang at the University of California, Davis. So, I traveled to Davis

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Fig. 1. Professor Bernard Roth in the d.school (circa 2015).

and at the end of our meeting, Professor Yang offered to serve as my thesis advisor and provide me with financial support. The following year I commenced my graduate program at UC Davis and I obtained my Ph.D. in June 1983. So, in hindsight, I am very grateful to Bernie for connecting me to the underground network that led me to my thesis advisor and an academic career in the School of Mechanical Engineering at Purdue University. As a young faculty member in machine design I was influenced by my colleague, the renowned kinematician, Professor Allen S. Hall, Jr. The interesting connection here is that Bernie presented his first technical paper at the Seventh Conference on Mechanisms [2] that was organized on the Purdue campus by Professor Hall.

2. The first part of the journey – New York to California

Bernie was born on May 28th, 1933, in New York City, where his parents had emigrated from Eastern Europe. His father Morris suffered from a severe manic-depressive disorder and his mother Sarah died when he was only twelve years old. Fig. 2 shows Bernie when he was a young boy of about four years of age.

Bernie attended Public School 96 in the Bronx, New York. He recalls that on one occasion, in fourth grade, he was chastised by a teacher for making too much noise in the stairwell. In sixth grade he was appointed the police commissioner by his friend Seymour (the elected mayor of the school). Bernie claims that he used this position to cover up some of his misdemeanors, such as, truancy and tardiness, but regards the experience as a good training for the real world. Also, in junior high at Public School 89 during the seventh grade, Bernie remembers, with some pride, how he succeeded in building a rather sophisticated glass bottle cutter. (Perhaps, this was the beginning of the creative mind that was to display itself so vividly in later years.)

Bernie moved on to Stuyvesant High School in New York City. A so-called friend had told him that with his ability he should not apply to the Bronx Science School as he would not be admitted. Stuyvesant had a double session plan to accommodate the large number of students, some students would attend in the morning and the remaining students would attend in the afternoon and early evening. All students, however, studied a full set of courses. Bernie claims that he was a lazy student at high school and that he spent most of his time on the streets of New York. He found that waking early for the hour-long subway ride to Stuyvesant interfered with his lifestyle and so he transferred to Christopher Columbus, his local high school, midway through his junior year. However, upon his graduation 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. They were both raised in the same neighborhood of New York City near the Bronx Park. Today, they have two grown sons; Steven, born in 1958, and Elliot, born in 1960.

In 1956, Bernie graduated from the City College with a Bachelor of Mechanical Engineering degree and commenced his graduate studies at Columbia University. He also lectured in Mechanical Engineering at the City College during his graduate studies between 1956 and 1959. Bernie worked on his course work and his research in the afternoons and evenings and obtained his Master of Science degree in 1958. This was followed by a Ph.D. degree in 1962, studying under the mentorship of Professor Ferdinand Freudenstein who was some seven years older than Bernie and establishing an international reputation

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