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Obituary

Professor RICHARD BELLMAN

Richard Bellman was lost to the scientific world on March 19, 1984. To the last day, his mind was alive with surging ideas for new works. He will be remembered as a giant of the mathematical sciences of this century. His books and papers will influence generations of researchers and students in many fields. He personally knew and was respected by mathematicians in almost every country. He was a Professor of Mathematics, Electrical Engineering, and Medicine at the University of Southern California, and Professor of Applied Mathematics at the Center for Applied Mathematics of the University of Georgia.

He was awarded the first Norbert Wiener International Prize in Applied Mathematics, he as a member of the National Academy of Engineering and the National Academy of Sciences, Fellow of the American Academy of Arts and Sciences, a member of the Operations Research Society, and winner of the von Neumann Award of the Institute of Management Sciences and the Operations Research Society of America, as well as winner of the Heritage Award of the American Control Society, the Gold Medal of the Institute of Electrical and Electronics Engineers. He was on the editorial board of 20 international journals, and was best known as Editor of the *Journal of Mathematical Analysis and Applications* and of the *Mathematics in Science and Engineering* series of books of Academic Press. He wrote 640 papers and 44 books, but this hardly measures his contribution. He worked with people around the world and assisted and influenced and motivated uncounted researchers. He motivated many graduate students into computers, control theory, and dynamic programming with frequent talks over many years. A frequent remark in lectures 20 and 25 years before his death was that all educated people should know computers.

He influenced considerably the use of computers in medicine and brought about an awareness of the relationships to control theory, delay equations, partial differential equations, and dynamic programming. The evolution of computers and of robotics leads to questions of artificial intelligence which he discussed in *An Introduction to Artificial Intelligence – Can Computers Think*? (Boyd and Fraser Company, San Francisco, 1978) and decision processes (deterministic as well as those involving chance events). He devoted much thought to consciousness and learning and the idea of treating learning as a change of an initial probability distribution on the basis of observation. He hoped to apply the combination of the theory of fuzzy systems and computer simulation to study processes of the social sciences and increase the use of mathematics from the inanimate to the animate. He understood very clearly questions of the modeling of systems, the dynamics, the control mechanisms to bring about desired objectives, the flow of information and the interaction between systems, data input required, the mathematical problems of analytical solution, and the precise questions which should be asked for a deeper understanding. Aided by computers and the rapidly developing mathematics of nonlinear stochastic dynamical systems which he also assisted and motivated, we can look to understanding of national and world economy, to intelligent computers and robotics, to better medical diagnosis, and to unforeseen advances in the next century.

He was much concerned with efficient numerical algorithms and time and memory saving methods. The numerical solution of nonlinear (and stochastic) partial differential equations plays a prominent role in weather forecasting, optimal control theory, radiative transfer, biology, the fluid mechanics of aircraft shapes and engine design, and many other problems. The standard methods used require tremendous computer time and storage. He studied techniques which can be applied in a large number of cases to circumvent those difficulties and considered specifically applications in fluid flow, turbulence, and biology. In problems relating to pattern recognition, optimal drug administration, construction of prosthetic devices, etc., he saw early the need for rapid-access storage and speed of execution. This need is now rapidly leading to parallel processors and "supercomputers." He understood the scheduling theory involved in designing effective computational algorithms for a complex of processing elements.

Richard Bellman was respected around the world as one of the world's important mathematicians of the century. His prolific works will influence generations of researchers and students. Yet, those who were privileged to work most closely with him in research and writings realize particularly how much more the man was than all his published works. His output was so great that its complete assimilation and assessment may take decades. His ideas were fundamental in control theory and applications.

Richard Bellman, often characterized as a Renaissance Man because of the global nature of his contributions, was clearly a giant in many fields. He will be remembered as one of the great mathematical scientists of this century.

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