Remembering Donald P. Eckman (1915–1962)

STEPHEN KAHNE

During this period in which the IEEE Control Systems Society and the American Automatic Control Council (AACC) celebrates more than 50 years of successful service to the control community, one of the names best known to members of these organizations is that of Donald P. Eckman. The Eckman Award recognizes outstanding young contributors to the control field and is the oldest AACC award. Probably less well known are the contributions of Donald Eckman himself and the nature of the man for whom the award is named.

Donald's academic career was at Case Institute of Technology in Cleveland, which joined Western Reserve University in the early 1970s to create Case Western Reserve University. Don Eckman's short but very productive life ended tragically in an automobile accident in 1962 while he was driving to a meeting of the International Federation of Automatic Control (IFAC) Executive Council in Cambridge, England. This occurred shortly before the Joint Automatic Control Conference (JACC) held that year at New York University.

Irving Lefkowitz, a close friend and colleague of Eckman's, was asked to give the eulogy for Don in a plenary session of the 1962 JACC. Irv's remarks were not recorded at the time; however, some years later he was prevailed upon to recall and expand upon his 1962 remarks, and the resulting article was published in this magazine in 1984 [1].

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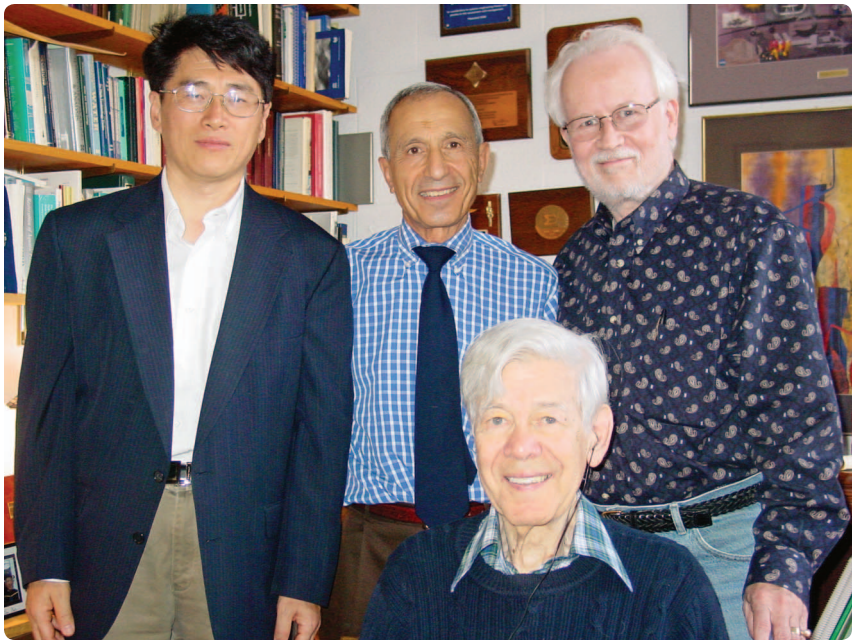
When Donald became director of the newly constituted Case Systems Research Center in 1958, he appointed Irving Lefkowitz to take over the reins of his brainchild, the research program in the control of industrial systems. Irv was a well-known process control engineer with ten years of industrial experience prior to joining Don at Case in 1953. Irv was particularly knowledgeable about practical aspects of the control of multivariable, interacting process systems based on what then represented state-of-the-art, advanced process control technology, including feedforward control and multiloop cascade control. This expertise was what Donald felt would be needed to implement analytical results on a laboratory-scale pilot plant at the university. Irv directed the program until his retirement in 1987. He is now 90 years old and lives in Charlottesville, Virginia.

Donald P. Eckman around 1957. (Used with permission from the Case Western Reserve University Archives.)



(From right) Stephen Kahne, Irving Lefkowitz, Yacov Haimes (University of Virginia), and Duan Li (Chinese University of Hong Kong). Photo taken circa 2005.

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Don Eckman and His Impact on Process Control

Donald P. Eckman was, to borrow the title of the *Reader's Digest* series, "the most unforgettable character I've ever known." Distinguished scientist and engineer, inspiring teacher, and international leader in the fields of automatic control and systems engineering, he was also a colorful, many-faceted, and very human person. He was a gifted raconteur with a zest for life; an avid sports car enthusiast (everything from reconditioning old cars to participating in rallies and racing); and a musician, proud of the fact that he worked his way through college playing saxophone in a dance band. He could be harshly critical and iconoclastic in confrontations with professional peers, yet supportive and encouraging with students and younger colleagues.

I first met Don in the fall of 1952. I had asked for the meeting to discuss some innovative things I had done with the control of distillation columns. After we dispensed with that subject, he told me about his ideas for a research project in computer control. His enthusiasm was infectious and his vision, persuasive. By the end of the conversation, I had agreed to leave my position as director of Instrumentation Research for J. E. Seagram & Sons in Louisville, Kentucky, and work with him in developing this program. That was the beginning of a close and meaningful relationship.

Don was born December 21, 1915, in Hillsdale, Michigan. He earned the B.S. and M.S. degrees in mechanical engineering in 1938 and 1939, respectively, from the University of Michigan; and from 1939 to 1946, he worked as development engineer for Brown Instruments Division of Minneapolis-Honeywell. During this short period, he wrote an important book and numerous articles on process control, had several technical inventions, and secured a national reputation as a leader in the process control field.

He enjoyed his successful stint with industry, but decided he could be more effective in a university environment. In 1946 he entered the doctoral program at Cornell University and became an instructor in mechanical engineering.

In 1950, with a Ph.D. in hand and an already-established reputation, Don had his pick of attractive offers from universities around the country. His approach to deciding which offer to accept was typical of his approach to problems in general: methodical, analytical, and thorough. In effect, he formulated the problem in a multiattribute decision-making framework, identifying and prioritizing all the relevant factors. Case Institute of Technology in Cleveland, Ohio, was his choice, based on such factors as Case's relatively small size; the aggressive leadership of its president, Keith Glennan; the broad industrial base of northern Ohio; and, not least of all, the proximity of outstanding cultural institutions (e.g., the Cleveland Orchestra and the Cleveland Museum of Art).

Reprinted from I. Lefkowitz, "Don Eckman and His Impact on Process Control," *IEEE Control Systems Magazine,* vol. 4, no. 4, pp. 32–34, 1984.

I associate Don Eckman with three major contributions to the fields of control and systems engineering. First, he pioneered a quantitative mathematical approach to the analysis and design of process control systems and demonstrated the applicability to process control of the analytical tools that were so effective in feedback amplifier and servomechanism design. Second, he foresaw very early the tremendous impact computers were to have on the control of industrial systems and actively promoted research and development in this area. Lastly, he recognized the growing importance of a systems approach and proselytized the introduction of research and educational programs in systems analysis and systems engineering.

Distinguished scientist and engineer, inspiring teacher, and international leader in the fields of automatic control and systems engineering, [Don] was also a colorful, many-faceted, and very human person.

In each of these endeavors, his was not necessarily the first or the only voice, but he was especially articulate and effective in transmitting the message.

Don's first book, *Principles of Industrial Process Control*, was published in 1945. As he stated in the preface, its purpose was "to present to the beginning engineer the important principles of automatic control, beginning with process analysis and carrying on into the generalized behavior of closed-loop systems. The techniques of analysis are used to the fullest extent, and enough detail is carefully presented so that some of the more difficult problems in automatic control may be inspected rather closely."

A companion text, *Industrial Instrumentation*, appeared in 1950. This presented the basic principles of measurement, particularly as applied to process control. His third, and last in the series, was *Automatic Process Control*, published in 1958. This was a completely revised and expanded version of his first book, with "the material updated to include all recent advancements and developments in the field of automatic control."

These books (and those by many other authors that followed) had enormous impact on process control education and practice. For example, engineering curricula began to introduce courses in control and dynamic analysis, contributing to the evolution of a new breed of control engineers—professionals

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Don also stressed the importance of maintaining a balance between theoretical and practical issues.

with an understanding and appreciation of the methods of dynamic analysis and feedback control and capable of bringing the full power of these analytical tools to bear on the solution of control problems in the process industries.

While the effect of these developments was to bring the separate evolving fields of servomechanisms and process control under a common umbrella of theory and analytical techniques, there remained, nevertheless, many essential differences, as indicated by the following incident that occurred at a control conference in Montreal around 1959. Don and Gordon Brown, then director of the MIT Servomechanisms Laboratory, were members of a panel discussing future directions of automatic control. Brown alleged at one point that the subject was moot, since all the important problems had already been solved. Don took strong exception to this statement, maintaining that there was a whole new world of challenging problems still to be addressed.

Their different responses reflected, in part, fundamentally different perspectives concerning the nature of the system being controlled. In particular, Don's perspective was based on problems induced by very complex dynamics, approximate and incomplete models, inadequate measurements, and economic constraints—all typical characteristics of process systems.

Motivated by these kinds of problems, Don saw many opportunities in the use of computers to control industrial processes. Specifically, he saw the computer as a means of handling the complex interrelationships of the process and determining how the variables need to be controlled in order to achieve optimum economic performance.

Imbued with this vision, he set about to sell his ideas to industry and to establish a new research program at Case Institute concerned with developing "concepts, techniques, and methodology for real-time computer applications in industry." It took a year of persistent and dedicated effort, but he succeeded in persuading five companies to invest $20,000 each (convert to 1984 dollars to appreciate this accomplishment!) in what was then a blue-sky venture in university-industry collaborative research.

The research started in January 1954, with funding for a two-year period. The stated purpose was to develop principles and techniques of process automation, which Don defined as "the automatic control of a process according to a set of functional relationships that define the conditions for its optimum performance." Integral to this concept were the notions of feedback and control based on mathematical models.

The term "automation" was also being used by Diebold and others in the sense of mechanization of human tasks in manufacturing systems. The concept of the "manless" factory of the future was a frequent theme of magazine and newspaper articles. Don felt so strongly about the importance of distinguishing his concept of computer control (with its emphasis on improving technical performance) from the popular image of automation (with its emphasis on displacing labor) that he changed the name of the program from "Process Automation" to "Control of Complex Systems.

The initial phase of the research was very successful. The study focused on the control of a batch chemical process along a trajectory determined to yield a product of specified composition in minimum time. Feasibility of the approach was demonstrated in a laboratory-scale pilot plant.

The industrial sponsors agreed to fund a two-year extension in order to expand the work on optimizing control and to initiate studies in model adaptation and direct digital control. By the end of the second phase, the number of industrial sponsors had increased considerably, and a decision was made to maintain the program on a continuing basis. A testimonial to Don's foresight and organizational skills is the fact that the program continues to be active to this day and still follows the principles he outlined.

The program that Don initiated was unique in many ways besides the technical aspects of the research. First, it was interdisciplinary, involving students and faculty from several branches of engineering. Second, Don insisted that the program be supported by industry (rather than through government funding) and, in particular, that it be supported by companies that represented diverse industries. He felt this was the only way of ensuring that the research would be concerned with basic principles and generic techniques (appropriate to the university environment) and would not get side-tracked into solving specific, sponsor-directed problems. Indeed, one factor in choosing the batch hydrogenation process to serve as the experimental vehicle for the first phase of the research was that this process was unrelated to the business of any of the sponsors.

Don also stressed the importance of maintaining a balance between theoretical and practical issues. From the start, experimental and computer facilities were prominent features of the research plan. Interaction with industry personnel contributed to this balance.

The research program in computer control set the stage for Don's third—and perhaps most important—contribution, the promotion of systems engineering as an important new discipline and the establishment of Case's System Research Center. We see, in the following excerpts from the proposal

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Don submitted to the Ford Foundation in 1959, how his ideas evolved from his experiences with the research in control of complex systems.

> It is proposed to establish at Case Institute of Technology a systems center for research and engineering study. The purpose of the center is to develop a research program of interdisciplinary nature in systems analysis and synthesis and to institute an education program as well as a special program related to graduate study of systems.
>
> Systems research and systems engineering are the natural development of technology in the age when communications and control have made it possible to unify the study of large-scale endeavor. The ever-increasing demand for high-performance systems, particularly by the military, has motivated considerable research effort in the development of more advanced control concepts along with more powerful analytical tools. Indeed, the growth of a "systems" concept in engineering is leading away from the conventional static approach. Manifestations of such integrated approach may be found in applications of analysis techniques to industrial chemical processing, manufacturing operations, military weapons, and even commercial retailing organizations.
>
> The advent of the modern high-speed computer has opened up many new and exciting possibilities for the control of processes to specified performance criteria. We might assume, for example, criteria based on satisfying product specifications consistent with minimum cost of production.
>
> The effective use of the systems engineer demands a broad background which cuts across conventional boundaries of the physical engineering and mathematical sciences. It requires also an ability to approach problems analytically, to reduce the physical systems to an appropriate mathematical model to which all the power of mathematical manipulation, extrapolation, and interpretation can be applied.

Don played an important role in the establishment of IFAC, the International Federation of Automatic Control. As first chairman of its Advisory Committee, he strongly influenced the structure of the organization, for example, he proposed the basic ideas embodied in the current IFAC Technical Committee structure. Tragically, he was killed in an automobile accident in May 1962, while on his way to an IFAC Executive Council meeting.

Don took special pride in his role as an educator, and he enjoyed working with young, creative people. It was most fitting, therefore, that the American Automatic Control Council, in sponsoring the Donald P. Eckman award, stipulated that it be granted for an outstanding contribution to the field of automatic control where the contribution represents work performed prior to the age of 27. Thus, as stated in the brochure describing the award, "This Award is an expression of respect and appreciation on the part of his many personal and professional associates for the legacy of accomplishment and dedication he has left behind. Its purposes represent the perennial encouragement to young creative people so ably exemplified by the all-too-brief career of Donald P. Eckman."

Past recipients of the Award represent a veritable "Who's Who" in the field today—leaders and innovators cast in the image of Don Eckman—in living tribute to his memory.

Irving Lefkowitz
Case Western Reserve University

I succeeded Irv as head of the Department of Systems Engineering at Case when I arrived in 1976 from the University of Minnesota. Irving and I worked together while I was at the university from 1976 to 1983. By that time, the research program had grown to about a dozen industrial sponsors with research studies ranging from microprocessor-based direct digital control, optimizing control techniques appropriate to minicomputer applications, model-based computer control, and multilevel and multilayer control hierarchies. I was involved in the study of communications protocols for controlling multi-stand steel rolling mills [2].

In recognition, in part, of Irv's pioneering research on computer-based control of process systems [3] he was awarded in 1982 AACC's prestigious Richard E. Bellman Control Heritage Award, and he was elected IEEE Life Fellow in 1981. Irv is first to acknowledge his debt to Don for making this recognition possible. It was Donald Eckman whose foresight conceived the research program, whose drive and determination generated industry interest and funding, and whose guidance and understanding ensured success of the venture. Irv made it happen.

As part of recent efforts to document the history of the AACC (available online at http://a2c2.org), Irving's 1984 tribute was rediscovered, and it seems to me that its reprinting is a fitting way to mark the 50th anniversary of Donald's death. We also honor the accomplishments of the Eckman Award winners by providing a complete list of awardees, beginning with Michael Athans in 1964. This list and Irving's 1984 article accompany this article.

AUTHOR INFORMATION

Stephen Kahne earned the B.E.E. from Cornell University and M.S. and Ph.D. from the University of Illinois. He is professor emeritus at Embry-Riddle

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David Angeli, Jean-Michel Coron, and Hal Smith.

Zvi Artstein, Frank Allgower, and Peter Caines.

dozen participants stayed on for informal discussion sessions, on topics ranging from automated traffic management and models of cell movement to control under actuator saturation.

Social occasions included group dinners on Sunday through Thursday, with a formal banquet on Tuesday night that was hosted by Yutaka Yamamoto and featured personal remarks by many of Eduardo's colleagues and former students.

A grant from the National Science Foundation is gratefully acknowledged for support of travel and local expenses for junior researchers, graduate students, and invited participants. The workshop Web site http://dimacs.rutgers.edu/Workshops/ControlTheory has complete information, including the final program and slides of most of the presentations.

Yuan Wang
Florida Atlantic University

» HISTORICAL PERSPECTIVES *(continued from page 159)*

Aeronautical University in Prescott, Arizona. He has held various professorial and administrative positions at the University of Minnesota, Case Western Reserve University, Polytechnic Institute of Brooklyn, the Oregon Graduate Center, and Embry-Riddle University, in addition to industry and government leadership positions. He was president of the IEEE Control Systems Society, vice president of the IEEE, and president of IFAC. These activities are described in "A Path Through the Control Community," *IEEE Control Systems Magazine*, vol. 30, no. 3, pp. 79–84, 2010.

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Donald P. Eckman Award Winners

1964: Michael Athans
1965: John Bollinger
1966: Roger Bakke
1967: Roger W. Brockett
1968: Robert E. Larson
1969: W. Harmon Ray
1970: John Seinfeld
1971: Raman Mehra
1972: Cecil L. Smith
1973: Edison Tse
1974: Timothy L. Johnson
1975: Alan S. Willsky
1976: Robert W. Atherton
1977: Nils R. Sandell Jr.
1978: Narendra K. Gupta
1979: Joe Hong Chow
1980: Manfred Morari
1981: Rajan Suri
1982: Bruce Hajek
1983: John C. Doyle
1984: Mark A. Shayman
1985: P.R. Kumar
1986: Yaman Arkun
1987: Rahmatallah Shoureshi
1988: Bijoy K. Ghosh
1989: Pramod P. Khargonekar
1990: S. Shankar Sastry
1991: Carl N. Nett
1992: Stephen P. Boyd
1993: Munther A. Dahleh
1994: Kameshwar Poola
1995: Andrew Packard
1996: Jeff S. Shamma
1997: Richard M. Murray
1998: Ioannis Kanellakopoulos,
1999: Andrew R. Teel
2000: Richard D. Braatz
2001: Dawn M. Tilbury
2002: Ilya Kolmanovsky
2003: Claire J. Tomlin
2004: Panagiotis D. Christofides
2005: Pablo A. Parrilo
2006: Murat Arcak
2007: Daniel Liberzon
2008: Asuman E. Ozdaglar
2009: Paulo Tabuada
2010: Domitilla Del Vecchio
2011: Hana El-Samad

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