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Alan Pritsker's multifaceted career: theory, practice, education, entrepreneurship, and service

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In this lead article for the special issue of *IIE Transactions* honoring Alan Pritsker, we summarize Alan's most significant contributions to the fields of industrial engineering and operations research, with special emphasis on his contributions to computer simulation.

1. Introduction

Since he began his career as an industrial engineer over 45 years ago, Alan Pritsker made seminal contributions to many areas of the field of simulation and to the larger fields of industrial engineering and operations research. Particularly notable is the extent to which Alan's accomplishments spanned both the theory and practice of engineering and science – Alan was always keenly interested in bringing the latest research results quickly into practical applications for the benefit of society at large. From his pioneering work in developing theory and methodology for modeling and analysis of large-scale industrial systems to his leadership in developing commercial simulation software products and in crafting policy analyses to address major societal problems, Alan's multifaceted contributions to the engineering profession are striking not only for their scope and impact but also for the remarkably long time period over which that impact has been sustained in all its dimensions.

Alan studied under Jack Mitten at The Ohio State University, who taught him how to be a compassionate professor while pursuing research goals. Alan's research focus at the time was on the discrete control of stochastic processes, which he applied at the Battelle Memorial Institute (now Battelle Institute) on such projects as understanding human-computer joint decision making, the basis for automatic checkout techniques, and modeling railroading as a system. Alan's other projects at Battelle included: simulation of an air duel environment; the application of the traveling salesman procedure to the wiring design of a computer; and development and use of a mathematical model of the supply-chain network for toys and games from the manufacturer to distribution centers and finally to retail stores. These applications and other aspects of Alan's career can be found in Alan's professional autobiography *Papers*, *Experiences*, *Perspectives* (Pritsker, 1990).

2. Contributions to engineering theory and methodology

Foremost among Alan's achievements is his work in the theory and methodology of discrete and combined discrete-continuous system simulation.

2.1. *General modeling techniques*

With an eye towards applications, Alan and his students formulated the basic principles of combined discrete-continuous simulation and implemented those principles in the GASP IV, SAINT, and SMOOTH simulation languages (Hurst and Pritsker, 1973; Pritsker and Hurst, 1973; Pritsker, 1974a; Pritsker *et al.*, 1974; Sigal and Pritsker, 1974). Subsequently Alan extended the foundations of combined simulation to encompass the process-interaction approach; and working with several collaborators, he implemented a family of combined discrete-continuous simulation languages, including SLAM (Pritsker and Pegden, 1979) and its extensions – SLAM II and SLAM II/PC (Pritsker, 1984a, 1986, 1995); TESS (Standridge and Pritsker, 1987); SLAMSYSTEM (Pritsker Corporation, 1989); FACTOR/AIM (Lilegdon *et al.*, 1994); and Visual SLAM/AweSim (Pritsker *et al.*, 1997; Pritsker and O'Reilly, 1999). Alan's pioneering work on

combined simulation forms the basis for virtually all of the major combined simulation languages in use today.

2.2. *General analysis techniques*

Alan made numerous fundamental contributions to general simulation analysis techniques in the following areas: the spectral method for output analysis (Duket and Pritsker, 1978); the simulation start-up problem (Wilson and Pritsker, 1978a, b); variance reduction techniques for the simulation of queueing systems (Wilson and Pritsker, 1984a, b); and analytic characterizations of the transient and steady-state behavior of the variance of the sample mean for simulated Markov processes in discrete and continuous time (Hazen and Pritsker, 1980). Although much of this work was done in the 1970s and early 1980s, it is still frequently cited in the current literature. In 1985, Wilson and Pritsker (1984b) received the "Outstanding Simulation Publication Award" from The Institute of Management Sciences (TIMS, now INFORMS) College on Simulation and Gaming (now the College on Simulation, or INFORMS–CS). Alan's most recent research was focused on: (i) the formulation of practical, efficient statistical screening, selection, and multiple-comparison procedures that are adapted to large-scale system simulation; and (ii) the implementation of these procedures in commercial simulation software (Goldsman *et al*., 1999). Professor Barry Nelson of Northwestern University described his work with Alan on this topic as follows.

> Over the past three years, Alan (via Pritsker Corporation) was a co-sponsor of one of my National Science Foundation grants on comparing systems via simulation. I originally envisioned the role of the corporate sponsors of this work as directing my efforts toward practical problems and implementing research results in their software. But in very short order, Alan became a *participant* in the research itself, despite the fact he had no previous experience in the types of multiple-comparison procedures I derive. As usual, he provided insights and directions that would never have occurred to me.

2.3. *Modeling and analysis of stochastic networks*

Alan's contributions to techniques for modeling, analysis, and simulation of stochastic networks deserve special mention. The Graphical Evaluation and Review Technique (GERT) was a breakthrough that provided a method to calculate the moment-generating function of the accumulated time (or cost) to realize a stochastic network composed of "exclusive-or" nodes and arcs whose traversal times (costs) are independent random variables (Pritsker and Happ, 1966; Pritsker and Whitehouse, 1966; Whitehouse and Pritsker, 1969). For this work Alan and Gary Whitehouse received the "H. B. Maynard Innovative Achievement in Industrial Engineering Award" from the American Institute of Industrial Engineers (AIIE, now IIE) in 1978. The analytic intractability of stochastic networks with more general node and arc characteristics prompted Alan to develop the Q-GERT simulation language (Pritsker, 1977, 1979) as a vehicle for analyzing general stochastic networks. Of equal interest is the work of Alan, Elliott Sigal, and Jim Solberg on the stochastic shortest route problem, including graph-theoretic constructs such as uniformly directed cutsets that enable effective use of the Monte Carlo method of conditional expectations for simulation-based analysis of this problem (Sigal *et al*., 1979, 1980). This work has stimulated substantial follow-up research in graph theory as well as in simulation.

2.4. *Commercial simulation software systems*

Since the late 1960s, Alan has perhaps become most widely known for leading the development of a series of highly successful software systems designed to support all aspects of a large-scale simulation study. Alan made simulation "easy to use." As President of Pritsker & Associates, Inc. (later Pritsker Corporation and then the Pritsker Division of Symix Systems, Inc.), Alan supervised the design and implementation of the following commercial simulation software systems:

- GASP II simulation language (Pritsker and Kiviat, 1969).
- GERTE program for analyzing GERT networks (Pritsker, 1974b).
- GASP IV simulation language (Hurst and Pritsker, 1973; Pritsker and Hurst, 1973; Pritsker, 1974a).
- SAINT simulation language (Pritsker *et al*., 1974).
- GASP_PL/I simulation language (Pritsker and Young, 1975).
- Q-GERT simulation language (Pritsker, 1977, 1979).
- SLAM, SLAM II, and SLAM II/PC simulation languages (Pritsker and Pegden, 1979; Pritsker, 1984a, 1986, 1995).
- TESS simulation environment (Standridge and Pritsker, 1987).
- SLAMSYSTEM simulation environment (Pritsker Corporation, 1989).
- FACTOR/AIM manufacturing simulation environment (Pritsker *et al*., 1986; Lilegdon *et al*., 1994).
- Visual SLAM simulation language and AweSim simulation environment (Pritsker *et al*., 1997; Pritsker and O'Reilly, 1999).

It is also noteworthy that the Micro Saint software package currently distributed by Micro Analysis and Design, Inc., is a direct descendant of the original SAINT package developed by Alan and his collaborators (Pritsker *et al*., 1974) for the US Government.

The Extended Simulation Support System (TESS) was one of the first comprehensive simulation "environments" for specification, development, verification, validation, documentation, management, anima-

tion, and presentation of simulation models (Standridge and Pritsker, 1987). In parallel with his work on simulation-oriented environments, Alan (working with David Yancey) oversaw the development of the US Air Force's ICAM Decision Support System (IDSS) 2.0, a prototype designed to provide total engineering support (including the development of the IDEF2 simulation language) to aerospace manufacturers; and IDSS 2.0 was recognized by the Secretary of Defense as one of the "Top Ten Manufacturing Technology Programs" of 1983.

The availability of high-quality, user-friendly software documented in widely used textbooks, user guides, and tutorials has dramatically expanded the scope of simulation applications and the pool of simulation users at all levels of expertise; and Alan's strategic vision of a family of related simulation software products has played a crucial role in the growth and maturing of the field of simulation over the past 30 years.

In addition to commercial software packages, Alan supervised the work of many master's and doctoral students in the development of non-commercial software systems to support their research. Among these packages are: (i) SMOOTH, developed at roughly the same time as GASP IV by Elliott Sigal for his master's thesis research (Sigal and Pritsker, 1974); (ii) GASP IV/E, a version of GASP IV with interactive operator-in-the-loop capabilities that was developed by Mark Fox for his master's thesis research; (iii) GASPPI, a version of GASP IV with process-interaction capabilities that was developed by Ware Washam for her master's thesis research; and (iv) Simulation Data Language (SDL), a predecessor of TESS that was developed by Charles Standridge for his doctoral dissertation research.

3. Contributions to engineering practice

Most of Alan's work in theory and methodology was driven by real-world problems arising in the practice of industrial and systems engineering. The application areas detailed below are indicative of the scope and impact of his contributions to simulation practice.

3.1. *Policy analysis for organ transplantation*

From 1995 to 1999, Alan led the development and use of large-scale simulation models of various operations of the United Network for Organ Sharing (UNOS) (Pritsker *et al.*, 1995, 1996; Pritsker, 1998). In particular, the UNOS Liver Allocation Model (ULAM) has been used to compare proposed policies for allocating donated livers to patients who are waiting for a liver transplant. Partially on the basis of Alan's extensive analyses of ULAM-generated predictions of the effects of implementing various organ-allocation policies, the UNOS Board of Directors made a highly publicized change to the UNOS liver-allocation policy on January 20, 1997. Moreover on June 18, 1998, Alan testified in Congressional Hearings on the results of his comparison of the current liver-allocation policy versus a policy based on a sickest-patient-first national waiting list; and shortly thereafter, Congress authorized the continuation of the current policy for a year pending an independent review of this policy by the Institute of Medicine of the National Academy of Sciences. This is a remarkable example of the definitive practice of system simulation in addressing ultimate questions of life and death. Dr. Pat Daily, Assistant Executive Director of UNOS, assessed the significance of Alan's work in this area as follows.

> The outstanding leadership provided by Alan Pritsker in organ allocation simulation modeling will have a lasting effect on the efforts of the transplant community to select the best possible organ allocation policies which will benefit thousands of individuals in the United States. ...
>
> We are grateful and honored to have worked with Alan Pritsker on a project of such magnitude and consider him a friend of all transplant patients.

3.2. *Capital investment, facilities design, and scheduling in the steel industry*

Over the past 30 years, Alan was involved in a series of applications of simulation to problems concerning capital investment, facilities design, and scheduling in the steel industry. In a simulation study of the hot metal delivery system at the Lackawanna Plant of Bethlehem Steel Corporation (Weinberger *et al.*, 1977), Alan and his collaborators confronted the problem of sizing the fleet of hot metal submarine ladles – that is, specially constructed railroad cars for transporting molten steel. Savings of $1200 000 were realized from this study based on analyses of the submarine fleet size that would be required under various schemes for: (i) balancing the production rates of the blast furnaces and the scrap smelter against the production rate of the basic oxygen furnace; and (ii) rerouting submarines to the blast furnace to avoid emergency breakouts of hot metal from the blast furnace. Robert H. Evans, Assistant Chief Industrial Engineer (retired) of Bethlehem Steel Corporation, summarized Alan's work in the steel industry.

> The submarine model attracted considerable interest and attention from other plants and participants in the training program. A succession of similar projects was subsequently identified, particularly involving material handling and inventory problems. ...
>
> Alan's work with Bethlehem continued over a number of years and there can be no doubt that he played a major role in instilling simulation thinking and the use of modeling tools among engineers and operating personnel throughout Bethlehem's steel making operations. Mention of his name and work among my associates of the time still raises a sense of awe.

Some of Pritsker Corporation's more recent work with Bethlehem Steel is documented in Cobbs and Pritsker (1996), Hannah (1996), and Duket (1996).

3.3. *Real-time factory control*

Since the mid-1980s, Alan and his collaborators have led the development of the concept of the *Factory in the Computer* (Pritsker, 1992) in which simulation models of manufacturing facilities are used not only for design and planning but also for real-time operation of these facilities (Pritsker *et al.*, 1986). Such an approach requires integration of databases containing continuously updated information on: (i) orders; (ii) process plans for the jobs required to fill those orders; (iii) the status of the workstations on the shop floor; and (iv) the status of the material handling devices used to transport jobs between the workstations. The FACTOR manufacturing simulation system is the centerpiece of current implementations of the *Factory in the Computer* (Lilegdon *et al.*, 1994).

3.4. *Other simulation applications*

Alan and his collaborators developed innovative simulation models for solving problems in many other application areas. For the pharmaceutical industry, Alan supervised the development of simulation models to evaluate the capability of current and proposed tablet-manufacturing facilities to satisfy forecasted production requirements while operating under complex production-scheduling schemes (Pritsker, 1982). A novel simulation study of sporting events at the Rose Bowl was used to plan deployment of personnel from the Los Angeles County Sheriff's Department so as to respond promptly to disturbances such as fights, fires, and acts of terrorism (Pritsker, 1984b). Evaluating the production rate of a proposed facility for manufacturing a multiple launch rocket system and determining the associated storage-space requirements for key buffers was the objective of another large-scale simulation study (Pritsker, 1982). Many of Alan's contributions to engineering practice are documented in his numerous undergraduate and graduate textbooks as discussed in the following section covering his contributions to engineering education.

4. Contributions to engineering education

Alan's first love was teaching, including not only undergraduate- and graduate-level university courses but also professional short courses. He was a dedicated, inspiring teacher who possessed a rare gift for making difficult material readily accessible to students drawn from a broad diversity of disciplines and backgrounds. Alan served on the faculties of Arizona State University (1962–69), Virginia Polytechnic Institute and State University (1969–70), and Purdue University (1970–98). During the 1970s and 1980s, Alan's activities at Purdue led to what many have called the "Golden Age of Simulation." Professor Bruce Schmeiser of the School of Industrial Engineering at Purdue reminisced about Alan's achievements at Purdue.

> I am (as have been many other people) at Purdue because of the culture that Alan created beginning with his arrival in the early 1970s. Not just in industrial engineering, but throughout the campus, system simulation today remains widely used in research. ...
>
> Alan advised many Ph.D. students during his years as a professor. Many of these former students are leaders in the simulation community. But more impressive, at least to me, are the many students advised by other professors who have been helped, guided, and inspired by Alan. Certainly many of my students have seen such benefits.

Professor Lee Schruben of the University of California, Berkeley, expressed the following view of Alan's work at Purdue.

> He was instrumental in helping simulation become a credible academic discipline by establishing the world's strongest simulation research tradition at Purdue University. Many of the top researchers in simulation methodology have at one time or another been associated with the program at Purdue.

4.1. *Undergraduate and graduate textbooks*

Most of Alan's groundbreaking contributions to engineering theory, methodology, and practice are widely available via numerous well-known texts and book chapters that he wrote over the past 45 years. Perhaps more than any other single individual, Alan effectively disseminated knowledge about simulation technology at all levels of academia, government, and industry through the following books:

- *Simulation with GASP II: A FORTRAN Based Simulation Language* (Pritsker and Kiviat, 1969).
- *The GASP IV Simulation Language* (Pritsker, 1974a).
- *Simulation with GASP_PL/I* (Pritsker and Young, 1975).
- *Modeling and Analysis Using Q-GERT Networks* (Pritsker, 1977, 1979).
- *Introduction to Simulation and SLAM* (Pritsker and Pegden, 1979).
- *Introduction to Simulation and SLAM II* (Pritsker, 1984a, 1986, 1995).
- *Management Decision Making: A Network Simulation Approach* (Pritsker and Sigal, 1983).
- *TESS*: *The Extended Simulation Support System* (Standridge and Pritsker, 1987).
- *SLAM II Network Models for Decision Support* (Pritsker *et al.*, 1994).
- *Papers*, *Experiences*, *Perspectives* (Pritsker, 1990).
- *Systems of Automization in Ecology and Geophysics* (Kurkovsky and Pritsker, 1995).
- *Simulation with Visual SLAM and AweSim* (Pritsker *et al.*, 1997; Pritsker and O'Reilly, 1999).

Alan received Honorable Mention in the 1980 Lanchester Prize Competition of the Operations Research Society of

America (now The Institute for Operations Research and the Management Sciences or INFORMS) for three of his books – namely, Pritsker (1974a); Pritsker (1979); and Pritsker and Pegden (1979). Over the past three decades, Alan also wrote 15 book chapters on simulation and its applications to manufacturing, production scheduling, computer science, and ergonomics.

4.2. *Mentoring of students and colleagues*

In addition to educating many undergraduate-level students in hundreds of traditional academic courses and industrial short courses on simulation, Alan compiled a remarkable record as an adviser of graduate students. Of the 18 doctoral students and over 60 master's students who completed their graduate work under Alan's supervision, virtually all of these individuals are highly successful professionals in academia, government, or industry. Alan's Ph.D. students are listed below.

Hamdy A. Taha (1964)
Ronald W. Skeith (1965)
Gary E. Whitehouse (1965)
Merlyn E. Nightengale (1966)
Lawrence J. Watters (1966)
Hewitt H. Young (1966)
Charles C. Mitchell (1968)
Richard L. Smith (1968)
Thomas W. Hill, Jr. (1969)
Ronald A. Enlow (1970)
Michael S. Heschel (1970)
William J. Thompson (1970)
Nicholas R. Hurst (1973)
C. Elliott Sigal (1977)
Charles R. Standridge (1978)
James R. Wilson (1979)
David P. Yancey (1981)
Neal M. Bengtson (1983)

Dr. Elliott Sigal, Vice President for Applied Genomics of the Bristol-Myers Squibb Pharmaceutical Research Institute, shared his thoughts about Alan as a mentor, teacher, and friend.

I was one of his students in the classroom, wrote a Ph.D. dissertation under him, helped co-found Pritsker & Associates with him, and have co-authored several papers and two books. In addition, Alan Pritsker has served as a mentor for me not only in my early work involving the field of engineering but also in my later work combining that field with medical research and genomics, the study of genes and disease. ...

There were times when I had self-doubt on how best to accomplish a transformation from engineering to medical research. I had the goal of an inter-disciplinary career, but that was a long haul and a difficult challenge. I consulted Alan Pritsker regularly. Giving unselfishly of his time, Alan met with me during his trips to the West Coast and mine to the Mid-West to discuss our respective interests. At one critical junction of my career, I can remember quite distinctly Alan taking me to lunch and drawing on a napkin a decision network with probabilities, expected outcomes, performance measures; discussing how to approach a fork in the road in one's career. I still have the napkin. As usual, his advice was helpful and wise.

Alan Pritsker taught me the basics of technical writing and technical presentation. He also taught me strategic planning. All of these skills are something that I use daily. When leaders in the field of medicine trained me in other aspects of my career, they invariably asked where I was trained in the art of decision making and analysis. The answer is with Alan Pritsker at Purdue University. I know that I am only one of hundreds of individuals that Alan trained and influenced, not only in the field of decision analysis and simulation, but in the practical aspects of strategic analysis. His influence has been tremendously amplified throughout industrial engineering and most importantly, in fields beyond.

Professor Gary Whitehouse, Provost and Vice President for Academic Affairs of the University of Central Florida, emphasized Alan's impact as a role model and mentor.

Alan has had a tremendous influence on my career, not only from a technical standpoint but also as a role model. His enthusiasm, creativity, and devotion to industrial engineering, operations research, and simulation were major factors influencing my activities. Hopefully, I was able to pass these traits on to my students and they, in turn, to theirs.

Professor George Fishman of the Department of Operations Research in The University of North Carolina at Chapel Hill offered his perspective on Alan's work as an educator.

More than any of his other contributions, there is one that I regard as his greatest accomplishment and the one that other teachers of simulation can only envy. That is the great number of students that Alan has interested in simulation and who have gone on to successful careers using this methodology either in academia or industry. No one among us in the simulation community comes close to Alan in this regard.

Not only his students but also his professional colleagues around the world have benefited from Alan's steadfast support, guidance, and advice. Professor John White, Chancellor of the University of Arkansas, provided an illuminating personal insight into the full extent of Alan's efforts in mentoring colleagues.

Alan had a profound impact on me during our brief, shared time at Virginia Tech in 1970. From that time on, he "looked out for me" and provided advice and counsel as I developed professionally. He served on the Board of Directors of my consulting firm, SysteCon, and he served on my advisory boards when I was NSF's Assistant Director for Engineering and Georgia Tech's Dean of Engineering. Of all the people I have known, Alan Pritsker has had the greatest influence on me, professionally.

4.3. *Leadership of academic programs*

From 1970 to 1973, Alan served as Director of the Center for Large-Scale Systems (LSS) at Purdue University; and in this capacity he held professorial positions not only in the School of Industrial Engineering but also in the School of Aeronautical, Astronautical, and Engineering Science. Beyond these disciplines, faculty and students in the LSS program were drawn from Civil, Mechanical,

and Chemical Engineering as well as Sociology, Psychology, and Political Science. The concept behind LSS was to change engineering education to address societal needs more directly. The program was interdisciplinary, involving full-time professors in LSS from five departments and support faculty from the departments named above. Ten new courses were developed and added to the curriculum in 3 years. Among the research programs for which Alan was the project director, two noteworthy projects involved: (i) assessing the impact of self-contained buildings on urban areas; and (ii) determining the flow of cadmium in the environment. Both Q-GERT and GASP IV simulation models were developed in these projects. John F. Shirey, one of the LSS students, is currently the City Manager for Cincinnati, Ohio.

4.4. *Keynote addresses at technical conferences*

Alan gave the following keynote addresses at major national and international conferences:

- "Why Simulation Works," 1989 Winter Simulation Conference, Washington, DC, December 1989 (Pritsker, 1989).
- "The State of Simulation in the United States," Opening of the Department of Business Logistics, Fraunhofer Material Flow and Logistics Institute, Bielefeld, Germany, June 1991.
- "Industrial Engineering Research: A Perspective," First Industrial Engineering Research Conference, Chicago, Illinois, May 1992.
- "Factory-in-the-Computer," Kozo User's Conference, Tokyo, Japan, October 1993.
- "A View of Industrial Engineering," Korean National IIE Meeting, Seoul, Korea, October 1993.
- "New Roles for Simulation in Industry," European Simulation Society, Erlangen, Germany, October 1995.
- "New Roles for Simulation in Industry," Progress in Manufacturing Conference, Kansas State University, Manhattan, Kansas, January 1996.
- "Using Simulation to Build Bridges," Conference of the Association for Business Simulation and Experiential Learning (ABSEL), Maui, Hawaii, January 1998.

A common theme running through all of these presentations is that simulation is the premier technique for modeling and analysis of complex systems in a wide range of disciplines.

5. Entrepreneurship and leadership in commercial enterprises

Another prominent aspect of Alan's contributions to the growth of the field of simulation was his role in founding and leading several commercial enterprises dedicated to the development and dissemination of simulation technology. He was a cofounder of Pritsker & Associates, Inc. (1973); and at various times he was President (1973–86) or Board Chair and CEO (1987–89) of that organization. He also served as the Board Chair of FACTROL, Inc. (1986–89). When Pritsker Corporation was created in 1989 through the merger of Pritsker & Associates and FACTROL, Alan served the new company as Board Chair and CEO (1989–91; 1996–98) and as President and CEO (1991–96). In 1989, Alan was President of INventure, Inc., a company partially funded by the Corporation for Science and Technology of Indiana to foster the creation of successful technology start-up companies in that state; and he served on the INventure Board of Directors from 1985 to 1995. As a result of his leadership of Pritsker & Associates, FACTROL, Pritsker Corporation, and INventure, Alan was asked to serve on the Board of Directors for the following engineering companies:

- Radian Research (1985–87).
- Vetronics, Inc. (1987–97).
- Batch Process Technologies (1986–88; 1995–98), the developer of the BATCHES and BDIST-SimOpt simulation packages for predicting and optimizing the performance of multiproduct batch/semicontinuous processes in the pharmaceutical, specialty chemical, and food industries.
- SysteCon (1984–87), a consulting organization (now a division of PriceWaterhouseCoopers) specializing in logistics and supply chain operations.
- CAPS Logistics, Inc. (1988–1991), developer of the CAPS Logistics Toolkit, the leading software package for optimizing supply chain operations.

In 1987 Alan received the "Arthur Young/*VENTURE* Magazine Entrepreneur of the Year Award".

Dr. Ken Musselman, a former Vice President of Pritsker Corporation and currently a Senior Business Consultant with Symix Systems, Inc., commented on Alan's leadership of commercial enterprises.

> Of most importance in my professional life and for many other practicing simulationists was the existence of Pritsker Corporation, formerly Pritsker & Associates. In forming this company, Dr. Pritsker made possible the opportunity for those having a strong application interest in the field of simulation to pursue it as a career. When the company was started in 1973, no other opportunities like this existed – a company totally dedicated to the design, justification, implementation, and operation of systems using simulation. Simulation was in its infancy, and little was generally known about it in the business world. Yet, by leveraging his skills as a teacher and businessman, Dr. Pritsker grew the company to 140 people, with as many as 30 practicing simulation engineers at one time. Over the years, Pritsker Corporation has given more than 100 engineers an opportunity to serve over 2000 customers. With simulation software such as GASP IV, Q-GERT, FACTOR, SLAM, and AweSim, the company, along with its 19 foreign distributors, serviced over 6000 installations worldwide. This gave convincing proof of the commercial viability of simulation. With

the company becoming a commercial success, the practice of simulation was validated.

6. Service to the engineering profession

Alan's service to the profession spanned a broad range of activities sustained over the past four decades.

6.1. *Leadership in the Winter Simulation Conference*

Perhaps Alan's most prominent contributions in service to the simulation community were made through his leadership of the Winter Simulation Conference (WSC). He served as a member of the WSC Board of Directors representing AIIE from 1970 to 1973. He also served on the WSC Board of Directors representing TIMS-College on Simulation and Gaming (now INFORMS–CS) from 1981 to 1987; and he served as Board Chair from 1984 to 1985. Alan was an active participant in the technical program of the WSC each year for over 30 years, and in 1989 he delivered the keynote address for that conference.

6.2. *Leadership in professional societies*

By his leadership in various professional societies and governmental organizations over the past 45 years, Alan contributed significantly to the dramatic growth of the field of simulation as well as the larger fields of industrial engineering and operations research. He cofounded the Operations Research Division of AIIE in 1968, and he served as the director of that division from 1968 to 1970. He also co-originated the AIIE Systems Engineering Conference in 1973. He received the "AIIE Distinguished Research Award" in 1966, and he was elected a Fellow of AIIE in 1978. It is especially noteworthy that in 1991, Alan received from IIE the "Frank and Lillian Gilbreth Industrial Engineering Award," which bears the following designation:

> This award is the highest and most esteemed honor presented by the Institute and recognizes individuals who have distinguished themselves through contributions to the welfare of mankind in the field of industrial engineering. The contributions must be of the highest caliber and be nationally or internationally recognized.

Alan's service to professional societies was not limited to the IIE. From 1973 to 1979, he served the Society for Computer Simulation as the area editor for combined discrete-continuous simulation of the journal *SIMULATION*. For his long-standing, exceptional service to the international simulation community, Alan received the "Distinguished Service Award" from INFORMS–CS in 1991; and subsequently he served on the selection committee for that award (1994–97; chair in 1995). At the 1992 Winter Simulation Conference, he delivered the opening address for the doctoral-student colloquium sponsored by INFORMS–CS. In 1999 Alan received the INFORMS–CS "Lifetime Professional Achievement Award," which is the highest honor given by that society. The award recognizes major contributions to the field of computer simulation that are sustained over a professional career, with the critical consideration being the total impact of those contributions on the field. An individual's contributions may fall in one or more of the following areas: research, practice, dissemination of knowledge, development of software or hardware, service, and advancement of the status of the field. In the award citation, the selection committee stated that "Alan is that rare individual who could have won the award based on his contributions in *any* of the areas, let alone all six!"

6.3. *Leadership in the National Academy of Engineering*

Elected to the National Academy of Engineering (NAE) in 1985, Alan enjoyed the distinction of being the second industrial engineer to join that organization; and over the past 15 years, Alan actively served NAE in many capacities. From 1987 to 1990, he was a member of the Peer Committee for the Industrial, Manufacturing, and Operational Systems Engineering Section; and in 1988 he was the chair of that committee. He was also a member of the Advisory Committee for the Design and Analysis of Integrated Manufacturing Systems (1986–88), the Panel on Foundations of Manufacturing Systems (1988–1995), the Committee on Membership (1989–93), and the Honors and Awards Board (1991–1995). Alan was elected chair of the Industrial, Manufacturing, and Operational Systems Engineering Section for the period 1996–98; and in 1997 he was a member of the Nominating Committee for President of NAE. Professor Henry Yang, Chancellor of the University of California, Santa Barbara, summarized Alan's work with NAE as follows.

> I had the pleasure of knowing Dr. Pritsker for many years. He served with dedication and effectiveness on numerous committees, panels, and boards of the National Academy of Engineering. Dr. Pritsker's wise leadership and unique insights earned him the great respect of his NAE peers.

6.4. *Leadership in educational and governmental organizations*

Alan served the National Science Foundation as a member of the Advisory Committee for the Division of Design & Manufacturing Systems (1992–93) and as a member of the Review Panel for the Strategic Manufacturing Initiative (1989). From 1985 to 1987, he was a member of the National Research Council's Committee on Air Force Base Level Automation Environment. From 1980 to 1984, he was a member of the Visiting Advisory Committee of the School of Industrial Engineering and Management at Oklahoma State University; and he also served on similar engineering advisory com-

mittees at Mercer University (1985–88), Lehigh University (1990–94), and Georgia Institute of Technology (1992–98).

7. Recapitulation

In the course of doing background research for this article, we amassed numerous statements from distinguished individuals who could evaluate authoritatively various facets of Alan Pritsker's remarkable professional achievements. A common theme running through many of these statements is the extraordinary effect that Alan had on all his students, colleagues, and friends. Another dominant theme is the exceptional scope and depth of Alan's professional activities. Professor Lee Schruben tied these themes together neatly:

> Alan is directly responsible for the success of many careers in simulation, mine included. Indeed, he was the first, and maybe the last, to demonstrate that it is possible to be a first-rate practicing engineer, scholarly researcher, devoted teacher, and successful entrepreneur. Many people in the field have modeled their careers after one of these characteristics of Alan – none, to date, have succeeded in doing all four. Almost everyone in our field has been influenced at least indirectly by Alan's activities.

Professor John White succinctly summarized Alan's contributions to the field of simulation with the following memorable comparison.

> I believe Alan Pritsker's accomplishments surpass those of, arguably, the world's greatest hockey player, Wayne Gretzky. It is said that good hockey players skate to where the puck is, but Gretzky skates to where the puck is going to be. Alan Pritsker did not just skate to where simulation was going to be; instead he took it to where it needed to be. He has shaped and defined the field.

From a larger perspective, Alan exerted the same superlative leadership in all aspects of his work in the field of industrial engineering. We are indeed fortunate to have benefited from Alan Pritsker's multifaceted contributions to the life of our profession over the past five decades.

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