



Dean E. Eastman

1940–2018

BIOGRAPHICAL

Memoirs

*A Biographical Memoir by
Franz J. Himpfel,
Joseph E. Demuth,
Ella Mae Eastman,
Peter E. King,
and Thomas N. Theis*

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NATIONAL ACADEMY OF SCIENCES

DEAN ERIC EASTMAN

January 21, 1940–March 4, 2018

Elected to the NAS, 1982

Dean Eastman's father emigrated from Sweden during the Great Depression to seek an opportunity in the iron-mining industry of Michigan's Upper Peninsula. Dean spent his youth in the small town of Stambaugh, with a population under 2000, and a total high-school enrollment of about 300 students. The town had a large park with multiple athletic fields, which were the center of community youth activities. Dean took full advantage of them all, playing on the basketball, baseball, and tennis teams.

Dean's academic options shrank after 8th grade, when his father purchased a small farm two miles out of town. The farm was on the "wrong side of the road" in terms of local competing school districts, forcing him to attend an even smaller school of approximately 30 students for grades 9 through 10, after which he returned to Stambaugh to finish his high-school education. The faculty immediately realized they had a special student in their midst. As a junior (pictured on page 3), Dean took over teaching the physics course from a teacher who recognized that he himself was unqualified to do it properly. Dean was then given an IQ test, which he had missed when transferring schools. The resulting score was not made public, but word got around that it was off the charts, and the faculty became intimidated by this transfer student.

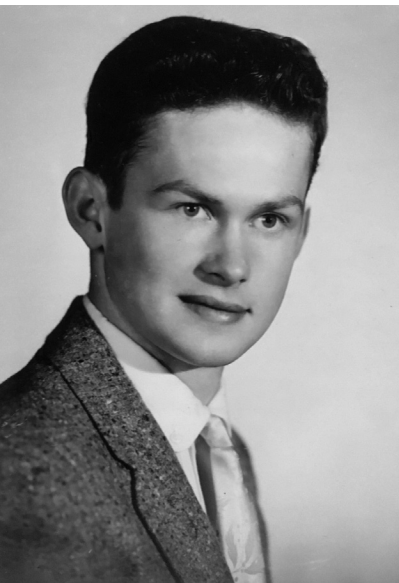


Dean E. Eastman

*By Franz J. Himpsel,
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Of course, intelligence is no shield from the harsh realities of life. In the summer before his senior year, the mine and steel workers went on strike, leaving Dean's father unemployed for a time. Like many of his classmates, Dean joined his father cutting pulpwood in the forest. That backbreaking work paid a paltry five dollars a day, but it provided much-needed income for their families.

Dean received a shock of a different sort when the Soviet Union launched its Sputnik satellite, an event that also traumatized the American public. In fact, the following day,



the high-school chemistry teacher told students he was glad he was old and would soon die, and that he pitied the students because they would likely spend their lives living under communist rule!

Together with one of the authors (PEK) and one other student, Dean immediately began constructing a rocket for a science club project. We built a solid-fuel projectile and successfully tested it in a vertical flight in the spring, but we had ambitions to reach the maximum possible flight distance. As science club members and “mature” honor students, we were allowed to work independently on our project in the chemistry lab. But we were running out of time—graduation (in June 1958) was only one week away. Under the circumstances, we decided to simplify logistics by doing our second launch right out of the laboratory window—conveniently assuming that nothing could possibly go wrong!

When the time came, we set up the launch pipe at a 45° tilt and ignited the fuel. But instead of the anticipated blast-off, the rocket jammed in the unstable tube and the exhaust gases filled the laboratory. It burned for what seemed an eternity, but probably on the order of a minute. Meanwhile, we scrambled around the room, opening all the windows and turning on the hood fans. This was not effective response, and moreover the chemistry teacher caught us red-handed.

That night, the three rocket musketeers held a clandestine meeting to plan our damage-control strategy, but we had to concede that in all likelihood we’d be expelled. The next day we were tasked with repairing the lab floor, which had been charred from the hot exhaust gases. But to our surprise, we were not summoned to the principal’s office. Every day that week we waited for the call, but nothing! They let us sweat it out right up to the graduation ceremony, in which Dean served, as planned, as valedictorian. The rocket fiasco was apparently forgiven.

So college was still in our future. Dean planned to attend Michigan Tech, with its affordable in-state tuition. His academic horizons broadened, though, when his College Board exam scores landed him a full national merit scholarship and his acing of the Michigan Mathematics Exam resulted in a second scholarship to cover his additional expenses.

Given the distraction of the rocket fiasco, it was only a month after graduation, in July, that Dean belatedly applied to MIT. He was immediately accepted, and the national merit scholarship was increased to reflect MIT's greater costs.

Scientific career

Dean majored in electrical engineering (EE) at MIT and earned his B.S. in 1962. He was naturally attracted to a professor who had a much broader view of EE—encompassing, for example, the scientific understanding of materials used in electronic devices—than the average faculty member. Dean did a senior's project under him on ferrite memory devices and ultimately wrote his B.S. thesis on this topic. Dean then continued his studies in EE by pursuing a master's degree; his thesis addressed high-speed pulse transmission in strip-line arrays. Dean's multiple theses, together with his high grades and participation in class, undoubtedly helped attract the attention of IBM.

At that time, IBM was greatly expanding its R&D efforts, having established the Thomas J. Watson Research Center in 1963. A major part of this expansion was the recruitment of young scientists, recently graduated from top-tier universities, who had been trained to think broadly and who would be willing to tackle problems that eluded solution by standard engineering methods. IBM anticipated that some of these young recruits would join top management later in their careers and help steer the company in the right direction.

Dean, who was doing his doctoral research under a young professor named Frederick Morgenthaler, was seen as an unusually promising prospect in this regard. Thus IBM hired Dean while he was still a graduate student, and it supported him until he finished his PhD. at MIT, whereupon he would come to IBM. Dean's clearly defined research topic (ultrasonic study of magnetoelastic and inelastic properties of yttrium iron garnet) allowed him to finish quickly and move onto a steep career path at IBM.

When Dean arrived at IBM's T. J. Watson Research Center in 1965, a solid-state theory group had just been formed there. These researchers were using large-scale first-principles calculations to probe and predict the electronic structure of solids, starting with metals. Given Dean's interest in the fundamentals of materials, he was attracted to the emerging technique of photoelectron spectroscopy, which he thought would complement the theoretical work.

Dean applied photoelectron spectroscopy to a wide range of topics, pioneering the characterization of electrons in a variety of materials. In addition to bulk materials Dean studied surfaces, using a combination of ultra-high-vacuum technology and ultraviolet photons. Careful control of surfaces enabled him to demonstrate how photoemission could reveal the molecular nature of chemisorbed molecules on a metal surface. [1971, 1974] Since then, such experiments have been used widely to study chemical reactions at surfaces, such as in catalysis. Dean also explored the energy levels at clean surfaces of metals, [1970, 1979b] and semiconductors. [1972] His work on the efficient emission of electrons from the diamond surface has generated continued interest over the years. [1979a] He was particularly interested in magnetism, and he managed to resolve the magnetic exchange splitting, [1978] which causes a material to become ferromagnetic.



To characterize electrons in solids completely, one needs to measure not only their energy but also their momentum (in all three directions). The ultimate goal is to determine the relationship between energy and momentum (often called the energy band dispersion); and angle-resolved photoelectron spectroscopy is uniquely suited to pursuing that goal. Dean designed a special instrument for this purpose, which he called the ellipsoidal mirror display analyzer. [1980]

Dean's device selected not only the energy, but also displayed two components of the momentum simultaneously. The third momentum component was more difficult to obtain [1979b] because it required photons with continuously variable energy. Such photons were provided by using synchrotron radiation, the area in which Dean had arguably his largest impact.

Synchrotron radiation was ideal for photoelectron spectroscopy, given that it was tunable, orders of magnitude brighter than traditional ultraviolet lamps and X-ray tubes, and could produce polarized photons. These features made it possible to extract the complete information about electrons in solids. Dean became widely known for his push toward continuously variable photon energy by means of synchrotron radiation. [1975, 1977, 1981] Because synchrotron radiation was generated by high-energy accelerators

and storage rings, Dean and other early users had to travel to particle physics centers to get access to synchrotron radiation in the so-called “parasitic” mode. Since then, these parasites have overtaken their hosts at several major accelerator labs worldwide. Dean’s efforts in using synchrotron radiation started with a sabbatical to the MIT Cambridge accelerator in 1974.

Dean’s early results played an important role in this reversal by demonstrating the potential of synchrotron radiation. With Frederick Seitz, he cochaired a committee that outlined the future of major facilities for materials research.¹ The committee’s recommendations eventually led to the construction of the Advanced Photon Source and the Advanced Light Source, which respectively became the premier X-ray and ultraviolet light sources in the United States.

Dean’s pioneering experiments made him famous at a young age. He was a sought-after speaker at international conferences, impressing audiences with his magisterial style of presentation and his insights into future research avenues. Moreover, having contributed so much to IBM Research’s reputation as a center of excellence in science and technology, he was named an IBM Fellow—the highest honor that can be bestowed upon an IBM technical employee—in 1974. This status, which comes with substantial freedom and funding to pursue new ideas, allowed Dean to expand his operation in photoelectron spectroscopy by establishing his own IBM beamline at the Tantalus electron storage ring of the Synchrotron Radiation Center (SRC) near Madison, WI.

The IBM beamline, together with beamlines from Bell Labs and collaborations between universities and national labs, attracted researchers from all over the world. Many of them went on to careers in synchrotron radiation, sometimes as leaders of their own synchrotron light sources. The Tantalus storage ring is now a Historic Site of the American Physical Society.² The cartoon by Franco Cerrina characterizes the (mostly) friendly competition between IBM and Bell Labs. It was drawn on the back of a box for graph paper, the standard medium for recording data at the time.

A second cartoon by Franco alludes to Dean’s influential role at the Tantalus storage ring. Ed Rowe, who led the technical development of the SRC, reflects on the name Aladdin, which he gave to Tantalus’s successor.

1 Major Materials Facilities Committee of the Commission on Physical Sciences, Mathematics, and Resources at the National Research Council. 1984. *Major Facilities for Materials Research and Related Disciplines*. Washington, DC: National Academy Press.

2 The Synchrotron Radiation Center (SRC) in Wisconsin: A historic site of the APS. 2018. Online at www.aps.org/programs/outreach/history/historicsites/synchrotron.cfm.

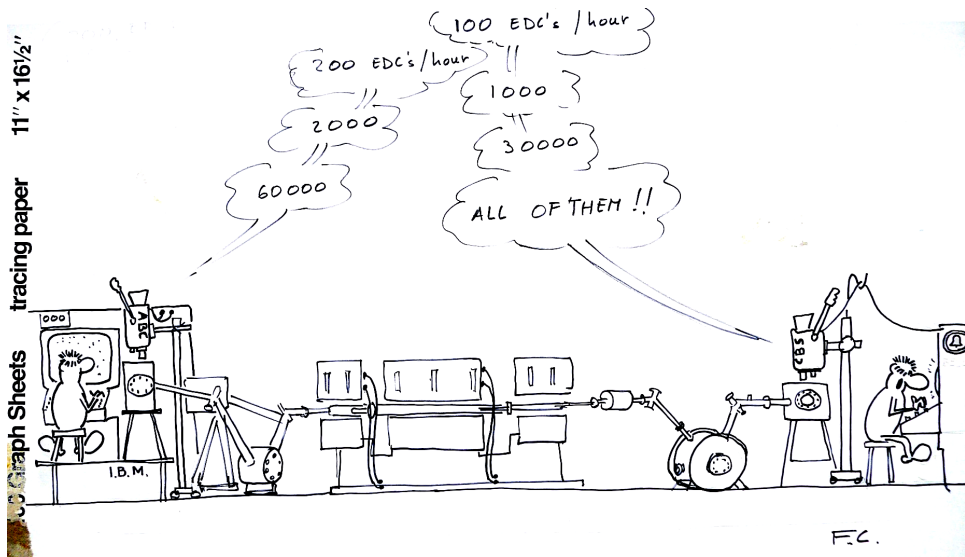


FIG.

In 1980, Dean received the Oliver E. Buckley Prize, the highest honor in solid state physics, which is awarded by the American Physical Society. He shared it with Bill Spicer, his long-time competitor. The two were cited for “their effective development and application of photoelectron spectroscopy as an indispensable tool for study of bulk and surface electronic structure of solids.”



Contributions to IBM’s technology

Having attained worldwide recognition for his scientific work, Dean decided in 1981 to switch from research to technology development—a more direct way, he thought, of contributing to IBM’s business successes. He moved up rapidly in management, simultaneously leading R&D in compound semiconductor devices, lithography, and “packaging” (which refers to the sophisticated manufacturing processes for the assembly of semiconductor chips to build complete computing systems). In 1986, Dean became vice president for logic, memory, and packaging and vice president and director of product development.

Eventually, he moved from the IBM Research Lab at Yorktown Heights, NY, to IBM headquarters at Armonk, NY, where he led the Department of Hardware Development and Reengineering.

As a leader in technology development, Dean took on the enormous challenges facing IBM at the time. And because he pushed farther and harder toward solutions than anyone else, in the end he either won big or lost big.

One such challenge was the development of X-ray lithography for semiconductor manufacturing. [1976] The project addressed a perceived obstacle to the continued miniaturization of digital electronics—the inability of optical lithography to pattern devices with critical dimensions smaller than 1 micrometer. To replace the established optical lithographic tools and processes and deliver the necessary manufacturing throughput, a very bright X-ray source would be necessary.

Dean and his team favored X-ray contact lithography in particular. Under his informed technical leadership and forceful direction, they assembled, tested, and largely demonstrated a compact synchrotron source at IBM's East Fishkill (NY) manufacturing site. However, a series of innovations, some unforeseen, extended the established optical lithographic processes far beyond 1 micrometer to today's critical dimensions measured in tens of nanometers. While X-ray contact lithography had some important niche applications, it never much contributed to the development of digital electronics or to IBM's business.

By contrast, Dean's forceful advancement of another exploratory project had great positive impact for IBM. The enterprise began when one of the authors (TNT) briefed Dean on test results indicating that in the scientific and technical computing arena, IBM's new engineering workstations based on the emerging RISC (reduced instruction set computing) architecture, could deliver some 60 percent of the performance of IBM's mainframes at about 5 percent of the cost. Within days, Dean had assembled a small team of semiconductor packaging experts, led by Janusz Wilczynski, to prototype a high-performance scientific computer based on harnessing many RISC processors in a modularly expandable system.

Thinking Machines, a noted company at the time, was already selling scientific supercomputers which harnessed multiple processors, but these were based on expensive proprietary processor designs. The IBM team used workstation processors that were manufactured in high volume and thus had a low per-unit cost.

With Dean's encouragement and support, a prototype piece of hardware was very quickly built, and this helped to kick-start a larger effort within the IBM Research Division. Selling the concept to the product divisions as well as potential customers was an uphill battle involving many people over several years, but the inexpensive modular architecture gradually prevailed. The company's ultimate influence in this arena may be seen by the racks of interchangeable computers that now fill every modern server center. The crash execution of the kick-start project and its contribution to a greater success set a precedent for other IBM researchers confronting the company's looming financial crisis of the early 1990s. Their attitude was: Be bold, and you can make a difference!

Years before, Dean had foreseen some of the company's looming problems and voiced his conviction that extraordinary measures would be necessary to address them. In particular, he understood that the exponentially compounding miniaturization of semiconductor electronic devices would greatly reduce the part count for even the most complex and powerful computing systems. He predicted that this development would reduce the value of IBM's lead in chip-packaging technology and render much of the associated manufacturing capacity extraneous. When Dean was appointed director of hardware development and reengineering in 1994, reporting to CFO Jerry York at corporate headquarters, his job was to identify and develop plans to address this new direction and other structural problems that plagued the company. Where other executives hesitated, Dean usually prescribed action, and he was very effective in this role.

In 1996, Dean was tapped by the U.S. Department of Energy to lead the Argonne National Laboratory. But his attempt to transfer IBM's management and budgeting practices to a national lab did not go over well with its managers. He left in 1998 to start a second career in science as professor of physics at the James Franck Institute of the University of Chicago. In a return to his past, he initiated a synchrotron radiation experiment at the SRC with one of the authors (FJH), this time at the Aladdin storage ring. Dean impressed the old-timers with his attention to the details of the experiment, making valuable suggestions to improve the setup. But by now he was preoccupied by his new challenge in life, the renovation of Frank Lloyd Wright's Coonley House. The last time he came to Madison was not for a physics experiment but for an invited talk at a conference about preserving Wright's buildings (famous for their beauty and infamous for their poor construction).

Second career: Renovating Frank Lloyd Wright's Coonley House

Dean was not only a physicist; he was an engineer who liked designing things, particularly buildings. The Coonley estate wasn't his first building project. At age 12 he built a small barn for his father, and he was hooked. Dean would later move into ever-larger houses in need of repair and completely redo them, waxing especially proud when he managed to improve on a contractor's design. Eventually he would oversee building projects at homes in New York, Maine, and Chicago.



Dean's ultimate challenge was the Coonley House in Riverside, a suburb of Chicago. This was a masterpiece of Frank Lloyd Wright's Prairie Style, but it had fallen into disrepair. Dean's restoration earned him the admiration and praise of preservationists, and the 2004 Wright Spirit Award from the Frank Lloyd Wright Building Conservancy. Dean and his wife Ella Mae purchased the "public wing" of the sprawling former estate in 2000 and spent four years restoring it with exquisite attention to detail, as in chasing down old photographs of the original

design, obtaining a chemical analysis of the original paint, and dealing with the onerous constraints encountered and permits required for renovating a building listed in the National Register of Historic Places. Dean actually lived near the construction site for quite some time in order to monitor progress and be available for quick decisions. In a kind of victory lap, but primarily to reveal the secrets of his success for the benefit of other such projects, Dean wrote a book about his restoration efforts. [2014]

Personal traits

Dean really liked cars. After he moved to a house with a three-car garage, he started collecting them. First a truck, then a big white Cadillac convertible with a huge engine, a Camaro (with a comparable engine), a BMW, and a classic Corvette. There was also a newer Corvette model, which he purchased because it was a deal he could not pass up. (Dean was always keenly conscious of value, and a lover of bargains.)

One of the authors (JED) once borrowed Dean's truck to pick up some nursery supplies and almost drove it off the road. As he belatedly learned from Dean, the gas pedal would stick in the "on" position when making a hard-right turn. On another occasion, Dean loaned his Camaro to a postdoc who got lost in the wilds of Westchester. He was



nervously watching the gas gauge approaching zero and barely made it back.

Riding on the Interstate with Dean in his BMW could be a precarious experience. He always had a sensitive radar detector on his dashboard, and while cruising at high speed he would quickly break whenever there was the slightest alert. His passengers would worry about getting rear-ended. But this was not an issue, because he was going so fast. Dean also had the unsettling habit of facing his passengers when talking to them during a drive—even those in the rear seats.

Colleagues and students always enjoyed the annual Christmas party hosted by Dean and Ella Mae. Everyone remembers the steep tiers of cement steps that led from the driveway up to the house. Because Dean was becoming a wine connoisseur, he always had a variety of excellent wines for that event. After an evening of celebration, it was a miracle that none of us hurt ourselves on our way down the steps.

Dean was a lighthearted and jovial person, but he could intensely focus on a technical problem or a managerial issue. He could be a demanding manager, but also took time to provide detailed suggestions on how to accomplish a task. He appreciated smart people who worked hard and helped their careers in various ways “Picking smart people’s brains” was his efficient way of becoming familiar with the gist of a new topic. He quickly grasped the heart of a problem and was articulate in stating it. Dean also was an excellent writer and speaker; he expressed things clearly and with uncanny insight.

CAREER SUMMARY

1940 Born in Oxford, Wisconsin

1962 B.S. in electrical engineering, Massachusetts Institute of Technology (MIT)

1963 M.S. in electrical engineering, MIT

1965 Ph.D. in electrical engineering, MIT

1963–1996 with International Business Machines Corporation (IBM), New York

Researcher, Research Division (1963–1971)

Manager, photoemission and surface physics, Research Division (1971–1981)

Manager, lithography, packaging, and compound semiconductor technology (1981–1982)

Director, Advanced Packaging Laboratory (1983–1985)

Vice president for logic, memory, and packaging (1986–1994)

Vice president and director of product development (1986–1994)

Director, hardware development and reengineering, IBM Headquarters (1994–1996)

1972–1973 Visiting professor, MIT

1996–1998 Director, Argonne National Laboratory

1998–2018 Professor (emeritus) of physics, James Franck Institute, University of Chicago

2018 Passed away at the age of 78, following a massive stroke.

HONORS

1958 National Merit Scholarship and Michigan Math Scholarship

1974 IBM Fellow

1980 Oliver E. Buckley Condensed Matter Prize, American Physical Society

1981 Fellow, American Physical Society

1982 Member, National Academy of Sciences

1988 Member, National Academy of Engineering

1991 Fellow, American Academy of Arts and Sciences

2004 Wright Spirit Award from the Frank Lloyd Wright Building Conservancy

Honorary member of the American Institute of Architects

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