REYNOLD B. JOHNSON

1906–1998

BY ARTHUR O. ANDERSON

REYNOLD B. JOHNSON, International Business Machines Corporation Fellow, long-time IBM employee, prolific inventor, and president of Education Engineering Associates, died in Palo Alto, California, on September 15, 1998. His leadership earned him national recognition in test scoring machinery and random access disk files and a determining role in the building of IBM West Coast Research and Development.

Rey was born near Dassel, Minnesota, on July 7, 1906, ninth of ten children, with seven sisters and two brothers. His father and mother, John and Elizabeth, were Swedish immigrants, and Rey was raised on a farm, where from the beginning he showed a keen mechanical talent. At an early age he built a submersible submarine, which he exhibited in the horse trough. After completion of his early schooling in Dassel, Rey attended and graduated from the Minnehaha Academy High School in Minneapolis. His older sisters are said to have taken a keen interest in his education.

He then went on to the University of Minnesota, where he received a bachelor of science degree in (science) education administration in 1929. He completed his degree with a strong conviction that measurement of educational performance was critical to teaching. He obtained his first job at Ironwood High School on the Michigan Peninsula, where he taught mathematics and science.

Having entered teaching with those strong convictions about testing, Rey soon began to review his and fellow teachers' textbooks and their quizzes with the belief that there must be a way to automate the grading task. His first experiments and models made use of holes that students could punch out on perforated test sheets combined with an electrical contact system that switched on lights where answers had been correctly identified. While carrying this idea to application in a potential product, with the investment of much time and effort, he suddenly remembered that pencil marks are conductive and discarded the first path in favor of a better approach using pencil marks to identify the correct answer on the test sheet. This experience of a better idea making obsolete a good idea underlies his subsequent insistence that all possible solutions to a problem must be examined to find the best solution. Critical to his "machine" in its earliest stages was the use of close tolerance, separate answer sheets where pencil marks could be read by machine within wide tolerances for the resistance of the pencil marks themselves. All this testing and modeling was taking place while Rey was teaching school. In 1933 he lost his job as the school was scaled back to a depression era budget. The next many months were hard times even though his ideas had attracted national attention. His efforts were assisted by his fiancée, Bea, who became his wife.

Fortunately, Professor Wood at Columbia University, head of the Bureau of Education Research, and Thomas J. Watson, president of IBM, had built a strong relationship, starting in 1929, based on Columbia's desire to use accounting and punch card machinery in education and research and on Watson's belief that these desires should be supported through the donation of machines and talent. Wood was a proponent of automatic testing and had been working with IBM, unsuccessfully, to design a machine for this purpose. Rey knew of Wood's interest in testing and was able to provide a description and a model for him. Wood informed Watson that the concepts were sound. Rey and Bea were brought to New York City for the evaluation of his ideas and his model. After weeks of discussion, and while Watson was on vacation, Rey was informed that an analysis showed that his

concepts were not acceptable. While Rey prepared to demonstrate that the analysis was incorrect, Wood took a different route and called Watson to inform him that IBM was about to make a mistake. However, the concepts were still sound. Shortly thereafter, IBM purchased Rey's invention and hired the unemployed high school teacher as a senior engineer in Endicott, New York. The test scoring machine, the IBM 805, was announced in 1937. Rey went on to a prolific career in Endicott, where he had fifty-three patents, mostly in the area he called input, before leaving for San Jose, California, in 1951.

Rey was approached that year with an offer, that was to change his life and work and to have a major impact on IBM and the computing world. He was asked to move to California to head a new laboratory where IBM would have a better chance to hire the engineers needed to move into the technical areas just being established and to provide closer contact with IBM's most innovative customers. Rey was given a charter to define his own programs so long as they did not duplicate the programs of others and he was expected to devote some of his efforts to adapting IBM machines to special customer needs. With Rey's background in data input, then mainly punched cards, programs were soon directed at means of automating the input function. The massive input data source he addressed was the punched-card tub file from which, for each transaction, cards were pulled identifying customer, inventory, pricing and so forth for subsequent punch card processing. The tub file was that eras' data source with random access to the data. Many configurations were addressed for machine access to stored data. They included magnetic data storage on rigid rotating disks, on drums, on tape strips, and on wires. Early in the life of the new lab, Rey became convinced that disks offered significant advantages over the other alternatives and, despite obvious unsolved problems, directed the laboratory in that direction. His belief in the inventive capabilities of his staff was rewarded when in a relatively short time, from present perspectives, air bearings were providing close spacings to rotating (and wobbling) disks, the electronics of read-write heads was taking shape, and the disk and its magnetic coating were in early definition. The new disk file was then defined

as a five million-character machine, and the IBM 350 Random Access Method of Accounting and Control was established.

The product was transferred from Rey's lab to a new development lab and subsequently was shipped in 1956, with a total volume of 1,000. The product did what it was intended to do, replacing the tub file system. But it had become clear that a new era had dawned with this introduction of a transaction processing system. From those early beginnings, the pressure for rapid evolution the disk file and its components were on. The improvements in the technology since that time have provided the storage and access to storage underlying the modern computer with its large databases, formidable operating systems, and extensive application programs.

In Rey's laboratory there were many other activities aimed in various ways at input of data or response to human beings. These activities included analog-to-digital conversion projects, nonimpact printing, voice recognition, communication technology, and somewhat later projects directed toward random access to image files to replace paper files. Although storage for image files was on film of one sort or another, the drive to automate showed Rey's continued devotion to solving problems involving large data input and information retrieval. As a special effort an image file, dramatically modified and extended, was used to produce a random access trillion-bit file system. Rey's early establishment of Random Access Method of Accounting and Control (RAMAC) follow-on programs, his laboratory's continued innovation, his building of technical capabilities, and his address to new problems made his laboratory a challenging and exciting place in which to work. He insisted on open communications across projects, cheerful and extensive help when asked, thorough examination of alternatives, and respect for all ideas. He built an environment of cooperation across technical boundaries and inspired a research-development relationship that has served IBM well.

Rey turned over a part of his laboratory to research in 1959 as he formed a new Advanced Systems Development Laboratory. Both laboratories grew from that point, the research lab carrying on many of his interests in advanced support of storage,

nonimpact printing, and physical sciences. The new laboratory continued the exploration of his many “new territory” exploratory developments. In 1965 Rey was made an IBM Fellow. He then devoted himself to concepts, such as a learning center which developed the form factor for the present videocassette, which he felt could have an impact on education. After retirement he and his wife, Bea founded Education Engineering Associates and explored numerous ideas, including a small plastic disk that could be built into books and read by a handheld reader to supplement reading in textbooks with audio, could be used to play bird sounds for bird watcher books, or could be used for reading and talking language books; the *Talk to Me Books* microphonograph was acquired by Fisher Price. One of Rey's last projects was a Chinese-language typewriter. His inventions continued throughout his career in IBM and after, with the total number running into the nineties and with the span varying from test scoring to Data Recording to Education Systems.

Reynold B. Johnson believed in being a member of organizations that supported his many and varied interests. These included professional societies, educational societies, and civic societies, including the National Academy of Engineering, the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers (IEEE), the American Education Association, Association for Education Data Systems, the Commonwealth Club of San Francisco, and the Silicon Valley Engineering Council.

Rey was elected to the National Academy of Engineering in 1981. He received numerous awards for his work, including the president's National Medal of Technology in 1986, the Founder's Gold Medal from the Educational Records Bureau in 1997, the Computer Pioneer Award from the IEEE in 1987, and the Magnetics Society Award for Information Storage in 1989.

Reynold B. Johnson is survived by his wife, Beatrice; sons, Philip and David; four grandchildren; two great-grandchildren; a sister; and two brothers. The original farm is still run within the family.