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Donald Knuth Biography

Donald Knuth was born on January 10, 1938 in Milwaukee, Wisconsin. His parents were Ervin Knuth and Louise Marie Bohning. His father, a church organist and a teacher at a Lutheran high school, played a very important role in determining Donald’s interests. Donald attended Milwaukee Lutheran High School, the same Lutheran high school where his father taught. During his attendance, he applied his intelligence in unusual ways, including winning a contest created by Ziegler, a confectionary manufacturer. The objective of the competition was to determine the most words that could be formed from the letters in “Ziegler’s Giant Bar”. While the judges only had about 2500 words on their answer list, Donald found over 4500. Despite this accomplishment, his high school interests were more directed towards music and English than they were mathematics. But, he did not neglect his other school subjects. He graduated from high school in 1956, with the highest grade point average ever achieved at Milwaukee Lutheran High School, and received a scholarship to Case Institute of Technology, to study physics. It was not until his first year at Case that he had his first encounter with computers. Although Donald Knuth was undecided about the direction in which he would take his studies during his youth, he would quickly develop his passion for mathematics and programming at Case, and become one of the world’s leading computer scientists and mathematicians.

During his freshman year, Donald Knuth was convinced by a mathematics professor to switch majors from physics to mathematics. Although at he feared that he would not pass, Knuth discovered that his mathematical skills exceeded those of the other students. Given his abilities, he began to make the move towards mathematics, and would quickly develop a passion for it. During this time, Knuth also developed an interest towards programming, when he encountered the IBM 650. He used the computer’s manual to quickly master the inner workings of the machine and began writing programs. Knuth stated, “... the manual we got from IBM would show examples of programs and I knew I could do ... better than that. So, I thought I might have some talent” (1). Utilizing his growing programming and mathematical knowledge, Knuth developed a program to analyze the performance of the Case basketball team, earning him publicity. Knuth graduated from Case in 1960 with a Bachelor of Science in mathematics, and was awarded a Master of Science as well for his outstanding performance. “Knuth was so good at mathematical studies at Case that the faculty awarded him an M.S. in mathematics when he finished his B.S. work” (3). In the year of his graduation, Knuth was presented two fellowships: a Woodrow Wilson Fellowship and a National Foundation Fellowship. In 1960, Knuth began attending the California Institute of Technology to earn his Doctor of Philosophy in mathematics.

During his time as a doctoral student, Knuth began writing compilers for different computers. Knowledge of his computer expertise became well-known, which launched his career as an author. “The word got around that he knew a lot about compilers, and in January 1962, in his second year at Cal Tech, Addison-Wesley asked him to write a book on compilers. He sketched 12 chapters and signed a contract” (3). In 1963, Knuth earned his PhD in mathematics, and continued work on his book on compilers. The book on compilers would later evolve into Volume 1 of *The Art of Computer Programming*, which was published in 1968. After the publication of Volume 1, his work on the project did not cease. He published Volume 2 the following year, and Volume 3 in 1963. Although the project started as a book on compilers, it later emphasized the use of mathematics in the analysis of algorithms. Knuth stated that he wanted the books to “... organize and summarize what is known about the fast subject of computer methods and to give it firm mathematical and historical foundations.... show that the connection between computers and mathematics is far deeper and more intimate than these traditional relationships would imply” (1). Knuth succeeded in his intentions, and the *The Art of Computer Programming* had a significant impact on the world of commuting. In 1974, he was awarded the Turing Award for his work. Although Knuth has stated “…that developing analysis of algorithms as an academic subject is his proudest achievement” (3), he became irritated with the poor quality of typography planned for a forthcoming new Volume of *The Art of Computer Programming.* His frustration led to his invention of a new, reformed typesetting language for scientific and mathematical texts.

In 1977, Knuth began development on his new typesetting system, which became known as TeX and METAFONT. The objective of Knuth’s typesetting and font design was to achieve “…the finest quality printed documents”, and to create “…a system that would be archival in the sense that it was independent of changes in printing technology to the maximum extent possible” (3). With help from his Stanford colleagues, Knuth developed the TeX typesetting engine, the METAFONT font design system, and the Computer Modern set of type fonts, which revolutionized digital typsetting. After becoming open-source, the system became widely adapted by commercial typsetting systems. Soon, there was an international community of developers, contributors, and users for TeX and TeX related systems, which had a profound influence on the open-source software movement. Today, TeX is used to produce most of the worlds scientific literature in mathematics and physics. But, during the extensive development of *The Art of Computer Programming*, TeX, and beyond, Knuth made many other contributions to computing and mathematics as well, including the creation of multiple groundbreaking algorithms.

In 1970, Knuth published a fundamental algorithm with his student Peter Bendix, known as the Knuth-Bendix algorithm, for solving the word problem in algebraic system. In 1977, another fundamental algorithm, which Knuth contributed to, was published: the Knuth-Morris-Pratt string searching algorithm. The Knuth-Morris-Pratt algorithm revolutionized pattern matching in strings, by bypassing previously matched characters. In 1965, he introduced the development of LR(k) parsing, which proficiently handles deterministic, context-free languages in linear time. Knuth writes, “LR(k) grammars…provide the basis for understanding all of the special tricks which have been used in the construction of parsing algorithms for languages with simple structure...” (1). These concepts introduced fundamental methods of data processing which had a significant influence on the development of other algorithms.

Donald Knuth revolutionized the world of mathematics and computing, and is one of the most influential and distinguished computer scientists of our time. His research papers, which effectively balance theory and practice, played a fundamental role in establishing numerous areas of software engineering and computer science. For his remarkable contributions throughout his life, he has received various honors and awards including the Turing Award, the Kyoto Prize, the National Medal of Science, the John von Neumann Medal, and Stanford University School of Engineering Hero Award. In addition, he has received honorary degrees and doctorates from more than a dozen institutions around the world including Waterloo University, Harvard University, Oxford University, Concordia University. In 2015, Knuth was granted an honorary membership into the London Mathematical Society. Upon his election, the society stated, “Professor Knuth is one of the world's greatest computer scientists, whose works have had a profound influence on the subject over the past half-century. His research covers diverse areas of mathematics and computer science…” (2). Without Donald Knuth and his remarkable contributions to the world, the history of computing and mathematics would have been significantly different.

Works Cited

[1] Knuth, E Donald, in D J Albers and G L Alexanderson (eds.), Mathematical People: Profiles and Interviews (Boston, 1985), 183-203.

[2] O'Connor, JJ, and EF Robertson. "Donald Ervin Knuth." MacTutor History of Mathematics Archive. JOC/EFR, Oct. 2015. Web. 26 July 2017.

[3] Walden, David. "Donald ("Don") Ervin Knuth." Donald E. Knuth - A.M. Turing Award Winner. Association for Computing Machinery, 2012. Web. 26 July 2017.