## Edsger Wybe Dijkstra: An influence in Software Engineering

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Edsger Wybe Dijkstra was born on May 11th 1930, in the city of Rotterdam in the Netherlands. His father, Douwe Wybe Dijkstra, was the president of the Dutch Chemical Society, and his mother, Brechtje Cornelia Kluijver, was a trained mathematician. Initially he was interested in pursuing a career in law. He was later convinced by his parents to pursue a career in science when he scored the highest possible marks in mathematics, physics, chemistry, and biology in his final school exams. He studied mathematics and physics at the University of Leiden in the Netherlands due to his interest in theoretical physics. In 1951 Dijkstra went on a three-week long computer programming course in the University of Cambridge in England, where he met Adriaan Van Wijngaarden. Van Wijngaarden was the director of the Computation Department of Mathematisch Centrum (now called Centrum Wiskunde & Informatica) in Amsterdam. Having done the same course the previous year, Van Wijngaarden offered Dijkstra a job as a programmer at Mathematisch Centrum. He accepted and chose to work at Mathematisch Centrum part time as he completed his studies. Here Dijkstra’s interest in programming developed, leading him to choose a career in programming instead of theoretical physics when he graduated in 1956.

In 1956 the Mathematisch Centrum were building a computer called “Automatische Rekenmachine Mathematisch Centrum” (ARMAC) and needed to give a public demonstration. Dijkstra realised that for the demonstration to work it had to have a problem that normal, everyday people would be able to understand. This led him to design a programme that would calculate the shortest distance between two cities in the Netherlands. This was achieved using a downsized map of the Netherlands on which he had chosen sixty-four cities. He later published the shortest distance algorithm “Dijkstra’s algorithm” in 1959, in a paper he entitled “A Note on Two Problems in Connexion with Graphs”. In the same year he earned his PhD for his thesis “Communication with an Automatic Computer”. “A Note on Two Problems in Connexion with Graphs” is one of the most cited papers in computer science. This paper and algorithm have had a significant impact on the world of computer science, and the world in general. It remains a huge part of Global Positioning System navigation for finding the shortest route from one location to another. It is used in routing protocols which provides the shortest cost path from the source router to other routers in the network. Its use can even be seen in social media algorithms which identify potential friends based on close or mutual contacts.

Another project Dijkstra worked on was “Algorithmic Language 1960*”* (ALGOL 60). ALGOL 60 was a programming language designed by a group of international programmers in the late 1950s. Although Dijkstra made several major contributions including the introduction of recursion, Dijkstra was not credited as an author of the final report. This was due to him leaving committee as he did not agree with several majority opinions. Following this, he went on to write the first ALGOL 60 compiler using a new method for implementing recursion with Jaap Zonneveld, a colleague from Mathematisch Centrum in Amsterdam. Dijkstra authored a short book entitled “A Primer of ALGOL 60 Programming” which was the standard reference for ALGOL 60 at the time, which was used mostly by research computer scientists in the United States and Europe.

Dijkstra became a Professor of Mathematics at Eindhoven University of Technology. At that time, there was no computer science department. Dijkstra created a team of computer scientists within the Mathematical Department. With this group, Dijkstra wrote an operating system called “Technische Hogeschool te Eindhoven” (THE) which was named after the university. The THE operating system had a layered functional structure meaning that the higher layers relied only on the lower layers. It was working on this that led Dijkstra to become interested in parallel programs as THE was an early example of parallel programming. In the early 1960s parallel programming had not been greatly explored, with problems such as deadlocking and interspersed data not being properly analysed. Dijkstra published a paper in which he talked about a synchronization problem, which he called the mutual exclusion problem. He also identified the deadlock problem and illustrated it in the “Dining Philosophers Problem” in 1971. He talked about five philosophers at a table eating spaghetti and sharing five forks, but the philosophers each needing two forks to eat. This example was a great visualisation of how deadlock could occur and has become a common visualisation in the teaching of deadlocks.

In 1972 Dijkstra received the Turing Award from the Association for Computing Machinery, which is considered the most prestigious prize in computer science and is often referred to as the Nobel Prize of Computing. This was in recognition of his “fundamental contributions to programming as a high, intellectual challenge”, for “eloquent insistence and practical demonstration that programs should be composed correctly, not just debugged into correctness”, and for “illuminating perception of problems at the foundations of program design”. Dijkstra became a Research Fellow for the Burroughs Corporation and was honoured with the title of Professor Extraordinarius at Eindhoven. While he mainly worked from his home in Nuenen, his fellowship for Burroughs required him to visit several of the company’s research centres, including the Burroughs Research Centre in Austin, Texas. He became familiar with the Computer Science department at the University of Texas, who later offered him a position in 1984. He moved to America with his wife and children, where he worked in the university until he retired in 1999. He died of cancer on the 6th of August 2002 in Nuenen. Titles held at the time of death included, Foreign Honorary Member of the American Academy of Arts and Sciences, Member of the Royal Netherlands Academy of Arts and Sciences (KNAW), Doctor Honoris Causa from both Queen’s University Belfast in Northern Ireland and the Athens University of Economics and Business in Greece. Throughout his expansive career, Dijkstra contributed hugely to the fields of software engineering and computer science, which has dramatically shaped the world we live in today.

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