

= Richard Hamming =

Richard Wesley Hamming (February 11 , 1915 ? January 7 , 1998) was an American mathematician whose work had many implications for computer engineering and telecommunications . His contributions include the Hamming code (which makes use of a Hamming matrix) , the Hamming window , Hamming numbers , sphere @-@ packing (or Hamming bound) , and the Hamming distance .

Born in Chicago , Hamming attended University of Chicago , University of Nebraska and the University of Illinois at Urbana @-@ Champaign , where he wrote his doctoral thesis in mathematics under the supervision of Waldemar Trjitzinsky (1901 @-@ 1973) . In April 1945 he joined the Manhattan Project at the Los Alamos Laboratory , where he programmed the IBM calculating machines that computed the solution to equations provided by the project 's physicists . He left to join the Bell Telephone Laboratories in 1946 . Over the next fifteen years he was involved in nearly all of the Laboratories ' most prominent achievements .

After retiring from the Bell Labs in 1976 , Hamming took a position at the Naval Postgraduate School in Monterey , California , where he worked as an Adjunct Professor and senior lecturer in computer science , and devoted himself to teaching and writing books . He delivered his last lecture in December 1997 , just a few weeks before he died from a heart attack on January 7 , 1998 .

= = Early life = =

Richard Wesley Hamming was born in Chicago , Illinois , on February 11 , 1915 , the son of Richard J. Hamming , a credit manager , and Mabel G. Redfield . He grew up in Chicago , where he attended Crane Technical High School and Crane Junior College .

Hamming initially wanted to study engineering , but money was scarce during the Great Depression , and the only scholarship offer he received came from the University of Chicago , which had no engineering school . Instead , he became a science student , majoring in mathematics , and received his Bachelor of Science degree in 1937 . He later considered this a fortunate turn of events . " As an engineer , " he said , " I would have been the guy going down manholes instead of having the excitement of frontier research work . "

He went on to earn a Master of Arts degree from the University of Nebraska in 1939 , and then entered the University of Illinois at Urbana @-@ Champaign , where he wrote his doctoral thesis on Some Problems in the Boundary Value Theory of Linear Differential Equations under the supervision of Waldemar Trjitzinsky . His thesis was an extension of Trjitzinsky 's work in that area . He looked at Green 's function and further developed Jacob Tamarkin 's methods for obtaining characteristic solutions . While he was a graduate student , he discovered and read George Boole 's The Laws of Thought .

The University of Illinois at Urbana @-@ Champaign awarded Hamming his Doctor of Philosophy in 1942 , and he became an Instructor in Mathematics there . He married Wanda Little , a fellow student , on September 5 , 1942 , immediately after she was awarded her own Master of Arts in English literature . They would remain married until his death , but had no children . In 1944 , he became an Assistant Professor at the J.B. Speed Scientific School at the University of Louisville in Louisville , Kentucky .

= = Manhattan Project = =

With World War II still ongoing , Hamming left Louisville in April 1945 to work on the Manhattan Project at the Los Alamos Laboratory , in Hans Bethe 's division , programming the IBM calculating machines that computed the solution to equations provided by the project 's physicists . His wife Wanda soon followed , taking a job at Los Alamos as a human computer , working for Bethe and Edward Teller . Hamming later recalled that :

Shortly before the first field test (you realize that no small scale experiment can be done ? either you have a critical mass or you do not) , a man asked me to check some arithmetic he had done ,

and I agreed , thinking to fob it off on some subordinate . When I asked what it was , he said , " It is the probability that the test bomb will ignite the whole atmosphere . " I decided I would check it myself ! The next day when he came for the answers I remarked to him , " The arithmetic was apparently correct but I do not know about the formulas for the capture cross sections for oxygen and nitrogen ? after all , there could be no experiments at the needed energy levels . " He replied , like a physicist talking to a mathematician , that he wanted me to check the arithmetic not the physics , and left . I said to myself , " What have you done , Hamming , you are involved in risking all of life that is known in the Universe , and you do not know much of an essential part ? " I was pacing up and down the corridor when a friend asked me what was bothering me . I told him . His reply was , " Never mind , Hamming , no one will ever blame you . "

Hamming remained at Los Alamos until 1946 , when he accepted a post at the Bell Telephone Laboratories (BTL) . For the trip to New Jersey , he bought Klaus Fuchs 's old car . When he later sold it just weeks before Fuchs was unmasked as a spy , the FBI regarded the timing as suspicious enough to interrogate Hamming . Although Hamming described his role at Los Alamos as being that of a " computer janitor " , he saw computer simulations of experiments that would have been impossible to perform in a laboratory . " And when I had time to think about it , " he later recalled , " I realized that it meant that science was going to be changed " .

= = Bell Laboratories = =

At the Bell Labs Hamming shared an office for a time with Claude Shannon . The Mathematical Research Department also included John Tukey and Los Alamos veterans Donald Ling and Brockway McMillan . Shannon , Ling , McMillan and Hamming came to call themselves the Young Turks . " We were first @-@ class troublemakers , " Hamming later recalled . " We did unconventional things in unconventional ways and still got valuable results . Thus management had to tolerate us and let us alone a lot of the time . "

Although Hamming had been hired to work on elasticity theory , he still spent much of his time with the calculating machines . Before he went home on one Friday in 1947 , he set the machines to perform a long and complex series of calculations over the weekend , only to find when he arrived on Monday morning that an error had occurred early in the process and the calculation had errored off . Digital machines manipulated information as sequences of zeroes and ones , units of information that Tukey would christen " bits " . If a single bit in a sequence was wrong , then the whole sequence would be . To detect this , a parity bit was used to verify the correctness of each sequence . " If the computer can tell when an error has occurred , " Hamming reasoned , " surely there is a way of telling where the error is so that the computer can correct the error itself . "

Hamming set himself the task of solving this problem , which he realised would have an enormous range of applications . Each bit can only be a zero or a one , so if you know which bit is wrong , then it can be corrected . In a landmark paper published in 1950 , he introduced a concept of the number of positions in which two code words differ , and therefore how many changes are required to transform one code word into another , which is today known as the Hamming distance . Hamming thereby created a family of mathematical error @-@ correcting code , which are called Hamming codes . This not only solved an important problem in telecommunications and computer science , it opened up a whole new field of study .

The Hamming bound , also known as the sphere @-@ packing or volume bound is a limit on the parameters of an arbitrary block code . It is from an interpretation in terms of sphere packing in the Hamming distance into the space of all possible words . It gives an important limitation on the efficiency with which any error @-@ correcting code can utilize the space in which its code words are embedded . A code which attains the Hamming bound is said to be a perfect code . Hamming codes are perfect codes .

Returning to differential equations , Hamming studied means of numerically integrating them . A popular approach at the time was Milne 's Method , attributed to Arthur Milne . This had the drawback of being unstable , so that under certain conditions the result could be swamped by roundoff noise . Hamming developed an improved version , the Hamming predictor @-@ corrector .

This was in use for many years , but has since been superseded by the Adams method . He did extensive research into digital filters , devising a new filter , the Hamming window , and eventually writing an entire book on the subject , Digital Filters (1977) .

During the 1950s , he programmed one of the earliest computers , the IBM 650 , and with Ruth A. Weiss developed the L2 programming language , one of the earliest computer languages , in 1956 . It was widely used within the Bell Labs , and also by external users , who knew it as Bell 2 . It was superseded by Fortran when the Bell Labs ' IBM 650 were replaced by the IBM 704 in 1957 .

In A Discipline of Programming (1967) , Edsger Dijkstra attributed to Hamming the problem of efficiently finding regular numbers . The problem became known as " Hamming 's problem " , and the regular numbers are often referred to as Hamming numbers in Computer Science , although he did not discover them .

Throughout his time at Bell Labs , Hamming avoided management responsibilities . He was promoted to management positions several times , but always managed to make these only temporary . " I knew in a sense that by avoiding management , " he later recalled , " I was not doing my duty by the organization . That is one of my biggest failures . "

= = Later life = =

Hamming served as president of the Association for Computing Machinery from 1958 to 1960 . In 1960 , he predicted that one day half of the Bell Lab 's budget would be spent on computing . None of his colleagues thought that it would ever be so high , but his forecast actually proved to be too low . His philosophy on scientific computing appeared as the motto of his Numerical Methods for Scientists and Engineers (1962) :

The purpose of computing is insight , not numbers .

In later life , Hamming became interested in teaching . Between 1960 and 1976 , when he left the Bell labs , he held visiting or adjunct professorships at Stanford University , the City College of New York , the University of California at Irvine and Princeton University . As a Young Turk , Hamming had resented older scientists who had used up space and resources that would have been put to much better use by the young Turks . Looking at a commemorative poster of the Bell Labs ' valued achievements , he noted that he had worked on or been associated with nearly all of those listed in the first half of his career at Bell Labs , but none in the second . He therefore resolved to retire in 1976 , after thirty years .

In 1976 he moved to the Naval Postgraduate School in Monterey , California , where he worked as an Adjunct Professor and senior lecturer in computer science . He gave up research , and concentrated on teaching and writing books . He noted that :

The way mathematics is currently taught it is exceedingly dull . In the calculus book we are currently using on my campus , I found no single problem whose answer I felt the student would care about ! The problems in the text have the dignity of solving a crossword puzzle ? hard to be sure , but the result is of no significance in life .

Hamming attempted to rectify the situation with a new text , Methods of Mathematics Applied to Calculus , Probability , and Statistics (1985) . In 1993 , he remarked that " when I left BTL , I knew that that was the end of my scientific career . When I retire from here , in another sense , it 's really the end . " And so it proved . He became Professor Emeritus in June 1997 , and delivered his last lecture in December 1997 , just a few weeks before his death from a heart attack on January 7 , 1998 . He was survived by his wife Wanda .

= = Awards and professional recognition = =

Turing Award , Association for Computing Machinery , 1968 .

IEEE Emanuel R. Piore Award , 1979 .

Member of the National Academy of Engineering , 1980 .

Harold Pender Award , University of Pennsylvania , 1981 .

IEEE Richard W. Hamming Medal , 1988 .

Fellow of the Association for Computing Machinery , 1994 .

Basic Research Award , Eduard Rhein Foundation , 1996 .

The IEEE Richard W. Hamming Medal , named after him , is an award given annually by the Institute of Electrical and Electronics Engineers (IEEE) , for " exceptional contributions to information sciences , systems and technology " , and he was the first recipient of this medal . The reverse side of the medal depicts a Hamming parity check matrix for a Hamming error @-@ correcting code .

= = Appearances = =

Hamming discusses the use and potential of computers in the 1965 film Logic By Machine .