Alan Mathison Turing

Born June 23, 1912, London, England; died June 7, 1954, Manchester, England, creator of the concept of the "universal machine," the concepts of early computational machines, and computer logic.

Education: Sherborne School, 1926-1931; wrangler, mathematics tripos, Kings College, Cambridge; PhD, Princeton University, 1938.

Professional Experience: fellow, King's College, 1935-1945; Princeton University, 1936-1938; British Foreign Office, Bletchley Park, 1939-1945; National Physical Laboratory, 1945-1948; University of Manchester, 1948-1954.

Honors and Awards: Smith's Prize, Cambridge University, 1936; Order of the British Empire (OBE), 1946; fellow, Royal Society, 1951.

Alan Turing's interest in science began early and never wavered. Both at his preparatory schools and later at Sherborne, which he entered in 1926, the contrast between his absorbed interest in science and mathematics, and his indifference to Latin and "English subjects," perplexed and distressed his teachers, bent on giving him a well-balanced education. Many of the characteristics that were strongly marked in his later life can already be clearly seen in remembered incidents of this time: his particular delight in problems, large or small, that enabled him to combine theory with the kind of experiments he could carry out with his own hands, with the help of whatever apparatus was at hand; and his strong preference for working everything out from first principles instead of borrowing from others—a habit which gave freshness and independence to his work, but also undoubtedly slowed him down, and later on made him a difficult author to read.

In 1931 he entered King's College, Cambridge, as a mathematical scholar. A second class in Part I of the tripos showed him still determined not to spend time on subjects that did not interest him. In Part II he was a wrangler, with "b*," and he won a Smith's Prize in 1936. He was elected a fellow of King's in 1935 for a dissertation on the central limit theorem of probability (which he discovered anew, in ignorance of recent previous work).

It was in 1935 that he first began to work in mathematical logic, and almost immediately started on the investigation that was to lead to his best known results, on computable numbers and the "Turing machine." The paper attracted attention as soon as it appeared and the resulting correspondence led to his spending the next two years (1936-1938) in Princeton, the second of them as Procter Fellow, working with Professor Alonzo Church.

In 1938 Turing returned to Cambridge; in 1939 the war broke out. For the next six years he was fully occupied with his work at the Government Code and Cypher School, otherwise known as Bletchley Park. His application of logic to code breaking has still not been well documented, though his influence on the development of Colossus is well known. But the loss to his published scientific work of the years between the ages of 27 and 33 was a cruel one. Three remarkable papers written just before the war, on three diverse mathematical subjects, show the quality of the work that might have been produced if he had settled down to work on some big problem at that critical time. For his work at Bletchley Park he was awarded the OBE.

At the end of the war many circumstances combined to turn his attention to the new automatic computing machines. They were in principle realizations of the "universal machine" which he had described in the 1937 paper for the purpose of a logical argument, although their designers did not yet know of Turing's work. Besides this theoretical link, there was a strong attraction in the many-sided nature of the work, ranging from electric circuit design to the entirely new field of organizing mathematical problems for a machine. He decided to decline an offer of a Cambridge University lectureship, and join the group that was being formed at the National Physical Laboratory for the design, construction, and use of a large automatic computing machine. In the three years (1945-1948) that this association lasted, he made the first plan of the ACE,[1] the NPL's automatic computer, and did a great deal of pioneering work in the design of subroutines. The machine was still incomplete when he left.

In 1948 he was appointed to a readership in the University of Manchester, where work was beginning on the construction of a computing machine by F.C. Williams and T. Kilburn. The expectation was that Turing would lead the mathematical side of the work, and for a few years he continued to work, first on the design of the subroutines out of which the larger programs for such a machine are built, and then, as this kind of work became standardized, on more general problems of numerical analysis. From 1950 onward he turned back for a while to mathematics and finally to his biological theory. But he remained in close contact with the Computing Machine Laboratory, whose members found him ready to tackle the mathematical problems that arose in their work, and what is more, to find the answers, by that combination of powerful mathematical analysis and intuitive shortcuts that showed him at heart more of an applied than a pure mathematician.

After the war, feeling in need of violent exercise, he took to long distance running, and found that he was very successful at it. He won the 3-mile and 10-mile championships of his club (the Walton Athletic Club), both in record time, and was placed fifth in the Amateur Athletic Association Marathon race in 1947. He thought it quite natural to put this accomplishment to practical use from time to time, for example, by running some 9 miles from Teddington to a technical conference at the Post Office Research Station in North London, when the public transport proved tedious.

In conversation he had a gift for comical but brilliantly apt analogies, which found its full scope in the discussions on "brains v. machines" of the late 1940s. He delighted in confounding those who, as he thought, too easily assumed that the two things are separated by an impassable gulf, by challenging them to produce an examination paper that could be passed by a man, but not by a machine.

Robin Addie and Maurice Wilkes were students together at Cambridge University in the years before World War II. They were both active in the Cambridge University Wireless Society, and were both keen radio hams. Their later careers took different directions. Addie held a Royal Signals commission in the Territorial Army Volunteer Reserve, and was mobilized soon after the outbreak of the war on, September 3, 1939. He found himself, at the age of 23, in command of the Wireless Section of the 52nd (Lowland) Divisional Signals in France. Later in the war, when attached to the "Y" service, Addie met Alan Turing:

> One of my wartime activities was to be involved in the planning, design, and construction of a large radio receiving station at Hanslope Park a few miles from Bletchley. It was known as a 'Y' station and was intended for the interception of enemy radio signals. The project was aimed at setting a new standard for intercept stations. It was a green field exercise involving a new station building, and much

[1] Automatic Computing Engine.

of the equipment for it had to be specially designed and made. To this end, workshop and laboratory space was provided. The antenna system consisted of numbers of 3-wire rhombics spaced radially round the main building which housed banks of receivers fed from wide band amplifiers to whose inputs selected antennas could be connected. Dedicated land lines fed outgoing signals to Bletchley Park, which was only a few miles away, and to other places. The engineering section, with which I was associated, undertook all constructional and maintenance work in the technical field.

It was in 1944, when the station was operational, that I was asked to provide facilities for Alan Turing so that he might pursue his ideas on speech encryption. Thus I came to know him well and appreciate his intellectual qualifies, which clearly dwarfed those of us who were trying to help him.

His aim was to develop active elements for his computer ideas, largely NOR/AND gates, etc. I gave him room and assistants, and supplied him with chassis, components, power supplies, etc.

My vivid memories are of a man of medium build with a round head of crewcut hair bending over what we used to describe as an "electrified bird's nest" of resistors, capacitors, and odd components insecurely fixed to a prototype chassis. All components were held aloft by little blobs of solder, hence the "nest." At one end was a power supply delivering several hundreds of volts. I would watch fascinated as Turing plunged a hot soldering iron in the midst of this wonderwork. Needless to say, calamities happened; sparks flew, fuses blew, and things got hot, but Turing just pressed on in the sure knowledge of what he wished to achieve. Working on experimental gear with the power on was a common practice in those days, but not everybody was as reckless as Turing.

It had been arranged to find him digs locally, to and from which he rode an ancient bicycle. He seemed impervious to weather and, on more than one occasion, arrived soaked to the skin. On these occasions, he was coaxed into removing his trousers and given a lab coat in which he marched throughout the complex, regardless of his hairy legs and sock suspenders (garters) being on general view. He decided that our impregnating oven was the place to dry his garments, and on one occasion, with his mind on other weightier matters, he caused a minor fire. Clothes were then rationed in the UK, and we had to have a collection of ration coupons to help him buy a new pair of trousers.

In the Mess, he was both lively and amusing, and would engage in all manner of discussions on all kinds of diverse topics. I recall a most interesting tete-à-tete between Turing and Professor Stratton (the astrophysicist), then Colonel Stratton, which went on for a long time, way above my head, as can be imagined.

Turing was indeed a most dedicated man, totally oblivious of the wherewithal required for his own comfort. He took it for granted that all would somehow be provided, and we did provide it as far as we could. The girls at Hanslope took him in hand, calling him "prof," which he seemed to like. He was pleasant to me, and I always kept close touch with the work he did, and showed that I was interested. He always took trouble to explain his thoughts, which I appreciated.

Unfortunately, I did not see the outcome of Turing's experiments, since I was posted to the Far East to help mastermind the communications for Mountbatten in India and beyond. I was particularly distressed at the manner of his death in 1954, and the utter waste of a brilliant mind.

Much has been made of the homosexuality of Alan Turing. The biography by Andrew Hodges was initially intended (according to the publishers) to be a celebration of his sexual preference, but they were able to convince Hodges that there was more to the story than just that aspect of his life. Similarly, the play by Hugh Whitemore makes homosexuality the central theme, and a recent (1992) video play by the British Broadcasting Corporation, entitled "The Strange Life and Death of Dr. Turing," followed the same thread.

In a set of interviews in 1992 with I. Jack Good and Donald Michie,[1] both colleagues of Turing during his Bletchley Park sojourn, I led them to discuss their knowledge of Turing's homosexuality:

Good: …when we walked down King's Parade [in 1947] that was the first time I discovered that he was homosexual. That was when he said that he was going to Paris to "see a boy." It was obvious that he was admitting or proclaiming his homosexuality.

Lee: He was very open about it?

Good: Yes, at that time.

Michie: He certainly wasn't during the war, for some of us, including both of us, were quite unaware.... I took quite seriously his engagement to ...

Good: Joan Clarke?

Michie: At the same time I was thoroughly aware that the whole problem of converse with women was a great burden, and a problem, for him. And I recall his explaining to me once, I didn't think he was homosexual as a result of this conversation, because I [saw him through] the eyes of a rather priggish young person (me) who had just left school and just experimenting with female company-I had grown up to look on women as undereducated relative to men, which to put it that way, was perhaps to some extent in those days was the case. But he put it in a very grotesque way to me and said "you know, the problem is that you have to talk to them," "If you take a girl out, you have to talk to her. And then so often when a woman says something, to me it is as though a frog has suddenly jumped out of her mouth." It was an extremely unpleasant metaphor.

Lee: Peter Hilton [1991] quotes you, Jack, as saying, 'It was fortunate that the authorities did not know during the war that Turing was a homosexual, otherwise the Allies might have lost the war."

Good: Yes

Michie: Oh but that's absolute nonsense, because Bletchley had some flamboyant homosexuals-Peter's ideas that security people were down on homosexuality itself, is absolute nonsense. I can't think how he could write that. The most flamboyant case was Angus Wilson-he later became a very successful novelist, and he had a boyfriend called Beverly, and these two, Angus was about that high [indicating small] with flowing yellow hair (I remember it went white later) and Beverly (I forget his second name) was very

[1] Sponsored in part by the National Science Foundation.

"weed-like," very tall. They could be seen shambling along the horizon, a daily sight, as they took their walk around lawns after lunch.

Good: I never knew that. I know that Angus Wilson ran around the pond in the nude, when he had a nervous breakdown.

Michie: He was also said to have poured ink on his head on another occasion; it was the first sign he was going nuts again. I had not heard about the nude bit.

Good: I assumed they were down on homosexuality.

Michie: I think that's a retrospective coloring actually. Because Henry Reed,[1]' you remember Henry Reed, you knew he was a homosexual didn't You?

Good: No!

Michie: I must have known him better than you. He was always complaining to me about how his current affair was, or was not, prospering.

Good: Well, I was in digs with him, and with David Rees … He never said anything about his affairs.

Michie: I had some links to a more literary set. There was a literary set in Bletchley, and I was fresh from a *wholly* arts education. There were these two cultures—the mathematicians' culture was another-I worked all my time in the mathematicians' culture but I retained, certainly for a year or two, quite a lot of social links to various classics dons and literary people like Henry Reed. And in that group, things like whether Henry Reed was a homosexual-everybody knew. And the same with Angus Wilson.

Good: I had no idea.

In 1952 Turing was convicted by a British court for his involvement in "unnatural acts" and was required to take female hormones in an effort to rid him of his preferences. The physical result was the development of Turing's breasts, and apparently his accompanying depression. This was the time of Turing's life when he was studying the chemical theory of morphogenesis. His "experimental methodology" was what Newman termed his "rules of the game," in which he attempted to solve problems using only the materials immediately at hand or which he could construct in his mind. Turing died by his own hand in 1954 by eating an apple dipped in strychnine. It is unknown whether this was an experiment which had an unfortunate result or whether his death was intentional. Either way, the world lost a mathematical genius at the height of his intellectual power.

QUOTATION

[1] Reed was a poet who had composed a poem entitled "Naming of Parts'--see Lewin, Ronald, 1978, Ultra Goes to War, Hutchinson & Co., Ltd., London, 490 pp.

"It is of course important that some efforts be made to verify the correctness of the assertions that are made about a routine. There are essentially two types of method available, the theoretical and the experimental. In the extreme form of the theoretical method a watertight mathematical proof is provided for the assertion. In the extreme form of the experimental method the routine is tried out on the machine with a variety of initial conditions and is pronounced fit if the assertions hold in each case. Both methods have their weaknesses." *(Manchester Mark I Programming Manual,* 1951)

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UPDATES

[1] This paper defined the concept of the universal machine.

[2] It is in this paper that Turing proposed the test of intelligence which we now know as the "Turing Test."